EFFICIENCY IN PRODUCTION OF BUTTER

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AN INVESTIGATION INTO CERTAIN FACTORS AFFECTING THE ECONOMIC ASPECTS OF TECHNICAL EFFICIENCY OF BUTTER FACTORIES OPERATING IN NEW ZEALAND, WITH SPECIAL REFERENCE TO THE 1949/50 SEASON

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by

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PREFACE.

New Zealand's economy is dependent on dairying as a source of national income to a very marked degree, for more than one-third of the country's total export income is derived from this source. Of the total whole milk produced "at the pail" in the 1952-53 season, over 68 per cent was manufactured into creamery butter, yielding 200,000 tons. A revenue in excess of £52,000,000 was derived from this butter.

A processing industry of this magnitude and importance merits close attention. Although much time and research have been devoted to technical manufacturing problems, very little analytical work has been conducted in New Zealand on the economic aspect of efficiency in dairy processing industry. Although data are available in the form of reports, compiled statistics and articles, they are descriptive in character, or mere compilations. As such they fail in the important task of analysis of the conditions they describe.

It seems strange that in a country like New Zealand where the standard of scientific reasearch is so high and where the dairy industry contributes so much to the national economy, that so little is known of the economic aspects of the dairy industry. Apart from TASKER's two papers* the amount of analytical research is almost nil. The valuable information compiled by the New Zealand Dairy Board is largely descriptive and statistical and does <u>not</u> throw light upon the problems as investigated by research workers in this field overseas.[+]

For example, we in this country, do not know the total costs of refrigeration, or steam production, or power used in factories. Nor do we know how much coal or units of electricity are consumed. From the standardised accounts[•] in current use we can tell the total cost of actual coal or heating agents used, but we do not know the cost of the labour appropriated to steam used, or any of the other capital or administration costs chargeable to refrigeration or steam power.

* TASKER, J.F. (1938): The Cost and Capitalization of North Auckland creameries during 1935-36. <u>The Accountants' J. (August)</u>
— New Zealand Creamery Costs and Pay-outs for the 1937-38 Season. <u>N.Z.Jnl. of Science and Technology, Vol. 26. No.4 (Sec. A), pp. 204-213, 1944</u>.

\+ See Appendix A: "Related Studies".

• See Appendix B:- "Form of Standardized Accounts used in the Butter Industry".

Nor do we know the costs of the various processes in butter production. What is the cost of reception on the stage, the cream processing costs, the cost of packing, storage and disposal? Frankly we just don't know, because our system of standardized accounts does not permit this important analysis. Our standardized system does advise total manufacturing charges, factory overheads, on-board charges and general overheads etc., which, together with cream collection costs disclose the total costs of butter manufactured. But the system fails to disclose the cost of each stage or process in production.

Apart from one company, it is doubtful whether any company can advise process costs without considerable investigation or delay. In most cases the minimum of detail is kept. Sufficient records are maintained to satisfy the requirements of the standardized accounts together with the statistical information required to be shown, also for statutory returns and for monthly reports at directors' meetings. But very few companies are able to advise the annual consumption of coal or units of electricity. It is rare to find a company that can advise the monthly consumption of heating agents. It is true that this information is needed for statutory returns, but many a manager confessed that too much reliance should not be placed on the figure submitted in the return as often it was an estimate or approximation. Less than ten per cent of companies are able to advise annual figures with any degree of confidence as to their accuracy.

Thus in the industry we do not know the tons of coal used per ton of butter made. Nor do we know the units of electricity per ton of butter, or the number of gallons of petrol per ton-mile in cream collection, or the man-hours or labour per ton of butter. In brief, we lack vital information which is basic in measuring the economic aspects of technical efficiency.

This lack of information could be multiplied. We do not know the percentage of cream hauled by operators employed by the factories, by outside contractors; or by road or rail. We do not know the average distance of cream suppliers from the factories. What percentage of cream comes from within a five-mile radius, or a ten-mile radius? What is the cost of hauling cream in terms of distance, weight or time? What is the most efficient size of lorry? Should three-tonners, five-tonners or heavy articulators be used in cream collection? At what point do cream collection costs double or treble or become quite uneconomic? What percentage of suppliers average under 5 lbs. of cream per collection-day or 10 lbs. or 100 lbs. etc.? These are elementary questions when efficiency is to be examined, and it has to be admitted that the answers are not known.

It is partly the purpose of this study to make a pioneering attempt to furnish answers to some of these questions, or to indicate the limitations or boundaries under which such research could be conducted.

While many of these questions are technical in character, they are considered sufficiently important to merit close examination, for technical efficiency underlies economic efficiency as an important determinant.

It should be added that much confidential information was made available on the explicit understanding that the identity of individual companies would not be disclosed. This injunction has been followed out carefully, and in many cases, the pattern of grouping data has been varied slightly to achieve this end.

it should be pointed out that when this research was planned, it was directed that the work should draw upon two disciplines or faculties, viz. Dairy Manufactures and Economics, so that in addition to being an academic appraisal, the thesis should be of value as a reference work on certain technical aspects of interest to the industry.

It has not been easy to achieve these dual aims, for in parts the economic content has had to be preceded by considerable discussion of technical aspects of butter manufacture. To minimise this, certain purely technical aspects have now been relegated to the Appendices. (1958)

ACKNOWLEDGEMENTS

A study of this type is largely the outcome of an inspiration from another source. In this case, the author is particularly indebted to Professor W. RIDDET, Director of Dairy Research Institute and Vice Principal of Massey Agricultural College, without whose suggestions, advice and encouragement, the study would never have been conceived, let alone developed.

In the industry, many provided considerable help, including officers of the New Zealand Dairy Board, and the secretaries and managers of dairy companies who provided such full information. Indebtedness is acknowledged to Mr. C.H. Courtany , of Wellington; and also to Mr. T.K. Fraser of Palmerston North, Mr. J.M. Rose of Kairange Co-operative Dairy Company, Mr. Halligan of Cheltenham Co-Operative Dairy Company, Mr. R.E. Blair of Rangitikei Plains Co-operative Dairy Company , and many others.

Deep gratitude is also expressed to Associate Professor J.O. Shearer of Victoria University College, and to Dr. H. Brian Low of Massey Agricultural College for their scholarly assistance in reading through and commenting on earlier drafts of the work, and to many others who have afforded valuable assistance.

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GENERAL INTRODUCTION.

SECTION I.

PURPOSE:

The purpose of this study is to examine the efficiency of the butter manufacturing industry in New Zealand, and of the individual plants or factories that comprise it.[1]

The study is designed to (1) provide data and analyse manufacturing costs in order to throw light on economic aspects of technical efficiency; (2) examine critically the efficiency of labour, transport, technical functions, management and administration; (3) consider those elements affecting or impairing individual plant or industrial efficiency; (4) present alternatives available to individual managers and industry leaders; and (5), examine cost-size relationships.

The meaning of the term "efficiency": The dictionary meaning of the term is competency or capacity to produce effects or results. In the economic sense the term "efficiency" is narrower, because the object of economics is to maximise the attainment of competing ends from allocable scarce means that are mediated by price. Efficiency is the degree to which this maximization is attained.

Efficiency is a relative concept in that it implies differential ability to maximise the attainment of competing ends from allocable scarce means. Whenever these means are utilised more effectively to maximise ends, the element of efficiency exists.

One common definition of efficiency is the ratio of output to input factors, or expressed more succinctly, "efficiency in the economic sense is the ratio of useful output to useful input".[2]

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[1] The study has special reference to the 1949/50 season, but includes trends up to 1953.

[2] George J. STIGIER (1947): The Theory of Price. The Macmillan Company, New York. p 33.

In this sense, allocable scarce means are the "useful inputs" and maximised achieved ends are the "useful outputs".

In manufacture, the term "efficiency" implies the collaboration or employment of factors of production in such a way, so as to achieve the optimum results with the minimum possible sacrifices. Efficiency describes the ability to obtain the most advantageous yield possible relative to the costs spent in their attainment, and involves choice.

Transferred to the narrower field of dairying manufacture, economic efficiency is the ability to maximise the attainment of the competing ends of revenue or income, quality of produce, stability, growth, and flexibility of manufacturing unit etc. from the allocable scarce means of labour, raw materials, power, and organizing ability when measured in terms of price. Hilding[3] defines economic efficiency in dairy manufacturing as "the ability of the dairy to achieve the highest possible income at the lowest possible sacrifice (costs)".[4]

SECTION II. SCOPE AND METHODS OF THE STUDY:

Butter manufacture[5] includes the collection of cream from suppliers; weighing, grading and recording it on arrival; the first processing stage, (neutralization of acid, pasteurization and cooling of cream); the second processing stage, (churning, salting, and working the product); and packing, storage and disposal.

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[3]Swedish Dairy Economist.

[4]Arne HILDING, (1949): XII. International Dairy Congress, Stockholm: Vol. IV. Sec. 3 & 4. Ivar Haeggstroms, Stockholm; "Methods of Rating the Economics of Dairy Production". p.17.

[5]See Appendix C for brief description of Butter Manufacture.

To analyse manufacture, the various processes[6] may be considered under the broad headings of labour, transport, the technical aspects of butter-making, management and administration. By "labour" is meant all physical and mental effort or exertion directed towards the manufacture of butter from cream reception to despatch of finished product. Labour is measured by Manufacturing Wages in the Standardized Accounts, and covers a functional or purposive activity in manufacturing. "Transport" covers cream haulage from farm-gate to factory and includes labour, technique and administration. "Technical aspects" include the provision of power, light and heat; and the technical skills of butter making and cream testing. "Management" includes the activities of decision-making, co-ordinating and supervision of activities; and is distinguished from "Administration" which covers policy formulation.

In scope, the study will follow the following pattern:

PART I.	Introduction.
PART II.	Efficiency of Labour.
PART III.	Efficiency of Transport.
PART IV.	Efficiency of Management.
PART V.	Efficiency of Administration.
PART VI.	Synthesis.
PART VII.	Appendices.

The broad method of the study is to examine each function separately,[7] distinguishing, measuring, analysing, and comparing the several activities that comprise it. The discussion follows the general pattern: (a)descriptive,

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[6] Processes are distinguished from functions, in that processes refer to each successive step or stage in manufacture, whereas functions refer to a purposive activity or contribution which may, or may not be common to all operations. The main processes are cream collection, cream reception on the stage, preparing cream for churning, making the butter, packing and storage. Labour is a function common to all these processes, as is management, technique and administration. The study is broken up largely into functional aspects, with the exception of transport, which is treated separately being an outside-of-factory activity organised variously. Processes are subdivided into operations, and functions into activities.

[7] Even "Transport" i.e. cream collection may be considered broadly as a function - procuration.

in which data are classified quantitatively; (b) cost aspects, in which the activity is evaluated; and (c) economic considerations.[8]

Certain elements which affect or impair efficiency are indicated in the course of examination of each function. These elements are factors that give rise to special problems in the functions examined. The problems are those of (a) waste, (b) fluctuations, (c) capacity, and (d) maladjustments.

The first five parts of the study deal mainly with endogenous considerations. Part six, which synthesizes earlier analysis, considers those exogenous characteristics of the industry; (a) institutional, (b) environmental, (c) structural and (d) dynamic considerations.

Three regressions are submitted in Parts II and III to bring out certain aspects of efficiency, and size-cost relationships are examined in Part VI, and the possible optimum scale[9] in the butter industry considered.

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[8]To follow this pattern, it has been necessary, at the expense of some repetition in places to refer back to subject matter briefly, in order to safeguard logical completeness of discussion. Purely technical sections are considered in the Appendices.

[9]The terms "scale", "volume", "capacity", and "output" need to be distinguished carefully. "Scale" has reference to those factors such as fixed equipment, buildings, plant, churns, etc., which are relatively fixed in character and cannot be altered in the short-run. "Volume" refers to variable input factors, the supply of which fluctuates through time, but within reasonably calculable limits, e.g. cream. By "output" is meant actual quantity of finished product. "Capacity" refers to possible output, that is, a technological maximum output related to a given time interval and permissible cost limit. Thus a factory of a given scale may have two 100 box churns, but receives just a sufficient volume of cream to make an output of 60 boxes on a given day. If volume increases greatly, the immediate capacity of 200 boxes may be increased by such expedients as overtime etc. Output, volume, and capacity can vary in the short-run, but scale is constant.

SECTION III. LIMITATIONS AND NECESSARY ASSUMPTIONS.

Although each Part indicates certain limitations and assumptions that apply to that portion, the following remarks refer to the study as a whole.

The term "efficiency" relates frequently to technical aspects. Usually the attainment of one specific end is dominating the activity of allocation of scarce means, (the cost of wages, power, management, organization etc.), so that the activity, although relevant for its economic significance, is strictly technical in character. When one specific end is dominating the activity, resources may be used more efficiently in such a way, that they do not detract from other co-ordinated activities. In cream reception, for example, labour and equipment may be organised more efficiently, so that reception costs are reduced without impairing other activities or ends. Although such may be technical efficiency, it has economic relevance in that time and costs saved will be directed to other ends.

It is difficult to distinguish between economic and technical efficiency in those cases in which there is one dominating aim or end with several subordinate ends. It is seldom that several competing ends have equal significance or importance, so that activities always tend to be weighted according to the significance any given end may have at any given time. For example, a manager may strive to maximise quality of his product (premium grade butter). To achieve this dominating end, he must maximise technical efficiency in certain fields such as processing, cleaning etc., but he must also allocate his resources to other competing ends such as maximising revenue, even if they occupy a subordinate place in his mind at the time.

Certain ends may have an intermediate place, and may be distinguished from ultimate ends. For example, reduction of cleaning costs or increasing cleanliness may be aimed at immediately in view of the ultimate end of maximising revenue. These intermediate aims are usually technical in character, especially where they can be achieved in isolation without affecting other ends.

Although technical and economic ends tend to interact, a multiplicity of ends do exist. A given factory must aim at retention of the patronage of its suppliers, and to do this must increase goodwill, and attempt to achieve maximum payout. To maximise revenue, it is necessary to hold costs at the minimum level and at the same time to achieve the highest grade of product in terms of quality. Minimum costs (in order to maximise revenue), may be at the expense of quality (double vacreation and cleanliness) and so reflects economic choice.

In addition to the obvious ends of maximising revenue, increasing goodwill, and gaining recognition for quality of product, are the less obvious ends of building in stability, flexibility, and expansion. Whatever the ends, they can be achieved only by recognising the need to employ each factor to the point where its marginal cost equates its marginal revenue. If a given factor is taken beyond its marginal point to maximise that factor, (e.g. to maximise the percentage of premium butter made), increased average costs will follow, resulting in reduced revenue or payout to suppliers. The problem is clearly one of balancing factors to achieve a final overall optimum.

Now a factory manager is paid according to output, gains promotion partly on quality of his product, and recognition from his directors on revenue-earning capacity. Hence his need of maximising the attainment of given ends. If he aims at quality, (gaining industrial recognition for highest percentage of premium butter), he can achieve this only at the cost of certain labour-intensive activites such as daily processing, double vacreation, cleaning etc. Whatever may be his dominant aim at the moment, total revenue, payout, and the amount earned from premium grade butter continue to persist as criteria of achievement in butter manufacture.

Technical efficiency tends to be measured by physical standards, while economic efficiency can only be measured by monetary standards. Physical input-output ratios are suitable for the former, and unit operating costs for the latter. Although physical input-output ratios are unencumbered by related factor price fluctuations, they are less suitable to measure economic efficiency because not all factors can be measured in physical terms, and those that can, tend to lack homogeneity. Labour for example, is heterogeneous, and each unit varies considerably.[10]

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[10]See Section 5 of Part II. (p. 52.) for more ample treatment.

But all factors can be measured in terms of price, and although not a simple test of efficiency, when interpreted properly, throw light on it, because choice is mediated by price (costs) in the final analysis.

Units of electricity, for example, are homogeneous, but vary in factor prices considerably. Coal may be measured readily in physical terms, but is heterogeneous and varies from place to place in factor price.

Consequently, considerable care must be exercised in comparing input-output ratios as a measure of technical efficiency, or unit costs as a measure of economic efficiency. Because one factory has lower unit costs, it must not be assumed that this factory is more efficient technically than another with higher unit costs.[11] Physical input-output ratios are very reliable for the interpretation of technical efficiency, but seldom for economic efficiency.

In assessing economic efficiency, as far as each individual factory goes, the problem lies in equating marginal cost to marginal revenue for each distinct function or process. Where any function is taken beyond its marginal point, (that point where an additional increment of the variable factor is just worth while), a cost diseconomy will result.

Factor substitution needs to be practised until aggregate costs are at a minimum. But any factory has a relatively constant supply of raw material, and the only factor that can be maximised in non-monetary terms is the grade of product. Total revenue is derived from total output and

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11 Lower unit costs are largely a function of scale and location, and may not reflect efficiency. Where two factories are similar in scale, location and output, it becomes possible to compare their efficiency. But to interpret the unit costs disclosed in the standardized accounts as measures of technical efficiency is to disregard the fact that unit costs often hide physical input-output ratios. A factory may have high technical efficiency but low economic efficiency; but high technical efficiency is significant as it aids economic efficiency. To illustrate: two homogeneous factories had similar unit costs for power, but one factory was making seven tons of butter per ton of coal, while the other was making only four tons of butter per ton of coal. The former factory was clearly more technically efficient, but heavy transport costs increased the price of coal so that unit costs were identical.

varies only according to quality of product (grade), diminished by aggregate cost of production. The economic problem for the individual factory then resolves itself into maximising the quality of finished product while minimising aggregate costs, and substituting factors[12a] until the gain from the increased quality is just balanced by the increased cost in achieving this; or conversely, by reducing costs until the saving just equates the loss resulting from diminished quality.

Assuming each factory will endeavour to minimise aggregate costs while maximising quality, any regression of factory costs to output will reveal deviations from the regressional line as probable indices of efficiency, provided allowance is made for exogenous causes of deviation such as location, number of suppliers, climate, etc. The extent of the deviations that appear when each function is plotted against output, suggest lack of balance in the ratio of relative unit costs of the function examined. Such functional regressions will also indicate the scale point at which unit costs will be minimised, for that function.

While marginal costs of a given function can be assessed, marginal revenue of that function cannot, as revenue is a function of output and quality. Obviously no point would be gained in making (say) labour costs per ton of butter as low as possible if it is accomplished only be increasing other costs in excess of the labour costs saved. If functional costs are reduced in isolation, that is, independent of other costs being affected, there is a technical gain. But it is seldom that costs can be so reduced, at least, to any extent.[12b]

12a Factor substitution occurs with each change in scale, and is most marked in the substitution of machinery for labour. Substitution tends to increase economic gain, which may be assessed by aggregating and comparing relative cost functions such as labour and power costs.

12b It is a matter to be investigated in each factory, in its actual situation, whether cost reduction in one line can be achieved either with no increase of other costs or with a lesser increase of other costs. This is the area of decision which belongs uniquely to the manager.

SECTION IV. SOURCE OF DATA.

Collection of Data: Data were collected partly from primary and partly from secondary sources.

1. Primary Data: A series of five detailed preliminary schedules were drawn up before the investigation commenced. The schedules covered the main functions of butter manufacture, viz., cream collection, factory employees, technical aspects, plant and equipment, and administration. They included 24 analytical tables and more than 300 questions.

The preliminary survey, however, indicated that it would not be possible to cover every company in such detail. This was partly due to the time taken to complete the schedules, partly because officials were unwilling to commit themselves to the amount of work involved, and partly because many companies did not have the detailed data required by the schedules.[13]

A number of companies were prepared to fill in all the details, so that full information was obtained in a number of cases.

In addition to the detailed schedules, a briefer schedule was drawn up covering the main essentials of the investigation. This schedule was completed by every company visited. In most cases the brief schedules were completed twice to ensure accuracy.

A. - The data obtained by personal interview included:-[14]

(1) Case histories of personnel who had left, or were about to leave the dairying industry.

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[13] About one-half of the information required on these detailed schedules could be filled in by personal observation of the enumerator. Accordingly, wherever possible, this information was completed by direct personal observation, supplemented by information given by company officials.

[14] In addition to the above, any information was noted down, whenever such was made available. All suggestions by managers, foremen, employees, secretaries were noted, and all complaints. Details of social interests of employees were taken, marital status, and condition of housing etc. Information was also obtained as to realty, investments, insurance covers, objects of reserves, methods of finance, details as to mortgages, loans, overdrafts, legal encumbrances, advances to suppliers etc.

(2) Details of cream collection facilities and methods; e.g. types of trucks, wages of lorry-drivers; length of cream routes, details of suppliers' weights and gradings of cream; details of the costs of cream collection and lorry operating ; analysis of annual haulage expenditure and details of cream haulage contracts.

(3) Weekly time-analysis sheets of employees showing amount of time devoted to various functions and processes.

(4) Details of organization of employees, labour incentives, housing facilities, labour turnover, number of Maoris engaged, length of service, sex, percentage of youths, accidents and service information.

(5) Technical methods employed in butter manufacture.

Wherever possible data from local authorities etc. were obtained - such as power consumption from power boards.

B. - The data obtained by direct personal observation covered details of:

(1) Machinery, plant, buildings, (and their floor-space allocations).

(2) Environment - location, proximity to populated areas, access roads, lawns and gardens, and recreational facilities.

(3) Office facilities and equipment.

(4) Auxiliary equipment and other activities.

C. - Special time-motion studies covered:

(1) Selected collection areas and routes; and time-consumption of cream haulage.

(2) Cream reception at the factory.

(3) Butter packing.

(4) Carton making.

D. - The data obtained by forms, schedules, and questionnaires sent through and returned by post included:

(1) Capacity, size and depreciation rates of plant and equipment.

(2) Distance of individual suppliers from factory and annual butterfat supplied by each.

(3) Dissection of office salaries, description of office equipment with values, insurance rates of depreciation, analysis of office expenses.

E. - Data obtained by schedules distributed to Companies and collected personally included:

(1) A brief, general schedule which gave the main essentials of the investigation.

(2) Time-analysis sheets (used for analysing time engaged on various activities).

(3) Monthly details of cream weights, and gradings, monthly details of wages, cartage expenses, details of staffing changes, and materials used in manufacture.

(4) Monthly production figures and consumption of coal and electricity, and man-hours including overtime.

2. Secondary data: Each company supplied a copy of its annual accounts and balance sheet. Many companies made available, in addition, detailed reports prepared for directors or shareholders.

The New Zealand Dairy Board made available all the primary data it had collected as well as all published data. Government departments, municipalities, and trade associations and undertakings allied with or auxiliary to the butter industry readily offered what information they had. Certain research agencies lent complete files on all similar research work; one body gave its complete files on transport rates in a certain province, while a number of companies gave statistical results of their findings.

3. Editing of Data: Primary material was scrutinized at an early stage to detect errors, omissions and inconsistencies. Where possible, schedules were returned for correction. Unsatisfactory data were rejected. Wherever possible the data were checked by reference to other sources. The number of employees and labour turnover data, for example, were checked from three distint sources.

Secondary data were examined minutely. Questions were asked about balance sheets and accounts. Differing interpretations of the standardized accounts were noted and in many cases secondary data were checked from primary observations and corrections made.

4. Tabulation of data: Not all data could be used. Some had to be rejected and others amended by estimates obtained from reliable sources. The condition of the records obtained from the companies was very good, as the standardized accounts necessitated uniform methods of accountancy. There were, however, many different procedures for allocating costs between main products and by-products, and many different methods of determining depreciation. These were noted. The pro-rating of expenses between subsidiary activities and the main activity of butter production was treated differently, especially indirect expenditure.

As the reliability of prorating of expenditure could be only as accurate as the subjective methods used by company officials, no degree of exactitude was possible, and such data is subject therefore to a margin of error.

SECTION V. STRUCTURE AND ACTIVITIES OF THE BUTTER INDUSTRY.

In this study it is not intended to give a historical survey of the industry. This has already been done by a number of writers among whom PHILPOTT, H.G. ranks high.[15] Nor is it intended to analyse the location of the industry.[16] The Annual Report of the New Zealand Dairy Board analyses factory revenue and disbursements for creamery butter according to production districts, while Hamilton[17] shows the actual disposition of both butter and cheese factories in the North Island. With a few minor exceptions the position is essentially the same today (1950).

Structure of the Industry: The number of co-operative companies manufacturing creamery butter for the period under survey was ninety-six. These companies all manufactured butter as a main and/or dual product. In addition to these there were twenty-four companies manufacturing butter[18] as a supplementary or as a by-product. Of these, eleven were winter-separation companies that made cheese in the flush of the season and a small quantity of butter in winter months, another eleven companies manufactured butter as a by-product, and two were classified as "experimental" department of companies or institutions. As these twenty four companies produced only 0.8 per cent. of the total butter manufactured in factories they have not been taken into consideration in this survey.

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[15] PHILPOTT, H.G. (1937): "A History of the New Zealand Dairy Industry" Govt. Printer, Wellington. Much historical matter is contained in the Annual Reports of the N.Z. Dairy Board and also in the appropriate sections of the N.Z. Official Year Books.

[16] That is, in a descriptive sense. Location is a very important aspect of efficiency and will be analysed in terms of cost and efficiency in relevant sections.

[17] HAMILTON, W.M. (1944): "The Dairy Industry in New Zealand", Council Sc. & I.R. Bull 89, Fig. 12, p.71.

[18] Butter is defined as "creamery butter" in each case, and necessarily excludes whey butter and farm butter, but includes unsalted butter manufactured in bulk in factories.

It is important to know the relationship of butter production to whole milk production and butterfat production "at the pail". The percentage of whole milk utilised in manufacture of dairy products for the season under review was 88.4 per cent, while the percentage of whole milk utilised in creamery butter making was 63.9 per cent.

Of the ninety-six companies[19] seventy-five operate with one factory only, and three with two factories. Ten companies operate dual plants (butter and cheese or butter and casein etc.).

The remaining eight companies can best be described as companies with heterogeneous branches. Of these, four companies manufactured casein and various milk powders; two manufactured casein only, (in addition to butter) one cheese and casein, and one manufactured casein, a large range of milk powders, and condensed milk as well as other dairy products.

In the survey it is necessary to refer to companies or factories. When the administrative side of efficiency is under consideration the reference is to companies, but where technical or managerial efficiency is in question the reference is to factories.[20] Accordingly the number of factories in the survey can be classified as follows:

19
By the term "company" is meant "co-operative company" as defined in Section 48. of Part III. of the Dairy Industry Act, 1908. The term is used in this sense.

20

A factory may be described as any single manufacturing unit in which milk and/or cream is received and processed into one or more finished dairy products, of which one is butter.

Number of Factories in Survey: 114

Factories making butter only		89
Dual factories: Butter and cheese	5	
Butter and casein	1	
Butter and market milk	1	7
Factories making butter only, but with auxiliary or complementary branches making: Cheese	4	
Casein	4	
Cheese and casein	1	
Milk powders	6	15
Factories manufacturing casein and milk powders with butter as a complementary branch:		3
Total Number of Factories -		114

The number of factories has tended to decline over the past 45 years. In 1904, 217 factories were operating,[21] so that the numbers of factories has declined by almost one-half, whereas the output has increased over seven times. This change has been due to amalgamation of small companies, zoning regulations and cessations. "Motor transport played an important part in rendering possible the amalgamation of small factories, though it is doubtful whether this development would have occurred but for the economies obtained by large-scale operation and reflected in higher pay-outs per pounds of butterfat."[22] Small factories still exist in isolated areas where dairying is largely carried on as a sideline, and in less-intensive dairying regions, and also in North Taranaki, where the process of amalgamation has been relatively slow.

All the factories surveyed are co-operatively owned. Whether each company is functioning as a truly co-operative dairy company is open to considerable doubts. The Committee on Co-Operative Dairy Company Legislation advised[23] that they were definitely of the opinion that the functions of dairy companies should be the processing of the members' raw material (milk, cream or butterfat) into saleable products and the return of the net proceeds of such operations to their members in proportion to the supply of raw material.

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21 HAMILTON, op. cit., p.69

22 HAMILTON, ibid. pp. 69-70

23 Report of Committee on Co-operative Dairy Company Legislation (1949): Govt. Printer, Wellington.

It was clear to this committee that on account of the large percentage of dry shareholders that existed in various companies, that true co-operation did not exist. This was remedied largely by the Co-Operative Dairy Companies' Act, 1949, which established the following points: -

(a) the right of the shareholders to surrender shares that had been dry for five years to the Company, and the right of the Company to resume shares that have been dry for twelve months - both at values mutually agreed upon or as fixed by the special tribunal to be set up for this purpose,

(b) the right of supplying shareholders to retain control of the company and to change its policy by a 75% majority vote, if so required, to meet changing times,

(c) the right of the company to purge its share register of untraceable shares by forfeiture of the same.

Moreover, all companies that have been registered under Part III. of the Dairy Industry Act, 1908, are deemed to be registered under the new Act, and must within two years of enactment (that is, before 20th October, 1951) adopt the model articles set out in the Act or cease to be registered co-operative dairy companies as defined by the Act.

Legally this defines the meaning of the term "co-operative" so that butter can be said to be manufactured in New Zealand under co-operative conditions. But it is open to question whether the industry is truly co-operative. This will be examined later in detail, but it may be stated here, that on account of additional activities, subsidiary undertakings and increase in scale, many companies which are co-operative in name are not so in practice.

Activities: A considerable range of complementary and subsidiary products are manufactured by the 114 factories. These products may be listed as follows:-

(1) Cheese (manufactured in conjunction with butter in dual plants).

(2) Whey butter manufactured

(a) as a by-product in dual plants
(b) from whey cream received from cheese factories.

(3) Buttermilk powder.

(4) Skim milk powder.

(5) Whole milk powders (includes reduced milk and cream).

(6) Casein.

(7) Ice-cream.

(8) Butter-milk.

(9) Cream.

(10) Whole milk (a) bottled
(b) bulk.

In addition to these auxiliary products most companies engaged in a range of activities which include:-

(a) general haulage (apart from purely cream, milk or factory stores haulage),

(b) retail store-keeping,

(c) engineering, which includes general blacksmithing work, garage work, plumbing, machinery repair work, electrical installations and repairs, and well-boring,

(d) farming activities - pig farming to utilize butter-milk and whey, dairy farming and farm contract work such as manure distribution,

(e) professional services - general insurance agency work, accounting and taxation service, arranging loans, advances and securities; veterinary services and herd testing.

Both the auxiliary products and services provide considerable revenue to the companies concerned. Over 60,000 tons of auxiliary products[24] were manufactured apart from liquid sales. In addition to this over £50,000 was earned from commissions, dividends, interest and rents. The total sales from the thirty-six largest store departments[25] amounted to a little over £2,659,000 for the season. These activities and auxiliary products have become such an important factor in the analysis of efficiency that separate treatment has been accorded them.[26]

Apart from earning revenue, these additional activities play an important role in the structure, organisation and scale of the butter

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[24]Viz. Nos. (3) to (7) listed above.

[25]Sales include general farming supplies, fertilizers, lime, manures as well as general stores.

[26]Auxiliary products and services are examined and analysed in Part V.

industry. Their development and growth have been the outcome of several factors. In the first place, they serve to attract and retain the patronage of suppliers. In the second place they afford real service not only to actual suppliers, but also to the farming community. In the third place apart from the profit motive, they serve to utilise capital, plant, equipment and labour more fully. In this way unit costs in manufacturing can be minimised by utilising economic capacity to the full. Lastly, they are allowed to absorb a portion of the manufacturing costs of butter and thereby present a more favourable payout for competitive purposes.

Output: The following table classifies all factories according to output of butter and number of suppliers.

TABLE I. CLASSIFICATION OF 114 BUTTER FACTORIES ACCORDING TO ANNUAL OUTPUT OF BUTTER IN POUNDS AND NUMBER OF SUPPLIERS. (1949/50 Season)

Size of Factory (Output of butter) lbs (1)	No. of Factories (2)	Percentage of total output (3)	Total No. of Suppliers (4)	Average No. of Suppliers per Factory (5)
Under 1,000,000	30	5	5443	181
1,000,001 - 2,000,000	26	11	7254	279
2,000,001 - 4,000,000	24	18	11597	483
4,000,001 - 6,000,000	16	20	5845	366
6,000,001 - 8,000,000	8	15	)	)
8,000,001 -10,000,000	4	10	) 14158	) 786
10,000,001 -12,000,000	2	6	)	)
Over 12,000,000	4	15	)	)
	114	100	44297	389

It is apparent from the above table that the majority of factories are relatively small, and that the average number of suppliers increases with scale of factory. The factories in the first two class-intervals are largely devoted to butter production and do not engage in auxiliary products or activities to any extent. The factories in the next two class-intervals engage in some auxiliary services, but very little, apart from some butter-milk powder is manufactured in addition to butter. In the last four class-intervals we have factories that engage in auxiliaries extensively. Here the scale of factory is relatively large and the scope of activities is considerable. Thus it has become necessary to consider this latter group as distinct from the former group in analysis and for comparisons. Their administrative set-up, their techniques, plant and equipment, and internal organisation all necessitate separate treatment. Briefly, all factories are not homogenous, and even within these two broad groups there is some heterogenity.

Further, the first broad group (consisting of the first four class-intervals) includes 85% of the factories but produces only 54% of the total output. Approximately 70% of total suppliers are found in this group which indicates that not only do the smaller factories have fewer suppliers, but the aggregate individual supply is smaller also.

Other descriptive details will be given in other sections of the general study.[27]

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[27] Structure, finance and organisation will be included in other sections, although descriptive in character. The administration of the industry, which is of considerable importance, as well as legal aspects, will be dealt with only insofar as they affect economic argument.

PART II.

LABOUR EFFICIENCY

SECTION I. INTRODUCTION.

In this part of the work, it is intended to survey briefly labour efficiency in the manufacture of butter. The employment of labour, its monetary cost and its economic efficiency will be analysed and examined in turn.

By economic efficiency of labour is meant the capacity to utilise labour effectively in terms of output or revenue. As labour costs are a part of aggregate costs, the problem becomes one of factor substitution, substituting a little more or less labour for other factors to minimise total outlay while maximising total revenue for a given butterfat intake.[1]

If costs other than labour are held constant or assumed constant, then the problem tends to become a technical one of minimum outlay on labour in relation to maximum revenue, in which effective utilization of labour is indicated by the ratio of labour inputs to butter output of given quality. Assuming a relatively constant pattern in the composition of labour in any given factory,[2] inputs of labour may be measured in terms of "hours of labour" against output of butter to yield a basis of comparing technical efficiency.

Thus if Factory A. can manufacture a given quantity of butter (other inputs constant), by utilising 100 units of labour, whereas Factory B. can manufacture the same quantity (other factor inputs identical), by utilising 95 units of labour, it is evident that the latter factory is more effectively utilising its labour and has the greater labour efficiency (technical) of the two factories.

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[1]As scale increases, machinery (capital outlay), tends to be substituted for labour.

[2]By constant pattern or composition is meant that in any given factory the relative grades of skill, as a percentage of the total labour force, is fairly constant. This is especially true with increased scale.

However, other inputs do not remain constant. In order to maximise revenue, labour tends to be substituted for other factors, so that the problem becomes an economic one in which choice determines the balancing of various factors to minimise total costs and maximise revenue. Labour costs are balanced against mechanization costs; interest on capital outlay in plant, buildings and machines is offset against wages bill; units of electricity and tons of coal are increased, while aggregate hours worked are decreased; greater organization and managerial concentration results in less labour effort; and more expenditure on accommodation and fringe benefits reduces labour turnover and its costs. Conversely, more labour may be used in cleaning and vacreation to increase quality or grade of the product.

Insofar as any operation can be simplified or performed with less labour content in isolation and without affecting any other function or factor input, the problem is technical. As soon as other factors are substituted or affected, the problem is economic.

Part II attempts to analyse the efficiency of labour and to indicate the extent to which labour content changes as plants increase in scale.

Definitions: Factories: Factories denote those plants producing creamery butter.[3] Dual plants (factories where butter and cheese, or butter and casein etc.) are included.

Employees: Employees denote those engaged in the manufacture of butter and includes managers, female employees and youths. The term employees, however, excludes lorry drivers, clerical workers, workers in casein plants and buttermilk drying plants, and all other supplementary or complementary activities of the factory concerned.

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[3] See p. 13. Part I (footnote) for fuller definition.

The test which determines whether an employee is engaged in butter manufacturing or not, is whether the wages or salary of the employee is properly chargeable to Manufacturing Wages[4] or not.

The number of employees per factory was taken as that standard figure described as the normal complement or establishment of the factory during the flush of the season. While an employee at the height of the season may be engaged entirely in manufacturing work, later, during the off-season he may be engaged in repairs and maintenance or other duties not strictly chargeable to butter manufacture. Nevertheless, he is considered an employee for statistical purposes, even if part of his earnings be charged elsewhere.

Replacements: The number of new employees or accessions engaged during the 1949/50 season who worked for a period longer than one week.[5]

Labour Turnover:[6] $\frac{\text{Total Replacements}}{\text{Total Employees}} \times \frac{100}{1}$

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[4]Manufacturing Wages (of butter), have been defined as "Wages, which shall include all emoluments connected with the manufacturing, packing and despatching of the produce... other than those applicable to cream collection, repairs or administration...". The Dairy Industry Accounts Regulations (1950-1) p. 8, para. 12.

[5]It is important to recognise that a given labour turnover of 100 per cent per annum may have arisen from every employee being replaced during the period under survey, or from 10 per cent of the dissatisfied workers being computed as the same number of separations or accessions due to their being "turned over" ten times in the period. A large number of casuals "float" into and out of the industry, and, in order to remove this inflating factor, an employee for the purpose of replacement and turnover statistics has been reckoned as one who worked for a period longer than one week.

[6]If labour turnover is to be used precisely, figures are required showing what percentage of the working force remained on the job for the season, as well as a ratio of accessions or replacements. (See p. 28.)

Source of Data: Enumeration of employees, wages, overtime, houses and accommodation, number of Maoris engaged, length of service, sex, percentage of youths, accidents, age etc., were obtained from:

(a) data and statistics made available by the Department of Labour and Employment,

(b) primary data collected by the N.Z. Dairy Board, being details of length of service, ages and salaries of all dairy factory employees as at 15th October, 1950,

(c) questionnaires sent through and returned by post,

(d) schedules distributed and collected personally,

(e) data obtained by direct personal questioning,

(f) and by personal interview by enumerator who filled in schedule from answers supplied by company officials.

Time analysis sheets, which were filled in by company officials, analysed labour functionally, showing the dissection of time devoted by employees to various functions and processes. This information was supplemented by similar time sheets filled by individual employees themselves. Time-motion studies of the various labour-intensive operations[7] were made by direct observation. Wherever possible, these studies were repeated under identical conditions to ensure accuracy.

Limitations and necessary assumptions:

In examining labour efficiency, one serious limitation is the lack of true homogeneity of the various factors examined.[8] Although every attempt has been made to define concepts employed, it is seldom found that one unit is a perfect substitute for another unit. Thus a factory employing a staff of five who manufacture under a million pounds of butter, collecting cream from 150 widely dispersed suppliers for seven months of the year in an isolated area with relatively inferior equipment, can scarcely be compared to a well equipped factory with a staff of thirty-five who manufacture over 14 million pounds of butter, collecting cream from 600 compactly situated suppliers for ten months of the year in a district favoured by transport facilities. It is true, that by definition, both manufacture creamery butter exclusively, but this may be the only point of similarity.

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[7] i.e. those operations or processes whose costs entail a relatively high proportion of labour as distinct from (say) capital costs.

[8] See p. 23. for more ample treatment of labour homogeneity.

The effect of size or scale on labour costs (or any costs) can be determined[9] by a comparison of establishments only when scale is the sole differentiating factor. That is, all other factors are homogeneous - employees, administration, district, suppliers, monthly outputs, equipment etc. are similar or substitutable. In the same way, the consideration of any given variable on labour costs is valid only when all other factors are constant. This heterogeneity of factors has been minimised by two methods, (a) by using broad classifications whereby all establishments or factors that are essentially similar are grouped together in broad classes for comparison and analysis, and (b) by using multiple regressional analysis.

Factor heterogeneity is marked in the concept "employee". The composition of employees in each factory is seldom identical. The term "employee" has had to be considered as a homogeneous one for statistical manipulation. Thus all types of worker had to be included in the term "employee", for no difference could be made between a factory manager and a female carton-maker. Each received equal weight. Even if employees were classified narrowly, it would be difficult to escape the danger of heterogeneity. For example, there is a vast difference between the efficiency of a "general hand" of three weeks' experience and another with 30 years' service to his credit, although both receive identical pay and thus reflect identical total costs for labour.

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[9] Subject to the possible presence of under-weighted or unknown component factors.

SECTION II. THE EMPLOYMENT OF LABOUR

The extent to which labour is employed:

The following table sets out the number of employees engaged in ninety-one factories manufacturing butter on the 15th October, 1950, and represents about 88 per cent of the total output of New Zealand creamery butter.

TABLE II. EMPLOYEES OF NINETY-ONE FACTORIES CLASSIFIED ACCORDING TO AGE-GROUPS AND COMPARED WITH TOTAL DAIRY FACTORY EMPLOYEES AND NEW ZEALAND WORKING MALES*

Age Group (1)	Total (2)	Percentages: % of Total (3)	Percentages: D.F. (4)	Percentages: N.Z. Males (5)	Cumulative Percentages: Butter (6)	Cumulative Percentages: D.F. (7)	Cumulative Percentages: N.Z. Males (8)
15-19	123	10.8	10.3	11.0	10.8	10.3	11.0
20-24	209	18.3	19.2	12.1	29.1	29.5	23.1
25-29	162	14.2	15.4	11.9	43.3	44.9	35.0
30-34	132	11.6	11.8	11.1	54.9	56.7	46.1
35-39	164	14.4	13.1	11.7	69.3	69.8	57.8
40-44	118	10.4	11.3	10.7	79.7	81.1	68.5
45-49	104	9.0	7.3	9.6	88.7	88.4	78.1
50-54	76	6.7	5.5	7.9	95.4	93.9	86.0
55-59	33	3.0	3.2	7.0	98.4	97.1	93.0
60 & over	18	1.6	2.9	7.0	100.0	100.0	100.0

*Columns (2), (3) and (6) refer to "employees" of butter factories as defined on P. 20. Columns (4) and (7) refer to all other Dairy Factory employees engaged in all duties whatsoever (i.e. minus the employees of Col. (2).) Columns (5) and (8) refer to all males in New Zealand. Columns (4) and (7) were extracted from the results of the survey made by the New Zealand Dairy Board of all dairy factory employees as at 15th October 1950 (Table II). Columns (5) and (8) were drawn from 1951/52 New Zealand Official Year Book, p.44 and refer to period slightly prior to that of the other data. The 7.0 % of Col. (5) for age-group 60 and over is strictly referable to the 60-64 age group for comparative purposes.

Some 1139 employees were analysed and represented nearly 88 per cent of the total engaged in butter output. They were drawn from all types of factories differing in location and output. Although a few factories appeared to employ mostly middle-aged workers, and conversely a few had young workers, the pattern of age groups did not seem to be influenced by the size of factory or its location. The range of ages was considerable in most factories, and usually reflected the pattern of the above table. In 12% of the factories the age-range covered 20 years, in 26% it covered a range of 30 years, in 52% of the factories there was an age-range of up to 40 years, and in the remaining 10% there was a range of more than 40 years. These age-ranges are noted because they vary from other age-ranges in the butter industry. Lorry drivers on cream haulage are usually between 23 to 40 years, boilermen about 35 to 55, and milk-powder hands from 17 to 27 years of age.

A comparison of columns (3), (4) and (5) yields some interesting points. In the first place, all three columns show the same trend of rise and fall. In column (5) it will be observed that there is a falling off in the percentage of the 30-34 age-group. This is more marked in columns (3) and (4) and probably reflects the high incidence of wastage in the 22-28 age group arising from World War II. and/or temporary changes in birth rate. But in addition, there are more men between 35-39 in butter than the rest of the dairy industry probably because there are fewer avenues for promotion in the rest of the dairy industry than in butter manufacture.

In the second place, it is to be noted that 18.6% of butter employees are between 45-60 compared with the 16.0% of the balance of the industry. This is probably due to higher salaries paid to foremen and first assistants in butter production. Oddly enough the over-60 group in Col. (4) is largely made up of general hands and not of managers.

In the third place, it must be evident that there is falling off in the numbers available in the higher age-groups. Whereas about four-fifths of men working in the dairy industry have not attained the age of 45, a little more than two-thirds of the men employed in the industry should fall within this age, had the industry followed the pattern of the New Zealand male employment. Obviously, it could hardly be expected that the disparity of 12 % could be entirely removed, but it does perhaps indicate that too many experienced employees of the industry are ceasing to function because of normal wastage and separation - suggesting that the rigour and working conditions of the dairy industry possibly require review.

Analysis of the personnel of the butter industry: The following table classifies the Managers, First Assistants, Second Assistants, Skilled and Unskilled employees of 91 butter factories according to age-groups.

TABLE III. PERSONNEL ENGAGED IN BUTTER MANUFACTURED IN 91 FACTORIES.

Age Group	Managers	1/A's	2/A's	Skilled	Unskilled	Total
15-19	-	-	-	2	121	123
20-24	-	7	9	25	158	199
25-29	-	8	19	46	89	162
30-34	3	15	8	61	45	132
35-39	17	28	14	58	47	164
40-44	18	10	18	36	36	118
45-49	28	12	9	29	26	104
50-54	16	10	6	27	27	86
55-59	4	1	5	13	10	33
60 & over	5	-	1	6	6	18
	91	91	89	303	565	1139

The "Skilled" group in this classification includes cream graders, testers, firemen, engineers, vacreator attendants and other who have some degree of skill, and to whom certificates are awarded for specific attainment in relevant fields. The "unskilled" have no special qualifications, and their duties include assisting with cream reception, packing butter, cleaning and general duties.

The first three groups represent employees who are experienced, and can be considered key personnel in the butter industry - for second assistants usually are butter-makers capable of responsibility, from whose ranks first assistants and later, managers are drawn. It is to be noted that roughly one-quarter fall into the key personnel group, one-quarter into the skilled group and one-half into the unskilled.

The New Zealand Dairy Factory Employees' Award indicates clearly the minimum number of each group to be employed in each size of factory. In terms of the award, the factories under review could have employed as many as 765 general (unskilled) hands, that is about two-thirds of the total employees may be in this category. It indicates that generally there is a preparedness to encourage certified workers in the industry.

It will be observed that more than one-quarter of the employees are unskilled and under the age of 25. Of the 121 unskilled under the age of 20, many are youths who have no intention of staying in the industry and who will work for a portion of the season only.

The symmetry of the distribution of Managers and First Assistants is apparent, more so than that of the Second Assistants and Skilled groups. The mean age of all Managers is 46, and that of First Assistants is 38. The bi-model character of the distribution of the Second Assistants is probably due to wastage and separations and possibly indicates that many employees in this group leave the industry partly owing to the slowness with which openings occur for promotion.

An examination of length of service of the various groups bears this out. The following table classifies the Managers, First Assistants, Second Assistants, Skilled and Unskilled employees of ninety-one factories according to length of service in their present jobs.

TABLE IV. PERSONNEL OF 91 BUTTER FACTORIES CLASSIFIED ACCORDING TO LENGTH OF SERVICE IN PRESENT POSITION

Length of Service	Managers	1A/'s	2A/'s	Skilled	Unskilled	Total
Under 1 month	-	2	3	11	62	78
1 & under 3 mths.	1	2	3	5	64	75
3 " " 6 mths.	1	2	3	11	53	70
6 " " 9 mths.	-	1	1	-	10	12
9 " " 12 mths.	-	-	1	-	-	1
1 " " 2 years	3	6	9	22	109	149
2 " " 3 years	4	4	8	31	96	143
3 " " 4 years	3	6	9	42	50	110
4 " " 5 years	6	7	7	24	43	87
5 " " 6 years	4	11	2	12	37	66
6 " " 10 years	10	18	12	52	26	118
10 " " 15 years	16	11	13	32	5	77
15 " " 20 years	17	5	6	19	6	53
20 " " 25 years	10	6	7	18	1	42
25 " " 30 years	8	7	3	17	2	37
30 " " 35 years	6	2	1	5	1	15
35 " " 40 years	1	1	1	1	-	4
Over 40 years	1	-	-	1	-	2
	91	91	89	303	565	1139

The above table affords sufficient data for the calculation of one aspect of labour turnover.

There are two measures of turnover:-[10]

(a) The ratio of total replacements to total employees.
(b) The percentage of employees that remain on the job for the season.

The former measure is utilised in Section V. of this study to determine objective causation of turnover. The second measure is used in what follows to calculate replacement rates in the butter industry.

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[10] See footnote 6. on page 21.

Turnover figures based on the second measure (b) are usually less than (a) as it is possible for multiple replacements to occur for any given position.

The following table classifies 91 factories as regards turnover, median ages and median length of service in years.

TABLE V. PERSONNEL OF 91 FACTORIES CLASSIFIED ACCORDING TO LABOUR TURNOVER, MEDIAN AGE AND LENGTH OF SERVICE IN PRESENT POSITION.

Positions	Turnover per cent[11]	Median Age (years)	Median length of service (years)
Managers	2.2	46	14
First Assistants	7.7	38	7
Second Assistants	12.3	38	8
Skilled workers	9.0	35	5
Unskilled workers	33.4	24	2

The turnover for all groups is 20.8%. That for Managers appears extremely low and may be biassed owing to the small statistical sample. It will be observed from the Table IV. on P.28 that 22 Managers have held positions for 5 years and under, indicating a turnover of 4.4 for 91 Managers based on a 5-year average. This latter figure is probably nearer the mark.[12]

If 60 years of age can be assumed to be the average age of retirement for managers, then, from the median[13] age of 46 it can be assessed that the average manager will have 14 years of service left should normal wastage not occur.

[11] Calculated from the formula: $\dfrac{\text{No. of employees with less than one year's service}}{\text{Total employees}} \times \dfrac{100}{1}$

[12] The number of observations for one year are inadequate and statistical error is consequently high. To avoid this it would be necessary to average data over a number of typical years.

[13] The arithmetical mean of ages and service were essentially the same for managers, first assistants and unskilled employees. They varied for second assistants and skilled employees, being 4 years more for service in each case.

Given the average length of service of managers is already 14 years, then the maximum service that can be expected from 91 managers is an average of 28 years, which has not taken into account normal wastage due to deaths, early retirements and illness, or separations due to other causes for future service. In 28 years, therefore, 91 managers must be replaced on the average, that is, 3.25 managers for the year, or 4.0 for the entire industry.[14]

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[14] This number of 4.0 is a minimum replacement figure only. One half is based on 14 years past service and includes all separations due to any reason whatever. The 14 years' future service has not taken into consideration separations due to other causes. It is necessary therefore, to increase future service by 100% as past surveys have indicated that total wastage of managers consists of 50% separations due to other causes. A fair assessment therefore would be 6.0 managers require to be replaced on an average yearly. This assessment is supported by the printed but unpublished Dairy Conference Report of 1945 presented to Dairy Board delegates and entitled "The Recruitment and Retention of Key Persons in N.Z. Dairy Factories". The report furnished by a special committee set up for the purpose, quoted a table based on movement of managers, first and second assistants for the 10 year period 1933-43, the information being provided by 183 companies owning 249 factories out of a total of 298 companies owning 413 factories of various types.

The table is:-

TABLE VI. SEPARATIONS OF KEY PERSONNEL OF DAIRY FACTORIES (ALL TYPES) 1933-43

	Average No. per year			No. expressed as % of total		
	Managers	1/A's	2/A's	Managers	1/A's	2/A's
No. retired	5.8	2.5	1.5	27.6	8.2	4.3
No. died	2.7	0.8	0.8	12.9	2.6	2.3
No. left through illness	1.2	1.3	1.7	5.7	4.2	4.8
No. left to other industries	9.8	22.7	24.7	46.7	74.2	70.6
No. left, reasons unknown	1.5	3.3	6.3	7.1	10.8	18.0
Total loss to industry	21.0	30.6	35.0	100.0	100.0	100.0

The turnover of Skilled employees is a little lower than Second Assistants but higher than First Assistants. One possible reason is that this group (skilled) is somewhat heterogeneous in composition, including (as it does) Engineers, who, on the whole, indicate a tardiness in moving from one job to another.

The replacement rate for the butter industry of the various groups has been calculated from the preceding data as follows:-

Managers	4 per annum
First Assistants	10 " "
Second Assistants	15 " "
Skilled	34 " "
Unskilled	235 " "

These figures are the bare minimum required to maintain the requisite establishment for manufacturing butter assuming the output constant as for the 1949/50 season.

From Table IV on P.28, it will be observed that there are certain critical periods of employment. In the unskilled ranks over 10% leave within the first month of employment, and over 22% within the first three months. Actually, more than 5% leave within the first week of employment, especially when commencement of duties coincides with the flush period of the season. Where men are taken on later in the season, the chances of their continuing into the next season are considerably greater. Where the employee continues past the first six months, the likelihood of continuance is considerable. Another critical period is immediately after two years' service.

In the other groups, the critical periods are after 3 years for the Skilled workers, 4 years for Second Assistants and 6 years for First Assistants.

Establishment Aspect of Labour: By "establishment" is meant the normal or usual number of employees considered necessary to manufacture butter during the flush of the season. The personnel and the composition of any two factories vary, not only at any given moment, but also through the season. The competition for labour, other employment available in the district, the amount of accommodation available, the extent of overtime and the policy adopted by management all help to determine the supply of labour for a factory of a given output. On the demand side, certain factors are important - the poundage of cream per supplier, the spread of supply through the season, the extent of effective mechanization and competent management.

Managerial policy varies even in factories working under identical conditions. Some managers prefer to retain "key personnel" and supplement with casual labour, where available. Others prefer to carry a full establishment throughout the year. Certain managers practise changing routine duties throughout the year in the unskilled ranks and also in skilled ranks where possible. In a few factories, the policy is adopted of encouraging the men to perform extra-manufacturing duties such as lorry-driving, butter-milk powder operation etc.

The establishment data for the 1949/50 season is as follows:-
(Flush of season):-

Factories with output of:		
Under 1,000,000 lbs. p.a.	Range	2 to 9 hands *
1,000,001 - 2,000,000		4 to 12 hands
2,000,001 - 4,000,000		7 to 18 hands
4,000,001 - 8,000,000		11 to 33 hands
Over 8,000,000		16 to 47 hands

* The upper limit of the range includes (in some cases) personnel engaged partly in butter manufacture and partly in other auxiliary activities, but submitted as "butter employees" in returns received.

The extent of the range of the numbers of employees in each group is considerable, being over 4 times in the first group, and averaging 3 times for all groups. Allowing for "fringe" employees being included, the extent of the above range reveals that all factories are not equally efficient in their utilization of labour. Granted that some disparity is due to a complex of locational, seasonal, managerial and structural[15] causation,

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15 "Structural" as a term is intended to denote the fixed capital of the company - as invested in buildings, plant, equipment - and especially refers to the degree of mechanization and labour-saving facilities available.

is the balance of the range caused by waste, maladjustments or fluctuations in the labour-intensive actions of manufacture? To what extent can the maladjustment be corrected technically? To what extent is it an economic problem? The following sections attempt to answer these questions.

SECTION III. THE GENERAL PATTERN OF LABOUR UTILIZATION

Responsible officials and employees of some 58 selected factories filled in daily and weekly time-analysis sheets from which processes and functions were analysed.[16] The majority of the sheets were filled in during November and December, and the balance in October and January. The time-analysis sheets were used to derive the following data:-

Process time-analysis of all factories:-

Reception:	(includes weighing, sampling, tipping etc.)	26%	
	Can-washing	5%	
	Testing	4%	
Processing:	Preparation of cream for churn	11%	
	Churning	14%	
Packing:	Packing or pounding of butter	27%	
	Carton making	6%	
General:	(Steam generation, Refrigeration & Misc.)	7%	100%

Summary:	Reception	35%	
	Processing	25%	
	Packing	33%	
	General	7%	100%

The variation between factories of similar output was small. As factories increased in scale, the percentage of time devoted to Reception diminished, Processing was constant, and Packing tended to increase, while General varied. This is shown in Table VII below:

16 For one week, an additional factory was time-checked personally to test the validity of the method employed.

TABLE VII. PERCENTAGE OF TIME DEVOTED TO PROCESSES IN 58 FACTORIES.

Output of Factory in lbs.		Reception %	Processing %	Packing %	General %
Up to 2,500,000		41	23	30	6
2,500,001 to 5,000,000		36	20	34	10
5,000,001 to 7,500,000		33	18	36	13
*Over 7,500,000	Type A.	22	22	46	10
	Type B.	13	26	48	13
Selected Test Factory (2,500,00/5,000,000)		38	19	33	10

* Type A.: Factories collecting and receiving their cream mostly from suppliers.

Type B.: Factories receiving a large portion of their cream as a by-product from other related activities. (These were not included in the average of all factories for obvious reasons).

Operational-time of processes for the same factories was broadly analysed into direct processes and indirect. The direct processes covered Preparation (actual "getting ready" of plant and other preliminaries); Operation (the process itself - reception, packing etc.); and Cleaning (excludes can washing). The indirect processes included Repairs (but excluded winter maintenance work); Administration (general oversight and management); and Unproductive (legitimate time, e.g. smoko).

Operational-time of processes for all factories:

A.	Preparation	4%		
	Operation	73%		
	Cleaning	20%	87%	
B.	Repairs	3%		
	Administration	7%		
	Unproductive	3%	13%	100%

When processes were examined for increase of scale, Preparation, Cleaning, Repairs and Administration decreased, Operation increased, and Unproductive time was constant. This is set out in Table VIII below:

TABLE VIII. PERCENTAGE OF TIME DEVOTED TO OPERATIONS (OF PROCESSES) IN 58 FACTORIES

Output of Factory in lbs. p.a.	Preparation %	Operation %	Cleaning %	Repairs %	Admin. %	Unproductive %
Up to 2,500,000	5	51	28	5	8	3
2,500,000 to 5m.	4	63	20	3	7	3
5 m. to 7,500,000	3	69	17	2	6	3
*Over 7.5 m. Type A.	1	78	15	-	3	3
Type B.	1	72	20	-	4	3
Selected Test Factory	4	64	16	2	8	6

* As in footnote to Table VII.

The following table shows the data from the selected test factory:

TABLE IX. DETAILS OF PROCESSES FURTHER ANALYSED (FROM SELECTED TEST FACTORY)

Function	Preparation %	Operation %	Cleaning %	Repairs %	Admin. %	Unproductive %
Cream reception	2	66	21	-	8	3
Can Washing	6	72	5	6	8	3
Preparation of Cream for churn	22	41	21	4	9	3
Churning	3	21	61	3	9	3
Packing	3	71	12	1	10	3
General	4	63	19	2	9	3

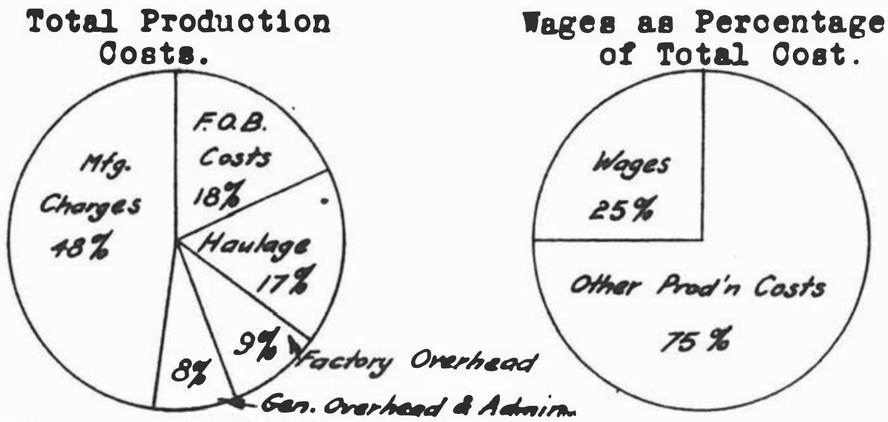
In Table VIII it will be observed that more time is devoted to actual operation with increase in scale. This is possible owing to the increased mechanization and instrumentation that is found in larger factories. The use of roller-conveyors, mechanical tippers, mechanical recording, modern can-washers, automatic pounders, butter-hoists, up-to-date butter moulders, automatic stokers and coal hoists all help to minimise time-consumption in labour-intensive sections of the industry. But such mechanization, at the same time, permits not only a fuller utilization of labour in a more skilled capacity, but also reduces the percentage of time devoted to repairs, cleaning, preparation and oversight as reflected in administration.

While it is true that scale permits increased mechanization, mechanization in turn (regardless of scale) permits more time to be devoted to actual operation and helps to relieve the operative of the laborious and monotonous aspects of his work.

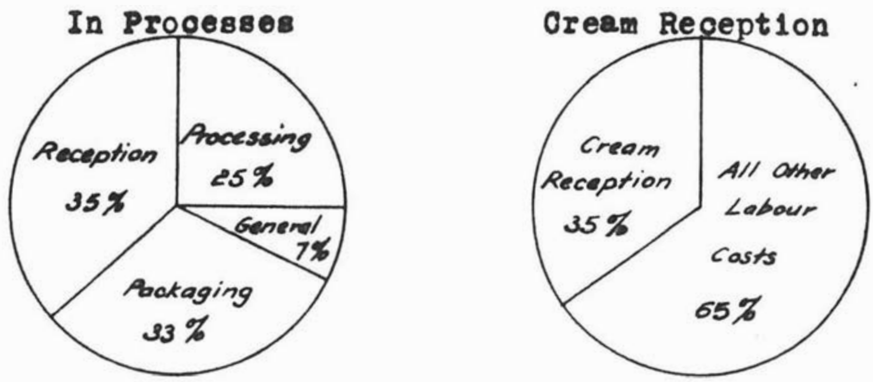
Cleaning, for example, is one of the most time-consuming, as well as most detested of all dairy chores. It accounts for one-fifth of all time in butter manufacture - more if can-washing is included - or about one-third of the time in smaller factories.

The extent of cleaning in the various processes is shown in Table IX which shows that over three-fifths of the time for churning is required for cleaning. In fact, five per cent of total butter manufacturing costs can be traced to cleaning, which helps to explain why so much technical research has been devoted to reducing cleaning time while maintaining a lower bacterial count for cleanliness.

(a) **Relationship of Wages to Total Manufacturing Cost of Production.**



(b) **Utilization of Labour.**



(c) **Utilization of Time in Cream Reception (Selected Typical Factory)**

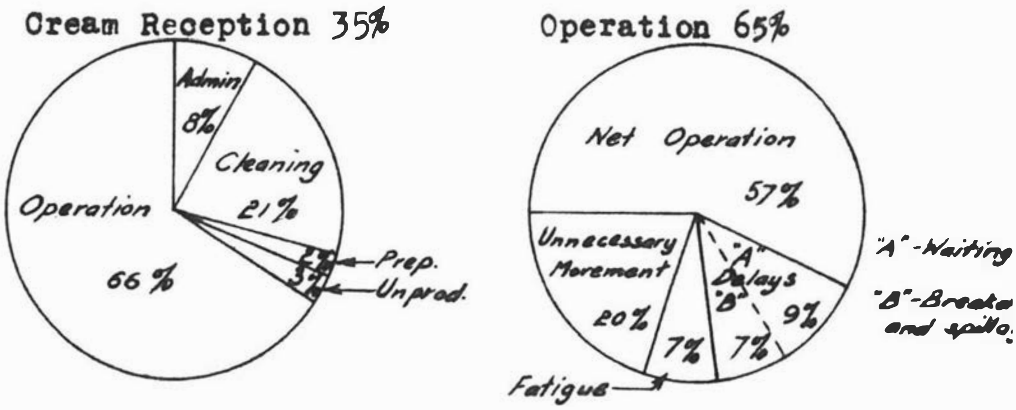


Figure 1. Labour Costs and Utilization in all Butter Factories - 1949/50 Season.

Technical and economic aspects of labour utilization:

Both technical and economic efficiency underlie effective labour utilization. With an increase in scale, as a result of greater specialization, factor substitution occurs as mechanization is substituted for labour. This is an economic problem, in which management must know when to offset increased costs of capitalization in plant and machinery against increased costs of labour, overtime and supervision.

Antecedent to this problem of substitution, is the technical problem of reducing the time con tent of every operation by more efficient organization of men, materials, and existing equipment. As the detail of every job is planned and carefully co-ordinated, operations, processes and teams become synchronised, so that with the optimum lay-out of plant and quipment it becomes possible to eliminate waste, fluctuations and maladjustments to the point where labour is operating at its maximum technical capacity.

Technical efficiency is achieved in isolation from other factors, and is the result of conscious organization and detailed planning. The extent of labour-planning is seen in the way in which the average time for a given operation differs from the time taken for the same operation carried out in a different factory under similar conditions, together with the extent of the fluctuations of average time for that operation in the factory itself.

Increased technical efficiency of labour not only reduces total costs and improves the grade of the finished product, but actually paves the way for, and indicates where factor substitution will be most effective. These technical aspects are highly significant to economic choice for they facilitate factor substitution and help to determine the direction substitution may take.

An analysis of the purely technical aspects of labour-intensive activities in butter manufacture is made in Appendix D, where time-motion studies of Cream Reception, Butter Packing and Carton Making are examined.

SECTION IV. THE COST OF LABOUR.

In this section the monetary costs of labour are now related to the variables analysed in the previous section. The extent of, and range of labour costs are examined, then process and functional costs are analysed. Those factors affecting the regularity and magnitude of wage payments, namely, seasonal and statutory costs are also examined.

The place of labour in the structure of costs:[1] Labour plays a very important role in butter manufacture. A summary of the percentage costs involved for the 1949/50 season butter costs are as follows:[2]

Cream Haulage	17%
Manufacturing Charges	48%
Factory Overheads	9%
Factory-FOB Charges	18%
General Overheads and Administration	8%
	100%

Of the total Manufacturing Charges, approximately 35% is represented by labour costs. That is, about 16.8% of the total cost of manufacturing butter is paid out in manufacturing wages. Added to this figure are other labour costs.

The most important of other labour costs is that of wages paid in Cream Haulage. But as a large fraction of cream collection is undertaken by haulage contractors, the actual aggregate of cream haulage wages cannot be determined. However, from figures that are available (extracted from data supplied by those companies that haul their own cream), it appears that 48% of Cream Haulage is paid out in wages. That is, approximately 8.2% of total costs is paid out for the wages of truck drivers hauling cream. (This presumes that labour forms an identical proportion of total costs in the contractors' accounts, which is unlikely owing to the different structure of haulage contractors' costs).

[1]This section deals with labour costs which enter Manufacturing Charges. Other labour components (such as Cream Haulage Labour etc.) are examined later.

[2]Extracted from New Zealand Dairy Board's 26th Annual Report (1950)

In addition to wages for cream haulage must be added administrative and office salaries, wages of factory workers engaged on repairs and maintenance and Factory-FOB haulage; these amount to approximately 8% of the total costs. Thus direct labour costs (wages paid), in the manufacture of butter amount to 16.8 plus 8.2 plus 8%, i.e. to approximately 33% of the total costs.

Added to this, are real wage elements as excess cost of providing accommodation over rents charged. Moreover, there is the expense of labour-turnover. This intangible expenditure is of greater magnitude than is generally realised. In fact, the very provision of accommodation for labour itself is an attempt to attract and retain labour. Labour turnover expenditure is even more difficult to isolate than that of accommodation (which tends to offset that of labour turnover). Accommodation expenditure is absorbed in the general wage bill in the form of overtime (rendered necessary in part by shortage of hands during the time-lag between separations and accessions), loss of time of responsible employees in direction, instruction and checking the work of hands recently taken on, to say nothing of minor overhead expenditure in the form of advertisements, travelling and settling-in, provision of requisite clothing, etc.

Thirdly, there are certain wastages of stocks which indirectly are chargeable to the cost of butter. Most employees receive certain perquisites either free, or at reduced cost. Under this heading is included coal, cream, buttermilk, milk, butter, petrol and oil, accommodation, loans, clothing, heating and lighting, transport, stores, and even medical attention.

Although more employees (51%) are engaged in the butter industry for subsidiary, complementary and administrative duties than for the manufacture of butter itself, the fact that one-third of direct labour costs of butter is traceable to labour, alone gives precedence to this factor in an economic study. No other element in cost fluctuates more than labour, and this, together with its magnitude, call for a more detailed analysis than otherwise would be accorded it.

Labour Costs Analysed: The total wages bill adjusted to cover manufacturing charges amounted to £613,512, which yielded a mean gross wage of £447 per employee. The average unit cost of labour in pence per pound of butterfat for all factories was 0.491d.

There was a considerable variation between factory and factory both in the aggregate wage bill and in the unit cost of labour. This variation manifests itself spatially or geographically as well as according to scale or output of factory.[3] The spatial distribution is largely, but not entirely accounted for by the output of the factories in that region examined.

While recognising that labour unit costs vary inversely with output and location, the highest unit cost factory has unit costs 7.6 times greater than the lowest unit cost factory. The following table shows 112 factories classified according to unit labour costs per pound of butterfat.

TABLE X. UNIT LABOUR COSTS IN 112 BUTTER FACTORIES

Labour unit costs per lb. b/fat. d.	No. of factories
Under 0.200d.	2
0.201 - 0.400	15
0.401 - 0.600	36
0.601 - 0.800	30
0.801 - 1.000	20
1.101 - 1.200	5
1.201 - 1.400	3
Over 1.400d.	1
	112

[3]See New Zealand Dairy Board's 26th Annual Report, (1950) pp 28-29 for an analysis of wage costs segregated spatially and according to size of output. As scale increases from category 1 to 6, unit costs drop to less than one-half of the first category.

The cost of labour will now be analysed under the following headings:-

(a) Process Costs.
(b) Functional Costs.
(c) Seasonal Costs.
(d) Statutory (Awarded) Costs.

(a) Process Costs: Process costs are those costs traceable to actual processes, operations, or stages in the manufacture of butter. In larger factories, departments have emerged which correspond with these processes. In this analysis the three essential elements examined are Cream Reception, Processing, (converting cream into butter) and Packing. Residual features, which cannot be conveniently grouped under the above headings are included under the heading "General". This latter group includes testing, engineering and administrative elements.

The following table classifies 61 butter factories according to output and Process Costs:

TABLE XI. PROCESS COSTS IN 61 BUTTER FACTORIES.

Output of factories in lbs.	Pence per lb. butterfat for different processes			
	Reception	Processing	Packing	General
Under 2,500,000	0.313	0.209	0.216	0.057
2,500,001 to 5,000,000	0.170	0.115	0.115	0.060
5,000,001 to 7,500,000	0.123	0.086	0.135	0.066
Over 7,500,000	0.084	0.087	0.133	0.046

The dispersion of labour-process costs is greatest in Reception, considerable in Processing, moderate in Packing and least in General. In the first group of low-output factories in the above table, Reception accounts for 39% of the wage-bill, whereas this percentage drops uniformly to 24% for Reception for the fourth group of high-output factories.

Two elements throw light on process cost structure - the ratio of any given process cost to total processes and the aggregate unit cost itself. With increase in scale, while aggregate unit costs for labour fall, the process ratio may fall, tend to be constant or increase. Actually, Packing increases, Processing tends to be constant, and Reception falls with increase in scale.

Where the process-ratio falls as well as aggregate unit costs, the dispersion will obviously be accentuated, and conversely, where the process-ratio rises whilst unit costs fall, the dispersion will be minimised or offset.

This accentuation is seen especially in Reception costs. In one or two very small factories, where suppliers were relatively numerous but their individual contributions small, Reception in the flush of the season accounted for almost 50% of the wage-bill. This percentage decreases to well under 20% in certain large factories. In fact, the least efficient unit had a labour reception cost of just 13 times that of the most efficient. But leaving out the extremes of the dispersion, the fourth group of high out-put factories has an average unit cost which is 37% that of the first group of low-output factories.

Both Process and Packing costs tend to be constant once output reaches moderate proportions, in spite of decreasing labour costs due to increased scale. Even General costs tend to uniformity until the high output category is reached.

It would appear therefore, that decreasing labour costs are made possible by economies resulting from advantages of scale in cream reception, rather than other processes. This is because cream reception lends itself particularly to mechanization and division of labour to a greater degree than do other processes.

It is significant that packing costs increase with scale, and indicates that substitution of mechanical packers for labour would probably increase overall economic efficiency.

(b) Functional costs: Functional costs are those costs which are traceable to certain purposeful activities common to each process or department. Thus regardless of the process; cleaning, administration and labour related to provision of lighting, power, steam (for example), apply to all. These common elements or functions perform a given service throughout the structure of the organization and can be measured separately for labour.[4]

The following table classifies functional costs in factories accounting for 30% of the national output.

TABLE XII. FUNCTIONAL COSTS IN 32 BUTTER FACTORIES

Functions:	Low-output Factories d. per lb. B/F.	High-output Factories d. per lb. B/F.
Direct process labour	0.247	0.217
Cleaning	0.162	0.064
Refrigeration labour	0.045	0.013
Power	0.065	0.006
Steam	0.078	0.030
Administration	0.052	0.053
Aggregate average unit cost	0.649	0.383

[4] Labour itself is a functional cost of broader manufacturing expenses and necessarily enters into office expenses, cream haulage, manufacturing, repairs and maintenance, factory-F.O.B. costs - in fact, it is a chief element of all costs.

In the above table, "direct process labour"[5] includes all labour directly engaged in reception, processing and packing, (such as analysed in Table XI). The balance is then functional labour. It was very difficult to obtain reliable data from very small factories, so that "low-output" factories is a cross-section of units with an output up to five million pounds per annum, the modal unit being between two to three million pounds.

Functional costs[6] vary more than the other types of costs, for they vary from time to time in the same factory as well as from factory to factory at the same time. These cost variations are most marked in smaller factories where division of labour is difficult and routine is at a minimum. A Manager is called upon to attend to refrigeration, power, steam and cleaning as well as administration and direct labour. Where scale permits functional division of labour, costs tend to be constant.

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[5]"Direct process labour" includes the actual operation itself, all preparation necessary to that operation, and running repairs. In addition it includes non-productive time and holiday pay. These elements are considerable. No attempt has been made to analyse preparation for an operation, but it is recognised because it involves distinct duties at different rates of pay. Preparation becomes more marked in larger organizations and is of considerable proportions (over 20%) in processing for churning. It adds some 0.015d. per lb. to unit wage costs. Running repairs (as distinct from off-season maintenance work) adds 0.018d. and all non-productive time accounts for 0.044d. to unit labour costs. The element of running repairs is much higher in low-output units and diminishes with scale. Non-productive cost elements are constant, whilst preparation tends to increase with scale. Over the entire range of factories these "extra-operational" elements amount to some 15% of direct labour process costs.

[6]These costs refer to the labour element of the function only.

In low-output factories direct labour ranges from as low as 29% to 46%, and in large-output factories from 43% to 65%, although most large units cluster round the 60% mark. The median scores are 38% and 57% respectively.

It will be observed that average unit cleaning costs in large factories are just under 40% of those of small factories, refrigeration costs under 30%, power costs under 10%, and steam costs under 40%.

Administration accounts for 8% of the aggregate unit labour cost in low-output units, but 14% in high-output units. However, when the effect of scale is taken into consideration, the two "weighted" unit functional costs are almost identical (viz. 0.052 and 0.053). Again, direct process labour is 57% of aggregate cost in low-cost units, but is 38% in high-cost units, but when weighted by decreasing aggregate unit costs as an outcome of scale, the low-cost process labour is 88% of the high cost labour.

There are, obviously, considerable cost reductions accruing from scale when measured in terms of unit costs. The structure of those reductions is partially obscured when aggregate unit costs are compared, but become evident when the costs are analysed in terms of process and functional costs.

The dispersion of functional costs is greatest in high-cost units, but decreases with scale. As output increases, it is the reduction in functional costs that contribute largely to falling aggregate unit costs, for they reflect substituted mechanization. Some stream-lining of costs has been achieved, however, through technical efficiency, but both technical and especially economic functional costs are significant in that they emphasize where costs have been reduced.

(c) Seasonal costs: Seasonal costs are those arising from the characteristic periodic variation in output which recur with regularity throughout a given period of time - in this case, a year. Although labour costs do have a periodic or seasonal tendency because penal rates of pay and overtime fall off as the off-season approaches, the output of butter throughout the year fluctuates to a much greater degree, resulting in a distinct seasonal cost pattern. Such a seasonal cost pattern is in part conditioned by geographical or spatial factors. In colder districts where the lactation period is shorter, seasonal variations are necessarily more marked.[7]

The following table sets out the monthly variation in output, total wages including penal rates, numbers employed and unit labour costs for 91 factories for 1949/50 season.[8]

TABLE XIII. MONTHLY VARIATIONS OF BUTTER OUTPUT, WAGES PAID, PERSONNEL EMPLOYED AND UNIT LABOUR COSTS IN 91 BUTTER FACTORIES

Month	Index of butter output Sept. = 100 (1)	Index of Wages of Males Sept. = 100 (2)	Index of Nos. employed Sept. = 100 (3)	Weighted average unit labour cost in pence per lb. (4)
June	9	79	94	2.946
July	11	60	82	1.613
August	59	72	91	0.497
Sept.	100	100	100	0.398
Oct.	133	127	102	0.349
November	141	142	105	0.357
December	139	141	106	0.354
January	118	137	102	0.423
February	85	123	95	0.489
March	76	118	92	0.533
April	46	110	89	0.724
May	24	91	84	1.093

[7] See New Zealand Dairy Board's 26th Annual Report, pp. 14-15 for a monthly and spatial analysis of butterfat production for the 1949/50 season. Factors influencing production trends are noted on p. 15 of the Report. These figures however refer to total butterfat production but are valid for utilization for comparing monthly fluctuations of butter production. It should be noted that certain districts, such as North Auckland, are almost entirely devoted to butter, and others such as Southland, to cheese.

[8] Col. (1) was extracted from monthly production data of individual factories; Col. (2) from aggregate total wages paid to males only, extracted from monthly returns submitted to Dept. of Labour and Employment; Col. (3) from the same source as Col. (2) and Col. (4) from the raw data of Cols. (1) and (2).

From Column (1) it will be seen that June is the lowest output month, and November the highest. In fact, in June, production was less than 1% of the year's output, whilst the months September to January inclusive accounted for just two-thirds of the annual aggregate.

The variations of the index numbers of Column (2) are of less magnitude than Column (1) and follow the same pattern as the first column, but closer examination reveals a time-lag of approximately one month. The wage index is lowest in the month of July, and indicates considerable outlay for the five months of October to February. When the first two columns are compared it will be evident that most factories retain a basic or regular labour complement throughout the off-season months. During this time overhauling of equipment and repairing and painting of buildings are done. This must be borne in mind in analysing and comparing monthly costs, for, the high unit costs of June and July are unduly burdened with fixed or overhead wage costs.

Column (3) shows the index of employees working and follows the pattern of the first two columns. The difference in magnitude between Columns (2) and (3) is a measure of overtime and penal rates earned throughout the year.

Column (4) shows the average unit cost of manufacturing wages per month in terms of pence per lb. of butterfat. The figures are relative and comparable. Thus it costs more than eight times as much in June to make a pound of butter than it does in October, November or December.[9]

This average unit cost pattern reaches its lowest point during the three months October-December and derives its flattened shape from the fact that increased overtime tends to offset the increased output.

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[9] See "The Problem of Capacity" pp. 353 - 357, - where economic aspects are considered.

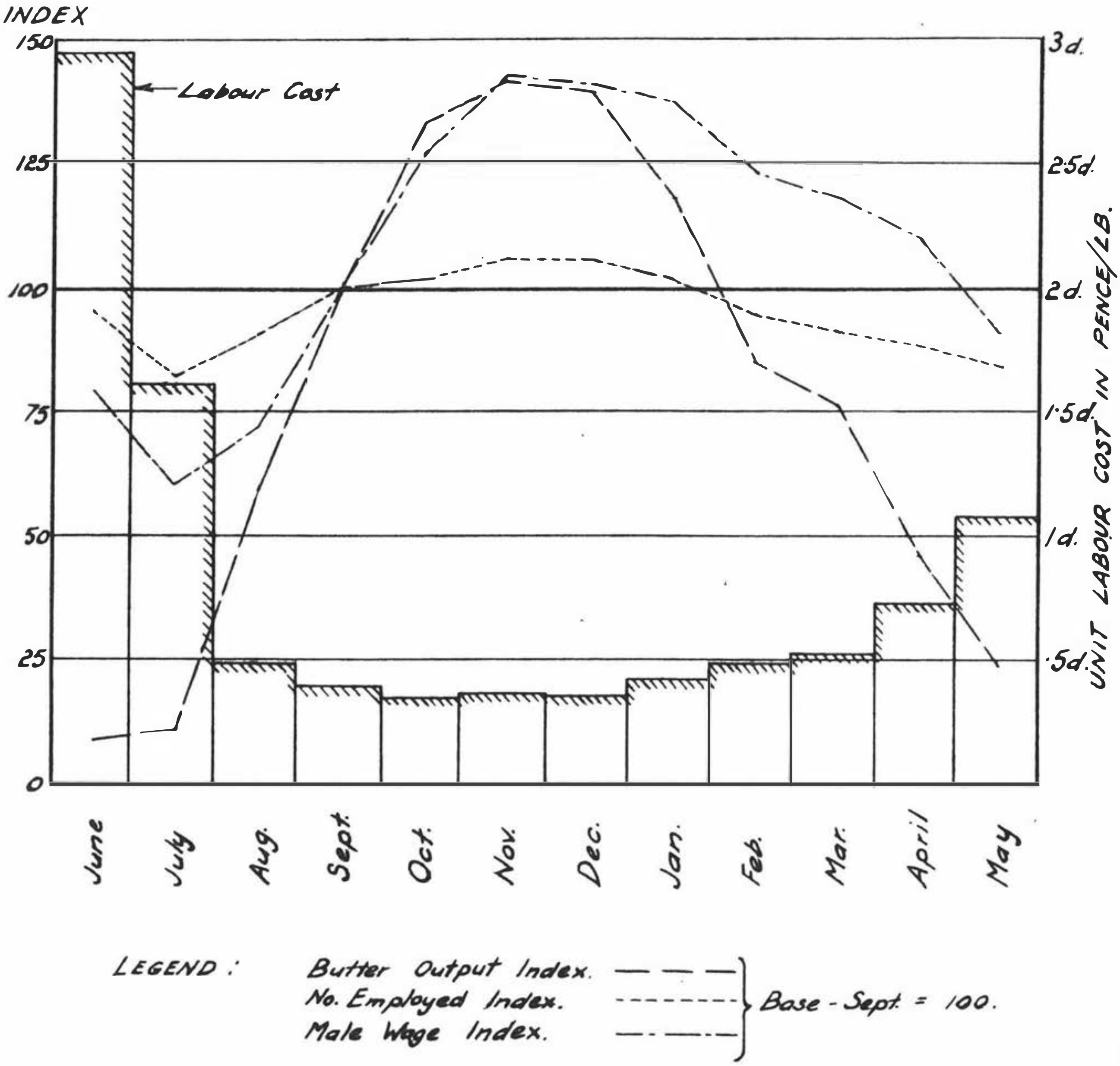

Figure 2. Relationship between Labour Unit Cost and Wages, Production and Employment for each Month of 1949/50 Season in 91 Butter Factories.

But the unit labour costs of the months May-July are relatively considerable and have occasioned much thought at the managerial level. Two or three managers have endeavoured to offset its incidence by having a permanent team of key workers, supplementing by casual or female labour at peak times. Others have directed their staff to other activities than butter during the winter months - farming, contracting and general haulage. However, the problem is inherent in the seasonal character of the industry and has been mitigated partly by favourable geographical or climatic conditions, and partly by co-operative "staggering" of the lactation period itself.

Of these mitigating features, geographical or locational factors are weightiest. Certain districts with mild winters and favourable conditions permit a low maximum-minimum ratio of production. Thus in three districts in the North Island the highest monthly output is only twelve times that of the lowest month. In the South Island, however, where climatic conditions are more rigorous, one district is over 20, another over 40, and another, namely Southland, over 80 times.

Seasonal cost differentials are even greater than those of functional costs, or differentials arising from scale. The problem is a managerial one of choice between unit costs and quality. As such, it affects cream collection costs as well as manufacturing costs, for during the off-season when offerings diminish, it becomes an economic question as to how frequently cream is to be collected and processed.[10]

(d) Statutory (Awarded) costs: Statutory costs are those arising from differentials permitted in wage rates as set out in the New Zealand Dairy Factories' Employees Award. These wage differentials arise from different rates for overtime, Saturdays and Sundays and Gazetted holidays.[11]

[10] This is discussed in Part III in a general way, pp.121-123 and in footnote - No. 24, - where the principle of frequency is examined and illustrations given.

[11] The New Zealand Dairy-Factories' Employees Award (No.174) specifies a maximum number of 40 hours a week at ordinary rates. Shift workers receive 3/- per day extra, as do others commencing work before 5 a.m. Saturday work is paid for at time-and-a-half rates, recognized holidays at double rates in addition to the ordinary weekly wage. Overtime up to eight hours per week is at time-and-a-half rates, and and over eight hours at double rates. Overtime in excess of three hours per day is at double rates. A minimum payment of four hours obtains for any work done on Saturdays and Sundays.

The following figures were extracted from representative factories with an aggregate output of more than 25 per cent of the Dominion's total.

Total wage bill including overtime and recognized holidays:

Five working days	£386,500	63%
Saturdays	98,150	16%
Sundays	128,850	21%
	£613,500	100%

Total wage bill with overtime and holidays segregated:

Five working days	£337,450	55%
Saturdays	79,750	13%
Sundays	92,000	15%
Overtime and recognised holidays	104,300	17%
	£613,500	100%

The amount of overtime increases considerably at the flush of the season when all hands may work for eight hours or more on Saturdays and Sundays. In some factories skeleton staffs operate when penal rates apply, whilst in a few factories no Sunday work is undertaken even in the flush of the season. Overtime tapers off as soon as the flush of the season is past. The increased use of vacreation has permitted a marked diminution in penal wage costs, but the additional wage costs arising from double and treble wage rates raises the question whether it is possible to confine operations to the low-cost working periods without marked deterioration in the quality of the product. A 20 per cent saving in the aggregate wage bill would amount to over £120,000 per annum which would be well worth while provided the average grade of butter did not fall substantially, and such cream held over for more than one day could be diverted to local consumption butter.[12]

[12] Butter consumed locally amounted to 16.3% of total production for the season reviewed. Other long-term factors would need to be considered however, such as market demand resulting from altered grades.

It is considered that in the long-run, as the gradings improve, especially in smaller factories, it will be economically worth while to hold cream over for manufacturing on ordinary week-days, deleting Sunday work entirely. This would necessitate increased capital outlay in plant, holding-tanks, refrigeration and vacreation facilities.

Again the problem is one of economic choice, in which the reduction of 20 per cent labour costs (in deleting Sunday work), would need to be offset against increased interest and maintenance costs of extra accommodating plant by which the extra raw material and processing would be spread over the week. Quality would, as with Seasonal Costs, be an important factor in shaping managerial decision, but provided the technical gains in processing offset the loss from diminished quality, the ultimate economic gains from such factor substitution should be worth it.

SECTION V. ECONOMIC ASPECTS OF LABOUR EFFICIENCY.

Economic choice operates when decisions have to be made between the output-efficiency of labour and staff retention costs, between fixed and variable costs, and between substitutable factors. These aspects of economic efficiency will now be considered under the following headings:

A. Labour Turnover.

B. Cost Aspects.

C. Regressional Analysis.

D. Factor Substitution.

A. LABOUR TURNOVER:

The object of efficiency in labour is to so utilise labour inputs that total outlay is minimised while maximising total revenue. To achieve this end, labour costs must be minimised, but in so doing, separations may increase. The cost of replacing labour and subsequent training may increase labour costs considerable. The problem then becomes one of equating the marginal costs of staff retention (reflected in incentives to reduce turnover). As retention costs tend to increase, turnover costs tends to decrease. The problem of labour turnover is, therefore, of considerable importance in labour efficiency.

There are two main approaches to a study of labour turnover - objective and subjective. By "objective" is meant the analysis of given data to determine functional relationships between turnover and measured variables. Such a method is precise and mathematical but is necessarily limited to the degree of the validity and accuracy of the variables examined. By "subjective" is meant the direct approach to individuals concerned whereby the information is obtained from replies afforded to the questions submitted to the subject concerned. While the information gleaned is more complete and extensive than the former method, the results obtained lack precision and accuracy, for they are opinionative in character and their value is necessarily limited by the character, mood and honesty of the informant.

It is considered that both methods are necessary to obtain a correct view of turnover. The subjective approach will now be considered for the findings from this approach indicated the significance of the independent variables to be introduced into the objective study.

Subjective approach:

Some 153 former butter factory employees were followed up from seven factories of varying outputs in three different areas. In addition over 300 employees at present working in the industry were questioned in an informal way and case notes were made of any employee who made complaint of any factor that was calculated to prejudice job satisfaction. This present section is compiled from the facts elicited from the 153 former employees and the case notes made from present workers.

Previous employees included those who left during the course of five years, and the details obtained were present address, age, marital status, nature of work and the cause of the separation.[13]

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[13] Full details of age, marital status were not obtained in every case, but causes of leaving job and present employment were. It was found necessary to check with previous employers as to cause of separation, for the reasons given by employer and employee did not tally in every case and were therefore analysed accordingly.

Whereas the attempt was made to elicit the main oause of leaving in each case, the interviewer had to assess the main cause in many cases, disentangling it from the host of irrelevancies, complaints and grouches. Many had a number of reasons which could be sifted down to one main reason with two or three minor features. The following causes of separation were elicited:-

		Percent
Dissatisfaction[14] with working conditions	..	25
Dissatisfaction with remuneration	..	19
Dissatisfaction with hours - too much overtime, Sunday work etc.	..	16
Dissatisfaction with Management - generally fed-up	..	12
Dissatisfaction with social facilities - no recreation facilities, sport opportunities, or social entertainments in evenings	..	10
Sickness, Injury or Age	..	5
Promotion within Industry	..	5
Location	..	1
No accommodation	..	7
		100

For the managerial point of view as to why employees left, the following classification is given:-

		Percent
Left to obtain better jobs outside	..	29
Generally dissatisfied	..	22
Dismissal due to unsatisfactory work	..	11
Left without reason being ascertained	..	13
Work satisfactory but services dispensed with due to absenteeism, disobedience or making trouble	..	6
Sickness, Injury or Age	..	8
Location	..	1
To better position in industry	..	6
Miscellaneous reasons (heaviness of work, overtime Sunday work etc.)	..	4
		100

[14]"Dissatisfaction with working conditions" was a peculiar complex of emotional and vocational maladjustments, deeply tinged with temperamental instability, technical incompetence and employer-employee relationships. "Can't stick it, or the boss", "too tough for the money", "had had it" were typical explanations. Specific dissatisfactions included health psychoses, too much steam-work, did not like working

The work taken up by former employees was:

		Percent
Farming (about one-half share-milking)	..	33
Industrial (timber, mining, metal)	..	15
Lorry driving	..	11
General labourer	..	10
Factory work (food)	..	3
Govt. Employees (Railways, Public Works, Postal and deer-culling)	..	6
University student	..	1
Retail business	..	5
Mechanical trades	..	3
Hotel workers (barmen and porters)	..	4
Building	..	2
Herd testing	..	2
Technical (laboratory work)	..	1
Unknown (including serving term in goal and one deported)	..	4
		100

From the many conversations with employees in the butter industry, certain distinct impressions have been conveyed as to tangible causes of dissatisfaction, which although not necessarily adequate on their own to cause an employee to leave, collectively have obviously tilted the balance many a time. One which can be remedied in many cases, is that arising from employer-employee relationships. Some employers expect too much from new beginners, who often take up the work as an outcome of intellectual deficiency and technical incompetency in other work. These workers would probably stay if helped through the first few weeks.[15]

14(cont.) hours, damp floors, fear of chest complaints from steamy atmosphere, heavy slog, no future, unfair discrimination, no superannuation, directors unconcerned, etc.

[15] It is well recognised that many unskilled workers who come to the industry are mere opportunists, who intend staying only for a few weeks until they can locate something better. Others in this category come, hoping to get a house and then decamp when opportunity offers. Others, again, won't stay because they are essentially not workers. Excluding these, there are those who would stay, other things being equal. It is these that are in mind.

A great number are youths, on lower rates of pay, who are put onto cleaning work, carton-making for long hours, or, on account of staff shortage are given laborious duties in the cream reception and butter-packing teams. In a few cases, (fortunately exceptions) Managers do not know how to direct, address or reprove employees, a condition which is often intensified when the pressure of work is great, staff is short-handed, and tempers frayed. The occasion of too many separations have occurred at such times, it being recognised that the causes are quite distinct from the occasion. These observations apply equally to the skilled and key men, for a number of foremen or first assistants have complained (in some cases bitterly) and have thoroughly resented sharp corrections or adjustments, especially in front of, or in the hearing of other employees.

One perennial complaint is inadequate pay and lack of differentiation between the various grades of skill, and submissions of what they could be earning elsewhere. There is probably much to be said against the differentials between some of the grades - at least, this is one of the chief complaints of men who have gone some way in the industry. There is some justification in the argument, that unskilled workers who have been two seasons in the industry merit an increment, an argument that some Managers wisely have implemented.

Another species of complaint lies in working conditions. This generally takes shape in the form of inadequate mechanical facilities, sub-standard washing, laundering and showering amenities - complaints that too many Directors overlook, as some of them on inspection certainly were well-grounded.

Others again referred to extra-factory conditions. For married men these features are less important, but single men often complain of inability to attend week-end social and sporting activities. The nature of their work preclude employees from being members of rugby and cricket teams in many cases owing partly to hours of work, and partly to travelling difficulties. Especially in rural areas, there appears to be a dearth of evening entertainments, of pictures, dances and opportunities of meeting the opposite sex. With senior employees there arises a subtle but similar factor that is not found in the lower paid grades. As salary increases, there sometimes awakens a sense of social inferiority as mingling occurs with others of equal economic resources.[16]

Overtime, pressure of work, Saturday and Sunday shifts are common reasons of dissatisfaction in all grades of employees, but appear to be intensified with key workers. Indeed, the pressure of work laid on Managers in peak times, when they are forced to almost "live on the job" and undertake all kinds of work and substitute for absentees, has been a real factor in causing dissatisfaction at the Managerial level culminating in more than one case of leaving the industry. It is abundantly evident that staff shortage falls most heavily on the senior employees and managers.

Other unnamed causes also pertain. One is the soulless attitude to work - disinterest, lack of team spirit and sense of oneness. Another is the dearth of information, or desire for information regarding the butter industry or opportunities in it. Very few unskilled employees have a satisfactory knowledge of the extent of the dairy industry, its range of products, its output, its research, its administration or the opportunities if offers. It is considered that it would be highly advantageous to the industry to publicise such matters by all available means - booklets, films, talks, visits and even brief refresher courses to that end.

There is one other feature that is disturbing - at least it is so in some companies. The lack of appreciation of working conditions in the factory by the directors is often a fundamental cause of dissatisfaction among the employees. Some directors, especially of certain small and medium-sized companies, have failed to appreciate the employee's point of view and have done little to improve his working conditions, and are not sympathetic with their Manager's recommendations to commit their company to the necessary expenditure on adequate mechanization and other capital expenditure. It is true that money has been the outcome of necessity in order to attract and detain the skilled, rather than promote job satisfaction.

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[16] One first assistant advised that he was compelled to leave the industry and accept a white-collared but inferior-paid job because his wife considered their social status was below that of her friends and associates.

The objective approach:[17] As the 1949-50 season was one of relative industrial stability as far as industrial relations go, it was considered a suitable normal period for examination.[18]

Labour turnover is assessed as the ratio per cent of total replacements to total employees in this survey, which covered 90 factories representing 87 per cent of New Zealand's butter output. The following figures will summarize the scope of the survey:

Total employees in all types of dairy factories engaged in all types of work, including administration, cartage, stores and all subsidiaries, for the season	5005
Total employees in the above survey	1110
Employees excluding managers	1010
Houses available	529
Houses available excluding managers' houses	439
Total replacements of labour	649
Labour turnover (inclusive of manager)	58 per cent[19]
Labour turnover (exclusive of managers)	64 per cent
Houses available per employee	48.5 per cent
Houses available per employee (excluding manager's house, which must be made available by the company)	40.3 per cent

The above data is classified in the following table in a summarized form.

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[17] Considerable portions of this approach have been quoted from "Labour Turnover in Butter Factories in New Zealand", a study by the author published in the "The Economic Record" No. 54, of May, 1952, pp 40-51.

[18] Labour turnover contracts in times of depression and expands in times of prosperity.

[19] This figure can be compared to that on p.30 where turnover based on percentage remaining on the job for the season was 20.8%. The disparity is largely due to the fact that replacement method takes into account the number of times a given position was filled during the year. In many cases one position was filled 6 or more times during the year.

TABLE XIV. LABOUR TURNOVER OF 90 BUTTER FACTORIES CLASSIFIED ACCORDING TO ANNUAL OUTPUT OF BUTTER IN POUNDS, TOTAL EMPLOYEES, TOTAL REPLACEMENTS, ACCOMMODATION UNITS, AND AVERAGE ANNUAL WAGE PAID TO EMPLOYEES

Size of Factory (Output of butter in lbs). (1)	No. of Factories (2)	Total Employees (3)	Total Replacements (4)	Accommodation Units* (5)	Percentage of Employees provided with Accommodation (6)	Average annual wage paid per Employee (7)	Labour Turnover per cent (8)
Up to 1,000,000	24	101	21	52	53	460	21
1,000,001 - 2,000,000	18	156	45	89	57	379	29
2,000,001 - 4,000,000	21	238	111	129	54	511	47
4,000,001 - 6,000,000	11	197	139	67	34	487	71
6,000,001 - 8,000,000	7	173	81	72	42	455	47
8,000,001 - 10,000,000	3	76	79	27	36	497	104
10,000,001 - 12,000,000	2	40	40	17	42	609	100
Over 12,000,000	4	129	133	76	51	527	103

* Accommodation units (Column 5) consist of 95 per cent of houses, the balance being "cottages", flats, "Baches", huts and hostels, which have been converted into units of accommodation on the basis of the average depreciated value of houses as disclosed in the annual accounts of the companies concerned.

From the subjective study the following variables appeared to be of significance:

(a) The size of the factories, which appeared to be associated with location and competition for labour by neighbouring industries, together with contagious dissatisfaction with working conditions.

(b) Instability and dissatisfaction from domestic and social factors, but mitigated by suitable accommodation provided.

(c) Dissatisfaction arising from monetary rewards and vocational opportunity as reflected in the general wage level.

These conditioning independent variables are influenced by the factors of geographical location and general competition for labour - elements that are difficult to measure in a precise way, but which merit some discussion.

By the factor of location is meant the function of the proximity (or otherwise) of the factory to dense centres of population. The location factor affects and is affected by the accommodation function, and also the competitive factor. To examine the density of population upon labour turnover, factories were classified into five groups.

GROUP A. Factories within access of a city over 50,000 population.

GROUP B. Factories within access of a town or city of 10,000 - 50,000 population.

GROUP C. Factories within access of a town of 2,000 - 10,000 population.

GROUP D. Factories within access of a township of 500 - 2,000 population.

GROUP E. Factories in rural areas.

"Access" means within three miles of the urban area.

The following Table shows ninety factories classified according to location and accommodation functions and labour turnover.

TABLE XV. LOCATION AND ACCOMMODATION RATIOS OF 90 BUTTER FACTORIES.

Location Classification	No. of Factories	No. of Employees	No. of Replacements	Accomm. Units	Labour Turnover	Accommodation / Employees (%)
A	2	43	68	7	158	16
B	7	83	69	40	83	48
C	16	260	192	88	74	34
D	27	364	169	171	47	47
E	38	360	151	223	42	62

Labour turnover tends to decrease as factories move from areas of dense population to rural areas.[20] But this can be attributed in part to the fact

[20]Maori employees amount to some 15% of total employees and as regards turnover, can be placed in two categories. The first category which is less than 20% of the total, includes those employed in large factories in Group A and B location types. Turnover in this category follows the same pattern as that shown by European employees in these factories - viz. fairly high. The second category refers to employees in Groups C, D and E types. Almost without exception, the turnover is very low in these location types, especially so in rural factories. A number of factories report zero turnover and the rest (except where the policy is to engage seasonal or temporary help) is under 20%. In 3 or 4 factories, certain Maoris have served continuously for more than 20 years.

that accommodation ratio falls from areas of dense population to the country districts. Several reasons may be offered for this:-

1. City labour seeking employment in city factories is already housed.
2. Higher building or acquisition costs in cities is a deterrent to building or providing accommodation.
3. Realization that to attract labour in rural areas accommodation MUST be provided.

Competitive Factor: By this term is meant the competition for labour by other classes of factories. In the butter industry, the main types of labour seeking employment are factory managers, skilled certificated assistants (such as butter-makers, testers, graders, etc.), general hands, lorry-drivers and engineers or boilermen.

Factory managers and their senior assistants are moderately substitutable in other types of dairy factories when viewed as labour factors. The labour turnover of this class of employee is relatively very low, being in the vicinity of 8 per cent., and derives from promotions, transfers, retirements and dissatisfaction. Promotions, transfers and retirements account for almost all of the turnover of managers, but dissatisfaction accounts for about 10 per cent of termination of first assistants. The competitive factor in this class of employee is therefore almost negligible.

There is, however, considerable competition for general hands of the unskilled labour class, and also for those employees who work as boilermen, engineers, fitters, mechanics and lorry drivers. As an economic factor these employees are highly substitutable as labour units.

Areas of competition for butter factory employees has been classified broadly into three main categories:-

Class X: Areas of intense competition for labour - marked by competition from other industries such as the coal mining industry, meat packing or processing, and food canning industries.

Class Y: Areas of moderate competition for labour - marked by competition from cheese and other dairy processing factories and others.

Class Z: Areas of little competition for factory labour.

TABLE XVI. NINETY FACTORIES CLASSIFIED ACCORDING TO INTENSITY OF COMPETITION FOR LABOUR AND LABOUR TURNOVER

Classification of factory	No. of factories	Total Employees	No. of Replacements	Labour Turnover
X	12	227	264	116
Y	19	256	149	58
Z	59	617	236	38

It will be seen that competition for employees is a considerable factor in that, ceteris paribus, turnover increases with competition for labour.

One other factor is the spread of the working week. On account of the highly perishable nature of cream, it is necessary to make butter seven days in the week during the season. A few factories work a strict five-day week,[21] and one or two smaller factories have gone so far as to close down on Sundays, even in the flush of the season. The reason for this is partly to stabilize labour and partly to reduce unit costs of production.

While the sample of five factories is too small to be significant statistically, it is interesting to note that these five factories which adhere to a strict five-day week (with an average of 3,000,000 pounds of butter output per annum), have an average labour turnover which is 35 per cent of that of all factories of a similar size.

Wages: Certain relationships which cannot be seen from Table XIV are shown in the following figures, which reveal the tendency for labour turnover to increase as average annual wage increases:

[21] Five factories were surveyed where employees, whilst processing cream seven days a week, strictly adhere to a five-day working week, Saturday and Sunday work being allocated on a pro-rata basis.

Average annual wage paid per employee	No. of factories	Labour turnover per cent
Under £400	13	29
£401 - £450	19	38
£451 - £500	22	72
£501 - £550	14	70
£551 - £600	13	71
Over £600	9	76

Variations in annual wages paid depend upon a number of factors, which are difficult to ascertain with any degree of precision. Two important elements are: -

(a) Extent of overtime permitted - which in turn usually indicates a staff shortage or the policy of working below the establishment commensurate with the output of the factory.

(b) The extent of "penal" wage rates - those rates over and above overtime rates for time worked on Sundays, statutory holidays, etc. Certain factories minimize penal rates by working a five-day week and/or closing down on Sunday.

The range of annual wage rates depends largely upon these two factors. Some employees prefer considerable overtime, some Sunday work; whereas others indicate a definite dislike of either or both, having submitted overtime and Sunday work as reasons for their leaving the dairying industry. These subjective preferences reflect social and psychological phenomena which can be traced to marital status, number of dependent children, preference for leisure and sporting activities, desire to improve position or change vocation.

Other elements which cause variation in average annual wage rates from factory to factory are: -

(a) Number of youths and women employed.

(b) The time-lag between separations and accessions - some Managers report up to two months before replacements can be effected.

(c) Hands laid off in winter months (not practised today to any extent).

(d) The composition of the personnel - number of senior positions and qualified or certified employees.

(e) Extent to which it is the policy of the company to pay bonuses and wages in excess of award rates.

The above figures are interesting in that the low turnover of the low income brackets possibly suggests immobility of labour rather than job satisfaction. The higher the wage received, the more economically independent the worker becomes, and the more mobile, so that he is prepared to seek an even higher remuneration or work of a different social level.

The above elements have been discussed in some detail, as they account for some of the inter-correlation appearing in the independent variables[22] selected for multiple correlation analysis. It would appear that both Location and Competition for Labour affect all three independent variables to some extent.

Limitations:

There are certain serious limitations in a study of this kind. In the first place, many factors are non-economic, whilst those that are economic often have a sociological and psychological complexion which renders analysis difficult.

In the second place, any study of labour turnover is liable to become the statistical counterpart of a study of job satisfaction. To measure labour turnover is to evaluate job satisfaction, and to evaluate job satisfaction it is necessary to probe into the causes of vocational maladjustments, disentangling the economic from the socio-psychological elements. But vocational maladjustment, in turn, is a reflection of emotional maladjustment arising more often than not from emotional maldevelopments. These maldevelopments may or may not be the outcome of intellectual deficiency, of technical incompetency, of environmental circumstances,

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[22] See P. 66: "Accommodation, Output and Wages".

of social status, of employer-employee relationships, of temperamental instability, and of many other causes too — but the fact remains that maldevelopments, maladjustments and general attitude to work of any kind become a complex of causation of job dissatisfaction.

In the third place, given the compexity of elements of economic causation of labour turnover, it must be borne in mind that any measure of turnover will fluctuate, not only from year to year and from month to month, but within the factory itself. Considerable care needs to be exercised therefore in making comparisons, as any measure of turnover will fluctuate with factors such as degree of prosperity of the country, of general industrial or political change or unrest. Thus any statistical measures have a limited value and need to be treated carefully.

In the fourth place, limitations arise from heterogeneity of the factors considered and the reliability of the primary data. In spite of standardized accounts being the basis of part of the primary data, personal investigation revealed that not all factories are interpreting the allocation of wages identically, and adjustments had to be made.

Again, it may be objected that butter is a seasonal occupation, but the following figures indicate that almost 99 per cent of all butter factories endeavour to retain their staff on a permanent basis.

TABLE XVII. INDEX NUMBERS OF SEASONAL EMPLOYMENT IN DAIRY FACTORIES (BUTTER), 1949-50 SEASON, FOR THE FIVE LARGEST EMPLOYING DISTRICTS IN NEW ZEALAND*. (BASE: ONE SEASON)

	BUTTER				
	Auckland**	Hamilton	New Ply.	Palm.North	I'gill
July	84	88	84	92	100
August	99	96	94	97	100
September	112	109	108	97	100
October	113	112	109	102	100
November	116	114	109	107	100
December	117	116	110	107	100
January	110	114	109	103	100
February	98	101	106	101	100
March	92	100	102	100	100
April	91	93	96	100	100
May	88	82	89	100	100
June	82	78	84	94	100

* Source: Extracted from monthly returns of Employment in Seasonal industries returned to Department of Labour and Employment.

* * The abbreviations stand for: New Plymouth and Invercargill.

The five employment districts in the above table account for over 60 per cent of butter factory employment in New Zealand. The figures omit dual factories but include the more seasonal type of worker, the lorry-driver.

Finally it is recognised that there are many other causes of labour turnover which cannot be incorporated readily in an objective approach to the problem. In addition to the subjective factors already examined, are factors causing staff movements such as promotions, transfers, dismissals, and normal wastage due to retirements, illness and death. These unavoidable separations form a basic core of replacements which vary with the type of personnel - 46% for Managers, 15% for First Assistants, 11% for Second Assistants and lower percentages for other workers.

Multiple correlation analysis: The data of Table XIV were subjected to multiple linear correlation analysis. As there were no definite curvilinear characteristics when plotted separately in scatter diagrams, the data were computed by linear methods. The four variables finally selected were:

X_1 Labour Turnover. (The dependent variable).

X_2 Accommodation ratio. This is summarised in Column (6) being calculated from Columns (3) and (5) of Table XIV. It measures the extent to which employees in a given factory were provided with accommodation as an incentive to detain them in employment. The measure as such, varies inversely with labour turnover.

X_3 Output (in lbs. of butter - measured in '00,000s).

X_4 Average annual gross wage per employee. (See Column (7) of Table XIV.

The results of the multiple regression were as follows:-[23]

[23] See Appendix E: Statistical Appendix, for further details.

$$X_1 = 14.03 - 0.3317X_2 + 0.5685X_3 + 0.0596X_4; \quad R = 0.5739; \quad N = 90$$

$$(3.90) \quad (0.1444) \quad (0.1233) \quad (0.0483) \quad \text{Std. Error of Est. } 35.6$$

$$t = 2.3 \quad t = 4.6 \quad t = 1.2 \quad (5\% \text{ level}; 1.96)$$

The coefficient of multiple regression (corrected for size of sample, the 1% level of significance for N: 86 being 0.2736) is highly significant, but the magnitude of the standard error of the Wages coefficient indicates that this variable explains little of the variation in the labour turnover. This is confirmed by the following partial correlation coefficients: -

$$r^2_{12.34} = 0.0576; \quad r^2_{13.24} = 0.1938; \quad \text{and} \quad r^2_{14.23} = 0.0176$$

The $r^2_{12.34}$ coefficient indicates that when X_2 is used, it helps to explain 5.76 per cent of the variation which X_3 and X_4 failed to explain. It measures the relationship between X_1 and X_2 when X_3 and X_4 are held statistically constant. Similarly $r^2_{13.24}$ indicates that when X_3 is used, it helps to explain 19.38 per cent of the variation which X_2 and X_4 failed to explain. But the third coefficient indicates that when X_4 is used it helps to explain only 1.76 per cent of the unexplained variation. Clearly Output (X_3) is the most significant in this respect, and Wages (X_4) the least.

Conclusions: The hypothesis examined, was that turnover was partly determined by size of factories, lack of housing accommodation, and inadequate monetary reward. The results of the analysis indicate that Output appears to be the most important single factor determining turnover, but that Accommodation is also significant. The inclusion of Wages, however, is discredited. Moreover, it (Wages) fails to satisfy the criterion of independence as revealed by its relatively high standard error of estimate. Bunch map analysis indicated that both Output and Accommodation were useful variables but that Wages was superfluous.[24]

[24] Although Wages is statistically discredited by its low measure of partial correlation, simple correlation, and its failure to satisfy the criterion of independence, nevertheless from the subjective aspect it has a place in the theory of turnover. Theoretically, turnover increases as Wages increase (not decrease) due to higher wages making the individual more independent and thus able to look elsewhere for employment.

The high standard error of estimate indicates that the actually observed values differ considerably from the estimated values, so that a high degree of reliability cannot be placed on the regression for forecast. The Standard Error suggests, too, that other unknown factors such as employer-employee relationships caused by non-economic factors are involved causing the deviations.

Summary: Labour Turnover in the butter industry arises from normal wastage, sociological and psychological causes, and economic causes. The non-economic causes include social status, lack of self-esteem, discipline, contagious discontent, monotony, occupational maladjustment, lack of social facilities and accommodation, and dissatisfaction with working conditions. The economic causes, which are of less significance, (although psychologically conditioned), include economic insecurity, inadequate recognition of wage differentials, lack of monetary incentives, inadequate leisure and week-end occupation, and insufficient opportunity for advancement.

Although much is being done in the larger factories, labour incentives are meagre. In very few factories are there social committees, welfare organizations, consultative committees or group financial schemes or superannuation (since implemented in the industry). Information bulletins were seldom seen, few companies had adequate staffing records, factory manuals or schedules of duties. The lack of positive approach, esprit de corps or social cohesion were marked weaknesses.

The economic burden arising from training and replacement is considerable, but turnover can be reduced by improving employer-employee relationships, reducing socio-psychological dissatisfaction, and increasing economic security, reward and attainment.

B. COST ASPECTS.

(1) Fixed and Variable Cost Elements: Manufacturing Wages, as an element of total costs is usually treated in economic analysis as a variable cost as distinct from fixed costs. Fixed costs are those, which, in the short-run, do not vary with output. Variable costs are those which rise or fall with change in volume or output.

The distinction is important in labour costs, for it is generally the fixed labour cost element that is substituted first for other factors. Both these elements of cost may be regarded as related to output or time. As a function of output, fixed costs remain constant provided scale is not changed. As related to time, the distinction between fixed and variable costs may be indistinct, or may merge. In the very long time, all costs are variable, for all costs obviously vary with total production. If the period of time is very short - say one day or a week - then costs tend to become fixed.

In butter production however, output itself tends to be related to time, being seasonal in character. To analyse butter manufacturing costs, a very short period of time is assumed with constant scale. Wages, as an element of total costs is normally recognised as a variable cost, but will now be examined under very short period conditions to assess to what extent wages are fixed or variable.

Labour costs, then, will be analysed into those elements of cost which vary directly with output, and those which do not. No clear-cut distinction can be drawn, for a number of factors cause a merging of the two types of labour.[25]

Generally speaking, administrative work, cleaning and functional labour dealing with refrigeration, power, and steam, tend to be fixed in character. Managerial duties must be carried out regardless of output. Organization, supervision, planning and oversight costs continues as an element which does not vary with the ebb and flow of production, but even here, it should be remarked, the variable element intrudes, for managerial reward itself is partly computed on the basis of output.

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[25] Degree of specialisation of labour is one factor, of mechanization another - these two factors being themselves a function of scale. Capacity, or rather, unused capacity is another, whilst overtime, speeding up tactics, shift work, contract labour and part-time employment all cause a blurring of any distinction of the two types.

Direct process labour tends to be variable but with definite fixed elements which include unproductive time, and that labour employed in the preparation of any process or operation. Bearing in mind the fact that clearcut distinctions are not possible, for the purpose of analysis the elements of wage-costs will be segregated as follows:-

Fixed labour costs	Variable labour costs
Functional elements of cleaning, preparation, administration and unproductive time in all processes.	The operational elements of the process costs of reception processing, packing and general. All over-time.
The functional wage-costs for refrigeration, power and steam.	

TABLE XVIII. FIXED AND VARIABLE COSTS OF 55 BUTTER FACTORIES.

Output of Factory in lbs. p.a.	Class	Fixed costs %	Variable costs %
Up to 2,500,000	A	47	53
2,500,000 to 5m.	B	36	64
5m. to 7,500,000	C	30	70
Over 7,500,000	D	25	75

The above figures were taken from a short-run period of one month d ring the flush of the season.

It will be observed that variable costs tend to increase with scale, so that the larger the scale, the greater tends to be the proportion of variable costs. A number of small-output factories had fixed costs amounting to a little more than one-half of total costs.

There is a distinct relationship between aggregate unit wage costs as a function of scale and the ratio of fixed to variable costs ($\frac{\text{Fixed costs}}{\text{Variable costs}}$). In Class A, the average unit wage cost is 0.80d. and the cost ratio 89%; in Class B the unit cost is 0.46d. and the ratio 56%; in Class C the unit cost is 0.41d. and the ratio 43%; and in Class D the nit cost is 0.35 d. and the ratio 33% respectively.

It would appear that variable costs as a component of total costs, increase relatively to fixed costs with increase in scale, so that fixed costs become a smaller percentage of total costs as production increases. This cost coefficient $\left(\frac{\text{Fixed costs}}{\text{Variable costs}}\right)$ diminishes with scale, and reveals a marked correspondence with the diminishing total unit wage cost, which decreases with increase in scale. In fact, when individual cases were examined, especially high output units where unit wage costs were very low relatively, a correspondingly low cost coefficient was observed. In small factories, however, where unit wage costs were high, the cost coefficient was also high, but the correspondence was less marked. That is, with low output units, the dispersion of the cost coefficients tended to be moderate, but this dispersion tended to diminish with increase in scale.

One reason for this lies in the fact that many small units had a wide fluctuation from month to month, and a relatively very low output in the off season. In other words, the seasonal curve of output tends to be leptokurtic or peaked in distribution for small factories, whereas distribution tends to be meso-kurtic or flatter as output increases. Moreover, this variation in kurtosis in the seasonal frequency curve is a measure of the extent of unused capacity deriving from the character of seasonal output itself.

Where a factory has a low monthly maximum-minimum ratio of production[26] the unused capacity was relatively low, the cost coefficient was low, and the aggregate wage unit cost was correspondingly low. Where the monthly-output coefficient was high, the cost-coefficient and aggregate unit wage cost were also high. Unused capacity is a result, generally, of idle factors reflected by fixed costs in the off-season.

In addition to idle factors arising from seasonal and geographical factors, unused capacity is caused by the heterogeneous and sporadic character of the quantity of cream received from individual suppliers.

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[26] Measured by the ratio: $\frac{\text{Output of highest output month}}{\text{Output of lowest output month}}$

One of the lowest monthly-output coefficients recorded was 10.

Where suppliers have small herds, factory wage costs are high as small cans take longer to handle than large cans as indicated by the time-motion studies. These small cream offerings are instrumental in intensifying unused capacity and fixed costs. Even in the flush of the season (when the cost-coefficients were calculated) fixed costs, and unused capacity can be intensified by the character of the cream-offerings together with other factors.

These other factors are largely managerial in character. Lack of organised planning, inadequacy of mechanization and excessive unproductive time all contribute to the magnitude of fixed costs. It need scarcely be added that average unit fixed costs relative to variable costs increase as production falls off, until in some cases where production ceases for one or two months, the costs are entirely fixed in character. Other things being equal, the magnitude of variable costs does appear as an indicator of efficiency and conversely, fixed costs as inefficiency.

Thus economic efficiency is apparent where an undue fixed cost element of labour has been recognised and substituted by other factors, so that total outlay in all avenues of expenditure has been reduced.

(2) Unit Costs related to Output: Two measures of efficiency are physical input-output ratios, and unit operating costs.

The former, which deal with physical units only, are a measure of technical efficiency, and if the factors examined are perfectly homogeneous and substitutable, a reliable measure is afforded because the ratios themselves remain unaffected by any change in factor price. But an hour of labour (the physical unit) does vary in output due to varying capacities of different individuals, or varies in the same individual due to onset of fatigue or other causes.

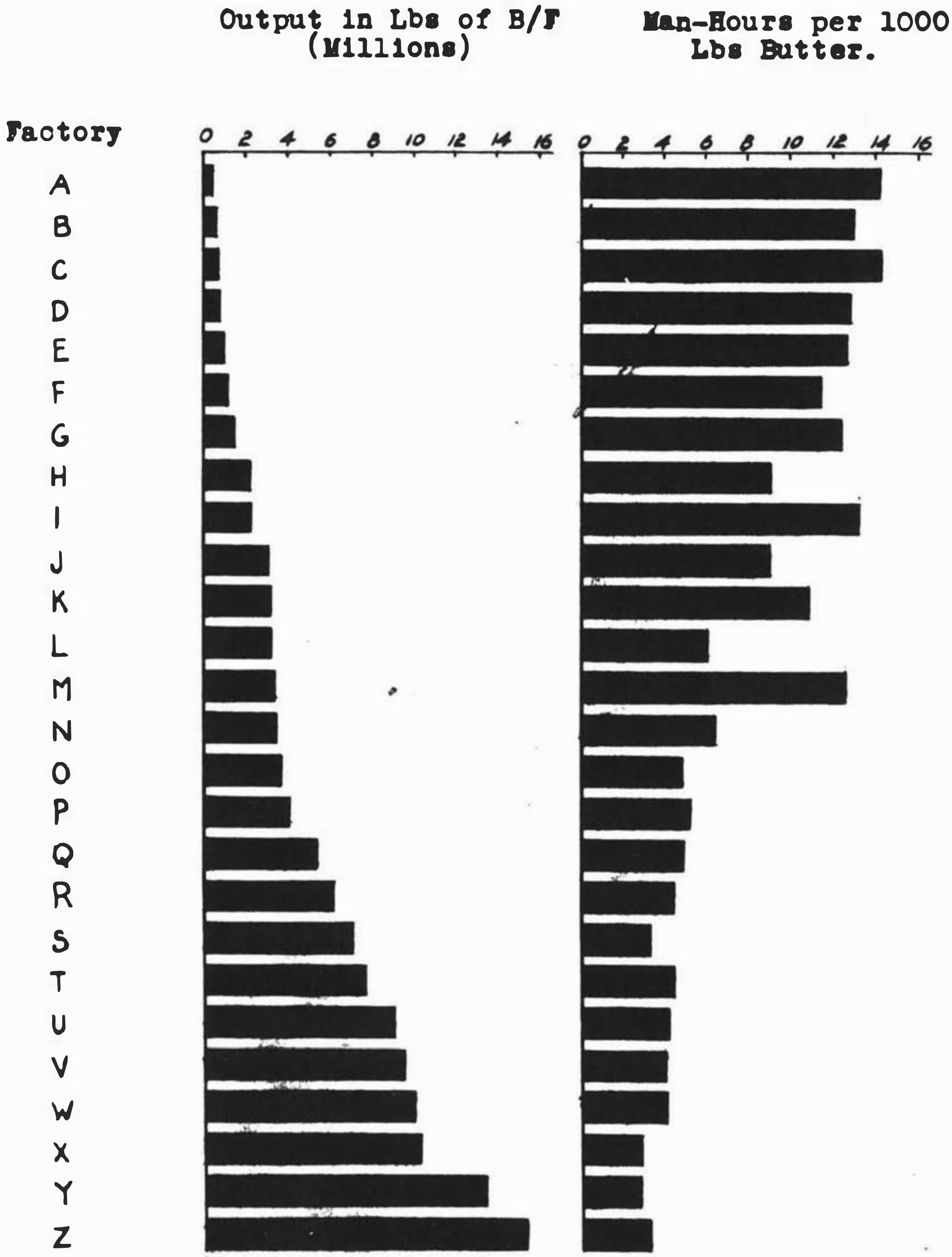
Physical inputs, when measured, illustrate increased technical efficiency with scale, for they demonstrate that the number of hours per unit of output tend to fall with increased volume. Some 26 factories kept sufficiently detailed records to extract the total number of man-hours worked for the 1949-50 season. The aggregate man-hours refers to total time chargeable to manufacturing wages regardless of wage-rates awarded or degree of skill. The following figures indicate the extent to which man-hours per 1,000 lbs. of butter varied with output.

Output of Factory in lbs. P.A.	No. of Factories	Man-hours per 1,000 lbs. of butter MIN:	MAX:	AVERAGE:
Up to 2,500,000	7	11.9	14.5	13.0
2,500,000 to 5m.	9	4.9	13.7	8.6
5m. to 7,500,000	4	3.8	5.0	4.3
Over 7,500,000	6	2.7	4.1	3.5

The diagram on the accompanying page (74) was plotted from the individual data classified above. Whereas the annual output in millions of pounds of butterfat is measured in homogeneous units, the man-hours are heterogeneous. Technical efficiency only may be assessed from the diagram in which the general trend is readily perceived.

This efficiency primarily arises from men, materials and equipment being more effectively organised so that the time content of the operation is reduced by minimising waste, maladjustments and fluctuations. Such is purely technical efficiency, but it aids economic efficiency which arises when the factors of labour are substituted for others such as mechanization, organization etc. Technical improvements are significant in that they generally underlie and make possible the substitution of factors that are basic to economic efficiency.

The pattern of labour costs to output is similar whether measured in physical terms (man-hours) or monetary (unit costs). In both, costs tend to fall as output increases, but this decrease or fall in cost is partly the outcome of improved technical efficiency, and partly the outcome of factor substitution or economic efficiency. It is this factor substitution which intensifies the reduction of unit costs. To measure the functional relationship between unit costs and output, 112 factories were ranked, (i) in order of output, from lowest output to highest, and (ii) in order of unit cost, from highest unit cost to the lowest. These rankings are shown in the accompanying table.



<u>Figure 3</u>. Relationship between Volume of Output and Time Paid per Unit of Production in 26 Butter Factories.

TABLE XIX. RANK OF 112 FACTORIES, (A) IN ORDER OF OUTPUT (FROM LOWEST TO HIGHEST), (B) IN ORDER OF LABOUR COST MEASURED IN UNIT COST PER LB. B/F.*, (FROM HIGHEST TO LOWEST)

A.	B.	A.	B.	A.	B.
1	104	44	48	87	36
2	102	45	23	88	19
3	66	46	70	89	20
4	94	47	54	90	18
5	110	48	79	91	22
6	108	49	80	92	33
7	100	50	43	93	31
8	93	51	85	94	11
9	109	52	58	95	28
10	91	53	71	96	10
11	73	54	77	97	50
12	98	55	12	98	37
13	69	56	84	99	4
14	111	57	41	100	13
15	112	58	57	101	9
16	105	59	53	102	26
17	96	60	97	103	40
18	106	61	44	104	27
19	92	62	90	105	7
20	81	63	62	106	5
21	78	64	32	107	6
22	86	65	64	108	2
23	95	66	51	109	16
24	101	67	52	110	38
25	103	68	47	111	1
26	99	69	14	112	3
27	61	70	63		
28	60	71	34		
29	107	72	55		
30	72	73	29		
31	49	74	30		
32	55	75	68		
33	89	76	24		
34	65	77	15		
35	67	78	25		
36	45	79	76		
37	75	80	21		
38	74	81	17		
39	59	82	8		
40	83	83	35		
41	87	84	46		
42	82	85	42		
43	88	86	39		

* Data from annual accounts for companies operating one factory, and from annual accounts together with statistics supplied by those companies operating more than one factory.

From these rankings it will be observed that there is a fairly high negative correlation in that low outputs are associated with high costs and vice versa. Mathematically the correlation was computed to be -0.784.

Had this correlation been in the vicinity of -0.9 or more, it could have been concluded that scale alone was the dominant factor in determining reduced labour costs.

In the lowest quartile as regards output, the best ranking in respect of cost is 60 and only 5 others rank below 80.

In the second lowest quartile, the best cost ranking is 12 and only 10 rank below 60.

In the third quartile, the best rank is 8; 21 rank below 60 and 12 below 40.

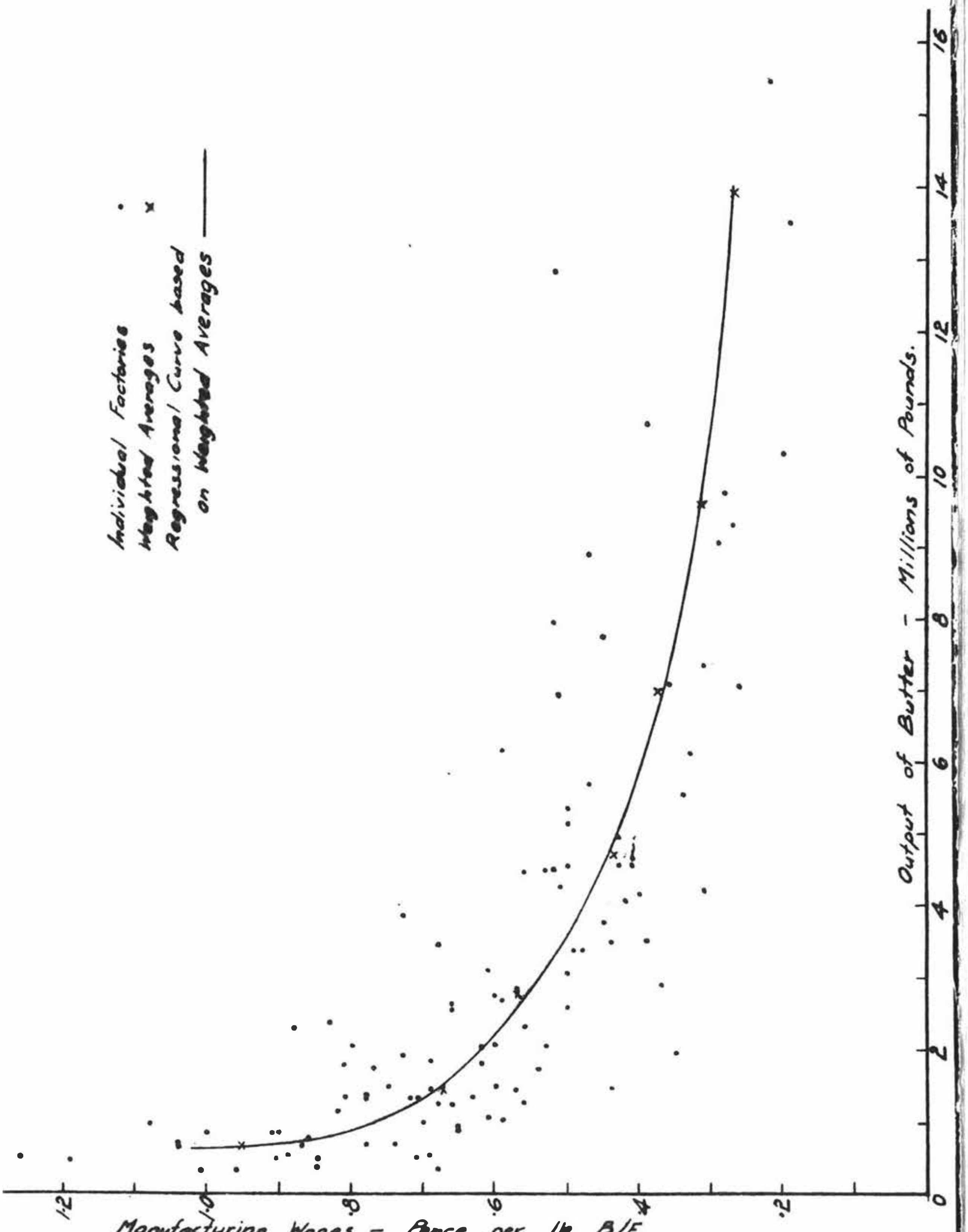
In the top quartile, only 3 rank 40 and above, and all but one cost ranking better than 10 are included.

Even as it is, it can be inferred that scale is an important factor, but it is obvious that there are other forces operating. The number of moderately erratic rankings suggest that certain factories are relatively more efficient or less efficient than others.

This same data was then plotted in scatter diagrams - unit wage costs against output. The scattering of the variables appeared in a broad band on either side of an asymptotic regression, the band becoming more dispersed as the higher output area was approached. (See Fig. 4). The extent of the dispersion of the variables about the regression suggested that there were other elements or factors in addition to scale which shaped the regression. Accordingly a multiple regressional analysis was undertaken.

C. REGRESSIONAL ANALYSIS.

Introduction: In the examination of 107 factories for wage cost functions, it appeared from the extent of the dispersion of the variables about the regression line (See Fig. 4, p.76A.) that certain factors apart from output



<u>Figure 4</u>. Relationship of Volume of Production to Unit Manufacturing Wage Costs per lb. of B/F in 107 Butter Factories, 1949/50 Season - Unadjusted Data.

were causing the degree of scatter. The question arose: What factors were causing this dispersion? From a general reconnaissance of possible causes, some of the more obvious factors appeared to be the degree of mechanization, the number of suppliers, and the extent to which cream was received regularly throughout the year.

Preliminary survey: Both the extent of capitalization and mechanization were plotted in scatter diagrams and checked by simple correlation, but both appeared to have little relative statistical significance as a wage cost function. Moreover, it was difficult to disentangle mechanization and scale, for they appeared to be inter-correlated. As output increased, so did mechanization. Further, it was most difficult to obtain objective reliable measures of mechanization for balance-sheet figures proved to be misleading in that "Plant and Machinery" in efficiently managed factories was often written down heavily. The correlation between Wage Costs and Plant-and-Machinery was almost zero.

Selection of Independent Variables: Having discarded Plant and Machinery, and Capital as possible negative variables, and assuming that Output was a major independent variable, two other variables were selected - Supplier and Seasonal coefficients.

The Supplier coefficient indicates the extent to which each supplier contributes to the total offerings, and is measured by the average quantity of butter per supplier in thousands of pounds. The greater the number of suppliers for a given intake of cream, the greater the number of cans, and the greater will be the time consumed in handling, receiving, testing, etc.

The composition of suppliers varies considerably. One factory may have 500 suppliers, the majority of whom milk over 20 cows, whereas another factory may have 500 suppliers, 200 of whom have herds of more than 50 cows and the balance are "billy-can" suppliers. Although the outputs of the factories may be the same, and the supplier coefficient identical, yet the time-consumption and labour costs of the second factory would be higher than the first due to supplier heterogeneity, other things being equal.

Some 52 factories had less than 250 suppliers, and of these, 18 factories had less than 100. Only one large factory had more than 1,000 suppliers, and the remaining medium and small-size factories with over 1,000 suppliers all had high wage and cream collection costs. Almost all factories located in or near cities, towns and populated areas had a large percentage of "billy-can" suppliers.[27]

The Seasonal coefficient is the ratio of the month of highest output to the three lowest months for each individual factory. It measures inversely the degree of unused capacity arising from climatic, seasonal or environmental causation.

An examination of the variables (seasonal) indicated that the dispersion was considerable throughout the entire range of observations, for location is the determining characteristic of this coefficient. In the Waikato and Auckland districts, where climatic conditions are propitious, factories were large or medium, and the coefficient was relatively low. In the Taranaki district, where climatic conditions were also favourable, the coefficient was also low in spite of the factories being medium or small in size. Thus, although there is some correspondence to scale, the seasonal coefficient appears to be related to location, output being subservient to this. However, in a few isolated cases, butter output was linked with market milk supply, so that a very low seasonal coefficient resulted, in spite of unfavourable climatic conditions. Obviously, favourable seasonal conditions are correlated with output, but the variable was included in the survey because unused capacity which adds to total wages, is largely the outcome of a short lactation period. (See pp. 46-50 for further details of Seasonal costs).

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27 Table XX. shows the structure of the Supplier coefficient in broad class intervals, but fails to indicate the true character of the dispersion. In the first class-interval, the mean average dispersion is 42%, then 39%, 42%, 21%, 35%, 23% and 26% of each successive class-interval respectively.

The three independent variables selected, then, were allotted the following symbols:

X_2: Output (measured in '00,000's lbs. of butter)

X_3: Supplier coefficient (measured by $\frac{\text{Output in lbs.}}{\text{Suppliers X 1,000}}$)

X_4: Seasonal coefficient (measured by the ratio of the highest month's output to the aggregate of the three lowest).

X_1: Unit Wage Cost.

The data: The data from which the multiple regressions were taken are set out in the following table:

TABLE XX. AVERAGE UNIT WAGE COST OF 107 FACTORIES CLASSIFIED ACCORDING TO ANNUAL OUTPUT OF BUTTER IN POUNDS, SUPPLIER CO-EFFICIENT AND SEASONAL COEFFICIENT

Size of Factory (Output of butter in lbs.)	No. of Factories	Average Unit Wage Cost in d./lb.	Average Output in lbs.butter ('000s)	Supplier Coefficient	Seasonal Coefficient
Up to 1,000,000	27	0.952	637	6.41	6.41
1,000,001 to 2,000,000	25	0.672	1,460	6.76	5.24
2,000,001 to 4,000,000	23	0.570	2,826	7.83	3.65
4,000,001 to 6,000,000	15	0.433	4,701	9.33	4.53
6,000,001 to 8,000,000	8	0.375	7,050	12.25	4.75
8,000,001 to 12,000,000	6	0.315	9,667	13.42*	3.83
Over 12,000,000	3	0.267	13,931	19.01*	1.34

* Excludes cream supplied as a by-product of powder manufacture.

Procedure: The choice of an exploratory equation and the type of curve to be used was determined from the consideration of preliminary scatter diagrams. These indicated that there was a marked relationship between Unit Costs (X_1) and Output (X_2). A regression, when plotted by free-hand methods through selected group averages, was curvilinear with marked asymptotic characteristics. When unit wage costs were plotted against Suppliers and

Seasonal coefficients, the trends appeared to offset the degree of curvilinearity in the X_1 and X_2 relationship. Especially was this so in the medium and large output range. (See Figure 5, p 80A)

The following procedure was then followed:-

(a) a multiple linear regression was carried out to assess general validity,

(b) data were then transformed to reciprocal and logarithmic forms to test linearity,

(c) a curvilinear multiple regression was next prepared with corrections for X_3 and X_4 to assess the reduction in curvilinearity, and

(d) a final linear multiple correlation was prepared, with curvilinearity removed (almost) by substituting Total Costs for Average Costs in the dependent variable (X_1).

The statistical findings were as follows:-

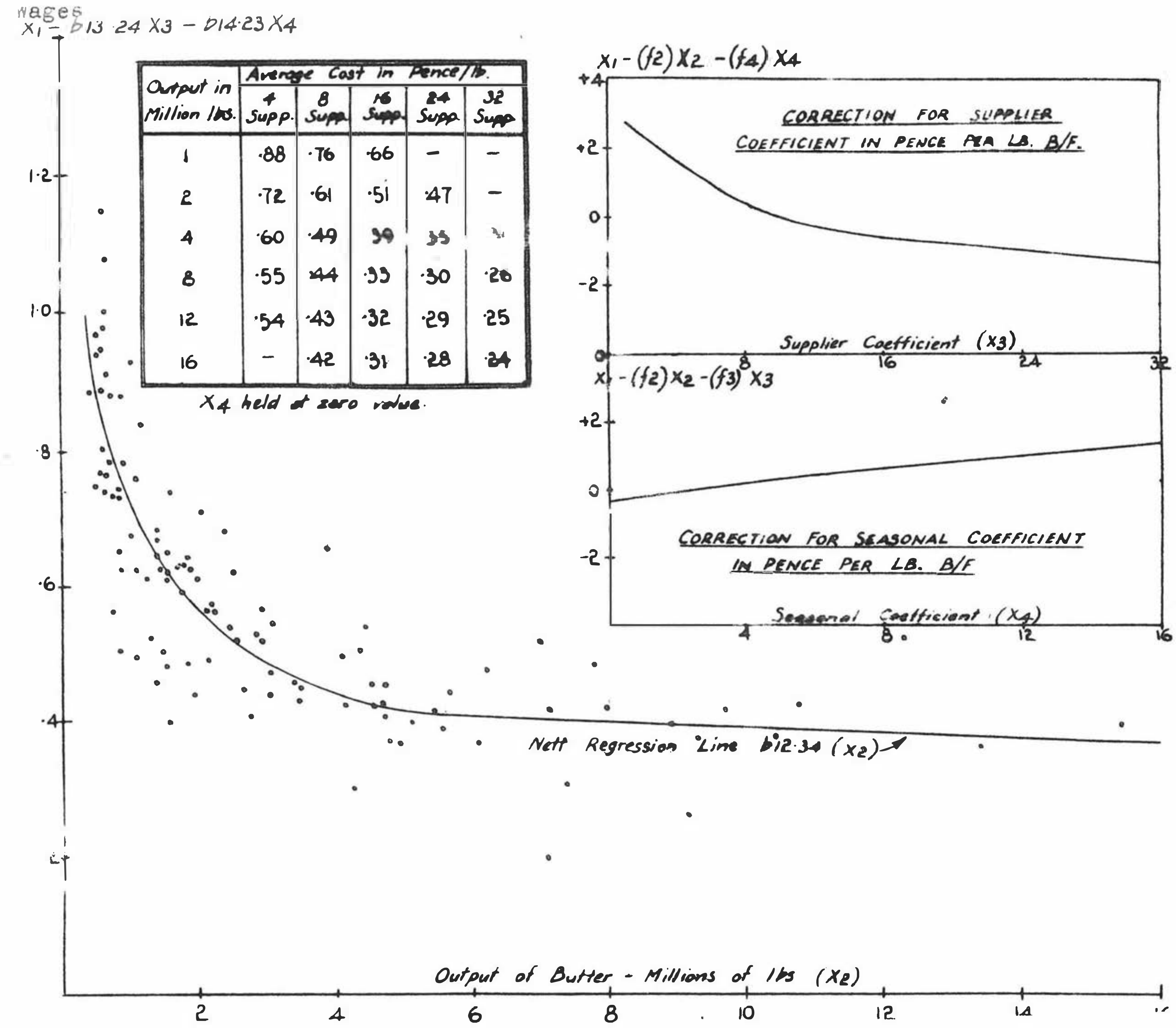
First multiple linear regression: The results were:

X_1 =	0.50998	$-0.00577X_2$	$-0.00074X_3$	$+ 0.01494X_4$	R = 0.7394;	N = 107
	(0.015)	(0.00060)	(0.00099)	(0.00451)	Std. Error	= 0.152
		t = 8.4	t = 0.8	t = 3.3	(5% level;	1.96)

The simple correlation coefficients were: $r_{12} = -0.674$; $r_{13} = +0.329$; $r_{14} = +0.111$; $r_{23} = +0.410$; $r_{24} = -0.205$ and $r_{34} = -0.119$.

While the multiple correlation coefficient is highly significant, and the first two simple coefficients also, that of r_{23} indicates inter-correlation of those independent variables. The inclusion of Suppliers (X_3) is discredited due to its failure to satisfy the criterion of independence and its inter-correlation with X_3 and X_4. The high standard error of estimate indicates that a high degree of reliability cannot be placed on the multiple regression for forecast, and the coefficient of Determination ($R^2 = 0.548$) at the level it is, suggests curvilinearity exists and other variables have been omitted from the regression.

Transformations: The data, when plotted in the logarithmic form, Log Y = log a + Xlog.b, was linear (almost). The reciprocal relationship $\frac{1}{Y} = a + bX$ reduced the asymptotic characteristics of the curve, the Standard Error of Estimate to 0.075 and simple correlation to 0.90 level.



Output in Million lbs.	Average Cost in Pence/lb.				
	4 Supp.	8 Supp.	16 Supp.	24 Supp.	32 Supp.
1	·88	·76	·66	–	–
2	·72	·61	·51	·47	–
4	·60	·49	39	35	[illegible]
8	·55	·44	·33	·30	·20
12	·54	·43	·32	·29	·25
16	–	·42	·31	·28	·24

X4 held at zero value.

Figure 5. Relationship of Estimated Cost & Wages in Pence per lb. B/F to Volume of Production in 107 Butter Factories, 1949/50 Season, showing Corrections for Supplier (X3) and Seasonal (X4) Co-efficients.

Curvilinear Multiple Regression: A curvilinear regression with corrections for X_3 and X_4 was next prepared by the method of "successive approximations".[28] In the final regression (see Figure 5, p.80A) the individual observations lay a little closer to the regression, which through successive corrections by holding each of the independent variables constant in turn, finally became a gentle curve with less pronounced asymptotic characteristics. The Standard Error of Estimate was 0.075 and the correlation coefficient exceeded 0.90. The supplier correction curve was a mildly-downward sloping curve, and the seasonal correction curve a rising straight line, but faintly concave at origin.

Final linear multiple correlation: An examination of the measures obtained from the above calculations suggested probable bias. Although correlation was high in each case and inter-correlation existed between some of the independent variables, it was considered necessary to assess the variables again with X_1 in a non-ratio form, and with certain observations removed from the data. (X_1 now becomes Total Wages measured in '000£s).

Total Wages instead of Average Unit Wages were now used for the dependent variable, for when Output is correlated with Average Wages, the correlation is strictly with $\frac{\text{Total Wages}}{\text{Output}}$, which in itself, gives rise to the curvilinearity, for it is similar to correlating Total Wages with $(\text{Output})^2$. Of the 107 factories surveyed, 14 were branches of multi-product organizations in which labour costs had been reduced considerably by bulk reception of cream and other means. As their total Wages were biased downwards, they were deleted in the revised regression undertaken.

The Total Wages data were as follows: The arithmetical mean for the 93 factories was £4,925 per factory. The average total wage for each class interval of Table XX. as factories increased in scale were: £1,925, £2,920, £5,550, £7,461, £12,400 and £17,010 (includes the last two class-intervals). The 14 factories deleted were from the last three class-intervals so that the relationship between Wages and the Output column of Table XX. is significant, especially for the first four class-intervals.

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[28] See Statistical Appendix E: Note on method of "successive approximations" employed.

The regression was undertaken, then, to attempt an answer to the question: To what extent are Total Wages a function of Output, Supplier Density and Seasonal unused capacity? The hypothesis now examined is Total Wages varies directly with Output, indirectly with Supplier density, and directly with unused capacity due to seasonal, climatic or environmental causes.

The results of the multiple regression were as follows:-[29]

$$X_1 = 1.8851 + 0.15931X_2 \; -0.14454X_3 + 0.00610X_4 \qquad R = 0.965; \quad N = 93$$

$$(0.101) \quad (0.00072) \quad (0.10000) \quad (0.02480) \qquad \text{Std. Error} = 0.989$$

$$t = 221 \qquad t = 1.4 \qquad t = 0.24 \qquad (\text{ 5\% level; } 1.96 \text{ })$$

Coefficients:

$r_{12} = +0.957$; $r_{13} = +0.317$; $r_{14} = -0.093$

$r_{23} = +0.451$; $r_{24} = -0.126$; $r_{34} = -0.202$

$r_{12.34} = +0.961$; $r_{13.24} = +0.205$; $r_{14.23} = -0.205$

$r^2_{12.34} = 0.924$; $r^2_{13.24} = 0.042$; $r^2_{14.23} = 0.042$.

Interpretation of data: With Probability at the 0.01 level or significance, the r_{12} and r_{13} coefficients are highly significant, but r_{14} fails to reach the level of significance. The r_{23}, and to a lesser degree r_{34} both indicate inter-correlation of the independent variables. When compared with the earlier multiple linear correlation data, there is a higher measure of correlation for both $r_{12.34}$ and r_{12} coefficients. When a simple correlation was run for Wages and Output for the 107 factories, the coefficient was 0.843, confirming the extent of the bias in the observations deleted from the survey.

From the partial correlation coefficients, it appears that X_2 (Output) explains 92% of the variation that X_3 and X_4 failed to explain. These latter variables only explain 4% each of that unexplained by X_2. Thus from the multiple, simple and partial coefficients, it is evident that Output is the major variable, the other two contributing only by purely chance relation.

29 See Statistical Appendix E. for further details.

The Standard Error of Estimate, although considerable, (0.989) is approximately 20 per cent of the mean wage cost of the industry (£4,925). While this indicates that the multiple regression is not highly reliable for forecasting, the S.E. is relatively more reliable than that of the earlier linear regression, where the S.E. was 0.152, which is about 33 per cent of the mean unit cost of the industry (0.491d.) Clearly the Total Wage regression is more reliable than the Unit Cost regression as the deviations of the actually observed values from the estimated values are less in the Total Wage regression.

With Probability at the 5 per cent level, the Standard Errors of the regressors indicate that both X_3 and X_4 fail to meet the criterion of reliability and independence. Bunch map analysis revealed that both the Supplier and Seasonal coefficients were superfluous, possibly detrimental, especially the Seasonal. Besides revealing inter-correlation, the beams of X_3 and X_3 were considerably diminished, that of X_4, very considerably diminished, indicating their lack of importance as variables. It should be observed that, whereas the X_4 regressor was reliable in the Average Wage regression, it now becomes highly unreliable in the Total Cost regression, which indicates that the removal of the bias has placed more significance on the Output variable to the detriment of the other two.

Conclusions: All correlation coefficients and measures indicate the importance of X_2 (Output) and the lack of significance and reliability of the other two variables, X_3 and X_4. Thus the hypothesis that Total Wages varies directly with Output and Seasonal factors, and indirectly with Suppliers is discredited. It appears that Wages is almost entirely a function of Output when measured statistically. Further, linear Total Wage regression explains more of the variance than Average Wage regressions whether based on linear or curvilinear calculations.

Summary: Although the supplier and seasonal coefficients are discredited statistically, they have considerable cost importance and economic significance in manufacturing. Statistically, there is a distinct linear relationship between Total Wage cost and Output. When X_3 and X_4 are removed from the regression, ($X_1 = 0.8306 + 0.15931X_2$), the b. constant indicates that for each 100,000 lb. increase in output, Wages will increase at the constant rate of £159.3. The relatively high S.E., however, precludes a high degree of reliability in forecasting wage costs from output.

D. FACTOR SUBSTITUTION AS AN ELEMENT CONTRIBUTING TO ECONOMIC EFFICIENCY.

In order to achieve multiplicity of ends, of which maximum possible revenue is a prime one, labour tends to be substituted for other factors. To minimise total costs, each factor tends to be employed to the point where its marginal cost just equates its marginal revenue. Labour costs, tend to increase with scale unless substitution of labour takes place. The following analysis attempts to indicate the character and extent of this substitution.

The average unit wage cost per lb. of butter decreases with greater volume.[30] But it must not be assumed that the reduced unit wage costs reflect efficiency commensurate with such reduction. For example, the average unit wage cost of each class-interval of output drops from 0.952d./lb. for the 27 factories producing under 1,000,000 lbs. to 0.267d./lb. for the three factories producing over 12,000,000 lbs. per annum. That is, costs are almost four times as great in the small output factories as in the large output factories. But this does not mean that the large factories are four times more efficient than the small factories, for, to a considerable extent, power costs, (coal and electricity), interest on additional plant, machinery and equipment, administrative costs, repairs and maintenance, and other capital costs have been substituted for labour costs.

The extent of the substitution may be gauged from the ordinal magnitude of the following cost relatives:

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[30] See the third column of Table XX, p. 79, for this decrease of unit costs.

TABLE XXI. UNIT COST RELATIVES OF SMALLEST AND LARGEST OUTPUT GROUPS OF FACTORIES[31]

Factory Output of Butter in lbs.	Unit costs in pence per lb. butterfat							
	Wages	Total Costs	Capital Costs			Sdry. Mnfg.	Power Costs	Adm. Costs
			Interest	Deprecn.	R.& M.			
Under 1m. (A)	0.952	3.990	0.019	0.183	0.182	0.023	0.248	0.245
Over 12m. (B)	0.267	2.828	0.000	0.067	0.187	0.020	0.151	0.059
(B)/(A) %	28.05%	70.88%	- - -	34.14%	102.7%	86.96%	60.89%	24.08%

In the above table, the (B)/(A) percentage of total costs (which includes all manufacturing costs to F.O.B.), is 70.9%, whereas that for Wages is 28.0%. Or, stated differently, the largest-output factories have reduced unit wage costs to 28% of that of the smallest-output factories, but have reduced unit total costs only to 71%. When the element of Wages is extracted from total costs, the residual total costs are reduced by largest-output factories to only 84%. That is, the largest factories have reduced wage costs to three times the extent of all other costs - an indicator of the extent of substitution of wage costs for other factor costs as volume of output increases.

It is true the residual total costs includes elements of constant costs, such as materials, Dairy Farm Instruction and Dairy Board Levy costs which approximate 0.840d. for all factories regardless of size. When allowance is made for these constant cost elements, the residual total cost figure for large factories is reduced to 78%. Even this figure is highly significant when compared to the 28% to which Wages have been reduced.

Further, it is recognised that these scale reductions are partly due to increase in technical efficiency and external economies of scale

[31] See Table LXIV. p.334 for fuller details of each class interval.

arising from exogenous causes, but even so, economic choice has regulated the balancing of various factor costs arising from all causes to maximise cost efficiency.

The total capitalization costs which include Interest, Depreciation and Repairs and Maintenance, represent the costs of increased outlay in mechanization, plant, equipment, and buildings, (including cool-storage space). The total reduction in capitalization costs is to 66%. Of this, Repairs and Maintenance shows an actual increase of 3%, while depreciation drops to 34%. It is interesting to note that (from Table LXIV,) both Depreciation and Interest drop only to a small extent with increase in scale up to the 6 million output level, but decrease rapidly after that point. As regards depreciation, the sudden reduction is due to large multi-activity factories diverting the bulk of the depreciation charges to powder manufacture and other activities for competitive reasons.[32] It is doubtful, therefore, if there is a reduction to much more than 80% for capitalization costs.[33]

Sundry Manufacturing Charges shows a constant reduction to the 6 million output level, then increases considerably with increasing scale.

Power costs, (refrigeration, factory power and steam) show a reduction to 61%. The reduction is greatest at the 4 to 6 million output level, at which point the technical efficiency of consumption of both coal and electricity appeared to be at its maximum. The high costs of low-output factories arose from unused capacity, so that substitution effects begin to appear after the two million level output. Increased mechanization at this point appears, and it is at the 2-4 million level that labour costs diminish

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[32] The inadequacy of depreciation provision for butter manufacture, and the extent to which depreciation costs are diverted elsewhere, are discussed in Section IV of Part IV pp. 213-215.

[33] Although manufacturing is largely done by labour input in smaller factories, the larger factories still employ a lower proportionate amount of capital. Factor substitution is therefore concealed in the figures given above.

as an outcome of substitution, rather than from technical cost savings arising from increased volume.

After the 6 million level of output, costs tend to increase, partly due to more intensive mechanization, and partly owing to wastage and technical inefficiency. Other elements tend to distort the extent of cost reductions of power as scale increases. In addition to unused capacity in small factories, location itself, has caused small factories to pay much higher factor prices for coal and electricity. In terms of physical in-puts of power, the cost disparity is considerably reduced even further, so that in the 1 to 2 million output level, where factor prices compare more favourably with larger factories, power costs have actually increased to 127%, suggesting that the smallest factories are unduly penalised by location and unused capacity.

Administrative costs show a reduction to 24%, but as it is not until factories reach the 1 million level that they tend to have their own administrative staff, a comparison between that level and larger factories of the 8-12 million output level is more significant. The cost reduction is then approximately 50%.

It is difficult to assess at what point substitution does take place, as this depends on managerial decision affected by administrative ability to finance the procurement of plant, machinery and buildings. Many managers are hampered by this financial aspect, but have planned ahead to this end. It is evident that labour substitution has taken place with increased efficiency as a result, and it is considered that costs will be reduced further by this means in the process of time.[34] The steady increase of innovations (such as automatic butter packing machines) will augment this, as will factory amalgamations which usually bring in their train the scrapping of obsolete plants and methods.

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[34] Every substantial increase in award rates initiates further factor substitution, (because capital items do not rise proportionately at the same time.)

Finally, the fact remains that unit labour costs tend to increase through time (with increasing fringe benefits, accommodation and statutory award increases), while mechanization costs tend to decrease.[35] Consequently it can be expected that labour will continue to be substituted increasingly with cost efficiency as a result.

CONCLUSIONS:

Those aspects of technical efficiency which may be affected in isolation, are set out in Appendix D. where the results of time-motion studies and suggested remedies are indicated.

As regards economic efficiency of labour, the most significant factor is substitution which is determined by choice at the managerial level and generally operates as a result of increased technical efficiency and greater volume, (output). Aspects of choice are seen in labour turnover problems where lower technical wage costs are balanced against staff retention costs, and in the proportion of fixed costs to aggregate costs where the technical advantages of reduced variable cost elements are balanced against the substitution of fixed cost elements with their lower unit costs.

The considerable reduction in unit wage costs as scale increases, is partly technical (elimination of waste, under-capacity, and maladjustments), and partly economic in that wage costs have been substituted for other factor costs (power, capital and administrative), so that the reduction in labour costs is more apparent than real.

The analysis of labour turnover indicates that approximately one-third of the turnover can be attributed to output but offset by fringe benefits such as accommodation, the balance being probably due to a complex of sociological and psychological causes. Wage variations were not significant.

The wage cost regression indicates there is a distinct linear function between wage costs and output, but that supplier-intensity and seasonal con-

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[35] The demand for capital, and its adequate provision and retention, is a matter of considerable significance for efficiency, as many factories are quite unable to replace obsolete plant, equipment and buildings.

siderations were not significant as affecting the relationship. More than four-fifths of reduced labour costs are associated with increased scale, the balance being due to managerial, technical and geographical differentials.

PART III.

TRANSPORT EFFICIENCY IN THE BUTTER INDUSTRY IN N.Z.

SECTION I. INTRODUCTION

Part III surveys the efficiency of Cream Haulage from the farm gate to the factory,[1] and deals with various methods of cream haulage, the distances covered, the nature of the routes traversed, supplier-distribution, the poundage of cream lifted, the frequency of collections together with their relative costs, and economic efficiency. Time-motion studies which were purely technical in character, and also statistical details of cream shelters are set out in Appendix F.

Historical: Although this survey relates to the 1949/50 season, and the corresponding statistical and time-motion sections relate to observations made in the summer of 1950/51, to a large extent, increase in transport efficiency has certain historical aspects. These are touched on in the Dairy Industry Commission Report of 1934.[2]

> "In the early days of the dairy industry, whole milk from farms was carted to butter-factories or creameries, which were erected at points that could be conveniently reached by a sufficiently large number of dairy-farmers to provide the supply necessary for economic manufacture. These factories, once established, have in most cases remained, notwithstanding that the introduction of the home separation system, the evolution of motor transport, and the provision of good roads have entirely altered the situation, and rendered it unnecessary to maintain a large number of small factories. Butter manufacturing companies, in their anxiety to continue their operations, and under stress of competition, have gone beyond their own territories to obtain larger supplies of cream in order to secure

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1 It is not intended to examine other transport activities related to butter manufacture in Part III. Factory-F.O.B. haulage, and transport as a subsidiary activity will be dealt with in later sections of the study.

2 Report of the Dairy Industry Commission, (1934): Govt. Printer, Wellington. Para. 249, p. 101.

increased outputs and thereby reduce their costs of manufacture."

The Report then indicated how overlapping and competition gave rise to malpractices and recommended zoning as a measure to increase economic efficiency in cream collection.

Zoning, in due course, was successfully implemented, but a certain amount of infringement took place.

(i) By contractors who have penetrated other zones.

(ii) By contractors who collect cream for more than one company.

(iii) By mutual agreement between companies.[3]

(iv) By straight-out pirating, especially where a strong company was adjoined by a weak, smaller company.

(v) Where zones have been affected by changes in transport routes, amalgamations, new dairy manufactures or farming practices.

Later, improvements in roads and larger and faster trucks permitted greater distances to be covered in cream collection. This created the possibility of expansion by extending the collection frontier. Larger factories opened up distant areas from the factory, and then had to resort to certain practices to keep haulage costs at an apparently low level.

These practices include[4] the transfer of part of the costs to delivering stores, the technical means of less frequent collections, the concealed transfer of part of the costs to suppliers (but not disclosed fully in the published annual accounts), and the technical means associated with auxiliary processing units which yielded cream as a by-product on the factory site.

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3 In one instance, the writer observed three lorries owned by three different companies loading cream from one stand. The first lorry took 5 cans, the second 3 cans, and the third 2 cans. In another instance lorries from Company A delivered Cream to Company B and vice versa. When questioned, the manager simply said; "It suits both companies to do it this way".

4 See p. 93 for fuller discussion .

During war years, as a result of labour shortage partly, the use of the articulator and larger capacity lorries became more marked. At the time of this survey, some companies were beginning to move towards smaller capacity lorries, making two, three or four sorties or collections per day. Moreover, more than one company had been considering tanker collection, and by 1950 one experimental route was established, which proved to be the forerunner of large-scale tanker-collection technique.

Thus, through several decades, organizational and technical improvements have been developed with a relative decrease in unit costs as a result. These reduced costs have been partly offset by increased operational costs, increased capital costs, and increasing costs arising from scale. At the same time, scale has been instrumental as a factor in reducing unit costs, other things being equal.[5]

Source of Data: Descriptive and statistical data were obtained from:

(a) Published annual accounts and duplicated reports supplied by various companies.

(b) Examination of books of first entry of company accounts.

(c) Personal interview by enumerator, who filled in schedules from answers supplied by company officials.

(d) Details about suppliers, and location from questionnaires sent through, and returned by, post.

Time-motion studies were made personally by accompanying lorry-drivers over entire routes and filling in multi-column, route-control charts for each route. Up to 30 sheets were required for each route as variables were plotted at 30 second intervals. Other details of route-control charts were completed later from company's records (e.g. cream weights, gradings etc.).

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[5] Generally speaking, certain administrative and overhead costs such as Director's fees, audit, cost of supervision etc., tend to increase relatively with scale, whilst outlay, for example, on labour-saving vehicles, (made possible by increase in scale), tends to reduce unit costs.

<u>Limitations and necessary assumptions:</u>

In addition to the lack of factor homogeneity, is the limiting fact that many companies arrange for cream haulage by contract. Indeed, even when companies operate their own fleet of lorries, they often resort to auxiliary means in cream collection. Contract rates vary - haulage conditions vary even where rates are similar. In fact, there is a marked heterogeneity and complexity in the payment of contractors, even when they operate over the same routes. It is quite common in some parts for a contractor to have 3 or 4 differential rates for one route depending on the time of the year and the quantity of cream hauled. Obviously there are real difficulties and statistical pitfalls in comparing contractors' costs with haulage costs incurred by the companies themselves, for the former have a percentage of profit added and usually protect themselves against unused capacity and non-operational days in one way or another.

Even where factories have similar outputs and suppliers, other factors may vary considerably. Roads will vary; also route lengths, density of suppliers, can sizes and stand facilities. One company may distribute stores, insist on can-grouping, forbid waiting for cream, or other unproductive time. Lorry capacities and types will vary. Large-capacity lorries involve much time consumed in sorting cans, unloading and re-arranging empties, or locating individual cans. Lorry-running costs vary for the same vehicle depending on the driver, the amount of maintenance attention given the vehicle, the condition of the roads, the weather and the protecting device afforded the cream.

Then charging of actual running costs vary. Some companies may charge part of running costs to Store-Trading Account, Wages to Cream Reception (where drivers assist in unloading etc.). Some companies engage in outside transport work such as general haulage, and often charge general overhead against such work. Others utilise drivers and trucks for F.O.B. haulage and inwards stores and coal transport. Some companies charge winter wages of drivers against repairs and maintenance to a greater extent than others.

Consequently, the lack of factor homogeneity is a serious limitation and must be borne in mind in comparing transport costs. Wherever possible, identical transport organizations have been compared, especially where route conditions and supplier dispersions are similar. Otherwise it has been necessary to resort to unit cream collection costs as a basis of comparison, assuming the company has utilised the minimum cost-combination to meet its own environmental circumstances.

Definitions: The following apply to this section:

Contractors: Any person or organization rendering services to a co-operative dairy company in haulage, transport or delivery of cream, milk, or related dairy produce, or stores, for emolument, compensation, or reward. Such definition is intended to include all transport services, rail, bus, ferry, launch, or ship; all haulage contractors and their sub-contractors; self-deliveries by farmers, and haulage performed by other dairy companies.

"Dead-Mileage": Distance from the factory to the first loading point in cream collection.

"Pick-up-Mileage": The length of route covered from the first loading point to the last.

SECTION II. CREAM HAULAGE DESCRIBED.

Methods: Cream arrives at factories by road, rail and water. Haulage is undertaken by the company itself in its own lorries, by contractors paid by the company, or by the supplier at his own expense, subsidised, or at the company's expense. Most of the cream arrives by road in lorries owned by the company or by contractors. The greater part come in suppliers' cans, ranging from small "billy-cans" to 10 to 12 gallon cans or larger, but an increasing part of the cream supply is arriving as a by-product from auxiliary undertakings.

Over 97 per cent of the cream arrives by road, about 2 per cent by rail and less than one per cent by water. Of eight factories receiving part of their cream by water transport, one receives approximately one-half this way, two receive over 25 per cent, and the remaining five varying odd amounts. Two of these receive cream by river transport, five by harbour ferries or launches, and one by open sea transport. Three companies receive more than 10 per cent by rail, 18 receive small quantities ranging up to 10 per cent, and many more receive an odd can or two picked up by lorries on their collection routes, from rail discharging points.

There are six companies receiving more than one per cent delivered by suppliers themselves. One company receives about 75 per cent, another more than 25 per cent, and the others less. Quite a few companies have one or two farmers living near the factory who deliver their own cream. In some districts, farmers deliver their winter cream, while in some companies, suppliers arriving late with their cream for the collection lorries must deliver their own.[6] Actual deliveries by suppliers to factories is less than one per cent of total deliveries, and various ways are used - lorries, cars, carts, and tractor-drawn trailers.

There are nine factories which receive more than 25 per cent of their cream from non-supplier sources, and another fourteen who receive between 10 to 25 per cent in this way. In addition, more than 60 factories receive some cream from non-supplier sources.[7]

There are 47 factories which receive all their cream through contractors only; 31 use their own lorries exclusively, 17 use their own lorries for 70 per cent or more of cream received, and 18 rely largely on contractors but use their own lorries to some extent. Approximately 50 per cent of cream arrives on contractors' lorries.

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[6]In most companies, outlying suppliers bring their cream to collection points. Some bring their own and neighbours' cream several miles to a collecting point for remuneration. Others group their cans at handy loading points on cream routes. It has not been possible to assess the extent of this, but it is quite considerable in some districts and almost non-existent in others.

[7]The term "supplier" refers to farmers; "non-suppliers" include all non-farming sources - auxiliary dairy manufacturing units owned by the company or separate enterprises, town and city milk distributing authorities, and cheese factories. Where auxiliary manufacturing plants are owned by the company, the cream may not be transported at all, but transferred by pipe. In these cases, the cartage of whole milk has been charged to the auxiliary product and does not appear as a cost of butter manufacture. There is a marked tendency in some large companies to utilise whole milk for auxiliary manufacturers up to a ten-mile radius or more, and receive cream from distant suppliers only.

Contractors: There were 282 contractors operating throughout New Zealand on the haulage of cream to factories for the 1949/50 season. These contractors range from individual farmers who take their district's cream to the factory, to large organizations serving a range of factories.

Most companies utilising the services of contractors, enter into an agreement which sets out specifically the terms, conditions and rewards for the services to be rendered. Such contracts vary considerably but usually cover a given period of time, the scope of what is to be carried, the method of payment, (by weight, distance, time etc.), the routes to be covered, the minimum number of days a year cream is to be collected, together with provisions for emergencies, can protection, waiting-time for cream, haulage rates for sundry stores, and indemnities covering company and supplier property.

In many factories where contractors and the company both operate, it is usual for contractors to bring cream to some point on routes served by the company's lorries, and cans are loaded on to these lorries and brought to the factory. That is, the contractor serves as a "feeder" for distant, outlying or inaccessible suppliers.

In certain districts surveyed, the feeder system was certainly the most economical, for the extra cost to the factory of the additional haulage by employing their own lorries, would have been in excess of the local contractors' charges. Many of these contractors are themselves suppliers, who agree to bring all the cream (say, in their valley) to a feeder point, and take back the empty cans on the return journey. Moreover, the above system enabled the cream to arrive at the factory at an earlier time than would have been possible otherwise.

Some companies utilising contractors' services as well as their own lorries have advised that they are changing from self-service to contractors. Others, prefer to retain certain short-distance rounds for themselves, letting the long distance routes to contractors. A few have been compelled to put on their own lorries in certain areas which are not well-served by adequate competitive transport facilities. Again, one or two companies have advised that they have retained two or three lorries as a means of keeping cartage rates under control by comparing their costs with those of the contractors.

In all, the sum of £356,283 was paid out to all contractors for cream haulage in the 1949/50 season, whilst the total sum for all cream haulage as revealed by published accounts amounted to £644,948. It is not possible to make a valid comparison as to the costs of the two methods - contractors' costs and factory-lorry costs. In the first place no two routes, terrains, districts, or distribution of suppliers is sufficiently alike to permit comparison. Secondly, where both methods operate side by side, the company's lorries usually cover areas near the factory and contractors serve more distant areas. Thirdly, contractors' lorries can be employed on haulage other than cream so that overhead costs are evenly spread. Many factories have lorries operating at less than full capacity, although most large companies have goods licences and use their vehicles for an eight-hour day or more in order to reduce overhead unit costs. Fourthly, contractors are operating for profit whereas factories are operating on a cost basis. Some companies, however, operate their transport department as a subsidiary company and charge the factory haulage at competitive rates.

Whereas it has been possible to obtain a fair coverage of haulage costs of companies operating their own fleets, it was not possible to obtain from contractors detailed cost data relating to cream haulage alone, except in one or two isolated cases. The contractors' costs or charges covering 212 routes for a number of factories in a typical district were as follows:

No. of routes surveyed	212
Total cost to factories	£147,886
Average cost per route	£698
Total B/F carried	61,871,755 lbs.
Unit cost per lb. B/F.	0.574d.

Of the 212 routes, 194 were based on a given charge per lb. B/F. carried, but 21 of these had a supplementary charge of so much per trip. The balance, 18 in all, charged a flat rate per mile which varied between 1/3d. and 1/6d. per mile. Many of these rates were calculated to two places of decimals per lb. of fat, and others in vulgar fractions, e.g. 57/128d.

The following classification shows the various rates classified for 212 routes.

Rate: d.	No. of routes	No. with supplementary charges
Up to 0.30	19	1
0.31 - 0.40	48	3
0.41 - 0.50	46	5
0.51 - 0.60	27	2
0.61 - 0.70	29	2
0.71 - 0.80	12	6
0.81 - 0.90	4	-
0.91 - 1.00	10	-
1.01 and over	9	-
On mileage basis	18	2
	212	21

Of the above, two routes accounted for more than one million lbs. B/F. per annum, and the other routes mostly varied from 100,000 lbs. upwards. The number of collections per annum varied from 136 to 309.

It is interesting to note that the average cost for cream collection for all New Zealand is 0.508d. per lb. B/F.[8] That for the 212 routes which were selected as typical routes, was 0.574d. It would appear that contractors' charges are higher than factory costs for cream haulage. Of the 47 companies using contractors only, some 27 were higher than the New Zealand average, and 20 below. Of the 31 companies using their own lorries exclusively, some 14 were above the Dominion average and 17 were below. When their weighted costs were averaged their relationships were not dissimilar to the pattern outlined; that of the contractors was 0.552d. and that of the factories, 0.454d.

Frequency of collections: The number of times cream is collected depends upon a number of factors, the more important being climate, topography, episodic or fortuitous happenings, and managerial decisions.

Climatic conditions arise largely from geographic location, and determine the characteristic periodic variations in output which recur in an

[8] New Zealand Dairy Board's 26th Annual Report op.cit. p.29.

undulatory way from year to year. Climate affects those seasonal factors which determine the length of the lactation period and govern the spatial frequency of cream collections throughout New Zealand.

Topographical factors include those that affect the distribution or dispersion of suppliers in any given area or district. The topography of the farm land plays a considerable part in the frequency of cream collection. Topography may affect distance of suppliers from the factory. The more distant the supplier, the less frequent tends to be cream collection, especially in the off-season. Another topographical element is the condition of roads. Bad, unmetalled roads, or time-consuming hilly roads or sand tracks cause a reduction in cream collecting frequency. Water transport, rivers, harbours or sea, cause a marked diminution in frequency, due largely to cost.[9]

Episodic or fortuitous happenings usually affect an entire district or province in a major way, and the whole of New Zealand in a minor way. These happenings are irregular in incidence and usually cause a specific change in the normal pattern of frequency. Thus a drought may be peculiar to a given district or province, or may be widespread, but is episodic or fortuitous in occurrence and causes a diminution in the quantity of cream collected. Another illustration of this would be a severe outbreak of some disease affecting lactation.

It is difficult in many cases to say precisely the number of times cream was collected for a given factory, for wherever topographical disadvantages occur, there is a tendency to maintain cream collection for the low-cost routes whilst curtailing the high-cost routes. Especially is this so where the quantity of cream from high-cost route areas is relatively less than from low-cost areas. In some factories, it is a custom to receive high-cost cream every second day, even during the flush of the season. Quality is partly controlled by double vacreation and segregation of cream, for it is

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[9] Thus cream from Great Barrier Island was transported 188 times during the year under survey. One other factory, with a considerable percentage of river transport collected cream 137 times.

considered that the additional cost of extra vacreation and lower grade butter netts a greater return and therefore payout than does the practice of daily reception for all cream.[10]

Managerial factors include all managerial decisions calculated to affect costs of cream collection, improve quality of butter manufactured, or otherwise promote smooth functioning of all operations connected with butter making. The very quantity of cream during the flush of the season, the length of lactation period, and climatic and environmental factors all contribute to the policy followed by management. This policy is often a compromise between unit costs and quality. Some managers, for competitive reasons, prefer to minimise costs, others to maximise premium butter. Where cream collection is carried out by contractors, frequency tends to increase, and, conversely, to decrease where the company collects its own cream. There are obvious reasons for this.

Turnover of lorry-drivers is relatively very high and most factories have difficulty in retaining adequate staff for the entire season. Sickness or absenteeism is usually met by curtailing collection of high-cost routes when the flush of the season is past. Supervision of cream-collection is a serious problem for managers even when the company employs a transport manager. This in itself tends to cause management to curtail rather than prolong the period of cream collection. Penal rates for Saturday and Sunday collections is also a factor.[11] Clearly these difficulties are not so great when management relies on contractors for cream haulage.

Some managers, (other things being equal), plan their frequency of collection in such a way, that the daily poundage of cream collection varies as little as possible. That is, if the factory receives in the flush of the season in the vicinity of 25,000 lbs. of butterfat per day, management will endeavour so to control frequency, that each time cream is collected, the aggregate approximates 25,000 lbs. As the off-season approaches, cream

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[10] At least one manager claimed that his duty to his shareholders lay in maximising payout, not in winning prizes for quality butter for personal advancement.

[11] There are a few small factories which do not collect cream on Sundays, even during the flush of the season, due largely to this reason.

collection is omitted one day, then two days and so on, the intervals increasing until a maximum practical interval is reached consistent with a constant intake of 25,000 lbs. of butterfat. Not only does this technique minimise collection costs, but also manufacturing costs.

The following figures show the frequency of cream collection for

(a) factories with consistent collections from all routes,
(b) factories with variable collections from all routes.[12]

Frequency (per annum)	Factories (consistent)	Routes (variable)
Under 100	-	3
101 - 200	3	11
201 - 250	7	10
251 - 300	26	28
Over 300	11	4
	47	56

Larger factories tend to have more frequent collections.

Condition of roads: Roading is a non-controllable topographical factor from the point of view of the factory, but the actual condition of the roads affects haulage costs. For the purpose of classification, all roads surveyed were classified according to surface and according to gradient. They are:

Surface: Tarseal: (includes bitumen, concrete or other types of sealed roads).
Metal: - first-class
Metal: - second-class[13]
Unmetalled.

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[12] By consistent collections is meant collections from all routes, or curtailing all routes as distinct from the practice of curtailing some routes only.

[13] The distinction between first-class and second-class roads does not necessarily conform to the Main Highways Board classification. Second-class roads were those tertiary roads causing loss of time when lorries had to manoeuvre due to narrowness of metalled built-up portion. These roads moreover, were poorly maintained, poorly graded, and had many unbridged streams. The distinction is arbitrary but sufficient.

Gradient: Hilly: Requiring lower gear work for periods of more than one minute.

Undulating: Gradient causing definite loss of speed and occasional change of gear for short periods.

Flat.

These classifications were selected as road conditions had a two-fold effect - on costs and on time consumed in cream collection.

Some 25 routes selected from typical factories covering several districts in the North Island were measured and classified as follows:

Total mileage examined	981 miles
Average length of route	39.24 miles
Percentage Tar-sealed	46. 0 %
Percentage Metalled, first-class	46. 6 %
Percentage Metalled, second-class	6. 4 %
Percentage unmetalled	1. 0 %
Percentage classified as Hilly	6. 0 %
Percentage classified as Undulating	12. 5 %
Percentage classified as Flat	81. 5 %

Of these 25 routes not one was totally tar-sealed, but 11 were 50 per cent or more tar-sealed whilst 7 had less than 25 per cent of tar seal. Moreover, only 5 routes had more than 10 per cent of second-class metalled road, while three had short lengths of unmetalled road which included unformed road, sand-formation and clay roads - all impassable in bad weather. Six routes had more than 10 per cent hilly, and ten routes had more than 10 per cent undulating. Eight routes were classified as entirely flat.

The better the surface of the road, the lower tended to be running costs, repairs and maintenance and petrol consumption. The greater the percentage of tar-seal, the lower (other things being equal) will be petrol consumption. This is especially true in wet weather where the frictional "drag" is most noticeable on metal roads.

During the survey of these routes, a full time-motion study programme was followed and it was observed that all hold-ups, due to road conditions (slips, repairs, drain insertions, manoeuvring past graders, road works) occurred on metalled sections of the road. Approximately 4 per cent of the metal road (during the time the survey was made) was in a condition of disrepair necessitating a dimished speed.[14] Often it was necessary to engage

[14]See Appendix F for data and diagrams relative to these routes. These route surveys illustrate well the falling off in speed due to inferior roading conditions experienced, and also low-gear work on hills.

a lower gear on a level grade mainly because the surface of the road was rough or storm-torn. It was noticed that where the grader had been working on the roads, the speed and driving was more consistent.

On the second-class metal roads, not only did the cream trucks have to pull to one side to permit other vehicles to pass, but general speeds were reduced as well. Moreover, it was observed that loading time for cans was usually longer than that taken on other roads. This arose from the camber of the road being too steep in most cases to permit the lorry running off the road to where the cans were sheltering. Because of the shoulders of the road, shelters were usually set well back from the edge of the road. This meant longer loading time as cans were sometimes carried over 25 yards to the tray of the lorry. In a few cases, the camber of the road formation was such that the top of the cream can on its shelter was below the level of the crown of the road. In fact, the average time taken to load one can on narrow roads was 31 seconds, whilst that on wider roads under similar conditions was 24 seconds.

Hold-ups due to stock grazing were largely on narrow roads. At times this may give rise to a considerable loss of time.

Although this 5% sample is small, yet it is of ample proportions to indicate certain problems that exist, and to call attention to the need of improved roading in many districts that are relatively rich in butterfat production.

Trucks employed: The following description applies almost exclusively to trucks owned by companies and operated by them for cream haulage. In some cases haulage is supplemented by contractors.

Some 51 companies owned 315 trucks, a little over an average of 6 vehicles apiece. Their distribution is as follows:-

Number of trucks owned	Number of Companies
1	3
2	5
3	11
4	4
5 to 7	12
8 to 10	4
11 to 16	7
17 or more	5
	51

Generally speaking, the trucks ranged from 30 cwt. vehicles up to 5 to 6 tonners and large-capacity articulators. It was observed that a given capacity vehicle was favoured in a given district. In one area three-tonners prevailed, in another 5 to 6 tonners and in yet another, articulators. Occassionally, trailers were used.[15] Some trucks were fitted with drop-sides for loading cans, others had approximately ½ inch battens which were sufficient to retain the cans safely on the tray. A few lorries and some articulators were fitted with rails about nine inches above tray-level. These rails could be removed when cans were being handled extensively. Also some lorries were fitted with an additional platform about four and one-half feet long immediately behind the cab for carrying additional cans. These platforms could be erected in a few minutes when required, and afforded an additional carrying capacity of 20 to 25 per cent in peak months. A few lorries had platforms at both ends, as did some articulators. Only rarely were adapted low-level tray-heights seen, for little attempt had been made to reduce the height of the tray for loading purposes. The tray-level of the articulators was usually some inches higher than that of the standard lorry tray.[16]

Details of the types, tonnages and ages of some 247 vehicles operated by these companies were obtained. They were classified into Articulators (I), 4 to 6 ton capacity (II) and under 3½ tons (III), as these three capacities cover all the makes examined.

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[15] These were used to great advantage to minimise handling, congestion, and time consumption. Trailers are considered an improvement on articulators under most conditions of haulage.

[16] One reason for this height of trays is that the trays need to be sufficiently high to match the unloading platforms at the factories. At the same time, a considerable amount of onerous lifting of heavy cans occurs, and lower tray-levels would be a time-saver and should present little difficulty in unloading, if suitable ramps were utilised for the purpose.

Makes and capacities		No.	Total
Austin	(I)	8	
	(II)	14	22
Bedford	(I)	22	
	(II)	43	
	(III)	32	97
Chevrolet	(I)	3	
	(II)	13	
	(III)	20	36
Commer	(I)	1	
	(II)	12	13
Dodge	(III)	2	2
Diamond T	(III)	1	1
Ford	(I)	6	
	(II)	34	
	(III)	21	61
International	(II)	7	7
Morris	(II)	4	
	(III)	2	6
Reo	(III)	2	2
			247

This classification contains 40 articulators, 127 heavy-weight lorries (including one six-wheeler) and the balance of 80 in medium and light-weight lorries. These lorries were of varying ages and it was not always possible to obtain the length of time they had been running or had been owned by the company. Details of 160 lorries were available in this respect and their various ages are as follows:

Age	Percent of total*
Up to 1 year	21
From 1 up to 2 years	15
" 2 up to 3 "	14
" 3 up to 4 "	8
" 4 up to 5 "	4
" 5 up to 6 "	4
" 6 up to 7 "	9
" 7 up to 8 "	7
" 8 up to 10 "	10
Over 10 years	8
	100

* It will be observed that 50% of the vehicles are under 3 years old, another 25% up to 7 years, and the final 25%, 7 years and over. This distribution of old vehicles is largely due to shortage and raticence in spending during the war years. The older the vehicle, the greater is the cost of maintenance.

In addition to the 247 vehicles classified above, details were available of an additional 39 vehicles as regards annual mileages run on cream collection. These mileages covered cream collection only, as some of the vehicles were engaged in up to double the cream-collection mileage on other haulage work including carrying under general licence. The total mileage run by 286 vehicles of all types was 3,361,997 miles or an average of 11,752 miles per vehicle.

Allowing an average of 270 collections per annum, the average distance covered per lorry per day is 44 miles. It must be remembered, however, that in some companies the policy exists of having one vehicle make two or three short rounds each day in order to have the cream flowing in continuously. This obviates all the lorries returning with their loads within a short compass of time.

The distribution of annual mileages on cream collection of 286 vehicles is as follows:-

Annual mileage	No. of vehicles
Under 5,000	3
5,001 - 10,000	128
10,001 - 15,000	79
15,001 - 20,000	53
20,001 - 25,000	21
Over 25,000	2
	286

Excluded from the 286 vehicles were those lorries held by their companies as reserve vehicles on account of breakdown. These were usually old machines with mileages recorded up to 1,000 miles or more per annum. The general pattern of the distribution can be readily seen, being assymetrical in character. The modal run was 6,800 to 7,000 miles per annum per lorry, the tendency being to taper off gradually from this point. The figures above relate to actual mileages recorded by the vehicles themselves. In nearly every company a vehicle would collect 5 or 6 times a week, the balance of the collections being made by relief drivers in relief lorries. For this reason, the actual mileages covered over these routes would be greater than those recorded.

<u>Organization of cream collection</u>: Both scale of the company and the extent to which the company engages in general haulage affect the organization of the fleet of vehicles. Although most large companies possess general carriers' licences, a few small companies do likewise in order to spread and recoup the cost of overhead, depreciation, and general maintenance of vehicle. The position will be examined first of all from the point of view of scale alone, and then with the additional factor of general haulage.

Small companies possessing one or two lorries usually organise cream collection as part of the general overall activities of the factory. That is, the function of cream collection is not specialised. The truck driver is a general hand performing routine duties during cream reception and the rest of the day. His duties take approximately 1½ hours on cream collection, and some servicing of truck during the afternoons. Four or five of these small companies do not collect cream on Sundays, but the relief driving is often done by the manager or first Assistant.

In medium-sized factories, the fleet usually consists of from four to eight vehicles. Outlying districts may be served by contractors feeding the cans to some loading point on one of the more accessible roads, or auxiliary contract haulage may be resorted to on one or more routes. Cream collection is now a specialised function, but there is still some merging or overlapping with general duties. In fleets of this size there is generally one reserve vehicle and one relief driver. Cream is collected seven days a week, and this means that no driver will be employed continuously on one route. Many men prefer to work for 10 days and then have a break for two or three days in the form of a long week-end. Whatever spell system is in operation, relief drivers are required; one at least for four routes, two for seven. Some companies employ one relief driver and a driver-mechanic who does some relief driving and general repair and maintenance work the rest of the time.

Lorry-drivers usually do their own running repairs, greasing and cleaning in this type of organization, although there are some instances of all greasing and running repair work being undertaken by a garage on a contract basis. These garages contract to keep the trucks on the road, do all minor repairs, (decarbonise and valve grind etc.), on a flat basis per annum, but carry out major repairs at scale charges. When seven or more vehicles need caring for, a full-time mechanic is usually employed.

Daily schedules of duties for lorry-drivers vary with the scope of the company's activities. Some commence work at 6.30 a.m. and pack butter from cool-room to trucks or railway wagons for an hour. Some load cans onto vehicles, insert stores into cans, or assist with general store despatch, until departure-time. On completion of the collection, lorry-drivers usually assist with unloading at cream-reception, rolling cans onto reception-stage in numerical sequence, and removing lids. This is followed by retrieving the cans from the can-washer, replacing lids, and later, inserting suppliers' cream-weight dockets. The afternoon is usually employed in loading-out cartons of butter and loading in factory stores and truck cleaning and maintenance.

Whatever time-table is used, actual cream-haulage takes between two to three hours, and although the men can be profitably occupied there is a large margin of unused capacity in valuable plant lying idle on the average, for four hours a day. It is this unused capacity that has given rise to general carrying activities.

Most companies of this size have a rough kind of time-table they endeavour to maintain. If cream reception takes three hours, there is some attempt to control the arrivals of the lorries so that general reception is staggered, say from 9.30 a.m. to noon. In order to arrive at this, routes may be broken up into such a size that lorry arrivals can roughly synchronize with half-hour intervals, or some other suitable interval. To do this, lorry-departure times must differ depending on route length and other variables. In fact, it was observed that those companies with class (III) vehicles, (three tonners), did have some such arrangement, whereas those with <u>only</u> class (II) vehicles, (five and six-tonners), tended to arrive within a short space of each other causing congestion and waiting, and thus loss of productive time.

But nowhere in the medium-sized factories was a strict time-table for reception maintained. A well organized factory operating with Class III vehicles had their vehicles arriving at the reception stage at the following times:-

Times	Intervals in minutes
9.02	-
9.16	14
9.41	25
10.04	23
10.11	7
10.51	40
11.43	52

The above company operated four vehicles, all three-tonners, but normally sent out only three vehicles, even during the flush of the season. The fourth vehicle was kept in reserve, and to achieve this, the routes were made small enough for any driver to handle two or three routes per day if needs be. In the above example, three vehicles handled seven routes and the cream-reception was so manned that, under optimum timing, the lorries should have arrived in at 30 minute intervals.[17]

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[17] Actually the picture is not quite as simple as that outlined above. The first lorries to arrive in normally have the lightest loads, and the later lorries the heavier loads. In the example above in spite of roughly 30-minute intervals, lorry loads of cream were marking time because of the variation in can-quota brought in. The size of the can-load can best be allowed for by the co-efficient

$$\frac{\text{minutes}}{\text{number of cans}}$$ (assuming constant sizes of cans).

In the above example, the number of cans carried in sequence of arrival of lorries, when calculated in terms of co-efficients, yielded the following ratios: 0.54, 0.45, 0.38, 0.11, 1.67 and 0.85. The dispersion of these co-efficients is greater than the uncorrected minute-intervals, indicating the need for further planning. When these co-efficients are identical in value, then reception is at an optimum.

Indeed, it was not an uncommon sight to observe two, and sometimes three lorries racing to be in first at the reception stage, indicating a lack of careful planning. Where Class (II) vehicles only were used because of the terrain and the distance to be covered, the following typical time intervals were observed:-

Times	Intervals in minutes
9.35	-
9.42	7
10.05	23
10.56	51
11.15	19
11.37	22
11.57	20
12.08	11
12.32	24

In this factory, the can-quota was fairly constant so that the average of interval of 22.5 minutes between each lorry was approximate in all but one or two instances.

One other example will be given; of a factory with Class (II) vehicles, but which practised no interval timing at all.

Times	Intervals in minutes
10.02	-
10.53	51
10.59	4
11.26	27
11.27	1
11.29	2

The can-quota shows these figures in an even worse light, for the first load was light, and the last three, heavy. It illustrates what was observed again and again - congestion of cream traffic resulting in either slack periods on the reception stage or such congestion that handling was slowed down or cans were spilled.

The length of time taken from leaving the factory until returning in medium-sized factories is set out below:-

Time in minutes	Frequency
Up to 60 mins.	2
61 - 120 "	6
121 - 180 "	8
181 - 240 "	6
Over 240 "	3
	25

The above factories were selected because the most distant supplier in each case ranged between 18 and 22 miles from the factory. The can-quota varied, but distances and terrain were relatively similar.

In the large-size factories, fleets of vehicles ranged from seven upwards. Organization was more highly developed for it generally paid the company to operate a Transport Department with an executive in charge who was responsible to Management. At this stage there was usually sufficient clerical assistance to operate a vehicle costing section, a workshop for vehicle maintenance, and a close liaison between transport and store for handling outward deliveries during cream collection. Work was reduced largely to routine. Daily checking of oil and water levels and inflations together with submitting daily running sheets were used in a number of companies. Suppliers were further from factories; six-tonners and articulators with bigger can-quotas were widely used. Consequently, more time was consumed per route because of greater distance, heavier loads, and more cans. But the time in handling cans was not proportionate to the number of cans handled. As a rule, the greater the number of cans handled, the greater was the amount of time per can in handling.[18]

Up to five or more hours were normally consumed in cream haulage and unloading, and further time was occupied in reloading empties and stores or

[18] This fact became apparent early in the survey, and a number of special time motion studies were undertaken in order to arrive at the answer to the question - what is the optimum can load? In addition it was desirable to be able to arrive at norms for calculating the standard time that should be taken for a route, given the mileage, number of stops and number of cans.
This and other data are developed in Appendix F Time-motion studies.

vehicle maintenance. The balance of the time, if not taken up by general haulage, was used for out-loading cartons of butter and inloading stores, (such time being charged to its appropriate expenditure classification).

Organization of cream reception will now be examined briefly, and the added factor of general haulage also considered.

General haulage has been practised by all sizes of companies, partly to spread heavy vehicle overhead, and partly to utilise their drivers to full capacity. This has been done in three ways.

(a) Small companies, with goods licences, operate in restricted areas as opportunity serves, and contract in winter months wherever such work offers - mostly from suppliers. No separate department functions to control the drivers' activities - instructions come from the factory manager through the head driver.

(b) In larger companies a separate department exists to control cream reception and undertake routine general haulage. The departmental manager is responsible directly to the factory manager, and organization operates similarly to that described previously in large companies. The factory is usually charged with the actual cost of cream haulage.

(c) In the largest concerns, the transport fleet and its activities are under the control of an executive who is responsible not to the factory manager, but directly to the directors of the company. The organization is run solely for profit, is in general competition for all haulage work and charges the factory a given price for cream haulage. It may function as a department or as a subsidiary company - but its main object is profit-making rather than minimising the cost of cream collection.[19]

Personnel: The personnel of cream haulage fall into three categories - lorry-drivers themselves, mechanics, and executive or clerical workers. Lorry-drivers are usually drawn from work other than driving, often from farming or from general duties in the dairy industry itself. Their turnover is relatively high - a little higher than that of butter factory employees.

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[19] Some companies prefer to charge a price for cream haulage based on alternative costs - others show no profit, but minimise collection costs for competitive reasons.

Their ages too, are a little higher than those of general labourers in butter factories. The group of drivers surveyed had an average age of 32 years. Most managers reported more difficulty in retention, control, management and discipline of lorry-drivers than in any other workers in the industry. Quite a few managers indicated that their reason for going over to contractors was because of the continual difficulties they experienced with lorry-drivers. In view of these statements a subjective approach was made to a number of lorry-drivers and their views were recorded. A few were thoroughly satisfied with their job; many regarded it merely as a change; and others again were looking for the first opportunity to leave.[20]

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[20] A large number of drivers were interviewed, but some 19 were interrogated extensively and case histories prepared. These men were drawn from a cross-section of companies, operating from 3 to 20 lorries, from composite duties to a highly organised department. The turnover of lorry-drivers in these companies was 54% - a little lower than normal; pay was, in each case, in excess of award rates; housing was either provided or subsidised for all married men in each case, and prospects of advancement were satisfactory.

Appearance: Of the 19, 16 came to work clean-shaven; 4 men were very clean; 11 moderately clean, 3 were dirty and one very dirty. Seven wore aprons (leather, heavy jute or sack); 3 wore overalls; 3 wore ordinary clothing and 6 singlets and denhams. Eleven wore boots (3 heavy hob-nail), three wore shoes; 3 sand-shoes and two sandals ; one wore a cap and two wore eyeshades.

Previous calling: Four were farm labourers, one farmed a small property, five had been general labourers in dairy factories, one worked in a sash and door factory, one was a slaughterman, one was a salt-plant foreman, one an electrician, one a shunter for 12 years, one a prison warder for 7 years, one drove a baker's van and two others, delivery vans.

Length of service: Eight had been on the job less than 6 months, 2 had 10 months and one almost a year. Five had had between 4 to 5 years, and two had 14 years' service each.

Comments made by drivers: A few considered they were overworked, driven, or did not receive adequate consideration from management. Some complained that they were incessantly the object of speeding up tactics; and no due allowance was made for flush of season loadings. Several openly avowed a go-slow policy, said they refused to bustle or run on the job to keep on schedule. One declared he was the object of abuse from his mates for refusing to go slow. Comments such as these came freely from about 40% of those interviewed. Others made some sound, positive suggestions, some of which were:-

<u>Routes</u>: The organization of routes is an increasingly important function of management in cream collection, for where organization was planned carefully, a reduction of collection time and mileage covered was observed. In many cases routes were unplanned, for they were the outcome of growth or rural development.

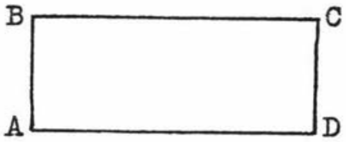
There are two main types of routes - the loop and the "fish-bone". In practice, each route consist of a complex of both. The "loop" strictly, is any type of route in which no part of the route is covered more than once. The "fish-bone" as the name implies is a route with a terminal point, which, by its very nature, must be retraced. The "fish-bone" route may be:-

(a) Simply a road from A to B and return.
(b) A number of "spoke" roads radiating out from a central point.
(c) Off-shoots on a main road such as (a).
(d) No-exit branches off a loop.

20(cont).
(a) Cans should be inverted to keep dogs etc. from contaminating empties.
(b) Farmers changing from 1 to 2 or more cans should advise management to facilitate maximum loading in the flush of season.
(c) Two longitudinal battens down truck would facilitate aggregation.
(d) The size of cans is important. The greater the number of sizes, the more difficult is the handling and recognition of numbers on the cans. Suppliers, when alternating cans from day to day should keep to the same size throughout and not vary. The eight-gallon can was considered to be the most awkward size of all.
(e) Can lids: When cans are worn, the worn lid tends to fall easily into the cream necessitating longer time in extraction of lid and loss of cream due to splashing.
(f) Dumping off empties pays in terms of time - in can sorting - where return along the same route is possible.

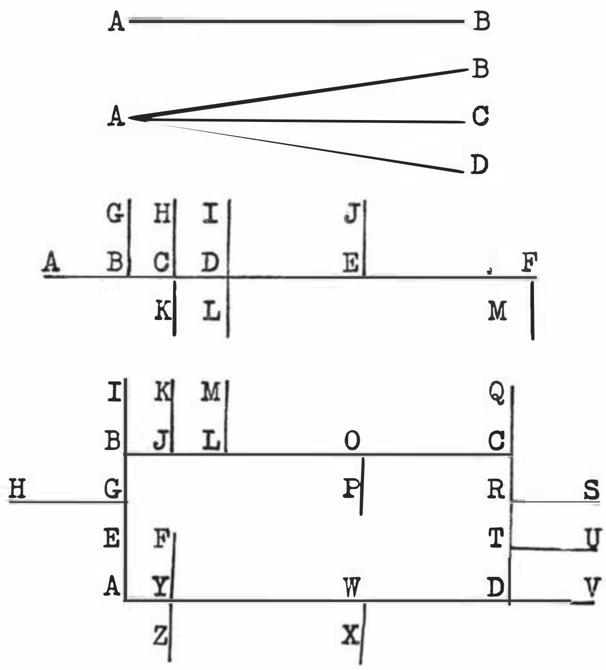
Typical patterns of these main types of routes are shown below:-

Loop.



Fishbone.

(a) (b) (c) (d)



In the "loop" route, the truck leaves A and proceeds through B, C, D and back to A. If the route is 24 miles long and suppliers are spaced at equal intervals of one mile, obviously one mile of haulage per supplier is necessary. In "fishbone" route (a), if the distance between A and B is 12 miles and there are 12 suppliers on the route, then obviously 24 miles will need to be covered, or two miles of haulage per supplier. The same applies in route (b) where each route is again 12 miles, and two miles of haulage per supplier is required for the three routes. Should BC be joined by a road, immediately a "loop" exists and the miles of haulage per supplier will be reduced.

In (c), let the route AF be 12 miles long, and let there be seven off-shoots from the main road, each one mile long. Let the 12 suppliers be located at points B, C, D, E, F, G, H, I, J, K, L and M. Then 24 miles will be covered on the main road AF and two miles for each of the seven off-shoot roads BG, CH, DI, EJ, FM, DL and CK - 38 miles in all or 3.17 miles of haulage per supplier. (It will be immaterial to the argument in what order the cans are picked up.).

In (d), we have a loop ABCD 16 miles long with 12 no-exit branches, each a mile long, emerging from the loop at E, G, B, J, L, O, C, R, T, D, W and Y. Let there be 16 suppliers on the loop, and one at each of the terminals H, I, K, M, P, Q, S, U, V, X and Z. The total distance covered will be 16 miles for the loop and an additional two miles for each of the 12 no-exit branches, i.e. 40 miles in all or 1.43 miles of haulage per supplier. If there had been no suppliers on the loop, then the result would have been 3.34 miles of haulage per supplier. If the number of suppliers had been greater than 16 on the loop, the miles of haulage per supplier would have been less than 1.43.

Where off-shoots are longer than one mile, the miles of haulage per supplier will increase.. This ratio can be decreased by can-grouping in which management uses every endeavour to have cans brought to the main route wherever short off-shoots occur. This has been practised in various areas with resulting cost reductions. Where the no-exit roads are of considerable mileage with a number of suppliers on the road, some companies have the cans brought down to the main road by a contractor - often a supplier living at the distant end of the road.

Occasionally, by careful organization, transport costs were kept down by detailed planning. From a survey of all roads in the area covered, on which every supplier was plotted, the routes were so planned that the maximum load could be lifted in the minimum of time with a minimum mileage. Where possible, complete loops were made the basis of a given route, which followed the configuration of the terrain.[21] These routes which avoided overlapping, minimised dead miles by radiating out from the factory along one road, returning to the factory by another road. Long terminal routes were offered to contractors.

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[21] It is recognised that terrain varies considerably. A few districts have a closely patterned roading system highly reticulated, in which suitable loops can be selected. Usually some tertiary road winds off into a terminal route valley with numerous off-shoots. Terrain is often broken by local physical features, rivers, hills, bush etc., so that on account of distance alone, or fewness of suppliers, it is often most difficult to apportion nicely the roads into given routes.

The loops were so planned that can-loads were nearly equal, and the number of cans per load were optimum (not maximum),in that no time was lost in loading, sorting, or locating cans. Maximum can loads, which cause congestion and loss of time were avoided. Suppliers were encouraged to practise can-grouping wherever possible to minimise the number of stops per route, and cans were loaded and unloaded always in the same sequence. Battens placed across the tray of the truck assisted in segregating empties and prevented cans packing tightly together when going down-hill. Some factories practise the collection of all billy-cans round a closely settled area by one truck. The size of cans is an important factor in time consumption, for where cans vary considerably in size, more time is taken to locate and handle the cans.

Tanker collection: During the period this survey was being conducted, tanker collection was in its experimental stage. This paragraph will describe tanker collection as it was observed, and then indicate the advantages and disadvantages as they appeared then.

The tanker (the original experimental vehicle) holding 1587 gallons and articulated upon an Austin chassis, left the factory at 5.03 p.m. and returned with a full load at 6.55 p.m., being away 112 minutes. The distance travelled was 20 miles, and whole milk from 10 suppliers was collected. Eight "dead" miles were traversed and milk was collected for seven miles before returning five miles to the factory. A total of 1,063 gallons was collected, (the observation was made in mid-January when the flush of the season was past but milk yield still good).

The tanker in each case received the milk directly from a calibrated container standing at the milking shed. The average time required to traverse the road from the farm gate to the milking shed was 45 seconds each way. The average time required per supplier from farm-gate (strictly, from cattle-stop) in etc., in to shed, joining up pipes, pumping milk into tanker, taking sample, reading quantity and returning out to farm gate was 3 minutes 20 seconds.

Collections began at 5.30 p.m., the speed out being 30 m.p.h., and the return speed being 35 m.p.h., (due to having to wait 10 minutes for one supplier to finish milking.). The time taken to pump out the tanker was 9 minutes. The average petrol consumption of the articulator was working out at approximately 10 m.p.g.

The various motions required in loading at a supplier's shed were:-

1. Manoeuvring truck into position for joining pipe.
2. Screwing up pipe to calibrated tank.
3. Fitting in the electric plug.
4. Opening the rear doors of the tanker.
5. Reading the calibrated scale and noting down in book.
6. Stirring milk in tank.
7. Fitting in sample collecting bottle.
8. Starting electric motor and turning on tap.
9. Collecting sample.
10. Stopping motor.
11. Unscrewing pipe.
12. Removing sample bottle and taking a small sample, putting balance of the milk collected into a can and replacing lid.
13. Shutting doors after rewinding electric conduit and replacing pipe onto rack on tanker.

The main advantages of tanker collection appeared to be considerable saving of time in loading and unloading, less contamination of milk, and the saving of manpower at the factory for reception.

The main disadvantage appeared to be the considerable initial outlay in capital items, not only of the tanker, but also of cattlestop, heavy road into milking shed, and erection of calibrated stainless metal container. Moreover, these expensive facilities are used only a small part of the day, and give rise to the problem of unused capacity.

One disadvantage is the churning of milk, which happens to some degree in transit, another depends upon the accuracy of the calibrated container. Further, when milk is left to stand an hour or two, the volume of the milk increases due to possible internal aeration of gases. Moreover, no grading of milk was done.

Other contingent disadvantages include the danger of power failure, (the tanker draws electricity from the consumer's shed for its pump), the lateness of one supplier holding up collection, and the possibility that in the flush of the season one tanker cannot contain all the milk in one round.

The significance of tanker collection appeared to lie in the time saved in collection and discharge of whole milk. It appears that this saving outweighs or balances the disadvantages.

SECTION III. TIME, WEIGHT AND DISTANCE AS FACTORS IN TRANSPORT EFFICIENCY.

There are three main elements that can be distinguished in transport efficiency - time, weight and distance covered. The following section will attempt to analyse these elements in a quantitative way in order to throw light on the cost and economic analyses of the two subsequent sections.

Time: As wages account for such a large percentage of total haulage costs, it was considered necessary to analyse time-consumption, and to this end, 25 routes of all kinds were selected from various parts of the North Island and subjected to time-motion analysis.

The technical details of this study are set out in Appendix F, but as certain aspects have an economic as well as technical bearing on efficiency, they will be included in the present section.

The 25 routes covered a total of 983 miles,(of which 236 were "dead miles") over which lorries stopped 1,062 times to lift cans and an additional 120 times for other reasons.

The total poundage of cream lifted for one day over all routes was 112,485 lbs. or 114 lbs. of cream per mile traversed.[22] The individual routes varied from a little under 70 lbs. per mile to over 140 lbs. per mile of route. The total weight of cream lifted per minute averaged 29 lbs. based on total time away from factory. Similarly, the average speed based on total time away from factory was 15.25 m.p.h.

Assuming these 25 routes as fairly representative of all cream routes, then a summary of a modal route is: Taking 2½ hours, the average lorry at an average overall speed of 15 m.p.h. covers 40 miles (of which 10 are "dead miles"), loading two cans per mile, yielding 45 lbs. of butterfat per mile.

Analysis of dispersion of time-consumption: The total time on the different routes varied according to two main elements - the number of miles covered

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[22] "One-day" does not mean the "same day", for actual poundages were obtained from recorded weights from the factories' records. The poundage refers to the late flush of the season, i.e. from mid-November to mid-January.

and the number of cans lifted. The following table sets out the position:-

TABLE XXII. RELATIONSHIP OF TIME CONSUMED ON 25 ROUTES TO LENGTH OF ROUTE AND NUMBER OF CANS LIFTED.

Time in mins.	No. of rounds	Average time in mins.	Average distance in miles	Average No. of cans	Ratio Mins./Cans
Under 60	2	47	16	25	1.88
61 - 120	6	92	21	61	1.51
121 - 180	8	141	38	68	2.07
181 - 240	6	215	53	94	2.29
Over 240	3	271	67	102	2.66

In the above table it will be observed that the time-consumption increases at a more rapid rate than does distance of suppliers from factory. Time increases nearly six times from the first to the last class-interval whereas both distance and cans increase just over four times. Both distance and cans must be considered independent variables, and time the dependent variable. It would appear that time does increase at a greater rate than do the independent variables, suggesting that as mileage and number of cans increase there is a decrease in efficiency. This is borne out by the last column which shows the ratio of Minutes to Cans.[23] This ratio measures the unit expenditure in terms of time.

The lowest level of time expenditure appears to be in the second class-interval, where an average of 61 cans are picked up over 21 miles in 92 minutes with a ratio of 1.51. It would appear from this sample therefore, that there is an optimum point of efficiency in length of collection routes together with number of cans lifted, and as routes and number of cans increase beyond this point, they do so at the expense of time consumed in so doing.

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[23] Essentially the same result is obtained by substituting cans for "suppliers" or "total stops per route".

This increase in time-consumption is due to onset of fatigue, increased difficulty in locating cans on tray of lorry, resorting, and the fact that the longer the drivers are away from direct supervision, the greater is the tendency to indulge in unproductive waste of time.

The Use of Norms in cream collection: To ensure the optimum flow of cans during cream reception, managers realise the importance of cans arriving according to a pre-determined schedule. For example, if a given factory is averaging 360 cans per day and devotes three hours a day to cream reception, (depending upon the personnel available), 60 cans per half-hour may be determined upon as the optimum rate of flow. If six routes serve the company's requirements, then the arrival of the lorries could be scheduled to arrive at half-hourly intervals, say at 9.15, 9.45, 10.15, 10.45, 11.15 and 11.45.[24]

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[24] It may be objected: "This may be alright during the flush of the season, but what happens when the flow diminishes?" The answer to this is: The average number of cans should be determined during the flush of the season, i.e. the maximum number, when allocating the load for each lorry, and the principle followed that cream should be collected with such frequency during the month that each load should vary in weight as little as possible. The principle of frequency of collection is an administrative problem. It affects the efficiency of manufacture (in minimising costs) as well as cream collection. During the flush of the season, cream will be collected each day and butter manufactured. But as supply falls off, cream will be collected every second day, or third day, or four times a week or on some other pattern. This pattern should be such that the total load should approximate as closely as possible the average optimum load brought in during the flush of the season. In the off-season, frequency may fall to once a week, meaning collection and manufacture occurs once a week.

This problem was investigated in a number of factories where the principle was followed out, and double vacreation resorted to, to off-set deterioration in the quality of the cream. In one sample factory, collections occurred 276 times per year with an average of 30,986 lbs. of cream per collection day.

The following table illustrates the extent to which the principle of frequency was observed by indicating the range between the weights of maximum and minimum loads for the month.

(cont.)

24(cont.)

TABLE XXIII. DIFFERENTIALS OF DAILY LOAD WEIGHTS OF SELECTED FACTORY AS INDICATED BY MONTHLY RANGE OF MAXIMUM-MINIMUM LOADS

Month 1949/1950	No. of times cream was collected	Range (being maximum minus minimum load for the month) (lbs. of cream)	Frequency co-efficient
June	6	8,323	27
July	5	10,975	35
August	13	7,512	24
September	28	7,994	26
October	31	2,885	10
November	30	1,102	4
December	31	1,671	5
January	31	2,843	10
February	28	1,142	4
March	31	1,659	5
April	26	1,806	6
May	16	3,759	12

The frequency co-efficient was calculated as a ratio of monthly range over the daily average collection. It will be observed that cream was collected each day from October to March inclusive, most of September and April, approximately every second day in August and May, and infrequently in June and July. With the exception of the first four months in the table the frequency co-efficient is low, indicating a fairly constant load-weight each day, (in other words, the principle of frequency is difficult to operate in the off-season .) But the range itself does not necessarily give a true picture, as the extremes of the range may be caused by circumstances difficult to control. Thus, for the months of June and July in the off-season, it often happens that it is difficult to foresee just how much the cream weights will fall off. Moreover, the dates of cream collection have to be determined in advance and the suppliers advised accordingly. These circumstances often cause exceptional weights to occur before appropriate action can be taken. Whilst previous years' figures may be taken as a fair guide, the very nature of the season, along with irregularity of calving of the cows in various herds, may make determination far from precise.

This lack of determination is illustrated in the following table which gives the total cream weights hauled in Table XXII in the form of index numbers.

24(cont.)

TABLE XXIV. INDEX OF CREAM HAULED IN MONTHS OF JUNE AND JULY, 1949, TO SELECTED FACTORY.

(June 3rd = 1,000. Weight relatives are chained together using previous index as base).

Date of collection		Index relative	No. of days intervening
June	3rd	1,000	-
	6th	1,171	3
	9th	655	3
	13th	933	4
	20th	1,328	7
	27th	1,216	7
July	4th	1,283	7
	11th	741	7
	18th	877	7
	25th	1,081	7
	28th	502	3

The immediate previous trend was used to estimate just when the next collection date was to take place. Later, once the interval in days became constant, the index relatives move in a consistent pattern. Minimization of change in the relative implies maximum smoothness in a changing input pattern, at a time when it is desirable to hold input constant to minimise costs, (collection and processing).

From the above, it can be stated as a principle, that during the off-season the frequency of cream collection should be such that the change in the index relatives is at a minimum.

Assuming that the maximum practical interval is seven days, then the onset of this maximum interval will be determined by endogenous causes such as number of cows in milk in the district, the extension of the lactation period, or the extent to which cows are calving more early than normally for that district.

It is immaterial to the general argument just when this maximum interval will occur, or how long it will last; but it is of prime importance that the change in index relatives be at a minimum, and processing costs too. Any sudden fluctuation would also cause greater change in the pattern of administrative and technical costs.

It will be assumed in setting norms, that management will be following the principle of frequency.

In order to ascertain when a given lorry will arrive back at the factory, it is necessary to know just how long the lorry will take on the route to calculate when the lorry should leave the factory. The application of norms[25] for cream collection aids in determining the length of time each lorry should take. The main variables in time-consumption are not constant, but include the type of lorry, the number of cans per stop, the character of the route, and the total number of cans carried.

For most normal conditions, the following norms proved applicable:-

Speed:	25 m.p.h.
Cans :	30 seconds

For example, assume a route 50 miles long and 80 cans to be picked up. Normal time may be computed as:

50 miles at 25 m.p.h. consumes	120 minutes	= 160 minutes
80 cans at 30 seconds consumes	40 minutes	

The entire time away should take 2 hours 40 minutes.

For longer routes, (over 30 miles), with more cans, (over 60 cans), the following norms may be substituted:-

Up to 80 cans:	Speed 25 m.p.h.	Cans 35 seconds each
" 100 "	" " "	" 40 " "
" 120 "	" " "	" 45 " "

The above norms in their simple form cover all stopping time, hold-ups, loading time and travelling time.

Case histories examined: Route control charts were prepared for a number of typical routes, and are intended to illustrate time consumption in Section III. These routes show the length of time of stoppages, the variations of speed and the contour of the roads.

Figure 6 illustrates a long route over hilly terrain from which 133 cans were lifted. The lorry left the factory at 7.30 and continued for 10½ minutes at a speed which varied very little around 42 m.p.h. A number of cans were dropped off and the lorry continued for almost 5 minutes at 40 m.p.h., when loading proper commenced. The steepness of the peaks show

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[25] Derived from observation of average times under various conditions.

the rapidity of acceleration. After five stops for cans, the lorry traversed some hilly sections of the road in which the vehicle climbed and then descended two or three times. These hilly sections continued until 8.35 a.m., at which point cans were re-arranged on the tray of the lorry. Loading continued until 9.36 a.m. when the lorry commenced climbing a mountainous section of the route in third and second gear at about 22-25 m.p.h. Then almost 13 minutes were devoted to a through sorting out of cans. Again cans were resorted at 10.22 a.m., and after loading the final can at 11.7 a.m., returned to the factory. No time was wasted by the driver on this difficult route.

Figure 7 illustrates the fact that time consumed in lifting individual cans is determined largely by the distance of the can from lorry. Where two or three cans were loaded at one stop, these are shown by two or three small horizontal lines placed at the apex of the time polygon.

Figure 8 illustrates a short route on moderate undulating to hilly country where 72 cans were picked up. Note that the driver seldom exceeded 30 m.p.h. and therefore did not have to use excessive braking as did the driver of Figure 6. Observe the slowing up after 11.20; then the unproductive period followed by a period of "hurry-up".

Figure 9 illustrates a new driver on moderate undulating and flat terrain, who was slow in lifting cans, but endeavoured to compensate by speeding up to over 45 m.p.h., (sometimes dangerously).

Figure 10 shows the inexperienced driver of Figure 9 compared with the experienced driver of Figure 8 who had so gauged his round that a number of suppliers lifted their cans onto his lorry and removed their empties without the driver leaving his seat. (This section is not shown in this diagram, however.)

In figure 11, an erratic driver is illustrated loading 104 cans from a 64 mile route in which the truck climbed over 1500 feet three times. At 8.9 a.m. the truck commenced climbing in second gear, whilst a very steep hill was traversed in low gear about 8.35 a.m. The low gear work at 9.40 a.m. was caused by a muddy surface due to road works in process. The unproductive time at 9 a.m. was due to private shopping at a township; that at 9.54 a.m., if disclosed, would incur magisterial wrath; and that at 11 a.m. merely the outcome of "popping in to see the girl friend". This route does illustrate, however, what often happens when no routine checks are made.

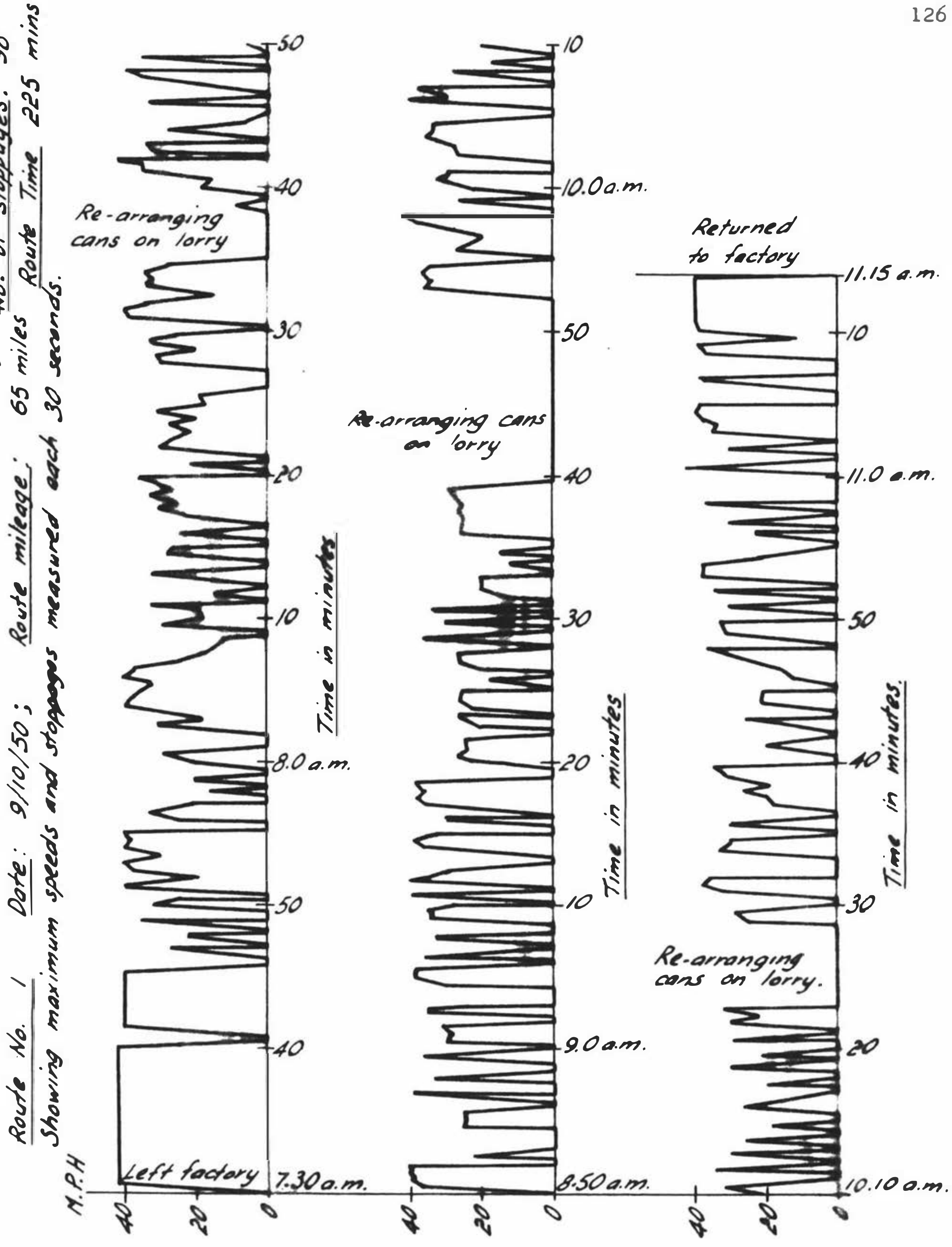
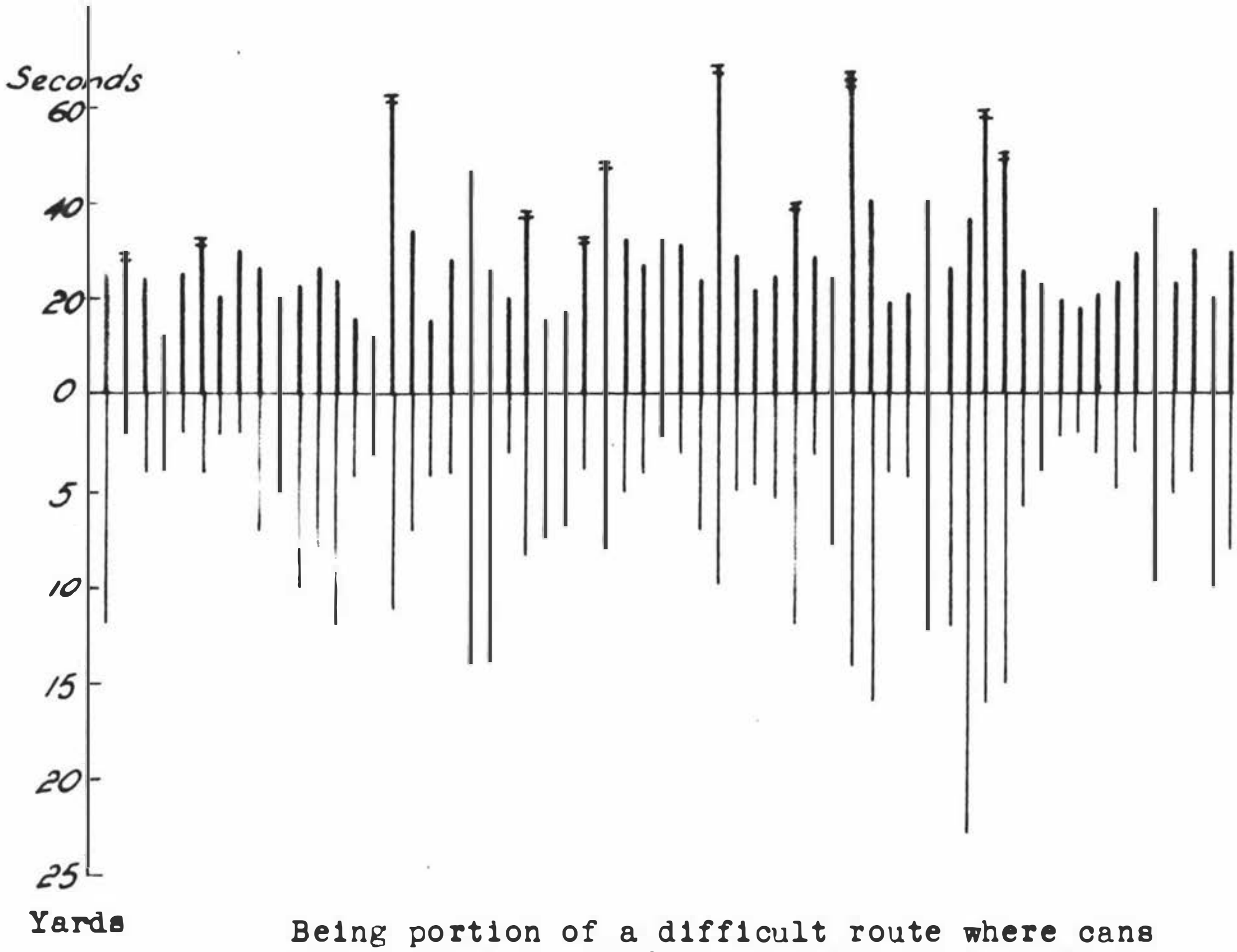


Figure 6. Route Control Chart.



Being portion of a difficult route where cans were not always left in a convenient position.

Average time per can: 20 secs.
Average distance: 6 yards.

Note: There is a considerable correlation between time loading and distance carried here.

Figure 7. Illustrating Time Taken to load Individual Cans of Cream in Sequence: Correlated with Distance of Cans from Lorry Route 1/1.

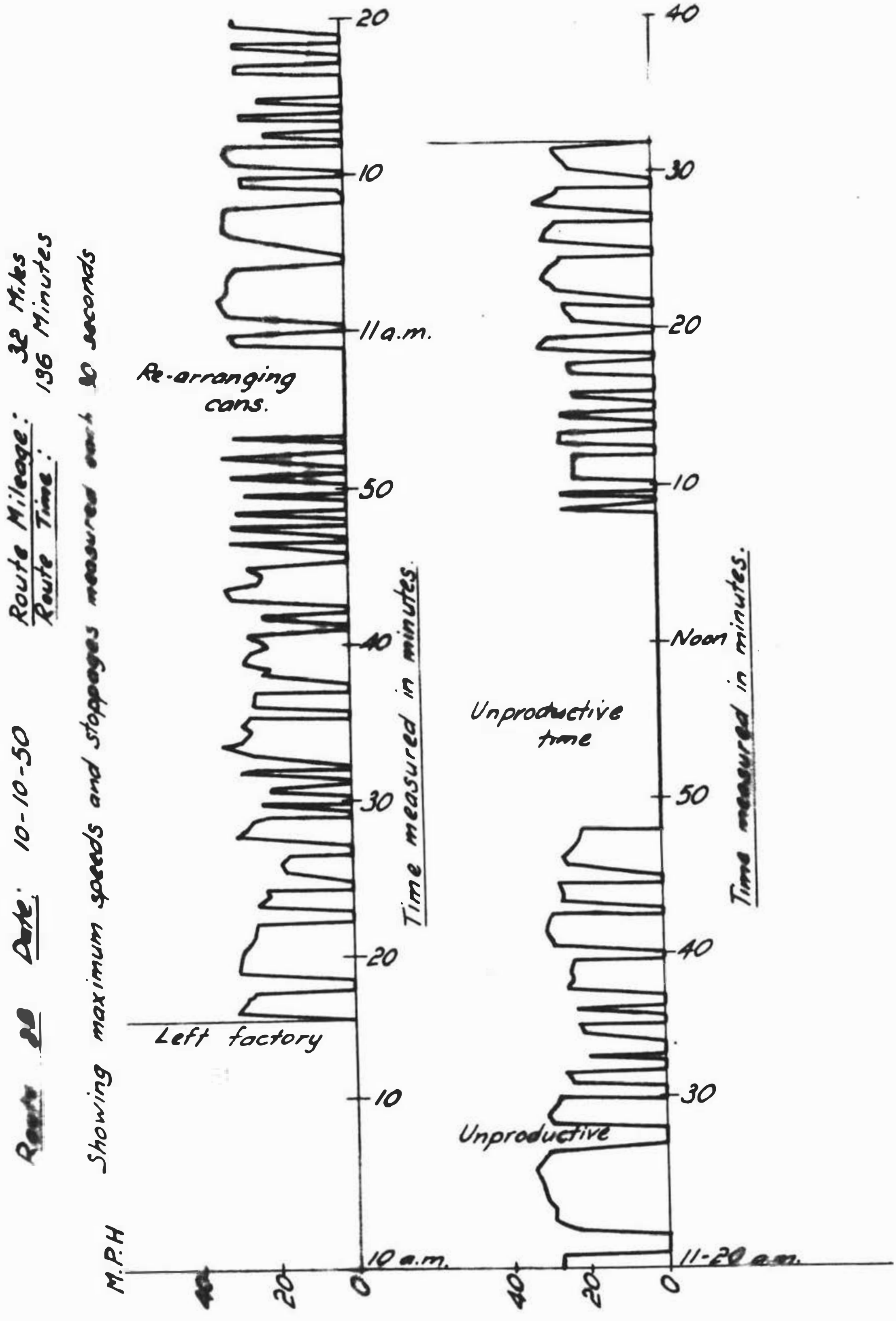


Figure 8. Route Control Chart.

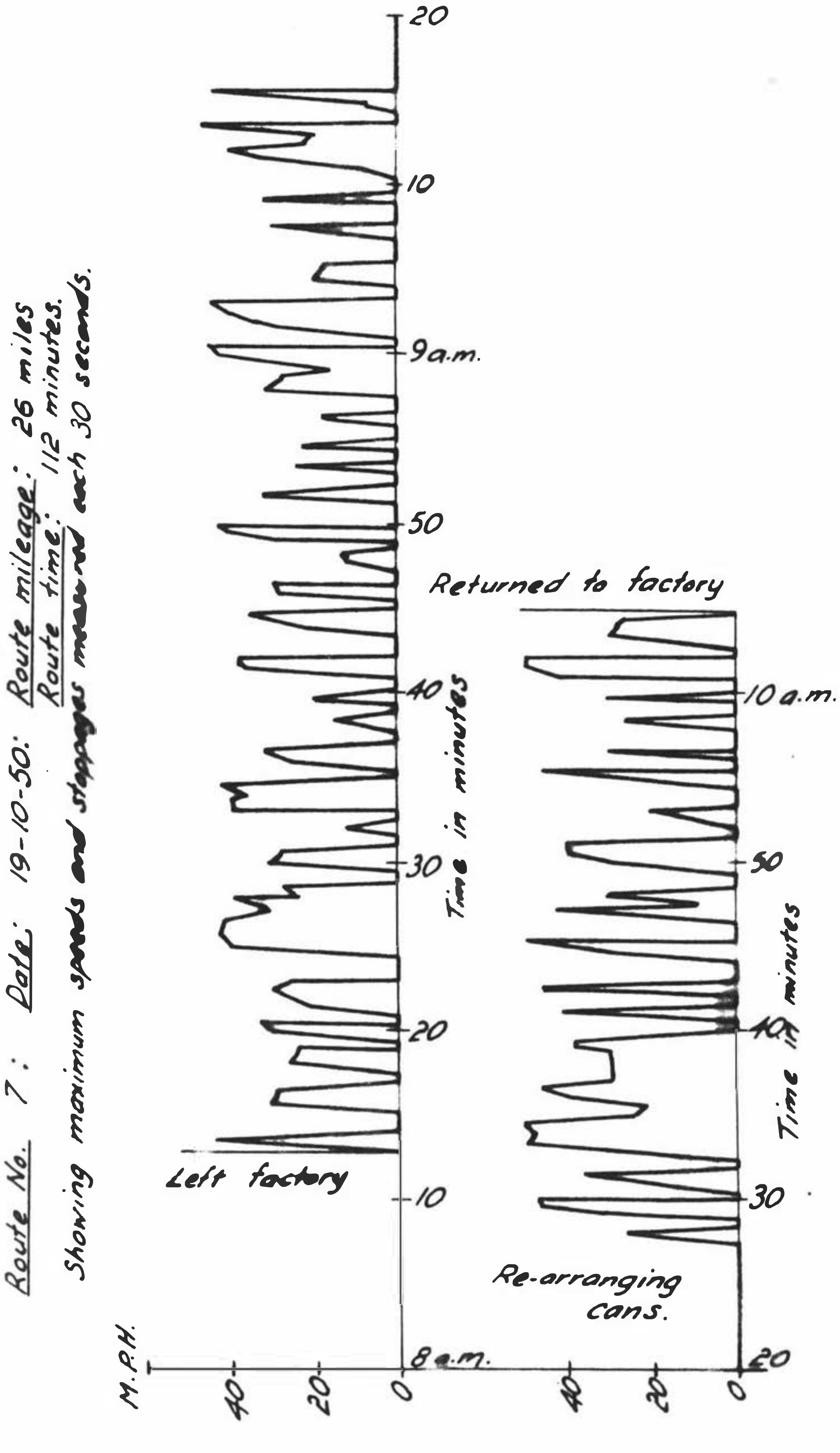
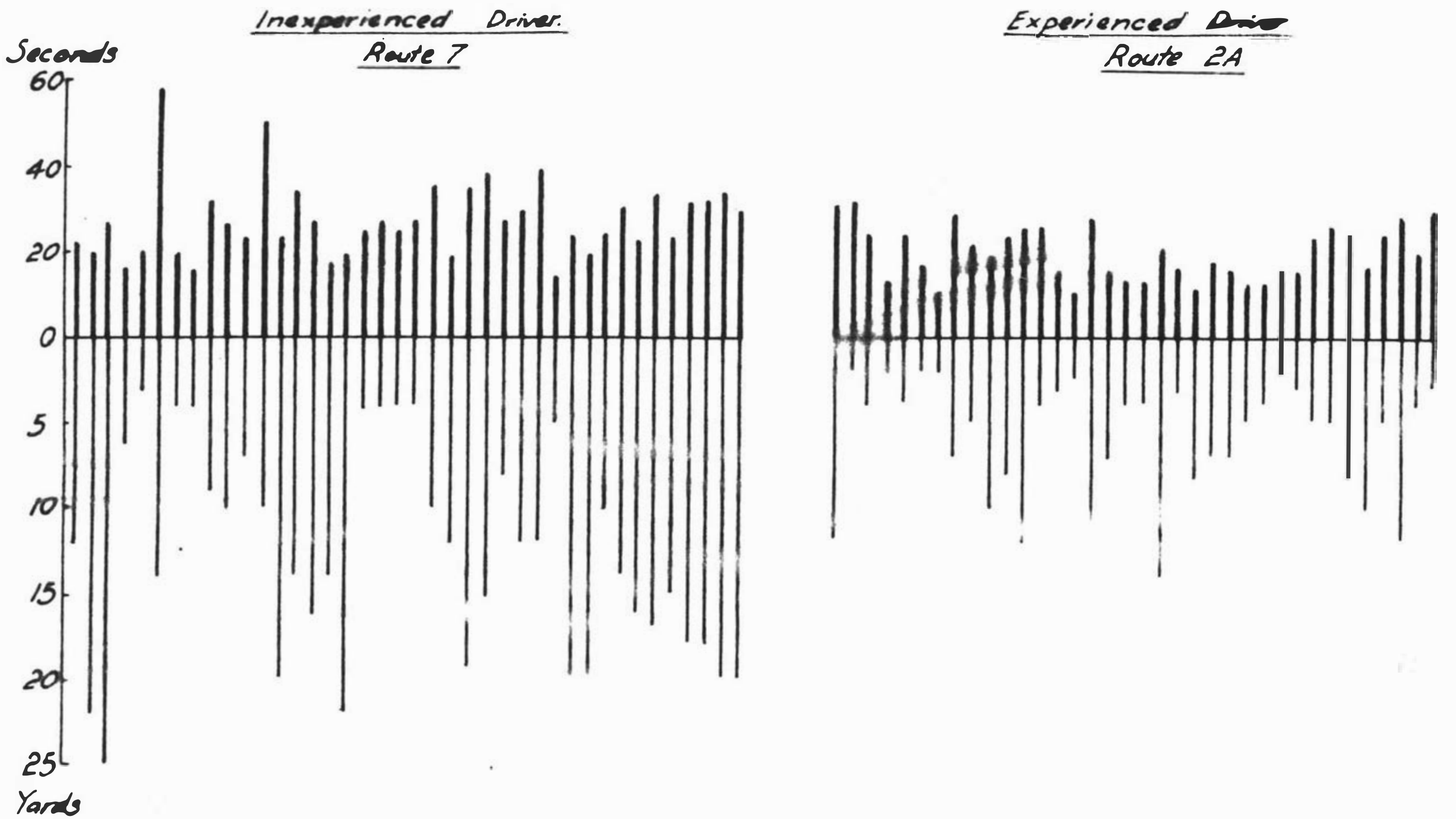


Figure 9. Route Control Chart.

Figure 10. Illustrating Time Taken to load Individual Cans of Cream in Sequence: Correlated with Distance of Individual Cans from Lorry.



Average time per can 26 secs
Average distance 10 yards.

Note: Very little correlation.

Average time per can 22 secs
Average distance from lorry 7 yards

Note: Considerable correlation.

(These are adjacent routes: part of route 2A was actually handed over to driver of Route 7.)

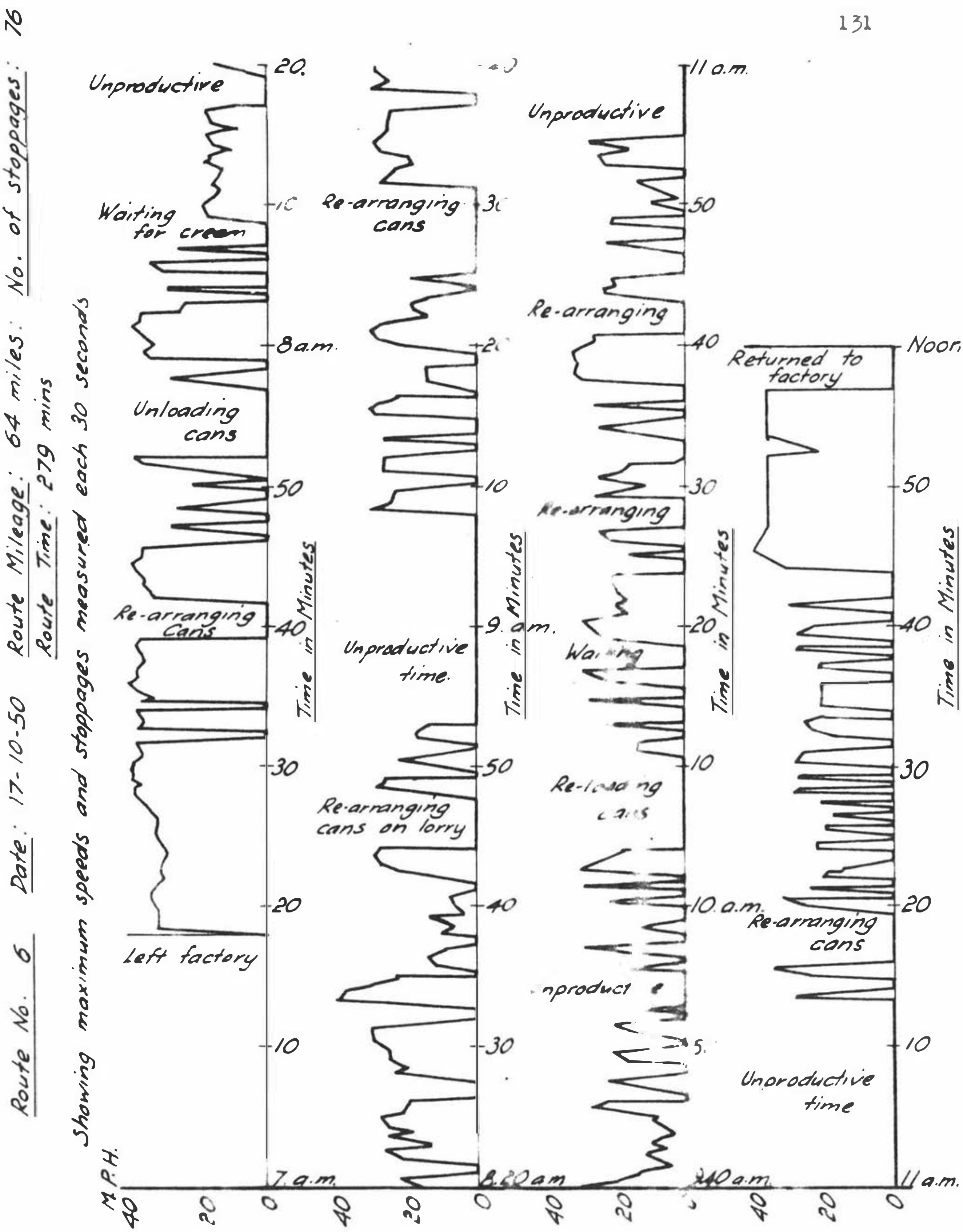


Figure 11. Route Control Chart.

Grades and weights: The small suppliers, (as measured by the quantity of cream supplied), gives rise to a number of diseconomies. His cream takes longer to sample, grade, and receive,[26] the time consumed in loading his cream is greater, his cream shelter is functionally poorer, and set in a more disadvantageous place for loading than the larger supplier. His functionally poorer shelter is matched by the infrequency of his offerings of cream and their quality. Many small suppliers do not offer cream each time the route is covered, meaning that the lorry often covers some distance without picking up any cream, for the supplier has elected to withold his token supply until he has sufficient quantity to offer. This, together with his lower standard of cleanliness on the farm due to poorer facilities, results in a lower grade of cream. The following table illustrates this by analysing quantity of cream offered by gradings. The data refers to collections made in mid-October with the temperature at 9,30 a.m. ranging from 58 to 63 degrees, i.e. under propitious weather conditions during the flush of the season.

TABLE XXV. QUALITY OF CREAM OF 603 SUPPLIERS, ANALYSED ACCORDING TO QUANTITY OFFERED AND GRADINGS

Cream weights lbs.	Total	No. classified as			Total	Percent of suppliers classified as:		
		Finest	First	Second		Finest	First	Second
0. - 20	211	94	102	15	35	15	17	3
21 - 40	105	62	36	7	17	10	6	1
41 - 60	58	43	13	2	9	7	2	-
61 - 80	66	52	11	3	11	8	2	1
81 - 100	52	43	8	1	8	7	1	-
101 - 120	38	34	4	-	6	6	-	-
121 - 140	27	25	2	-	5	5	-	-
141 - 160	16	14	2	-	3	3	-	-
161 - 180	16	15	1	-	3	3	-	-
181 - 200	4	4	-	-	1	1	-	-
Over 200	10	10	-	-	2	2	-	-
Total	603	396	179	28	100%	67%	28%	5%

It will be observed that the percentage of first and second grade decreases as quantity of cream offered increases.

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[26] See foot-note p. 404, Appendix D.

It should be pointed out here, that weight itself did not appear to influence time-consumption unduly. Indeed, smaller cans appeared to take longer to handle than larger and heavier cans, for time-motion studies attest that the weight of the can itself did not increase handling time. Furthermore, as most trucks were working at under maximum capacity, weight did not appear to diminish truck running time except in acceleration rates. By far the greatest factor in time consumption appeared to be mileage covered.[27]

Distance of suppliers from factory: By distance of suppliers from factory is meant distance by the shortest practical route or road, and is measured by the distance the supplier would have to travel if he had to deliver his own cream to the factory.

The procedure followed to obtain these distances was two-fold.

(a) For 20 factories covering 18 per cent of the Dominion's output of butter, mileages were obtained by actual measurement - usually correct to the nearest tenth of a mile, together with output for each supplier for the season.

(b) For an additional 68 factories covering 59 per cent of the Dominion's output, the mileages were advised by management either in the form of measurement, map calculations, driver's estimates or manager's estimates. Many of these assessments were computed in terms of 5 mile intervals and when cross-checked disclosed a small percentage of statistical error. Being liable to errors of estimate they have been segregated accordingly.

Having the distance of each supplier in miles, and the factory's annual butterfat, the amount of fat supplied in concentric zones of one mile from factory, two miles, three miles and so on, was then computed. Strictly each zone is: Up to one mile, from 1.1 to 2.0 miles, 2.1 to 3.0 miles and so on.

The following classification shows the distribution of the most distant supplier for 93 factories.

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[27] See p. 144 for further treatment.

Most distant supplier	Frequency
Under 10 miles	6
10.1 - 20 miles	23
20.1 - 30 miles	23
30.1 - 40 miles	18
40.1 - 50 miles	11
50.1 - 60 miles	7
Over 60 miles	5
	93

Two small factories had all their suppliers under 5 miles, and two larger factories had suppliers 73 miles away, but there was no distinct correlation between output of factory and most distant supplier. In fact, five very small factories had distant suppliers over 40 miles away (one 65 miles away), and eight very large factories collected all their cream within a radius of 25 miles.

The following table shows the measured suppliers from 20 factories ranged in zones of one mile up to the maximum of 47 miles.

TABLE XXVI. PERCENTAGE AND CUMULATIVE PERCENTAGE OF CREAM RECEIVED BY 20 FACTORIES IN ZONES MEASURED IN INCREMENTS OF ONE MILE FROM THE FACTORY

Zone	Percentage of total cream supplied	Cumulative percentage
Up to one mile	3.66	3.66
1.1 to 2.0 miles	6.01	9.67
2.1 to 3.0 miles	5.54	15.21
3.1 to 4.0 miles	8.58	23.79
4.1 to 5.0 miles	8.04	31.83
5.1 to 6.0 miles	7.04	38.87
6.1 to 7.0 miles	6.72	45.59
7.1 to 8.0 miles	6.37	51.96
8.1 to 9.0 miles	6.08	58.04
9.1 to 10.0 miles	4.34	62.38
10.1 to 11.0 miles	3.87	66.25
11.1 to 12.0 miles	4.52	70.77
12.1 to 13.0 miles	2.48	73.25
13.1 to 14.0 miles	2.60	75.85
14.1 to 15.0 miles	1.95	77.80
15.1 to 16.0 miles	2.44	80.24
16.1 to 17.0 miles	1.48	81.72
17.1 to 18.0 miles	2.14	83.86
18.1 to 19.0 miles	0.98	84.84
19.1 to 20.0 miles	1.32	86.16
20.1 to 21.0 miles	1.12	87.28
21.1 to 22.0 miles	1.28	88.56
22.1 to 23.0 miles	0.98	89.54
23.1 to 24.0 miles	1.19	90.73
24.1 to 25.0 miles	0.87	91.60
25.1 to 26.0 miles	1.21	92.81
26.1 to 27.0 miles	0.56	93.37
27.1 to 28.0 miles	1.51	94.88
28.1 to 29.0 miles	1.15	96.03
29.1 to 30.0 miles	1.04	97.07
30.1 to 31.0 miles	0.41	97.48
31.1 to 32.0 miles	0.30	97.78
32.1 to 33.0 miles	0.21	97.99
33.1 to 34.0 miles	0.03	98.02
34.1 to 35.0 miles	0.08	98.10
35.1 to 36.0 miles	0.03	98.13
36.1 to 37.0 miles	0.10	98.23
37.1 to 38.0 miles	0.23	98.46
38.1 to 39.0 miles	0.19	98.65
39.1 to 40.0 miles	0.33	98.98
40.1 to 41.0 miles	0.18	99.16
41.1 to 42.0 miles	0.09	99.25
42.1 to 43.0 miles	0.13	99.38
43.1 to 44.0 miles	0.05	99.43
44.1 to 45.0 miles	0.26	99.69
45.1 to 46.0 miles	0.21	99.90
46.1 to 47.0 miles	0.10	100.00

The total poundage of each factory was accounted for in the above table, in which every five-mile class interval of the cumulative percentages has been underscored to bring out the pattern of the successive five-mile zones. It will be observed that about 32 per cent of the total supply comes from an area within 5 miles of the factories, while another 30 per cent comes from the next five-mile radius, i.e. 62 per cent of the total supply comes from a ten-mile radius.

Cast a little differently, the following table shows, by the process of interpolation, the structure of percentage of cream collection in 10 per cent intervals. From Table XXVI it will be observed that 10 per cent of total cream appears in the cumulative percentage column as a point between the second and third class-interval, i.e. at about 2.1 miles. Similarly each additional 10 per cent evaluation is interpolated in the same way.

TABLE XXVII. CUMULATIVE PERCENTAGE OF CREAM AND DISTANCE FROM FACTORY SHOWN IN 10 PER CENT INTERVALS.

Percentage of cream collected[28] (to nearest 10 per cent)	Distance from factory (cumulative figures)
10%	2.1 miles
20%	3.6 miles
30%	4.8 miles
40%	6.2 miles
50%	7.8 miles
60%	9.5 miles
70%	11.9 miles
80%	15.9 miles
90%	23.4 miles
100%	47.0 miles

28 The above table should read: 10% of the total cream is collected from within a 2.1 radius from the factory; 20% from within a 3.6 radius from the factory, and so on.

Table XXVII is very significant. Half of the cream comes from within a radius of eight miles. Put slightly differently:

One quarter of our cream comes from a radius of about 4 miles.
One half of our cream comes from a radius of about 8 miles.
Two-thirds of our cream comes from a radius of about 11 miles.
Three-quarters of cream comes from a radius of about 14 miles.

When the additional data from 68 factories is added to the above data a similar pattern results. It is shown below, but has not the statistical significance of the above table, because portion of it results from estimate and not measurement.

TABLE XXVIII. PERCENTAGE AND CUMULATIVE PERCENTAGE OF CREAM RECEIVED BY 86 FACTORIES IN ZONES MEASURED IN INCREMENTS OF FIVE-MILES FROM THE FACTORY

Zone	Percentage of total supplied	Cumulative percentage
Up to 5 miles	29	29
5.1 to 10 miles	28	57
10.1 to 15 miles	17	74
15.1 to 20 miles	11	85
20.1 to 25 miles	6	91
25.1 to 30 miles	5	96
30.1 to 35 miles	2	98
35.1 to 40 miles	1	99
Over 40 miles	1	100

Summary: The time consumed in cream haulage depends largely upon number of miles covered, together with certain factors such as condition of road, cream loading facilities, congestion of can-load and speed travelled.

As the number of cans per route increases, so does the unit of time per can. The optimum can-load is about 60 to 80 cans for most routes. Where routes are very long, it may be more economical to increase the can-load considerably, as the extra time required may cost less than running two trucks. Where suppliers are not far distant from the factory, or where cream-weight per mile is considerable, it is more economical to have multiple short routes than one long one.

Suitable norms may be used in planning, based on 25 m.p.h. for running time, plus 30 seconds per can for 60 cans, increased by 5 seconds for each additional 20 cans lifted. Managers should plan for optimum loads in terms of time consumption, rather than maximum loads in terms of weight; and use contractors for feeder routes where cream is hauled long distances.

As weight is not the most important variable in time planning, special attention needs to be paid to route-planning, for mileage and time are closely related, and about two-thirds of total time on cream collection is running-time. To minimise mileage, routes should be planned with the maximum number of loops and the minimum number of off-shoot routes. Dead-miles should be kept to a minimum, overlapping or routes avoided, and distances travelled per driver should be kept as constant as possible.

SECTION IV. THE COST OF TRANSPORT

The total haulage cost as revealed by published accounts amounts to £644,948.[29] But in addition to actual cream collection costs, are certain other transport costs: carriage and freight-out of the finished product and haulage of raw materials such as coal, salt, cartons, parchment etc. into the factory. These, together with travelling expenses of executives amount to over 30 per cent of total butter costs and consequently merit special consideration and analysis due to their magnitude alone. However, this section relates only to cream haulage.

Contractors were paid the sum of £356,283 or 55 per cent of total haulage costs. The weighted costs of those companies relying on contractors only amounted to 0.552d. per lb. of fat, whereas the weighted costs of those companies providing their services exclusively, amounted to 0.454d. per lb.

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[29] This figure represents the accounting cost - the aggregation of all sums shown in published annual accounts. The true economic cost is more, as certain suppliers were charged for cream collection either directly or indirectly. Direct charging according to accounts amounted to some £15,000, but indirectly or by undisclosed amounts, the sum was considerably in excess of this. Certain charges were made but off-set by monthly account, and do not appear at all in the structure of the accounts. Other suppliers haul their cream a certain distance by tacit agreement. Moreover, haulage costs in many cases were charged against other auxiliary activities to a certain extent.

of fat. Contractors costs were 9 per cent above the New Zealand average cost of cream haulage and 22 per cent above those factories using their own lorries exclusively.

There are two reasons why contractors costs were higher. The first lies in the fact that contractors have added a given profit margin to their operating costs, whereas factories operate at net cost. Moreover, contractors rightly add into their structure of costs a given amount for administration, and overhead. It is only with the larger factories operating a considerable fleet that administrative expenses are charged in the structure of costs.[30] The second reason lies in the fact that all true operating costs of factory-run haulage are not charged against cream collection. It is true that part of the expenditure was correctly charged against other Manufacturing Charges, or against General Haulage account, so that general fixed overhead was thereby spread or disbursed, but at the same time part of the haulage costs were charged against other auxiliary activities beyond the extent of the services rendered.[31]

The rest of Section IV. will analyse those haulage costs which refer to those factories operating their own vehicles. The elements of cost will be classified and analysed, then related to mileage, weight and time. Unit costs will be examined and then the effect of distance of suppliers from factories will be scrutinised as a factor in total costs.

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[30] It was not possible to get reliable data to cover the break-up of contractors' cost, as many ran cream contracts merely as a section of general haulage work. However, it was possible to obtain accounts for a large section of cream contractors of one district who devoted themselves mainly to cream haulage. Their accounts did not relate to strictly similar periods, but their break-up of expenditure in terms of percent was considered sufficiently valid for comparison. It was: Petrol 17%, Oil 1%, Tyres 7%, Repairs 13%, (Running Costs 38%); License Fees 4%, Insurance 2%, Wages 25%, Depreciation 8%, Assessed value of Proprietors services 8%, Garaging 2%, (Total Standing Charges 49%); Overhead and administrative charges 13%. This latter category included in order of magnitude, Management, Office Salaries, Telephones and Tolls, Rent, Printing and Stationery, General Expenses, Accounting and Audit expenses, Postages and Stamps, Bad Debts, Interest, Trade Subs, and Miscellaneous

[31] (This will be amplified in Part V. dealing with Auxiliary Activities).

<u>Monetary costs of cream haulage</u>: Cream collection costs of some fifty companies, representing a little more than 60 per cent of New Zealand's output, were obtained and analysed. Cream collection costs were first dissected into lorry-running and non-lorry running costs, and then the lorry running costs were further diesected into (a) variable costs, (b) fixed costs. By "variable" costs is meant those costs which vary with mileage, and are distinguished from "fixed" costs which represent those overhead and administrative charges which, by their very nature, do not vary with mileage.

Variable costs are:	Petrol. Oil. Tyres and tubes. Repairs and maintenance.[32]
Fixed costs are:	Insurance. Depreciation. Licences etc. Repairs and maintenance.[32] Administrative charges.

The element of cost "Wages" has been segregated from the above costs in order to focus attention on Truck Running Costs. These latter, plus "wages" form Cream collection costs.[33] The structure of costs is shown in the following table.

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[32] This item has been charged as two-thirds against Variable Costs and one-third against Fixed Costs. This is in accordance with normal vehicle costing practice, and approximates closely what is fairly attributable to mileage as distinct from repairs arising from general maintenance.

[33] Wages: Wages have been allocated on a time basis usually. Where cream collection duties consume 60 per cent of the time, it is normal to charge 60 per cent against cream collection. In some cases an undue proportion of wages was charged against such items as store deliveries. Administrative salaries were included in administration as an overhead item, and arise only in larger concerns.

TABLE XXIX. CREAM COLLECTION COSTS OF 50 DAIRY COMPANIES FOR 1949/50 SEASON

Expenditure:	Amount Expended £	Percent of total cost	Cost per mile d.
Petrol & Oil	75,128	35,02	3.94
Tyres and Tubes	24,612	11.47	1.29
Repairs & Maintenance	29,326	13.67	1.54
Variable Costs	129,066	60.16	6.77
Repairs & Maintenance	14,663	6.85	0.77
General Overhead	70,749	32.99	3.71
Fixed costs	85,412	39.84	4.48
Total Truck Running Costs	214,478	100.00	11.25
Wages	161,136	- -	6.92
Total Cream Collection Costs:	£375,614		18.17

In the above table, it was possible in the majority of cases to segregate cream collection costs from general cartage expenditure, i.e. separate expenditure for general haulage was not included. However, in a few smaller companies, the amount of general haulage was of minor importance and separate accounts were not kept, and consequently the total expenditure was included.

The broad classification of costs is shown as all companies did not keep strictly comparable costs in detail. For example, some companies carefully dissected oil and petrol, but a few showed only "petrol and oil". Others again, bracketed Insurance and Depreciation, or, Licences and Insurance, so that it was necessary to show all as "General Overhead".

The mileage logged for all vehicles (there were 323) in Table XXIX, amounted to 4,576,047 miles, and the amount of petrol consumed was 558,505 gallons, so that the average rate of petrol consumption was 8.19 m.p.g.

Wages accounted for some 42.9 per cent of the total expenditure and cost approximately 7d. per mile. Average truck running costs amounted to 11¼d. per mile and total costs were a little over 1/6d. per mile. Moreover, variable costs were three-fifths of total running costs, or approximately one-third of total cream haulage costs.

Where detailed records were kept, Oil cost about 2 per cent of total running costs, Insurance 2.5 per cent, Depreciation 15 per cent, Licences 5 per cent, and in the few cases where administrative salaries and charges were included,[34] these amounted to over 10 per cent. These costs, however, varied from company to company.

Wages, as a percentage of total costs, varied considerably from company to company and showed no correlation with size of factory or mileage covered. Seven companies were under 40 per cent, twenty-eight were from 40.1 to 50 per cent, and fifteen were over 50 per cent.

Petrol and oil, as a percentage of total truck running costs, varied from 28.16 per cent to over 50 per cent; Tyres and Tubes from 6.17 per cent to 19.0 per cent; Repairs and Maintenance (total) from 6.0 to 29.3 per cent and Fixed costs (excluding portion of Repairs and Maintenance) from 10.28 to 46.6 per cent. Fixed costs tended to increase in terms per cent with the increase in size of the company because administrative elements were correctly charged against truck running.

The variation in average petrol consumption was very small indeed. The range lay between 6.3 m.p.g. and 13.99 m.p.g., but these were extremes, as 90 per cent of the companies lay between 7 and 10 m.p.g.

Truck running costs per mile varied from 5.24d. to 18.67d. while total cream collection costs varied from 7.9d. to 28.68d. per mile. There appears to be a distinct relationship between unit truck running costs and output of the factories concerned. The average unit cost of those factories with less than 2,000,000 lbs. fat per annum was approximately 8½d. per mile; that of factories with output ranging between 2 and 4,000,000 lbs. was 7½d. per mile; that of the 4 to 6,000,000 lbs. was 11d. and factories over 6 million lbs. output averaged over 13d. per mile.

It would appear therefore, that as far as truck running costs are concerned, minimum unit costs were associated with medium-sized companies of the two to four million lb. output range, - costs increasing progressively

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[34] One company included the sum of £11.0.6d. being Fines, in Administrative charges; others apparently were more careful or less disclosing.

with scale from this class-interval. Overhead costs and mileage also increased with scale, and it would appear that costs would be even more were it not for general haulage work reducing unit overhead costs.

Variable costs: The elements of variable costs tend to move together. Where petrol costs are relatively considerable, other costs tend to move in sympathy i.e. oil, tyres, and repairs tend to be considerable too. Where it was not possible to measure the influence of other variables on repairs, oil or tyres, it was possible to measure petrol consumption.

Those factors affecting changes in the consumption of petrol were examined by holding all factors except one constant, and measuring the change in that one variable. To do this it was necessary to analyse running data of given routes over a period of time in order to hold truck, driver, roading conditions and weights relatively constant.

Seasonal effects on petrol consumption: Although deviations from the New Zealand average were small, yet within individual companies deviations occurred from vehicle to vehicle and at different times for the same vehicle. A group of seven vehicles and their running costs were analysed over a period of time in order to examine the seasonal influences of weather on petrol consumption. These vehicles ran 119,784 miles for the year, were identical in type, and averaged 8.216 m.p.g. and 320.9 miles per gallon of engine oil. No vehicle had done more than 60,000 miles. The routes covered consisted of 34.6 per cent of tarseal, 55.9 per cent of double width metal and 9.5 per cent of single width road. Eleven per cent was hilly and 18 per cent undulating. Cream was collected all the year around with fairly constant loading each time cream was collected. The following table sets out the pattern of monthly mileages, petrol consumption and cream lifted.

TABLE XXX. RELATIONSHIP OF PETROL CONSUMPTION AND WEIGHT OF CREAM TO SEASONAL CONDITIONS MEASURED MONTHLY OVER SIX COLLECTION ROUTES

Month	Mileage	Lbs. of cream collected	No. of lbs. of cream per mile	Average petrol consumption m.p.g.	Rainfall in inches
June	2,604	149,736	57.6	7.15	4.67
July	2,710	181,114	83.5	5.47	5.59
August	5,642	469,091	83.2	7.66	3.21
September	12,152	802,647	66.3	8.91	1.42
October	13,454	1,087,459	81.2	8.30	2.93
November	13,020	1,151,654	88.5	8.04	2.70
December	13,454	1,125,167	84.0	8.06	3.17
January	13,454	989,190	73.8	7.99	2.77
February	12,152	756,800	62.5	8.00	4.92
March	13,454	801,773	59.9	8.38	1.47
April	11,284	625,789	55.4	9.14	1.72
May	6,944	410,610	59.5	8.89	0.52

In the survey set out in Table XXX, some 276 trips were made for the year, and each day's trips aggregated a mileage of 434 miles with average of 71.5 lbs. of cream per mile. The variation in lbs. of cream per mile for each month is set out in the table, and as the daily mileage was constant for the six routes covered, the deviation of average weights lifted per month is relatively small. That is, variation in petrol consumption is due partly to weight of cream lifted, and partly to rainfall. Considering m.p.g. as the dependent variable, and weight of cream and rainfall as independent variables, partial correlation co-efficients showed that the correlation of weight of cream with m.p.g. was -0.47, whereas rainfall when correlated with m.p.g. was -0.88.

It will be observed moreover, that the lowest m.p.g. occurred in July when rainfall was at its highest. Conversely, when rainfall is low, the m.p.g. was high. In fact all drivers report heavier "pulling" in wet weather, and slower travelling in winter months which indeed, is borne out by the figures submitted. But it must not be assumed that rainfall is the only factor causing increased petrol consumption on identical routes. The number of pounds of cream loaded is also significant, especially so when routes are hilly, and trucks are carrying maximum loads. Where more powerful trucks were operating on level roads, other surveys indicated that a 30% increase in load made practically no observable difference to petrol consumption.

Other factors besides rainfall and weight of cream that determine m.p.g. are:-

(a) Wind-drag caused by awnings being used to shelter the cream from sun.[35]

(b) The number of stoppages per mile.[36]

(c) Extent to which Reverse gear is used.

(d) Speed truck is driven and consistency of driving speed.

(e) Age and present mileage of truck.

(f) Roads: gradient and surface.

These points have been elaborated earlier in relation to time consumption relate to petrol consumption and other running costs, which amount to over 60 per cent of total running costs.

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[35] This can be considerable. It is seldom realised that loose awnings flapping over cream cans at a height slightly in excess of the cab cause a moderate increase in petrol consumption. In one company (whose m.p.g. was examined carefully), it was customary to erect awnings on a given date, 1st Sept. On the 31st August petrol consumption was measured and again on Sept. 1st. Mileage was identical, and cream weights varied only two per cent, but the 18 vehicles averaged 12 per cent increase in petrol consumption under otherwise identical conditions. When it is remembered that the average "waiting-time" for all New Zealand is only 55.28 minutes, i.e. the average can is standing still only one-half of this time, it is a question whether the deterioration of cream is matched by the increased petrol consumption. When enquiry was made further, it was revealed that the awnings had to be removed each day after cream was unloaded as the lorries were utilised for general haulage purposes. The cost to the company concerned amounted to over £650 per annum in petrol alone, besides other running costs. In addition, 1800 hours of driver's time was consumed plus a heavy replacement cost in canvas awnings. As cream deteriorates only when standing still on back of lorries (during haulage, the current of air is sufficient to prevent deterioration), it is considered that an average of less than half an hour exposure to sun does not warrant the expense of increased haulage costs, especially in days of vacreation.

[36] The number of stoppages per mile causes a very considerable increase in all truck running costs - especially repairs and maintenance. When a vehicle ceases to move, either the engine is left idling, or is turned off and started again. The vehicles operating in Table XXX, for example, always left their engines running, even for periods up to five minutes. They averaged, a total of 433 minutes a day in engine idling time, but this consumption of petrol is considered much (cont).

Unit costs of cream collection: The New Zealand average for all factories was 0.508d. per lb. of fat. The dispersion of unit costs lies between the range of 0.300d. to 1.477d. per pound. There is no obvious relationship between unit costs and scale, but there is a general tendency for unit costs to be less with increase of scale. The 27 companies with output of butter less than 1,000,000 lbs. per annum, show wide dispersion of costs. Two companies have costs under 0.4d. per lb., another 11 companies have costs between 0.4 and 0.6d. per lb., five companies lie between 0.6 and 0.8., another five lie between 0.8 and 1.0d. per lb. and four have costs in excess of 1.0d. per lb. The structure of unit costs for all companies is shown in the following table.

TABLE XXXI. CREAM HAULAGE UNIT COSTS OF 90 COMPANIES FOR 1949/50 SEASON.

Size of Company* (Output in lbs.)	No. of Companies	Average unit cost of cream haulage. (d. per lb. B/f.)	Truck running costs per mile
Up to 1,000,000	27	0.667d.	)
1,000,001 to 2,000,000	27	0.604d.	) 8½d.
2,000,001 to 4,000,000	20	0.633d.	7½d.
4,000,001 to 6,000,000	13	0.516d.	11d.
6,000,001 to 8,000,000	5	0.477d.	)
8,000,001 to 12,000,000	2	0.432d.	) 13d.
Over 12,000,000	2	0.419d.	)

* The data has been related to companies rather than factories, as in certain cases it was not possible to allocate costs exactly to individual factories.

36(cont.) less an economic expenditure than that which would be occasioned by turning off the engine and recommencing it again, as is done in some companies.
One company supplied some very interesting figures. They operated a considerable fleet of vehicles - some on milk and cream haulage and some on town milk deliveries. On the cream and milk haulage section, the vehicles were six-tonners, whereas on the town milk supply routes 30 cwt. trucks were employed. While the petrol and oil consumption was identical for both fleets, the repairs and maintenance on the town supply routes were just double those of the vehicles used exclusively for cream and milk haulage. It was considered that the excessive stopping, and starting per mile covered was the cause of the heavy running costs. Moreover those vehicles on closely settled deliveries all had petrol costs of over 4d. per mile.

There is an apparent decrease of unit costs with scale. In the third class-interval there is an increase over the second, but in the third class-interval four companies have costs in excess of 1d. Were these deleted, the decreasing pattern would have been uniform. The truck running costs per mile from data presented earlier are repeated for purposes of comparison only. These costs refer to 50 companies only and are placed in broader classifications. Whereas truck running costs per mile tend to increase, unit costs per lb. of fat tend to decrease. This is due partly to larger bulk of cream carried by larger companies, and their tendency to allocate haulage costs elsewhere.

Distance of suppliers from factory and its relation to costs:[37] Tables XXVI and XXVII show the distance of suppliers from their relative factories. Table XXVII shows the cumulative percentage of cream in class-intervals of 10 per cent together with distance from factory. This latter table will now be used to calculate the costs of cream haulage, as determined by distance of supplier from factory. Thus from Table XXVII it is assumed that the first 10 per cent of cream cost $\frac{2.1}{47.0}$ of the total costs; that the first 20 per cent cost $\frac{3.6}{47.0}$ of the total costs; and so on through the table. The resulting costs are shown in the following table:-

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[37] Strictly speaking, the following table refers to collection costs, i.e. variable costs, and assumes the "sunken" costs of capital outlay on vehicles etc., as constant.

TABLE XXXII. COST OF CUMULATIVE ZONES OF CREAM AS DISTANCE OF COLLECTING POINT INCREASES FROM FACTORY

Percentage of cream collected classified in zones of 10%	Cumulative cost as zone increases in distance from factory
10% of the cream costs	4.4% of total costs
20% of the cream costs	7.7% of total costs
30% of the cream costs	10.2% of total costs
40% of the cream costs	13.2% of total costs
50% of the cream costs	16.4% of total costs
60% of the cream costs	20.2% of total costs
70% of the cream costs	25.2% of total costs
80% of the cream costs	33.8% of total costs
90% of the cream costs	50.0% of total costs.

The table should be read: the first 10% of cream in a hypothetical zone nearest the factory costs 4.4% of the total costs; the first 20% of cream (including the previous zone or zones) nearest the factory etc., and so on.

It will be observed that the last 10 per cent of cream collected actually costs one-half of total costs on an average. Moreover, one-third of the cost will bring in 80 per cent of the total cream, and approximately one quarter of the cost will bring in 70 per cent, and one-fifth of the cost 60 per cent, and one-sixth of the cost 50 per cent.

The above table refers to data which represents a carefully selected cross-section of all types of routes for factories of different sizes. It would appear in Table XXVIII where 86 factories are examined, that suppliers are further from the factories than the suppliers of Table XXVI, from which these costs were taken. Moreover, it was assumed that the first five miles of the route are identical with the last five miles of the route as far as costs are concerned. That is, it had to be assumed that the last few miles were just as easy going as the those nearest the factory - for costs were worked on the assumption that if the route were 10 miles long, then the first two miles would cost just 20 per cent of the total costs. But the first two miles from the factory are usually "dead miles" of flat tar-sealed roads. Further from the factory, the roads become more difficult to traverse, narrower, often hilly, or tertiary roads. Time consumed at the distant end of the route was checked as being more than 40 per cent than at the beginning of the route in most cases, and running costs are probably up to 20 per cent higher. Non-productive time increased with length of route also.

With some large companies, with long distant routes and bad roads towards the terminals, as much as 60 to 70 per cent of total cost was in collecting the last 10 per cent of cream. This was because most of the cream came from loop routes with off-shoots of some distance, so that long mileages were necessary for a very small percentage of cream.

Smaller factories with shorter routes have a more compact cost structure, and can bring in 50 per cent of their cream for 25 to 30 per cent of the total cost. Those factories with most distant suppliers under 10 miles have a fairly evenly distributed cost pattern. One factory was selected as typically spaced as far as suppliers went, (the most distant 22 miles) and the cost structure worked out. Measured in 10 per cent of cream interval zones, the oost pattern was: 2, 5, 11, 18, 27 (at 50 per cent of cream received), 38, 51, 65, 82 and 100 per cent respectively.

<u>Summary</u>: Vehicle-running costs are 60 per cent variable, and 40 per cent fixed in character. Petrol consumption and repairs increase with the number of stops per mile (rather than by weight carried). Rainfall and wind-drag increase petrol consumption considerably. Backing into stands, excess stopping, and over-speeding should be controlled or eliminated where possible.

Running oosts tend to increase with the size of the company and the mileage run. Efficiency tends to decrease with scale, for larger companies tend to go further for cream, and although unit costs appear to decrease with scale, when costs are adjusted to a fixed weight for all factories, a steep rise in unit costs is revealed.* This is because haulage costs increase proportionately with distance from factory, while oream offerings decrease. The most distant 10 per cent of cream lifted costs about 50 per cent of total oosts. Non-operational time, too, tends to increase with scale and distance from factory.

* See Table XXXII D. p. 161 for further treatment.

SECTION V. ECONOMIC ASPECTS OF TRANSPORT EFFICIENCY

Efficiency in cream collection is partly technical in character, and partly economic. These aspects tend to merge, especially when technical efficiency underlies economic efficiency.[38]

Technical efficiency arises when aggregate transport costs are reduced for a given intake of cream by improving exogenous and endogenous factors which affect time-consumption and truck-running costs.[39] Such factors would include road conditions, cream-loading facilities, size of truck, can-load, planned length of route, can-grouping and driving techniques. As these factors can be improved in isolation they affect technical efficiency but once decisions affect other factors, the resulting efficiency is economic.

For example, a manager must choose between employing a contractor (at higher haulage rates) and factory-collection (at a lower haulage cost, but a higher administrative outlay); between a maximum intake of cream (together with poorer quality from marginal suppliers) and minimum haulage rates; between supplier-satisfaction (from services rendered) and reduced transport costs; and between premium grade (from frequent collections) and lower grade resulting from less frequent collections. But the major competing ends in cream haulage appear to be achieving maximum intake of cream, and minimum unit haulage costs. Other less important ends are administrative outlay, services rendered, quality of cream, and capital equipment outlay and maintenance.

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[38] A given route may have to be covered in a given time. To achieve this, speed may have to be increased at the expense of increased petrol consumption and vehicle maintenance. The problem becomes both technical and economic.

[39] Technical considerations generally focus on time, mileage and petrol consumption. This latter varies according to weight of cream, speed, horsepower of motor, skill of driver, age of motor and engine performance, wind-drag, gradient, rainfall and road surface.

The alternative methods of cream collection will be examined by comparing unit costs and assessing their relative advantages.

Contractor efficiency: As indicated in other sections of Transport (especially pp. 138 and 139 of Section IV), contractor cost efficiency appears to be less than factory-operated efficiency. [40] On an average contractors' costs are 22 per cent above factory-operated costs. The causes of this have been discussed but it is necessary to add that, for reasons already given, this differential of 22 per cent could well be reduced to a figure such as 15 per cent because:

(a) Contractors' costs include higher administrative costs than factory costs allow for on an average.

(b) Contractors' costs include the element of profit .

(c) Factory costs (in part) for haulage are appropriated against other activities of the company, and for competitive reasons generally have a bias in favour of lower-than-actual cream haulage costs.

Some companies, knowing that contractors' rates exceed factory haulage costs, work out rate-setting to a fine degree of competency, by through analysis of routes and experiment. Where cream density is considerable they calculate the ratio on a mileage basis, and where the cream density is light, on a poundage basis.

Contractor versus factory-operated methods: It will be necessary to survey the merits of each method. Strictly speaking there are three methods; (a) contractors only, (b) factory-operated only, and (c) mixed. Each method has its own advocates.

(a) The chief advantage of employing contractors only is that it removes a heavy administrative task from management. Transport work is a specialist field requiring specialist services. Especially in many small companies, where the chief executive is a working manager, and his entire time devoted

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[40] Cost patterns vary. Some companies operate a general goods licence and apportion costs on a purely subjective basis (mileage or time), while others charge the transport expenditure account with a nominal figure, transferring the surplus of profit or loss to the appropriation account. Other companies which utilise their transport facilities for purposes other than cream collection and appropriate a given percentage of the total haulage costs on some subjective or nominal basis.

to manufacture of butter, that extra time required for supervision can ill be spared. Moreover, in very small factories, where the establishment is two or three hands, a full-time driver would have surplus time on his hands, and besides the factory would have a considerable capital outlay tied up in a quickly depreciating vehicle. In small companies, idle overhead forbids factory-operated vehicles. It is claimed that contractors' costs work out much less than what it could be done for by the factory itself.[41] One other argument is that lorry drivers resent being placed on non-driving duties such as loading coal, cleaning, maintenance and cream reception work. The turnover of drivers is higher than other factory workers, and some managers have advised that they abandoned their own collection of cream because of the difficulty in finding suitable drivers who would stay through the season. In some cases, drivers would be taken on in the off-season and would give notice just as the flow of cream began in earnest. One final reason is that supervision of drivers away from immediate scrutiny has its own problems.

(b) It is contended for the purely factory-operated method, that the manager has immediate and flexible control over cream collection. He is able to give immediate decision and implement it when occasion arises. When flow of cream falls off, he is able to decide day by day just what to do, without prior notice or agreement with his contractors. Moreover, he is able to plan time for arrival of cream precisely so that cream reception can proceed in an orderly way without any waiting or congestion of lorries and cans. He can dictate just how cans are to be delivered, give rulings on how long to wait for cream to arrive and generally control collection effectively from the gate.

Where auxiliary services such as store-trading are engaged in, the function of store delivery can be incorporated with cream collection more cheaply and smoothly than it can be with contractor service. With contractors there arises the problem of charging and the subsequent book-work involved may be considerable.

Then there are those elements of transport required in every dairy company besides the collection of cream. Few companies have rail sidings alongside their cool stores, or if they do, do not always find it most convenient in railing stores inwards - except perhaps, for bulk coal. Although

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[41] It is essentially an example of opportunity costs operating.

contractors do deliver bulk butter and pick up stores, if the company has no lorries, it is more convenient and time-saving if the company can perform these services itself.

Finally, there is the element of cost. Many managers contend that they can operate their vehicles more cheaply than they can hire equivalent service, and utilise the added labour force on cream reception and other work of a maintenance character more effectively than by pure contract methods. More than one manager, moreover, advised that they used lorry driving work as an incentive to general hands to qualify for work yielding a higher rate of pay, and this assisted in reducing general labour turnover.

(c) The mixed method obviously combines certain advantages of the two previous methods. The manager has his own statistical cost data on truck running and can utilise it for rate-setting or checking contractors' rates.

It has been observed that those companies which have their own fleet and employ the services of contractors too, have highly differential and competitive rates which have been calculated to a nicety. One such company, for example, had several rates set such as 53/128d. of a penny per lb. of fat. Further, it is an advantage for any company to operate its "loop" routes by housing the vehicle at the factory, and returning to the factory with a minimum of "dead-miles"; and to let out to contractors such routes as are off-shoots from the main loops, or long solitary roads leading into some valley.

To summarise: It is considered that each method has its own especial advantage; small companies to utilise contractors; larger companies to use their own vehicles but to supplement by contractors where the special nature of the routes or terrain justify their use.

Minimum cost outlay as an alternative to maximum intake of cream: From Table XXXII (p. 148), it is obvious that the last 10 to 20 per cent of cream from frontier marginal suppliers causes a disproportionate increase in collection costs. Especially is this true in larger factories, where collection routes extend out much further than small factories to load the offerings of marginal suppliers. Long distances are often covered to pick up a relatively small weight of cream, and it would appear that the added revenue from frontier collections hardly equates the increased cost of collection.

The steep incidence of collection costs becomes marked beyond the 20 mile zone, and increases rapidly beyond that. In those factories where frontier suppliers are more than 40 miles from the factory, the last 10 per cent of cream usually costs about 50 per cent of total collection costs (i.e. total variable expenses, excluding overheads).

Managers are generally unwilling to relinquish their distant suppliers, partly because output and salary depends on maximising cream received, and partly because pressure groups demand the service of cream collection. Further, it is argued that if marginal suppliers are declined, there is every likelihood that a neighbouring factory will accept their offerings.

Moreover, it is recognised that unit costs fall with increased output, and most factories consider maximising cream intake a prime objective and prefer higher collection costs to a lower intake of cream with reduced unit costs of collection.[42]

From the point of economic efficiency, then, the added revenue from marginal suppliers must at least equate the increased haulage costs that result. The problem becomes one of marginal cost analysis. The marginal cream lifted may increase the total unit costs beyond the point gained from total reduction of unit processing costs. Maximum economic efficiency in cream haulage is determined therefore, at that point where the reduction in unit costs resulting from greater quantities of cream being processed, is just equated by the increase in costs resulting from increased haulage costs. Conversely, marginal suppliers can be eliminated to the point where reduced haulage costs just match the increased unit processing costs that result from a smaller intake.

To examine the effect of reducing a marginal intake on total costs, the position will be set out in two tables.

The first table sets out the data relevant to the total cost of manufacturing butter, and haulage of cream for precise class intervals, before marginal suppliers are curtailed.

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[42]Managers are also influenced by the consideration that a greater cream intake permits or qualifies the factory for improved technical facilities.

TABLE XXXII.B.. TOTAL COSTS, AVERAGE COSTS, AND MARGINAL COSTS OF MANUFACTURING BUTTER AND HAULING CREAM AT GIVEN CLASS INTERVALS

Output in lbs. ('000,000)	Total Manufacturing Costs			Cream Haulage Costs		
	Total Costs ('000,000) d.	Average Cost D.	Marginal Cost d.	Total Costs ('000,000) d.	Average Cost d.	Marginal Cost d.
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1	3.60	3.60		0.66	0.66	
2	6.52	3.26	2.92	1.22	0.61	0.56
3	9.24	3.08	2.72	1.68	0.56	0.46
4	11.84	2.96	2.60	2.08	0.52	0.40
5	14.40	2.88	2.56	2.40	0.48	0.38
6	16.92	2.82	2.52	2.76	0.46	0.36
7	19.46	2.78	2.54	3.08	0.44	0.32
8	22.08	2.76	2.62	3.36	0.42	0.28
9	24.75	2.75	2.67	3.69	0.41	0.33
10	27.50	2.75	2.75	4.10	0.41	0.41

The first column shows the various class intervals of output located at the precise levels of 1,000,000 lbs., 2,000,000 lbs. up to 10,000,000 lbs. Columns (2) and (3) show the Total Costs and Average Costs of aggregate butter manufacture expenditure derived from the smoothed Total Cost-Output curve shown in Figure 18 of p.338. As Column (2) is in millions of lbs., Columns (3) and (4) show Average Unit Costs and the Marginal Unit Costs in pence/lb.

Columns (5), (6) and (7) show the same pattern for total Cream Haulage Costs and are derived from Figure 18 also. Although marginal costs are usually derived from unit increments, the unit of analysis selected is one million lb. output intervals.[43]

[43] Strictly, in the economic sense, an average cost curve is plotted from the relationship of the varying costs related to alternative outputs of a given plant with fixed scale for a given unit of time. The above relationships (called curves in the text that follows), refer to alternative outputs of a variable scale, and theoretically therefore, does not conform to an economic cost curve model.

Cont'd. on p. 155A

Footnote 43 Cont'd:

These relationships or "average cost curves" can mean variously:
(1) Those of a fixed plant with variations of its output.
(2) Those of plants of different sizes with costs it would have in its given territory, but supposing it could get the different levels of butterfat to process.
(3) Those costs of a series of different sized factories in their particular situations (locations).

The third type of relationships (3) are not the analytical cost curves of theory, and these distinctions must be held in mind before it is safe to attempt to transfer the conclusions of discussions based on this type of data to those of the second type (2). The choices open to a manager in a particular territory belong strictly to cases in category (1) and (2), and only if his situation would resemble the average given in category (3) would it be safe to infer even tentatively that the conclusions which follow would apply in his case.

The discussion that follows is, however, regarded as useful in indicating a technique of analytical thinking towards a decision in the light of the relations uncovered. Further limitations of such relationships as these are discussed further in Part VI pp. 314-317. Another limitation, is the coarseness of the incremental step, which is, however, sufficient to indicate the method of analysis.

It should be noted from Table XXXII C, that a 20 per cent reduction in cream intake is presumed. Strictly, a much finer decrement should be used, otherwise the factory plant may have to "shift" to a smaller size appropriate to an 80 per cent cream intake. This coarse decrement is used to illustrate the variations which occur in sufficient magnitude to demonstrate the type of adjustment clearly. Otherwise it would be implied that the lower intake will only yield the savings noted if the appropriately smaller sized plant is chosen when a new factory is being considered or an older one replaced.

Table XXXII C, owing to these limitations, becomes an interesting exercise in indicating the magnitude of the effect of dropping suppliers under the assumption of average territory and the system of cost allocation adopted.

The pattern of costs is readily seen. Both sets of Average Cost data (if plotted) show a typical asymptotic flattening out at the 10 million output level. The Marginal Cost Data (if plotted) would show a Marginal Manufacturing Cost curve at its lowest point about 5.7 million output level, rising to intersect the Average Cost curve at about 9.5 million level. Similarly, the Marginal Cream-Haulage Curve is at its lowest point about 7.5 million level output, and is rising to intersect the A.C. curve at the 9.5 million level.

The second table shows the same data corrected for a 20 per cent reduction of cream intake, but adjusted to allow for the cost saving arising from eliminating marginal suppliers.

TABLE XXXII. C. EFFECT OF 20 PER CENT REDUCTION OF CREAM INTAKE (BY ELIMINATING MARGINAL SUPPLIERS), ON MARGINAL COSTS OF TOTAL EXPENDITURE OF MANUFACTURING BUTTER AT GIVEN OUTPUT LEVELS*

Output in lbs. ('000,000)	Total Mnfg. Costs		Tot. Cream Haulage Costs			Total Mnfg. Costs Adjusted 20%		
	Total Costs	Marginal Costs	Tot. Cost	Adjusted Tot. Cost	Amount saved	Nett T.C.	Nett M.C.	Nett Av. Cost
	d. (000,000)	d.	d. ('000,000)	d.	d.	d. ('000,000)	d.	d.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
0.8	2.88		0.53	0.32	0.21	2.67		3.34
1.6	5.35	2.47	1.00	0.60	0.40	4.95	2.28	3.09
2.4	7.61	2.26	1.40	0.82	0.58	7.03	2.08	2.93
3.2	9.76	2.15	1.76	1.02	0.74	9.02	1.99	2.82
4.0	11.84	2.08	2.08	1.18	0.90	10.94	1.92	2.73
4.8	13.89	2.05	2.34	1.35	0.99	12.90	1.96	2.69
5.6	15.91	2.02	2.62	1.51	1.11	14.80	1.90	2.64
6.4	17.93	2.02	2.89	1.65	1.24	16.69	1.89	2.61
7.2	19.98	2.05	3.14	1.81	1.33	18.65	1.96	2.59
8.0	22.08	2.10	3.56	2.01	1.35	20.73	2.08	2.59

* Total outputs are '000,000 lbs. in each instance.

Column (1) now shows cream intake reduced 20% so that the output levels are 80 per cent of each class interval of the previous Table. Columns (2) and (3) show the amounts of Cols. (2) and (4) of Table XXXIIB. so reduced. Column (2) of the above table was calculated by interpolating the total cost for each class level from its own appropriate marginal cost in order to make due allowance for change in the structure of cost at each output level. For example, at the 3.2 million output level, the TC of the third class interval of Table XXXIIB. was taken, 9.24 (i.e. 3.0 output) and to this was added 1/5th of the appropriate Marginal Cost increment of 2.60, making a total of 9.76 for the 3.2 level of output. This procedure was followed for the interpolation of all reduced Total Costs in Columns (2) and (4). The Marginal Costs of Column (3) were then derived from Column (2) and they represent the cost structure appropriate to reduced output levels.

Columns (4), (5) and (6) represent the cream intake reduced 20 per cent, by eliminating marginal suppliers (the last 20 per cent at the distant ends of collection routes). As shown in Table XXXIIA, (p.148), 80 per cent of the cream costs 33.8% of the total costs (variable collection costs). Those variable collection costs include all running costs (including wages), and amount to 77 per cent of total costs.[44] To arrive at the nett effect of 20 per cent reduction; the Fixed Costs of 23 per cent are added to 33.8 per cent of 77, making 49 per cent. Column (5), then, is 49 per cent of Column (4) for each output level, and Column (6), which is the nett saving, is derived from Column (4) minus Column (5).

Having calculated the nett saving on cream collection at each output level, Column (7) shows the cost decrement included in the total manufacturing costs, (Column (2) minus Column (6)). Column (8) is the Marginal cost of the data in Column (7), and Column (9) the Average Cost data of Column (7).[45]

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[44] See Table XXIX, (p.141) where cream collection costs are analysed. Total Costs come to £375,614, and Fixed Costs to £85,412. This Fixed Cost portion is 23 per cent of Total Haulage Costs.

[45] The Average Cost data of Column (7) may be compared with Column (3) of the previous table, as the output levels are reasonably comparable.

A comparison may now be made of Columns (3) and (8), which indicate the marginal costs at each output level for total manufacturing costs adjusted for the cost decrement from reduced cream intake together with the cost increment resulting from reduced output. The cost decrement of Column (6) has been offset at each level to some extent by the increased costs of manufacture due to reduced intake.

At the 80 per cent intake level, therefore, there is a marked cost saving at all output levels. A reduction of approximately 0.16d. per lb. in terms of marginal cost may be obtained from 1.5 to 7.5 levels of output. By curtailing marginal suppliers to the extent of 20%, there is a definite cost differential advantage at all levels of output up to the 8.0 level, where the differential cost advantage is slightly more advantageous than previously. This is confirmed by an examination of the Average Cost data of the two tables, which shows that the average unit costs indicate the same pattern of cost reduction throughout the range.

These data, however, while they indicate an overall economic advantage lies in curtailing marginal suppliers, do not furnish the point at which the incremental and decremental costs just balance. This can be located by testing each output level at increasing percentages of curtailment. When one per cent of marginal supply is curtailed, Total Cream Haulage costs are reduced by a little over 11 per cent.[46] At this one percent level, all outputs show reduced average costs, for one per cent makes an almost imperceptible incremental change to manufacturing costs, but a relatively important change to the decremental haulage costs.

It is not until the 50 per cent level of curtailment is reached, that a point is determined in the output level, where the incremental manufacturing cost just balances the decremental haulage cost - viz. at the 7 million output level. Above this level, it is still slightly advantageous, but below it, the savings in haulage costs do not match the increased manufacturing costs.[47] At the 40 per cent level it is advantageous at all levels in excess

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[46] This can be interpolated from the data of Table XXVI of p.135.

[47] This can be illustrated for the 50% level at 8m.output; At 8m. the Average Unit cost is 2.76d. When production (i.e. collection) is curtailed 50 per cent, the Total manufacturing costs are 9.24d. Subtract from this collection costs (2.08) and add 1.21 (being 36.5% of 3.36). The result, 10.97 is the total cost at the 4m. level. Average cost is 2.74d., which is slightly better than that of the 8m. level of 2.76d.

of approximately 1.5 millions output.

The question arises immediately; if there is such an advantage in terms of cost, by curtailing marginal suppliers, why is this not practised more? The answer appears to lie in the fact, that this curtailment is happening - not deliberately in most cases, (although many factories insist on frontier suppliers bringing their cream to a suitable loading point) - it is happening largely in the process of time. Supplier density is increasing all the time, and this has the indirect effect of offsetting the high haulage rates which arise from collecting relatively small offerings from marginal suppliers.

The average cost of hauling cream is greater than that of total wages, but in the course of time, wages tend to increase and that of transport tends to decrease largely due to greater supplier intensity which offsets the effect of distant marginal suppliers.[48] It is this process, together with the practice of contracting out the cartage of marginal cream, that has enabled transport costs to decline through time. In every instance where managers have declined to operate beyond a certain distance from the factory (although accepting cream at the supplier's expense), cream haulage costs have been kept at a lower level than unit wage costs, thus indicating economic efficiency has operated in that haulage costs have been substituted for other factor costs.

An analysis of the relationship between wages and haulage costs confirms this. Some 23 factories (of 90 examined) had cream haulage unit costs under 70 per cent of those of wage costs, while 23 factories had haulage costs in excess of 130 per cent of unit wage costs. Of the first 23 (low haulage cost group), 13 factories lifted cream from within a 15 mile radius and only 4 exceeded a 30 mile radius. Of the 23 high-cost group, 15 factories exceeded 30 miles, and 8 exceeded 15 miles from the factory. Of the smaller factories (up to 2 million lbs. output), 44 per cent had no supplier more than 15 miles from the factory and 44 per cent had costs under 70 per cent of wage costs.

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[48] The decline is relative to total costs. In one factory where conditions were relatively stable, and output over 20 years varied between 5 to 6 million lbs. per year, wages increased from 10 to 17 per cent, while Cream Haulage Total Costs decreased from 20 to 16 per cent for the same period. (1931-1950).

Of the larger factories (exceeding 6 million lbs. output), 67 per cent had suppliers in excess of 30 miles from the factory, all of which had haulage costs higher than wages costs (of which 37% exceeded 130% of the wage costs).

Generally speaking, where one-half of the cream was lifted within 7.5 miles from the factory, cream costs were lower than unit wage costs, but where one-half of the cream exceeded 7.5 miles, unit haulage costs exceeded wage costs proportionately as the 50 per-cent-point increased in distance from the factory.[49]

Other factors affecting Transport Efficiency: The main elements in cream haulage costs are weight, mileage and time. From a theoretical point of view, weight assumes a peculiar function in that it is not dissimilar to a kind of "fixed" element in cost, whereas mileage and time can be compared to "variable" elements. While haulage costs would be meaningless without weight, from a practical point of view, additional weight adds very little to total costs over a given fixed route. That is, a large part of haulage costs will be involved even if no cream were lifted at all, for the fixed expenses would be the same and the variable expenses would be slightly less only.

Some 26 factories which used their own vehicles exclusively were examined for cost of transport data. These factories were carefully selected as representative of the entire range of output and terrain over which collection may be made. The relevant data is shown in the following table:-

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[49] See the data given in Table XXX (p.144), where some of the highest (best) petrol consumption data occurred when the loads were the heaviest, and worst when the loads were lightest. Roading conditions affected petrol consumption more than loads.

TABLE XXXII.D. RELATIONSHIP BETWEEN MILEAGE, TIME, WEIGHT AND COST OF TRANSPORT DATA OF 26 BUTTER FACTORIES FOR THE 1949/50 SEASON

Weight of cream lifted ('000s lbs.)	No. of factories	Average weight of cream lifted ('000s lbs.)	Average annual mileage	Weight Mileage	Average Ann. Trsprt. Wages. £.	Av. Ann. Total Trspt. Costs £.	Av. Unit cost B/F. d.	Unit cost adjusted d.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Up to 2,000	5	1311	24,934	52	636	1416	0.601	0.197
2001 - 4,000	4	3235	49,406	68	1418	3281	0.650	0.527
4001 - 6,000	4	4390	66,210	67	2260	4455	0.606	0.660
6001 - 9,000	4	8214	97,824	84	3281	6374	0.476	0.976
9001 - 12,000	3	9273	112,487	83	3701	7204	0.462	1.071
12001 - 18,000	3	14, 529	150,767	97	5147	11,158	0.408	1.479
Over 18,000	3	23, 089	166,167	139	6758	16,361	0.426	2.712

Column (1) shows class-intervals of cream lifted to the nearest 1000 lbs. Column (3) shows the weighted average of Column (1). Thus in the first class-interval five factories lifting up to two million lbs. of cream are recorded. The class-intervals of Column (1) progress in heterogeneous intervals in order to bring out the pattern of relationships more closely. There were 9 or 10 factories in the last class-interval which might have been included but were deleted because of doubt about certain details. When examined separately, however, their average figures approximated very closely those of the above table in every respect.

Column (4) shows the weighted average annual mileage run on cream collection. Column (5) is a co-efficient or ratio computed as $\frac{\text{Column (3)}}{\text{Column (4)}}$. This ratio is a measure of the number of lbs. of cream lifted per mile; and is an indicator of the independent variable, weight. The greater this co-efficient, the lower should be the unit cost (other things being equal). Column (6) shows the weighted average annual wage-bill allocated to cream haulage and is a relative measure of Time consumed on cream collection.

Column (7) shows the weighted average of the annual cream collection costs. It includes the data of Column (6) and total truck haulage costs. Column (8) is the weighted average of unit cream collection costs in terms of pence per lb. B/F.

Column (9) is a derivative of Column (8) and Column (3). It assumes a constant average weight of cream lifted of 4,000,000 lbs. per annum. In the first class-interval in Column (3), 1,311,000 lbs. of cream were lifted. Had the hypothetical 4,000,000 lbs. been lifted, then obviously the average unit cost would have been $\frac{1311}{4000}$ of 0.601, i.e. 0.197d.[50] Column (9) unmasks the real efficiency of cream collection of the larger factories. It puts all factories on the same basis as regards weight of cream - in other words, it holds the variable element of "weight" constant, and this tends to reduce unit costs for low-output factories, and increase unit costs for high-output factories (as revealed in Column (5)). It should be observed here, that there was considerable dispersion of all individual observations from the mean of the class-intervals. This dispersion was quite marked when the individuals of Column (5) were plotted against column (9), and those of Column (4) against Column (8) and Column (7) against Columns (8) or (9). In fact, the only scatter diagram which showed any apparent relationship, was that obtained from plotting the individuals of Columns (4) and (7). Here a marked trend of closely clustering dots was observed up to about 10,000,000 lbs. of cream, and this continued in a more dispersed way with increased poundage and costs. It denoted a marked relationship between mileage and total costs. By averaging these individuals, other relationships can be observed.

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[50] This must assume other things held equal - the same distance covered, and the same taken time. Given a fleet of trucks, cream haulage costs are derivative of mileage, time and weight. Mileage and time are the two variables affecting the dispersion of costs mostly. Weight tends to be a constant. It takes just as many miles and time to collect 100 cans containing 10 lbs. of cream as 100 cans containing 20 or 30 lbs. of cream (assuming the cans to be in identical places etc.). But obviously the 30 lbs. cans will show unit costs just one-third of those with 10 lbs. each. Unit costs camouflage efficiency. If many large factories suddenly had their poundage cut by one half, their unit costs would double. Yet there are factories with an output of approximately 500 tons covering a collection area identical in size, area and dispersion as some factories with 5,000 tons output, at less than double the unit cost. Column 9 is useful as indicating the magnitude of this change, but practically tends to be unrealistic as the "other things held equal" do change in fact.

There is a steady increase in the density of cream lifted (see Column (5)). This should not be interpreted as meaning that small factories pick up about one-half the quantity of cream per mile, (for example) of those in the second last class-interval. This would be so if we could assume constant density per mile for each mile out from the factory. Quite a number of the larger factories picked up well over 1,000,000 lbs. of butterfat within the first five mile radius. A few picked up well over three million pounds of fat. The smaller factories picked up in the vicinity of 200,000 to 300,000 lbs. of fat, while medium-sized factories were often pressed to reach the half-million lbs. mark. That is, the fat density ratio is about 1:8 between the smallest and largest factories for the first few miles. However, larger factories extend out relatively much further than small factories and tend to go considerable distances to pick up the last 10 to 20 per cent of their cream, otherwise their weight-distance co-efficient would be even larger.

The relationship between Columns (6) and (7) is fairly constant, but there is an interesting relationship between Columns (4) and (6). Column (4) measures time indirectly, (in hours) for if mileage given is divided by 15, we have an approximate measure of time taken away from the factory on cream collection. Column (6) measures time paid for, whether consumed on cream haulage or not. For example, in the first class-interval, 24,934 miles at 15 m.p.h. indicates approximately 1662 hours were taken on cream collection, which, when divided into the aggregate average Wages, yields roughly 7/6 per hour. Taking penal rates of pay into consideration, this means one-third of time of drivers is not on cream collection. However, as scale increases, it is clear that these hourly rates tend to increase so that in the second last interval (for example), approximately 10,000 hours receive roughly £5,000 or 10/- per hour.[51]

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[51] This is based on the fact that the average driver with penal rates earned approximately £520 per annum or 5/- per hour. Depreciation of drivers' accommodation was charged in with wages occasionally, but apart from this exception it shows that one-third to one-half of the drivers' time would appear to be engaged in truck maintenance, assisting unloading or loading or other duties which may or may not rightly be considered "cream-collection" costs.

Another important relationship is that of Total Costs (Column (7)) to Mileage (Column (4), Time (Column (6), and Weight (Column (3). For each £1 of expenditure the following miles are run as scale increases in Table XXXII.D.: 17½ miles, 15, 14½, 15, 15½, 13½ and 10 miles. Smallest factories clearly have lower unit rates per mile. This in itself is an important indicator of efficiency and cannot be explained away by size of vehicle used. Running costs per mile for vehicles of same horsepower and make showed a similar pattern, when scale was considered. The relationship of Columns (7) to (6) is fairly constant; whilst that of (7) to (3) is reflected in Column (8) as unit costs.

A few remarks need to be made concerning Column (9). Assuming weight is relatively "fixed" in character, then it is distance and time that are the variables affecting costs from the practical view point. This confirms the previous section which analysed marginal suppliers and distances. It is obvious that time consumed increases with distance from the factory, but running costs tend to increase too with distance, because of inferior roading conditions as distance increases from the factory. Whether time and distance are important statistically, and weight unimportant, will now be examined by multiple correlation analysis.

MULTIPLE CORRELATION ANALYSIS:

Introduction: A multiple correlation analysis was conducted to find an answer to the question: What causes the variation in transport (cream haulage) costs from factory to factory? The hypothesis set up is that transport costs vary directly with mileage, time and weight.

The data in Table XXXII D. (p.161) were subjected to scatter diagram reconnaissance, and as there were no indications of curvilinearity, a linear regression was prepared, for the functional relationships appeared to have linear characteristics. N. was reduced from 26 to 20 to remove irre gularities existing in the annual Wage data of certain factories. (See Footnote 51. p.163).

The variables included: The four variables were allotted the following symbols:

X_1 = Total cream haulage costs (the dependent variable) in £'000s.

X_2 = Mileage: The total annual mileage run on cream haulage for each factory measured in '000s.

X_3 = Time: The total annual wage bill charged against cream haulage measured in £'00s. Wages are assumed to be in a direct proportion to Time. It is recognised that Wage rates vary, overtime varies, and other factors cause divergence in the relationship between these two concepts, but it is considered the best indirect measure of time available.

X_4 = Weight: Total cream lifted by lorries measured in '000,000 lbs. These data are subject to a slight error downwards, in that some cream in a few instances arrived by rail or was delivered by suppliers; probably less than one per cent in total, and up to 5 per cent in two individual cases.

The findings: $X_1 = -0.246 + 0.202X_2 + 0.058X_3 + 0.335X_4$ $R = 0.952$ $N = 20$

(0.306) (0.168) (0.070) (0.122) S.E. of Est. = 1.356

$t = 1.20$ $t = 0.83$ $t = 2.75$ (5% Probability $t = 2.1$[illegible]

Coefficients: $r_{12} = +0.907$; $r_{13} = +0.928$; $r_{14} = +0.937$

$r_{23} = +0.924$; $r_{24} = +0.857$; $r_{34} = +0.914$

$r_{12.34} = +0.214$ $r_{13.24} = \text{zero}$ $r_{14.23} = +0.566$.

Interpretation: The multiple correlation coefficient together with each of the simple coefficients are all highly significant at the 1 per cent level of probability. The S.E. of Estimate which is unduly high, indicates that the actually observed values differ considerably from the estimated values, meaning that a high degree of reliability cannot be placed on the regression as a basis of forecast, especially, as only one regressor (X_4) meets the criterion of reliability. The S.E. indicates that in the mean output factory, the estimated total transport costs will vary up to 25 per cent either way 68 times out of 100.

The fact that all the simple correlation coefficients are very high in magnitude indicate inter-correlation. All the independent variables correlate highly, and any one explains most of the variation in X_1. On the other hand, the partial coefficients are each of relatively low magnitude, only weight (X_4) being of any significance.

Only X_4 (Weight) of the regressors measures up to the 5 per cent probability criterion, and of the other two, Mileage (X_2) is less unreliable than time (X_3). When subjected to bunch map analysis, results showed that r_{14} beams were closer together than r_{13} or r_{12}. The inclusion of additional variables caused the beams to "shrink" in each case to a grossly diminished length. This latter analysis, together with high correlation of all independent variables but partial correlations varying so considerably indicate an almost perfect example of multicollinearity.

Conclusion: The hypothesis that Transport cost is a function of Mileage, plus Weight, plus Time is discredited. From the above analysis, it appears that statistically, Transport costs are a function of Weight, and that Mileage and especially Time* are unreliable as regressors.

The most significant economic decision in cream haulage, refers to that point which, due to distance from factory, cream must be declined. Almost one-third of the cream in New Zealand is picked up within 5 miles, one-half in $7\frac{1}{2}$ miles, and three-quarters within 15 miles from the factory. Beyond 15 miles, costs increase disproportionately to distance, so that, generally speaking, the decremental costs of haulage up to 40 per cent reduction offset the incremental costs of manufacture resulting from decreased intake.

Curtailing marginal suppliers may be achieved in a number of ways, of which contracting-out, infrequent collections, and charging such suppliers are some. The question arises whether paying for all cream at the gate is economically sound. Paying for cream at the gate means that all collection must be at the charge of the company. But this overlooks the fact that the supplier alongside the factory is already paying a much higher capital value for his land, and is called upon in the interests of fair co-operation, to pay for the excessive charges of picking up the cream of the distant supplier, who, because the factor of distance itself, is paying only a low capital value for his land. Such co-operation would recognise the principle of all sharing the burden of cost arising from distance. Many companies recognise this but make a differential charge on distant suppliers; some charge according to the distance over a prescribed limit and others make a charge where total butterfat falls below a prescribed weight limit. Some companies reveal these

* At least with Time derived from this particular assumption. Were a better measure of Time available, some separate significance might be found.

charges in their annual accounts, while others do not reveal them fully, but offset these charges by contra accounts.

Their motive, however, is not always to equate the differential disadvantages arising from environmental capital valuations, but rather to minimise haulage costs for competitive reasons.

Apart from these considerations, the substitution of contractors for factory-collection for certain portions of routes is advantageous economically. Moreover, the slightly higher contractor rates, tend to be offset by reduced capital outlay and maintenance.

Of distance, weight and time, time is most significant from the technical aspect, for costs can be reduced considerably by careful planning and organization of optimum loads; which can be readily achieved by using contractors for feeder routes, avoiding "dead-miles" and overlapping. Time, too, has economic significance in that it may represent services rendered to suppliers, for delivery of stores, so that part of fixed costs may be covered by these means.

Statistically, weight is the only significant variable, the unexplained variance is probably due to differential managerial ability and other exogenous causes.

PART IV.

MANAGERIAL EFFICIENCY

SECTION I. INTRODUCTION

It is customary in theoretical economics to consider the activities of management as those non-technical duties which include decision-making, responsibility and risk-taking. For this empirical study, as the statistical data available were patterned on the classification of expenditure as set out in the Standardized Accounts (see Appendix B. pp. 396-8), it was more convenient and practical to follow this pattern which broadly separates management and administration.

This present section of the work will cover, then, certain aspects of organisation, co-ordination, delegation and supervision of current operations covering the procurement, production and distribution of the manufactured product, butter. Managerial efficiency will refer to particular and general efficiency in making those decisions that relate to technical operations, and will include the provision of power and steam; quality control of the finished product; haulage, reception and processing of cream; manufacture, packing and delivery of butter; the use and maintenance of plant and equipment; and the control of manufacturing expenditure and factory overheads. Certain aspects covering the use of labour and transport have already been considered in earlier Parts.

General policy-making, capital outlay, provision of finance, determination of surplus or payout, considerations relating to secretarial and accounting activities, specific responsibilities of directors, and all auxiliary activities will be considered in Part V. on "Administrative Efficiency".

There is no hard and fast line of demarcation between managerial and administrative efficiency, for they overlap in a number of respects. Managers often formulate policy and submit it to their directors for ratification. Again, some directors are charged with the oversight of certain functions such as power, transport or technical developments, and thus intrude in the managerial sphere. Certain expenditure items such as depreciation will be examined in this Part, although they could be examined just as logically in Part V. as a policy matter, while Auxiliary Activities which fall usually to the Manager, are considered in Part V. for the sake of expediency. One further difficulty lies in the fact that the term "Manager" covers all grades of management from responsible working operatives to the highest administrative officers.

Management, then, will cover those executive duties affecting current technical efficiency and expenditure outlay[1].

<u>The problem of finding suitable objective tests for Managerial Efficiency</u>: It is difficult to obtain direct measures of managerial efficiency. So many elements or variables that influence management (and costs too), are a heterogeneous complex of environmental and institutional causation - cream density of the area, numbers of suppliers, distance from cool stores and coal supply, condition and age of buildings, and plant and machinery. The impact or influence of these variables, or elements on management (while not exactly similar), set a problem for management, the effectiveness of which, will still be reflected in short-period and long-period costs. However, costs in any one case can be assessed only strictly with reference to the special conditions of this case, and this makes general comparison of costs difficult.

<u>Types of Management</u>: The following is a classification of the types of management existing in the 96 companies comprising the butter manufacturing industry:

Type A. Senior functional operative. Manager works full time in factory as operative. Number of companies - 45.

Type B. Factory Managers: Responsible directly to directors. Usually subsidiary managers (such as store managers) who answer partly to factory manager, partly to Secretary, and partly to Directors. Factory manager works about 50 per cent of time as a functional operative. Number of companies - 9.

Type C. Manager: Fully responsible for butter factory and activities. Has oversight of other semi-executives and is senior to the Secretary as an officer. Works some time in factory as operative - up to 25 per cent but usually in relief capacity. Number of companies - 24.

Type D. Managing Secretary (or equivalent): Responsible to directors for all undertakings, technical, executive and administrative. Usually multi-branch companies, ranging from small two-branch companies to the largest organisations. Full-time factory managers are under his control, so that his salary is charged to General Overhead. Number of companies - 11.

Type E. Managers or General Managers: Purely executive duties with Secretary as distinctly subordinate officer. Usually multi-branch and multi activities. Number of companies - 7.

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[1]In addition to the intrusive item of depreciation, on the grounds of logical completeness other non-managerial considerations will be discussed in this Part. Past administrative decisions in the shape of current plant and equipment and their capacities are relevant to the cost patterns of steam, power, processing, repairs and maintenance, and other expenditure. Present administrative decisions affect quality of product, quantity of raw material offered, as well as general cost allocations. Other non-managerial factors such as substitution, scale, and location must necessarily be discussed, while others again, are border-line or overlap administrative considerations.

Of the above, Type A. represents small factories and Type E. the largest organisations. Type C. represents a medium-sized factory with some subsidiary activity, Type B. tends to bridge Types A. and C., with the additional feature of auxiliaries to a greater extent than Types A. and C.. Type D. includes a cross-section of all types of multi-branch factories of all sizes.

In small factories, the manager is a working manager who is both an executive and an operative. In moderate-sized factories the manager is able to delegate and supervise various processes and activities but he is still an operative to some extent. In larger companies management is specialised and executive in character. According to the structure, size and activities of the company, managerial duties will vary.

In the larger companies, managers will be executive heads responsible for the co-ordination of all the activities of the organisation. They will have oversight of departmental managers who may control an entire plant or factory, or who may be responsible for a distinct function in the organisation. Management is distinguished practically according to the allocation of salaries. A butter factory manager may be responsible for a 5,000 ton-output factory and its auxiliaries, but his salary will be allocated or charged to butter etc. The general manager, however, whose function is to co-ordinate butter, powder, transport, trading-store and secretarial activities, etc., will have his salary apportioned amongst the general overheads. These types of management tend to merge, and overlap into the administrative sphere.

With the exception of Type A. management, too many managers allow themselves to become operatives to an extent that is prejudicial to managerial efficiency. As a result, insufficient time is devoted to organisation, planning and administrative work. This is partly due to labour shortage and the inexperience of general hands.

Many a manager cannot resist being one of the team to set the pace when output is lagging behind what is normal, whereas this should only be done in an emergency or as an occasional calculated piece of leadership. The manager tends habitually, to take his place as an operative, overlooking the fact that it is a test of managerial ability to have the highest paid worker, himself, doing a task that calls for the greatest skill, that of planning, organising, delegating and supervising.

Certain figures and ratios act as an index of managerial efficiency for all types of management, but cannot be regarded necessarily as a valid comparative guide, for they are affected by environmental considerations. These figures and ratios do have value, (a) for internal use by managers, and (b) for general assessment purposes.

As an internal guide of efficiency, management can check its own efficiency through time by comparing results. For example, a manager can examine any variations in his monthly coal consumption per unit of output, his daily electrical power consumption, his annual cost ratios, his annual labour turnover or his percentage of overtime.

For general assessment purposes, these figures have a limited utility for comparing factory with factory, provided the factories being compared are moderately homogeneous as regards locality, suppliers and output.

Of the two types of efficiency checks which follow, the first is useful for checking technical efficiency, the second, economic efficiency.

I. Physical input-output ratios, and physical data, including:-

(a) Man-hours per unit of butter.
(b) Units of coal per unit of butter.
(c) Power units per unit of butter.
(d) Miles-per-gallon in transport haulage.
(e) Labour turnover per annum.
(f) Time-motion data: Seconds per man-can.
Seconds per man-carton.
(g) Percentage of Premium Butter to Average Grade.
(h) Ratio of Premium Butter to Finest Cream.
(i) Ratio of Average Grade to Finest Cream.
(j) Ratio of First and Second Grade Cream to previous year's gradings, etc.

II. Cost data and cost ratios, including:-

(a) Surplus on buttermaking account.
(b) Average payout for season.
(c) Overrun related to Manufacturing Charges.

(d) $\frac{\text{Wages}}{\text{Manufacturing Charges}}$

(e) $\frac{\text{Wages}}{\text{Materials}}$

(f) $\frac{\text{Fuel, Power \& Steam}}{\text{Manufacturing Charges}}$

(g) $\frac{\text{Manufacturing Charges}}{\text{Total Costs}}$

(h) $\frac{\text{General Overheads}}{\text{Total costs.}}$

(i) $\frac{\text{Factory Overheads}}{\text{Total costs.}}$

(j) $\frac{\text{Administrative Expenses}}{\text{Number of suppliers.}}$

(k) The relative unit costs as revealed by the Manufacturing Account.

Deviations in Regressional Analysis as an Index of Efficiency: Where multiple regressional analysis has been made of a number of variables related to a given function, the differential between the actual and estimate evaluations may, to some considerable extent, be largely attributable to differential managerial efficiency. Depending on the nature of the regressio and the number of independent variables in the formula and the standard error of estimate, these differentials are related to managerial ability and other unexplained variables. It is not possible to calculate precisely the percentage attributable to managerial efficiency, but it is evident that managerial efficiency is an independent variable functionally related to the dependent variables.[2] In those instances where management has changed, the dependent variables will change too (other factors held constant), suggesting that management has played a considerable part in determining the dependent

[2] Managerial efficiency will probably be inter-correlated with other independent variables, so that the residuals may not indicate fully the true relationship and proportion of management as a function.

variable.[3]

A relatively reliable guide to efficiency can be obtained by noting the position of the factory concerned relative to the regressional line in a scatter diagram. A factory below a regressional line indicates that there are certain favourable variables causing this position. But position alone in a scatter diagram cannot be assumed to be due to any one variable such as managerial efficiency, unless other variables are held constant.

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[3] Labour turnover, as measured by multiple correlation analysis, can be considered as caused by a number of independent variables, housing, scale, and wages (the measured independent variables), and the residuals be conceived as a complex of managerial efficiency, sociological and psychological propensities of the employees, and other locational factors. If sociological and psychological propensities are not abnormal, and other factors are constant, then it may be assumed that any residual deviation can be attributed to managerial efficiency (or the lack of it).

To illustrate: From the labour turnover regression it was computed that about 14 per cent of labour turnover in the butter industry is a constant factor due to normal staff wastage arising from death, retirement, transfers etc. About 7 per cent was due to lack of satisfactory accommodation, 24 per cent was due to scale or output, and 2 per cent was due to salary. That is, 47 per cent of turnover in the industry can be accounted for; the balance of 53 per cent is caused by other reasons, largely employer-employee relationships (if we can assume other elements constant).

In one large factory the actual turnover for the year was exactly 50, whereas the estimated turnover calculated for that identical factory by the regressional formula was 88.51. That is, the factory was some 77 per cent more efficient in handling labour than the average factory of that size with similar housing and salary conditions. In this factory, employer-employee conditions were excellent, and no effort was spared to keep the staff happy. This was verified by subjective enquiry. On the other hand, another factory with smaller output had a labour turnover of 132, whereas a standard factory of that size and working conditions should have had a turnover of 76. This latter factory was inefficient as regards handling labour, and subjective enquiry confirmed that there was much to be desired in employer-employee relationships.

(See Section V of Part II. of this study for further development).

Limitations: The question still remains as to what constitutes efficiency in management. Whilst efficiency itself is a relative measure, indicated by the ability to produce the most profitable level of output at the lowest possible total costs, there are certain other features including quality of output, which must be considered.

A manager may be proficient in technical efficiency if he is able to produce a high percentage of premium butter from a relatively high percentage of 1st and 2nd grade cream. But this technical efficiency may be at the expense of economic efficiency, in that the technical efficiency was made possible by the relatively high cost expedient of double vacreation. Or, economic efficiency may be at the expense of employer-employee relationships, which although not reflecting on costs immediately, have a long-term adverse effect on labour costs.[4] Again, a manager may be relatively efficient technically but inefficient administratively or in other respects.

Finally, in measuring efficiency, it must be recognised that it is nigh-well impossible to hold other factors constant in endeavouring to assess relative efficiency between managers of various factories. Efficiency is a subjective quality measured by objective evaluations. It is relatively safe to measure one manager from season to season, for other factors tend to be constant, but not necessarily so. But to rank all managers in an efficiency scale must be based on certain assumptions, the most important of which is the *ceteris paribus* assumption, an assumption which is not always true. Moreover, it should not be assumed that all managers above the median in an array are necessarily efficient and those below the median are inefficient. All may be efficient, but some more than others; or conversely, all may be inefficient but some more than others.

Efficiency has no common denominator.

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[4] One season is a relatively short-term period. Efficiency can be assumed by examining data relative to one season, but several seasons need to be examined conjointly as it is possible to postpone expenditure or to overlook the influence of a favourable season. Efficiency is a dynamic rather than static attribute.

SECTION II. TECHNICAL ASPECTS - UTILIZATION OF POWER.*

INTRODUCTION: This section deals with the efficiency of power utilization in the manufacture of butter.

Power is required for (a) motive power in driving and activating plant and machinery, (b) processing, (vacreation, sterilizing, cleaning, pasteurising etc.), and (c) lighting. It is derived from electricity supply, steam, fuel-combustion engines and water power (turbine).

Power is consumed, broadly speaking, in three main functions, (a) providing motive power, (b) providing steam for processing, and (c) refrigeration.

While most factories utilise electricity for motive power, all factories must have steam for various operations in processing and cleaning. A few factories use steam and/or internal combustion engines or other device for motive power instead of electricity.

Consequently care needs to be exercised to compare those factories generating steam for processing only and not for motive power, (unless special meters or separate boilers were used).

The total cost of "fuel, power and steam" as revealed by the N.Z. Dairy Board's 26th Annual Report is 5 per cent of the total manufacturing costs. But these costs refer solely to fuel, electrical power, and cost of transport of fuel to the factory.[5]

The total cost of power is much greater, for the cost of power in this section is meant to include not only "fuel, power and steam", but also costs relating to generating, supplying, procuring and transmitting power together with all costs relating to providing, operating and maintaining plant or equipment, and providing or transmitting power.

The main elements of power utilization costs, other than fuel, electricity and steam include:-

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[5] See "The Dairy Industry Accounts Regulations", 1950, Govt.Printer, Wellington, P. 8.

*Certain aspects of Section II, such as plant capacities, instrumentation and scale properly belong to Part V, but are discussed here for the sake of completeness.

Labour - firemen, engine drivers, engineering staff etc.
Repairs and maintenance of power plant.
Consumable stores - oil, grease, cleaning equipment.
Brine, ammonia, freon.
Depreciation of plant used for supplying or transmitting power.
Interest and insurance on plant used for supplying or transmitting power.
Administrative and managerial charges.
Overhead and other distributable charges relative to factory buildings etc.

When these other elements are included, the total cost of power of a medium-sized plant was 11.7 per cent of total costs of butter manufacture - or put differently, "fuel, power and steam" is about 42.5 per cent of total power costs. Power thus plays an important and costly function in butter manufacture.

Source of Data: A survey was made of all plant and equipment generating or utilising power, together with number of units consumed, in order to relate power consumption to butter production. To this end, each company was asked to supply the following data:

(a) Total units of power for 1949/50 season consumed in butter manufacture - (monthly units with power and lighting distinguished where possible).

(b) Total coal utilised for 1949/50 season in butter manufacture - (by the month where possible).

This information was cross-checked by analysing the accounts of the company (when available) and by referring to Electrical Power Boards for confirmation in certain districts. In addition, copies of returns made to Census and Statistics Department and also the 1950 Survey of Refrigeration and Mechanical factors as applied to Butter Factories were obtained.[6]

[6] It must be recorded that in many of these auxiliary surveys, the data were carefully compared and checked, and in most cases, discarded. In this latter survey 25 factories recorded their annual coal tonnage to the nearest 100 tons, and another 44 returns showed coal to the nearest 10 tons. C. and S. official returns were only a little better.

<u>Motive Power in factories</u>: Of the 114 factories examined, 16 utilized steam as motive power either in place of, or auxiliary to electrical power, five used diesel power plants, one a gas engine (from gas produced on the premises), and one a water turbine. The rest used electric motors for motive power.

In medium-sized factories it was usual to find two 25 H.P. motors for refrigeration plant, 20 to 25 H.P. motors for churns, 10 to 15 H.P. motors for vacreator water pump, and a number of smaller powered motors (up to 3 H.P.) for water cooler, valve pumps, butter-milk pumps, vacreator cream pumps, churn pumps, boiler-feed pumps, cream pumps, mechanical stokers, cool room plant, can-washers, packers, patting machines, salt crushers, D.E. holding vats, and grinding machines.

Most factories had individual motors for driving various units, but a few took a number of belt drives off a common power-driven shaft. A few factories had separate meters for different processes, but most of the larger units had separate meters for churning, vacreation and refrigeration. A few factories had warning devices for peak-loading.

One very evident fact was that different factories used motors of differing H.P. for similar work. Thus some motors were obviously undersized for their work, whilst others were over-sized, and therefore uneconomic. This will be illustrated from electrical motors used for refrigeration. Over-capacity was more marked than undercapacity. Generally, electric motors have to work at a very low load before there is a marked decrease in efficiency. Oversized motors have lower maintenance costs but higher initial capital outlay costs.

Many factories had a stand-by plant for refrigeration which was used in the off-season in addition to multi-refrigeration units. Sixty factories were equipped with one motor only, 33 with two motors, 6 with three motors, two with four motors, and two with more than four motors for refrigeration. There were 21 motors under 5 H.P., 8 between 5.1 and 10 H.P.; 32 between 10.1 and 20 H.P.; 43 between 21 and 30 H.P.; and 52 over 30 H.P.

Some 22 factories had identical refrigeration plants as regards capacity and type. Seven used 20 H.P. motors, 4 used 15 H.P. motors, 3 used 25 H.P. motors, and the balance ranged between 8 and 50 H.P. Making due allowance for types of motors and drives used, the range illustrates the fact that over and under-sized motors were being used.

This also applied to other electrical installations. Motors varied in capacity for driving similar capacity churns. In many cases it was reported that the wiring was installed for a given power load, but as the industry became more mechanised, it was necessary to improvise from the motive power then available, or to instal new meters and wiring for the additional motors. Thus some factories had separate meters installed when vacreation was introduced while one or two had separate processes meterised. A few factories practise daily reading of meters with separate determination of power used for churning, refrigeration, vacreation and other functions.[7]

The total consumption of power for 85 factories representing over 90 per cent of the total output was 6,323,000 units. The following table indicates the variation of consumption.

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[7]There are considerable benefits arising from daily reading of meters. A manager of one large factory complained that he could not account for the heavy consumption of power in his factory. It was suggested to him that he should make daily readings of each meter, and note any unusual variations. Later he advised that this simple procedure lead to the cause of the heavy power drain. Sunday readings showed heavy consumption (amongst other things), and this was traced to the practice of the buttermaker leaving the churns running (to save time) when they could be turned off. The saving thus affected, was considerable.

TABLE XXXIII. AVERAGE POWER CONSUMPTION ON BUTTER MANUFACTURE OF 85 FACTORIES CLASSIFIED ACCORDING TO OUTPUT

Output of Factory (lbs. of Butter)	No. of Factories	Average Output in lbs. butter ('000s)	Average Power Consumed (Units)
Up to 1,000,000	16	563	26,700
1,000,001 - 2,000,000	16	1481	51,200
2,000,001 - 4,000,000	21	2991	60,700
4,000,001 - 8,000,000	22	5659	158,200
Over 8,000,000	10	11179	313,800

Power for Processing: Data on coal consumption was obtained from 106 factories. Coal consumption depends on a number of economic factors, which need to be recognised in a quantitative survey. The more important are:-

(a) size of boiler and capacity relative to the plant,

(b) extent to which steam is used -

for vacreation
type of can washer
buttermilk powder drying
dual plants,

(c) technical condition of boiler and plant,

(d) technical degree of steam utilization practised, degree of waste heat recovered, steam loss due inadequately lagged piping and hot water tanks etc.,

(e) technical efficiency of operatives and degree to which boiler load is staggered at peak hours,

(f) quality and calorific content of coal.

All coal utilised in dual plants or auxiliary undertakings such as buttermilk powder, has been excluded from the following data. The following figures indicate the quantity of coal consumed in butter manufacture for all factories for the 1949/50 season.

Coal consumed in Butter Making (tons per annum)	No. of Factories
Up to 200	39
201 - 400	25
401 - 600	10
601 - 800	7
801 - 1000	6
Over 1000	18
(Unclassified due to auxiliary undertakings):	9
	114

The total coal used for butter-making for 105 factories was 55,595 tons. On the average $2\frac{3}{4}$ tons of butter was made per ton of coal consumed, or one ton of coal was required for each 5077 lbs. of butterfat received.

Many factories consumed varying quantities of coal for purposes other than buttermaking. Of 71 factories, 51 used up to 50 per cent more coal, 7 used from 50 to 100 per cent more coal, and 13 used more than 100 per cent more coal than that used for butter making.

With the advent of dried buttermilk, many factories installed additional boilers, so that some 24 factories have more than one boiler as an outcome of auxiliary activity, or increased steam consumption due to vacreation or increase in scale.

Horsepower of boilers varied: of 105 boilers, 22 were rated under 25 H.P., 41 were between 26 and 50 H.P., 15 were between 51 and 75 H.P., 15 were between 76 and 100 H.P. and 13 were rated in excess of 100 H.P.

Moreover, the ages and condition affecting technical efficiency of the boilers varied also. The ages of 99 boilers were ascertained as follows:-

Age in years	No. of Boilers
Under 5 years	13
6 - 10 years	8
11 - 20 years	28
21 - 30 years	24
31 - 40 years	12
41 - 50 years	11
Over 50 years	3
	99

Most of the above were horizontal multi-tubular boilers, except water-tube boilers in the larger plants. There were two or three old vertical types still functioning. Most boilers had automatic stokers, but only a few of the larger plants had automatic coal-handling machinery of the endless belt or vertical grab types. Smaller boilers were usually fed by hand, but much of the labour of stokers was taken up in shifting the coal from bunkers to the grating or hoppers of the automatic stoker. A few factories used a blade attached to a truck or tractor, but too many were using wheel-barrows, in some cases bringing the coal 50 yards to the hopper. A few factories were installing loader conveyors which elevated coal over obstructing walls onto chutes which fed down into the hoppers.

Boiler houses were often dirty, ill-lit and poorly ventilated. Surrounding brickwork was often cracked, tubes were not always cleaned frequently, and in many cases the boiler water had not been analysed chemically. Lagging usually seemed insufficient, especially in older plants in which joints, flanges and steam valves were often leaky. The length of the main steam conduit from the boiler to the first function was often exposed, and in many cases of considerable length.

Instrumentation was lacking - steam meters, draught gauges and carbon dioxide meters were seldom found. Consequently steam utilization for various processes was usually by guess-work, whilst fuel losses went by unheeded (apparently), and failure to stagger peak loads, or holding a head of steam when main steam-utilising functions were complete, caused excess consumption of coal.

One other factor causing variations in coal consumption was the size of boiler relative to output of butter. Factories with an output of less than 1,000,000 lbs. of butter per annum had boilers, ranging from 12 to 45 H.P. capacity (and these excluded the process of vacreation). In the next range of butter output, viz. from one to two million lbs., boiler capacities ranged from 15 to 80 H.P., and in the two to four million range, boilers varied from 15 to 100 H.P. Obviously many factory boilers were either over or under-capacity, and it was noted that some with over-capacity were not using vacreators, although under-capacity was precluding some.

Cost: Costs were analysed into electrical power and steam power costs. Their combined cost amounted to approximately £187,000 which includes the cost of coal, haulage inwards, and electricity consumed.[8] Both electricity and coal varied considerably in price per unit.

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[8]These figures refer to factory butter manufacturing costs only. They include coal substitutes (550 cords of wood, diesel fuel, sawdust etc.) and power for factory lighting, but not power or coal for non-manufacturing purposes. Where factories generated their own power, "power" wages were included. In some cases "boiler expenses" were also included. Otherwise, this figure does not include labour, repairs and maintenance, consumable stores, ammonia etc., depreciation and other overhead charges.

Power charges varied according to the district and its relevant supply authority. Different power boards had different scales of charges, and even different charges to the various factories supplied by them. A few factories, for example, enjoyed preferential rates, others differentials and rebates and/or other sundry charges. But apart from these local differentials, the scale of differential charges varied considerably from district to district. Some power boards granted considerable preferential rates for night consumption, and others had penal rates for peak loading. Moreover, some boards rendered accounts monthly, some bi-monthly, some quarterly and others at infrequent intervals. Monthly comparisons were therefore difficult.

Coal costs per ton were more varied. They ranged from 17/8d. per ton (and this price included freight and "fuel wages") to 155/- per ton delivered to bunkers. These prices, moreover, are average prices for the year - the dispersion of costs through the year cover even more than this - from approximately 15/- to 168/- per ton. Obviously the dispersion of coal costs is a factor of location, so that unit costs are partly environmental in character.

The actual location of the factory then is an important factor in the price of coal. Proximity to coal-mines, and having a rail siding, reduces the price of coal in bunkers. Road transport of fuel tends to increase costs. Thus the costs to all moderate-sized factories for coal range from 35/- to 120/- depending upon proximity of coal-mine, and railage facilities direct from mine to bunker. Modal prices ranged from 50/- to 65/- per ton.

This range of modal prices was due to the following variables entering into the structure of coal prices: In one typical factory the price of coal varied with:-

(a) The type of coal purchased. Three or four types were usually purchased - slack, mixed, steam and "household". These prices from the same mine ranged from 39/6 to 71/6 a ton for one delivery to the nearest rail siding.

(b) The prices varied from the same mine throughout the year.

(c) The quality of the same grades varied throughout the year.

(d) The purchases were made from different sources at different prices from those of the first mine.

(e) Transport rates varied at the same time, and throughout the year as well.

The cost of coal, not only varied with factory location, but also with purchasing efficiency. Some managers would build up heavy stocks of coal when prices and supply were advantageous, whilst others would pay premium prices due to allowing stocks to fall below a prudent margin. Thus some coal accounts had to bear premium prices, while others were able to average purchases made the season before.

The following table sets out the unit costs of fuel, power and steam.

TABLE XXXIV. FUEL, POWER AND STEAM COSTS FOR BUTTER MANUFACTURE FOR 94 COMPANIES FOR 1949/50 SEASON

Unit costs in pence/lb. B/F. (d.)	No. of Companies	Classified output in lbs. of butter			
		Up to 2m.	2.1 - 4.0m.	4.1 - 8.0m.	Over 8m.
Under 0.100d.	12	2	3	7	-
0.101 - 0.150	29	10	9	7	3
0.151 - 0.200	34	23	7	3	1
0.201 - 0.300	13	12	1	-	-
Over 0.300	6	6	-	-	-
	94	53	20	17	4

Any array of unit power costs, then, portrays in a major way, environmental advantages, and in a minor way, differentials of managerial efficiency. Scale too, is an important element, but it is considered that the scattering of unit costs is largely due to differentials in price of coal and transport to factory bunkers. The high unit costs in many small factories are due almost entirely to factor price of coal (or substitute).

Unit costs vary through the season both for coal consumption and power. The following data was obtained from those factories which kept reliable data and had monthly power readings of meters taken.

TABLE XXXV. AVERAGE MONTHLY VARIATIONS IN COSTS OF POWER AND COAL FOR SELECTED FACTORIES IN N. AUCKLAND, WAIKATO AND MANAWATU DISTRICTS*

Month	Percentage of Total Output of Butter	Percentage of Total Coal Costs	Percentage of Total Power Costs
June	1.0	3.0	2.0
July	1.5	4.0	2.5
August	7.5	7.0	8.0
September	12.0	9.0	11.0
October	14.0	12.0	13.0
November	15.0	13.0	13.0
December	14.0	12.0	13.5
January	12.0	11.0	11.5
February	8.0	9.0	8.0
March	8.0	7.0	8.0
April	5.0	6.0	6.5
May	2.0	5.0	3.0
	100.0	100.0	100.0

* Weighted averages were taken from three factories. It was necessary to make minor adjustments to coal and power data where these did not relate to corresponding periods.

The general pattern of the above table can be discerned readily. Coal costs increase two to three times in the off season but follow the output quantities fairly closely in the flush of the season. Power costs follow the same pattern but to a less marked degree.

There appears to be a fairly consistent apportionment between coal and electrical power costs. A detailed analysis of 15 large factories was made, and it was found that their power costs amounted to 37.4 per cent of their total costs for "fuel, power and steam". Smaller factories were also examined and averaged 36 per cent for power. While most factories show similar apportionment, there were cases in which power was less than 25 per cent of total "fuel, power and steam" costs. On the other hand, there were one or two cases where power cost more than steam.

Power costs appear to diminish with scale up to a point, then tend to increase due to increased mechanization. In the very largest factories, over 40 per cent of fuel and power costs was attributed to power and this figure tended to diminish as factories became smaller so that the smaller units often showed a power percentage of about 30 per cent.

The greatest drain on power is for refrigeration which consumes approximately 60 per cent of the total power in the medium-sized factory. This per cent tends to decrease with scale. Butter churning requires on the average about $6\frac{3}{4}$ units of power for each 1,000 lbs. of butter made, i.e. approximately 20 per cent of total power consumed. The balance (20%) is consumed in other power requirements in the factory.

An analysis of the elements of cost for (a) refrigeration, (b) factory power, and (c) steam, is as follows for a typical medium-sized factory:-

(a) Refrigeration:	Labour	17%	
	Motive power	27%	
	Brine & Ammonia	2%	
	Repairs and Maintenance	16%	
	Oil & Grease	20%	
	Depreciation	5%	
	Portion of Overhead	13%	100%
(b) Factory Power:	Labour	33%	
	Electricity	30%	
	Repairs and Maintenance	32%	
	Depreciation	1%	
	Oil and Grease	2%	
	Portion of Overhead	2%	100%
(c) Steam:	Labour	20%	
	Coal (includes transport inwards)	66%	
	Repairs and Maintenance	10%	
	Depreciation	2%	
	Portion of Overhead	2%	100%

The above figures were calculated from an analysis of costs from selected factories. Labour included a percentage of overtime, holiday pay, workers' compensation and other charges correctly chargeable as "labour". Overhead included interest and insurance on plant plus a percentage of interest, insurance, and rates on factory buildings, but not managerial overhead. The "fuel, power and steam" costs already analysed in this section appear in the above percentages as 27 per cent of refrigeration costs, 30 per cent of factory power and 66 per cent of steam costs. The other costs are normally found under the items of wages, depreciation, repairs and maintenance, and consumable stores, rates and land tax, and insurance as shown in the Company's annual published accounts.

Technical Aspects of Power Efficiency: Owing to locational differentials, efficiency cannot be measured by unit operating costs, as units of input vary in terms of factor prices. This is especially so in the case of coal, and to a lesser degree in electricity. Physical input-output ratios will be used as they are not affected by unrelated factor price differentials.

Power units are perfectly homogeneous and substitutable, and are well-suited as an technical measure of efficiency. Coal is not homogeneous as it varies physically and technically in calorific content, but it is considered that variations of grades on the average are much less than cost differentials.

The data from which Table XXXIII was compiled showed considerable dispersion within each class-interval.

For example, the sixteen factories in the first class-interval ranged from 14 to 49 lbs. of butter made per unit of power; or put differently, required from 20 to 71 units of power for each 1,000 lbs. of butter manufactured. In the second class-interval the range was even greater; 13 to 67 lbs. of butter was made per unit of power, or 15 to 77 units for each 1,000 lbs. of butter. As these deviations were considerable, and tended to hide the trend of the input-output ratio, the data was ranged in order of scale and weighted group averages taken. The following table sets out the result.

TABLE XXXVI. INPUT-OUTPUT RATIOS OF POWER AND BUTTER OF 77 FACTORIES

No. of Factories in Group	Weighted Average Output in lbs. ('000s)	Lbs. of Butter per Unit of Power	No. of Units per 1,000 lbs. Butter
14	557	31	32
14	1,439	34	30
14	2,562	38	26
14	3,739	47	21
14	5,684	41	24
7	10,713	36	28

When these input-output ratios are plotted on a graph having the number of units per 1,000 lbs. of butter as the ordinate, and output as the abscissa, a slightly assymetrical U-shaped curve is obtained with its lowest point in the vicinity of 4,000,000 lbs. output. The curve so obtained, is really a unit power cost curve, viz. the cost in terms of power of producing butter at different levels of output . The curve tends to slope down to its minimum point and then rise slowly at a constant rate. The steeper fall of the curve is attributed to economies of scale, and the rise to increased mechanisation (which in itself may save other inputs considerably, viz., labour), and probably unused capacity, or other technical and managerial diseconomies.[9] The results are plotted in Figure 12.

Technical aspects of Steam Efficiency: In measuring the input-output ratios of coal per unit of butter, the dispersion of ratios of the various factories is partly determined according to whether Vacreation is used or not. Many small factories do not use Vacreation, whereas most large factories do. For those intermediate cases, boiler capacity (or lack of it) has been a determining factor. Vacreation requires a greater consumption of steam than do other methods of pasteurization. Up to 25 per cent more coal appears to be used when vacreation is utilised but this percentage varies with scale of output and boiler capacity.[10]

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[9] Economies of scale continue through the range of output but are offset by increased mechanization requiring more power. There are examples of unused capacity in larger companies which probably force the curve upwards. Greater refrigeration capacity was noted in larger factories than corresponds with smaller output factories where potential increase is limited. In a larger plant, there is a tendency also to be less conscious of "power saving" than smaller plants - churns left running etc.

[10] Additional coal required for vacreation varies from district to district. In areas where cream is heavily tainted, a much higher percentage than 25% extra is required.

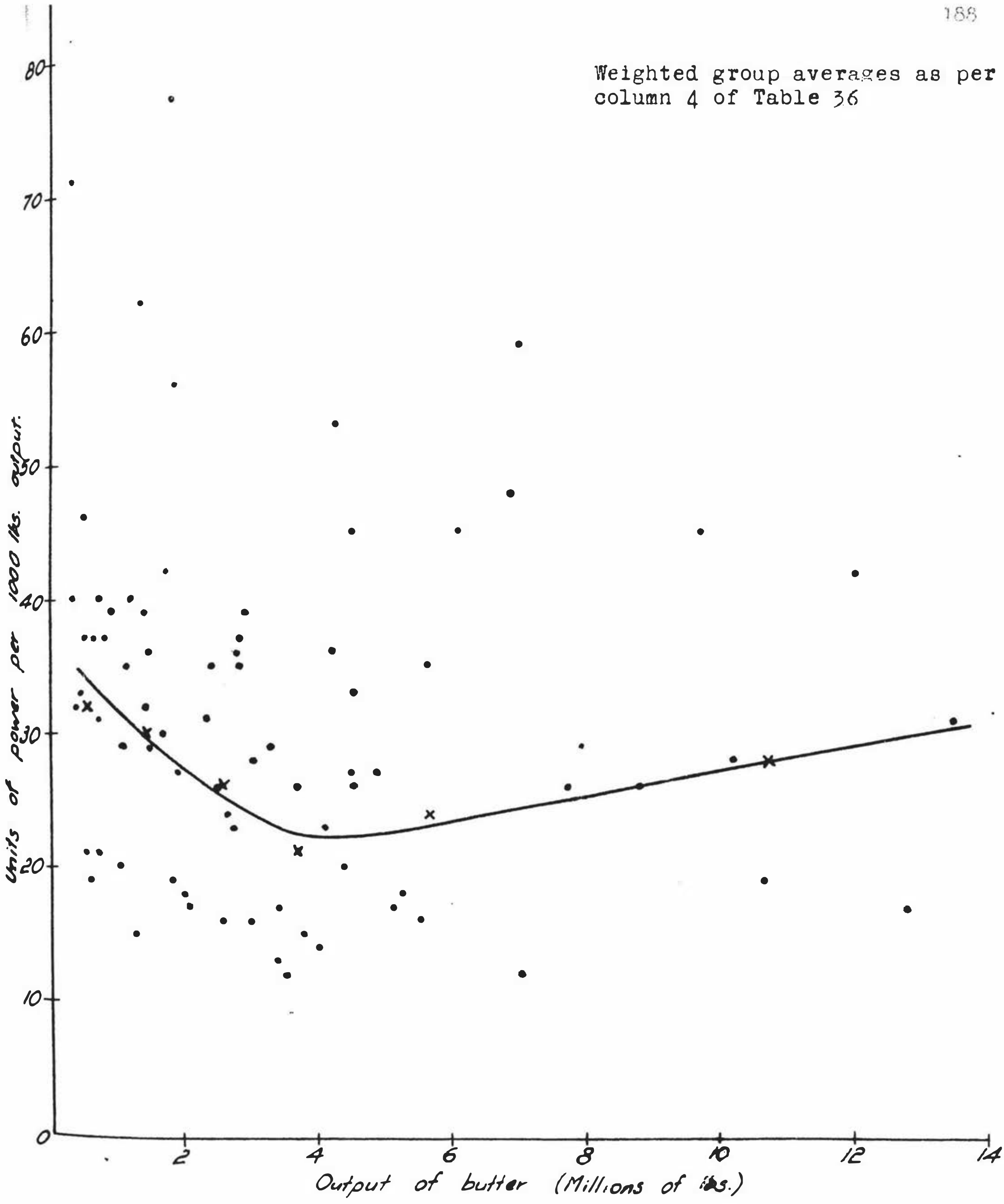

Figure 12. Relationship of Volume of Production to Power (Electrical) Consumption.

For those factories with an output under 5 million lbs. of butter, only two with vacreation exceeded 4 tons of butter per ton of coal, and another 9 exceeded 3 tons of butter per ton of coal. Without vacreation, four exceeded 4 tons, another 4 five tons, two 6 tons, and three 7 tons of butter per ton of coal.

The following table sets out the weighted group averages of coal consumption of 98 factories:-

TABLE XXXVII. INPUT-OUTPUT RATIOS OF COAL AND BUTTER OF 98 FACTORIES

No. of Factories in Group	Weighted Average Output in lbs. Butter('000s).	Lb. of Butter per lb.of coal	Lbs. of Coal per 1,000 lbs.Butter
14	500	2.0	500
14	804	2.7	370
14	1,328	2.9	345
14	1,820	3.1	323
14	2,828	3.6	278
14	4,480	4.2	238
14	9,763	2.8	356

As with electrical power, the data of Table XXXVII showed considerable dispersion within each class-interval, for example, the lbs. of butter to coal ranged from 0.9 to 3.2, and in the second class-interval from 0.9 to 5.7 lbs. of butter. As these deviations tended to hide the trend of the input-output ratio, the data were again ranged in order of scale, and weighted group averages taken for each group of 14 factories. Data were complete, but 16 factories had to be deleted owing to steam-drives being used on refrigeration and other processes in the factory. Some of these factories were in the largest class-interval where steam was used for generation of electricity.

The lowest point of the U-shaped curve (see Fig.13) which was slightly assymetrical, was in the region of 4 to 5 million lbs. output. As with the power curve, this curve is really a unit coal-cost or coal-consumption curve. It slopes down with increase of scale, and then tends to rise more slowly after the 5,000,000 point on the abscissa is reached.

This increased unit consumption is partly the result of substitution of power for labour, and should not be considered entirely as an example of diseconomies arising from increased scale or output.

Again the deviations of the individual observations are considerable and the general pattern is not dissimilar to that of the power scatter diagram. (Fig. 12). The falling curve is due to technical economies of scale. Smaller factories usually have considerable heat losses due to unconsumed particles of coal falling through the firebox grate, incomplete combustion, heat carried away in stack gases and radiation, and other losses often amounting to 35 to 50 per cent of heating efficiency. Unused capacity or over-capacity also is marked in smaller factories.

The upturn of the curve is probably due to the onset of the use of vacreators, but also due to the change in the boiler capacity relative to output. Under and over-capacity of boilers have a directly adverse effect on coal input costs. In the factories coming within the first class-interval of Table XXXVII, boiler capacities ranged from 12 to 50 H.P. In the second class-interval they ranged from 15 to 80 H.P., and in the third class-interval from 15 to 100 H.P. It is obvious that in spite of incorrect appropriations for buttermilk processing, there is a considerable number of over and under-capacity boilers at work.

Boiler capacity to output was measured by the ratio, $\frac{\text{Butter Output}}{\text{Boiler H.P.}}$ and was compared to another ratio: $\frac{\text{Butter Output}}{\text{Coal Input}}$.

The following table sets out the results:

TABLE XXXVIII. A. RELATIONSHIP OF BOILER CAPACITY TO COAL CONSUMED AND BUTTER OUTPUT IN 80 FACTORIES FOR THE 1949/50 SEASON*

Output of Factory (lbs. of butter)	No. of Factories in class-interval	Average Output of class-interval ('000s lbs.)	Boiler Coef.	Coal-Input Coefficient
Under 1,000,000	19	566	2.5	5.2
1,000,001 to 2,000,000	18	1,550	3.7	6.7
2,000,001 to 4,000,000	18	2,772	7.0	8.0
4,000,001 to 6,000,000	14	4,535	7.5	10.0
Over 6,000,000	11	7,940	5.1	6.9

* This is reviewed again in Section III, Part V, "Capital Efficiency", where boiler capacities are examined in terms of physical cost units. (See Table LIV p. 266).

These Boiler Coefficients have been plotted on Fig. 13. There is a distinct functional relationship between the Boiler Coefficients and Coal-Input Coefficients. The lower the boiler capacity, the greater the coefficient, butter output being held constant. Thus factories with smaller boiler capacity tend to have a high boiler coefficient and a corresponding high coal-input coefficient. This latter coefficient tends to move in the converse direction of the coal-consumption cost curve.

In the 4 to 6 million lbs. output group, there are a number of factories with relatively small boiler capacities yielding a high boiler coefficient with a corresponding low coal consumption per 1,000 lbs. of butter produced. As scale increases, boiler capacity tends to increase relatively beyond the 4 to 6 million output group. This may be the outcome of planning to have unused capacity for future expansion, or of substitution of power for labour, but either tends to cause the coal consumption curve to rise steadily above its minimum point. Possibly, further economies could be effected in the largest plants, for it is clear that management has tended to be complacent in the knowledge that its monetary costs are at least lower than others, without recognising that these low monetary costs are the outcome of relatively very low coal costs and not steam efficiency.[11]

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[11] The chief engineer of one very modern plant pointed out a number of obvious diseconomies and fuel wastage, but indicated that owing to the fact that his company's unit costs were very low, little was being done about it, and the wastages just continued.

× Weighted group averages as per Column 4 of Table 37

■ Weighted group averages of boiler coefficients as per Column 4 of Table 38A

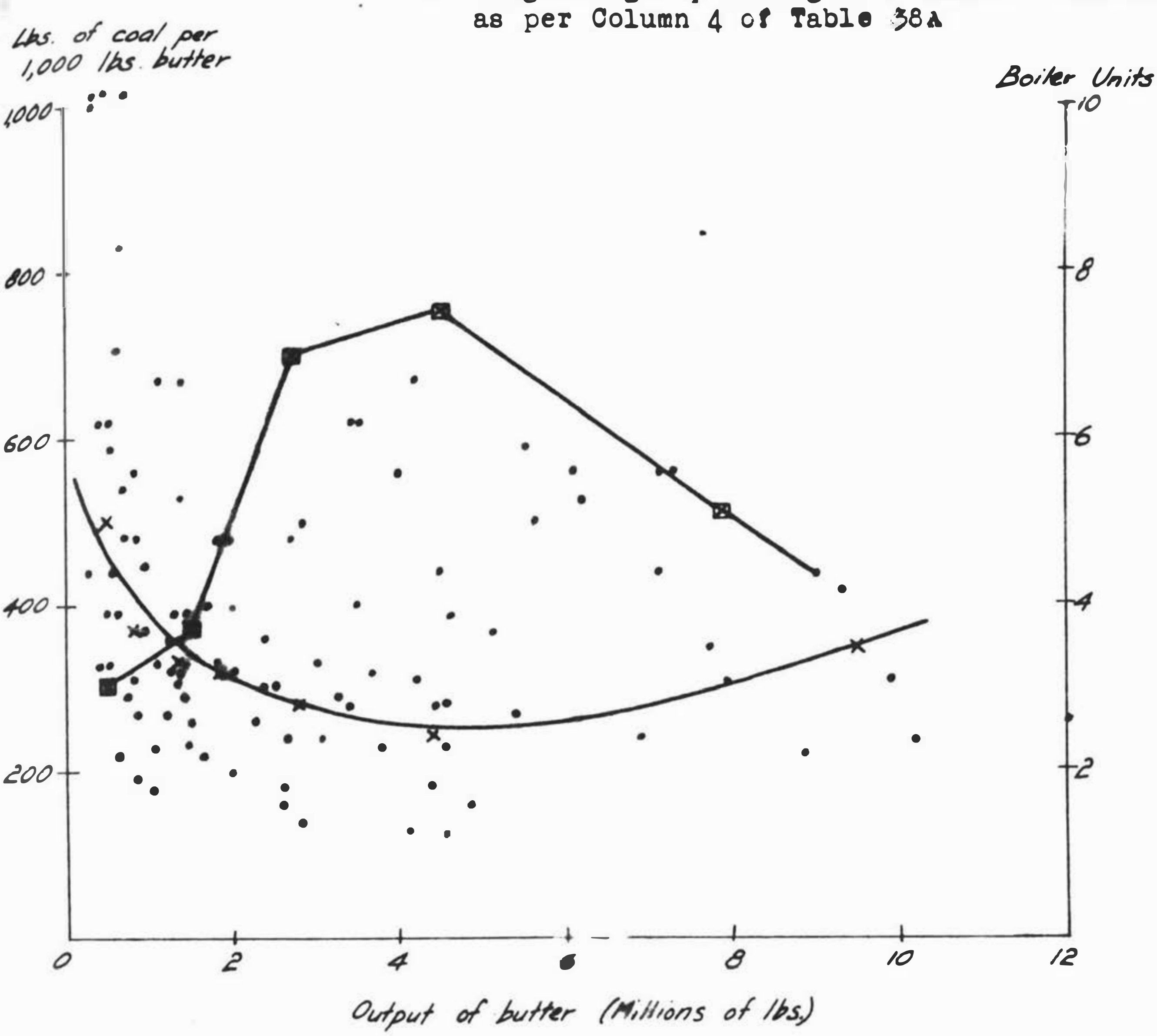

Figure 13. Relationship of Volume of Production to Coal Consumption.

Economic Considerations: The very considerable dispersion of power data of most factories in Figures 12 and 13, indicates a lack of uniformity of costs, in both monetary and physical terms (input-output ratios). This scattering around the regressions, which suggests that the industry is far from the optimum point of power efficiency, arises from technical waste and inefficiency, unused capacity, maladjustments, and lack of managerial attention.

The control of waste is partly technical and partly economic in that fixed plant capacities are difficult to adjust to changing scale. The technical problems arise from lack of precise knowledge and its implementation, lack of adequate instrumentation, and lack of sufficient competent instruction at an organized industry level.[12]

Maladjustments can be controlled by planned organization of processes, synchronization of functions, and avoidance of peak-loadings. The avoidance of delays during cream reception, or protracted periods requiring maximum steam generation reduce these diseconomies.

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[12] Technical losses arising from lack of knowledge is seen both in heat losses, power losses and refrigeration efficiency. In refrigeration, for example, costs are reduced 16% when head pressure is maintained at 150 lbs. in lieu of 200 lbs. Ammonia compressors should be run at as high a suction pressure and as low a discharge pressure as can be. This can be obtained by maximising heat transfer conditions and condenser cooling surfaces, but personal expert direction and advice is needed "on the spot" usually to affect this. At least one factory has converted their existing cream holding vats to the automatic freon system, in which the amount of refrigeration mirrors the extent to which the vat is filled, thus meeting one problem of waste, maladjustment and capacity.

These problems are strictly technical and arise from lack of adequate instrumentation. Types of instruments fall into three categories mainly - indicators, recorders and controllers. Indicators are the most useful as they show the man on duty when immediate action is necessary. A draught gauge helps the stoker to use his dampers correctly; a CO_2 meter shows him the amount of excess air in the flue gases; thermometers and pyrometers give the temperature of the flue gases and feed water; and steam flow meters indicate the rate at which plant is using steam, and the quantity used by a given process.

Factor substitution plays a part in power efficiency in that both power and steam unit costs tend to increase about the five million output level, and this increase is partly due to substitution. Increased mechanization is the most significant factor in this respect for labour tends to be replaced by machinery. The following cost-ratios of wages and power as a percentage of Total Manufacturing Expenditure indicate the operation of substitution in 114 factories.

Factory output lbs. of butter	Wage ratio %	Power Ratio %	Wage & Power ratio %
Under 1,000,000	50	13	63
1,000,001 - 2m.	43	8	51
2,000,001 - 4m.	40	10	50
4,000,001 - 8m.	30	10	40
8,000,001 - 12m.	26	9	35
Over 12,000,000	22	13	35

These figures suggest that some substitution has taken place. When individual cost-ratios were examined, in the 54 factories with an output of under 2 million lbs., only 8 appeared to have substituted power for labour to some extent; and 5 out of 60 in the larger-output factories.[13]

Factor substitution also occurs when the diseconomies of peak-loadings and waste power are balanced against the more effective utilization of labour and improved quality of butter. Premium grade butter is achieved largely at the expense of increased vacreation and intensive cleaning. Both these activities are costly in terms of power, especially vacreation, so that the increased revenue from premium butter must be offset against increased steam consumption.[14]

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[13]See Section V (D) of Part II (p. 84) where factor substitution has been developed.

[14]Premium grade butter earns 0.125d. lb., and as 58 per cent of all butter was premium grade, it is an interesting question as to what additional outlay in power (vacreation and cleaning) would raise this 58 per cent to (say) 75 per cent premium grade. As total unit power costs are approximately the same as premium earnings (0.125 lb. a number of factories could economically outlay more on quality at the expense of power costs.

Factor substitution can be used as a means of mitigating technical waste arising from unused plant capacities. It appears that over-capacity marks both power and steam rather than under-capacity. Over-capacity is a structural problem, but losses can be avoided by having smaller auxiliary refrigeration plants and auxiliary boilers and churns for use in the off-season. By these means, increased capital costs are offset against decreased power consumption.[15]

Factories in isolated areas, not only are required to purchase coal and electricity at higher rates, but also have to lay out more in cool-storage facilities, especially where outward delivery of butter is infrequent. In such instances, managerial decision must lie between greater power costs or lower quality of finished product.

Conclusions: There appears to be a point of optimum efficiency at about the five-million level output level. Beyond this level, power costs tend to increase partly from factor substitution, and partly from technical diseconomies and waste. The high unit cost of power in small factories is largely a function of over-capacity rather than technical inefficiency.

Technical efficiency may be improved in most factories by use of greater instrumentation, increased mechanization of coal handling facilities, and avoidance of waste. To this end, organised dissemination of technical knowledge, supported by a team of itinerant technical experts with mobile facilities for measuring, recording and adjusting plant would result in considerable technical improvement and economic saving.

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[15] The relationship of boiler and refrigeration capacities to output and efficiency is discussed further in Part V, Section III, pp. 265-267 especially Table LIV.

SECTION III. QUALITY AND PAYOUT ASPECTS

Introduction: Payout or revenue is maximised when both quality and quantity of butter is maximised from a given intake of butterfat, while keeping costs to a minimum, consistent with efficiency.

Premium grade or highest quality butter earns a greater unit revenue than a lower quality product. An important factor in management, then, is ability to maximise grade or quality of product, and this depends on quality of cream received, technical manufacturing ability, and the outlay expended on processing to improve final quality. The problem is essentially economic, in that the manager must choose between higher grade (revenue) and higher costs. He may sacrifice quality, for example, by allowing cream to accumulate in the off-season, or by curtailing excessive vacreation.

Assuming quality and a given intake of cream, quantity (and therefore) revenue, can be affected by maximising overrun and minimising mechanical losses in butter making - a technical problem. Management directly controls these technical aspects, as well as the economic aspects, and can affect the quality of cream received from suppliers indirectly by judicious grading of cream and other means.

Ratio of Average to Finest Grade Cream: This may be considered as one guide to technical efficiency. In 53 factories, which were comparable for environment, scale and technical facilities, a numerical evaluation was computed for each factory from the following ratio:

$$\frac{20\ (\text{Average Grade minus } 90)^{16}}{\text{Percentage of Finest Cream}}$$

For example, a given Factory X had an average grade for the season of 93.34 whilst 70.27 per cent of its cream was graded finest. Its technical evaluation was assessed: $\frac{20(93.34 - 90)}{70.27} = \frac{20\ (3.34)}{70.27} = 95.06$

Where the percentage of finest cream to total cream is higher, the evaluation is less; and vice versa. The evaluation takes into account the

[16] The critical minimum of first grade butter.

percentage of finest grade cream (and consequently the percentage of non-finest cream) as a prime factor in the ability to manufacture a given grade of butter for the season under review. It recognises that grade is a function of quality of cream received and technical ability.[17]

The average grade in the 53 factories ranged from 92.13 to 94.44 and the average percentage of finest cream ranged from 43.79 to 97.61 per cent. Second grade cream was less than 1 per cent on an average. The efficiency evaluations ranged from 69.08 to 137.47. The following table sets out the position:

TABLE XXXVIII.B. EVALUATIONS OF TECHNICAL EFFICIENCY IN CONVERTING CREAM OF GIVEN QUALITY INTO GRADED BUTTER IN 53 FACTORIES

Range of Efficiency Evaluations	No. of Factories	Range of Finest Cream % in Class Interval.	Range of Average Grade in Class Interval.
Under 75.0	3	21.4	0.65
75.1 to 85.0	19	43.7	1.58
85.1 to 95.0	17	34.7	1.96
95.1 to 105.0	9	28.8	1.34
105.1 to 115.0	3	8.3	0.48
Over 115.0	2	15.5	0.07

Both quality of cream and butter grading varied considerably. The very smallest factories had relatively low efficiency evaluations, but factories of average size output appeared to be more efficient than the largest size factories. This is borne out by an examination of those companies with an average grade of more than 94. There were four companies with an output of under 1 million lbs. with a grade of over 94, (i.e. 16%); ten companies in the 1 to 2 million lbs. output class, (37%); four companies in the 2 to 6 million lb. output class, (12%); and one company in the over 6 million lb. class (10%). Technical efficiency, as regards quality of product, appears to be maximum in the moderately small factory and then decrease with scale.[18]

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17 It does not allow for a number of other factors such as methods of pasteurization, as these are included in managerial ability in the widest sense.

18 Quality is regarded as a more desirable end than revenue by small-factory managers, because promotion tends to be governed by proof of ability to produce high grade butter.

Average Payout and Total Revenue for Season: The range of payouts is from 26.143d. to 29.581d. per lb. with a mean payout (or surplus, being total revenue minus total costs) of 28.720d. per lb. B/F.

Payout or surplus on butter-manufacture measures managerial efficiency in a two-fold way. It reflects the ability of management to minimise costs per unit of output, and to maximise overrun yield per unit of fat received.[19]

Revenue from creamery butter-making is derived from the quantity of butter made and is affected by the following factors:

(a) Grade of butter: Butter is paid for at the basic price, and according to the differential qualities as revealed by grading points, so additions or deductions are made to the basic price range of 93 to 93.5 points. Premium butter earns a higher price, and first and second grade a lower price than basic. Some 57.61 per cent was premium grade which earned 0.125d. per lb. over finest grade butter. Only 9.85 per cent of all butter received less than finest grade.

(b) Percentage of butter sold locally. This figure includes butter stocks held at balance date and intended for local markets. Such stock and sales are valued at the wholesale price applicable in that market. Creamery butter disposed of locally amounted to 14.91 per cent of the total manufactured.

(c) True overrun.

Percentage of Butter sold Locally: If the differential between the wholesale price and basic price is advantageous to the company, the total revenue will be increased.[20] Of 93 companies examined, 35 sold less than 5% locally; 17 sold from 5.1 to 15% locally; 23 sold from 15.1 to 30% locally; 5 sold 30.1 to 45% locally; 7 sold from 45.1 to 60% locally and 6 sold more than 60% locally. The range varied from nil to 100%. Smaller companies sold a greater

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[19] The former is largely economic ability, the latter, technical. Overrun is affected by the accuracy of weighing, sampling and testing of cream received, the composition of the butter manufactured and the extent of butterfat losses. Short-crediting, an expedient to window-dress overrun and hide technical deficiencies, cannot affect output of butter manufactured, but does inflate unit costs. The fact that there were 13 companies with overruns in excess of the possible maximum of 22.57 indicates the extent to which short-crediting was practised. Recent regulations introduced will enforce factories to disclose the extent of this.

[20] Generally, there was a distinct advantage in selling butter locally. The differential varied, but a common wholesale price was 28½d.lb.

percentage then larger companies, other things being equal. Larger companies with greater output were limited obviously by the extent of the local market, but where the local market was a city the percentage sold locally was relativevly high. Local markets, however, refer to locational opportunity, not efficiency.

Smaller companies, then, have an advantage in local sales over larger companies. Larger companies did not show to advantage in grading either, so that generally speaking revenue per lb. of butter made, tended to decrease with scale.

True Overrun and Revenue: Revenue, is shown in published accounts as so much per lb. B/F; not so much per lb. of butter made. Due to differentials in manufacturing efficiency and short-crediting, the pay-outs vary considerably - due largely to manufacturing efficiency. Although the pay-outs do vary, the total revenue per lb. B/F. is fairly constant for all companies.[21] Where payout was unduly high, the overrun was also high, suggesting the high rate was mostly due to short-crediting. The average of all total revenues per lb. B/F was 31.68d; the range lay between 30.848d. and 32.515d; and the average deviation was 0.18d. only. Technical efficiency then, as affecting grade of butter made, and the ability to reduce butterfat losses to the minimum has been concealed by the extent short-crediting has been practised.

Summary: The following table sets out revenue per lb. of butter made, average grade, overrun and local sales.

TABLE XXXIX. REVENUE PER LB. OF BUTTER MADE IN 114 FACTORIES WITH OVERRUN AVERAGE GRADE AND LOCAL SALES

Output in lbs.	Revenue per lb. Butter.	Average Overrun	Average Grade	Percentage of Local Sales %
Under 1,000,000	£0.1078	21.9	93.3	30
1,000,001 - 2,000,000	0.1083	21.9	93.5	18
2,000,001 - 4,000,000	0.1083	22.1	93.7	17
4,000,001 - 6,000,000	0.1081	22.0	93.6	9
6,000,001 - 8,000,000	0.1081	21.7	93.7	7
Over 8,000,000	0.1080	22.1	93.7	4

[21] That is, pay-out is fairly constant when measured in terms of B/F, but less constant when measured in terms of final product due to short-crediting and differential technical efficiency.

From the above table it is evident that with the exception of the very smallest class of factory, revenue per lb. of butter made tends to fall with scale. As overrun and grade is relatively constant,, it appears that local sales would account largely for this, with grade as a secondary cause. When measured in terms of butterfat, technical efficiency is partly hidden by the practice of short-crediting. Total revenue minus factory costs, shows pay-out per lb. of butterfat. The payout then largely measures the economic efficiency of management, due allowance being made for scale and location.

SECTION IV. CONTROL OF EXPENDITURE ELEMENTS[22]

There are a number of effective checks on expenditure available to managers. One of these is the cost ratio $\frac{\text{Wages}}{\text{Manufacturing Charges}}$, which is especially useful where a company is examining its efficiency through time.

Any change in a given ratio may be due to endogenous or exogenous causes affecting one or more elements comprising the ratio. An example of an exogenous change would be an arbitration award affecting aggregate wage payments, (other elements remaining fairly constant in the short run.) An example of an endogenous change would be a change in management or organization. An efficient manager taking over from a relatively inefficient man, may reduce wages 10 per cent or economise in the quantitative use of labour. Or, a change in organization may reduce wages £1,500, but increase fuel etc. by £1,000, , reducing total outlay thereby.

These changes are recognised as elements requiring intelligent interpretation, and may point to the necessity of an investigation. For example, an increase in the ratio $\frac{\text{Oil}}{\text{Motor Running Expenses}}$, clearly suggests an enquiry should be made to ascertain why oil consumption has increased. But a change in the ratio $\frac{\text{Wages}}{\text{Total Manufacturing Expenses}}$, may be the outcome of exogenous causes not related to efficiency, or to endogenous causes calling for careful scrutiny, or be the result of substitution. Indeed, cost ratios are a useful guide to substitution, for certain ratios tend to increase, while others, decrease.

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[22] The order of the various elements examined, follows the statutory order of published accounts rather than a stricter logical order.

Each factory will know the composition of its own elements of expenditure, and should examine any change carefully. For example, Materials account for 25 per cent, and wages 35 per cent of Total Manufacturing Charges for New Zealand. This latter ratio (35%) generally decreases with scale. Marked deviations from ratios commensurate with a given scale suggest differential efficiency or factor substitution.

Factor substitution probably increases to some extent with scale,but where there is a marked deviation from cost-ratios, it is probable that the variation is due to differential ability. In those cases where a factory has moderate total unit costs, but one factor-ratio is unduly high (e.g. power), and another unduly low (e.g. wages), substitution may be the cause, other things being equal. But where both factor ratios are high, there is little likelihood that substituion of factors has occurred.

Materials and Sundry Charges: "Materials" includes boxes or cartons, parchment, salt, nails, box-wire, glue and tape, being those materials incorporated in the finished packed product, plus the cost of transport of the "materials" inwards. The term does not include materials used in repairs and maintenance of factory buildings, plant and equipment such as cleansers, scrubs, brooms, lubricating and freezing oils, grease, sulphuric acid, or other consumable stores.

The item "materials" is of considerable importance to management as it amounted to 25.10 per cent of the total manufacturing costs of butter including cream haulage. The next largest individual item was cream collection at 17.16 per cent, and then Wages at 16.58 per cent.

The range of all factories in unit costs for Materials was from 0.329 to 1.020d. per lb. with the average cost for New Zealand at 0.743d. The distribution of these costs was as follows:-

TABLE XL. COST OF MATERIALS OF 95 COMPANIES, CLASSIFIED ACCORDING TO SCALE

Output in lbs. of butter	Number of factories classified according to cost of Materials in Unit Pence per lb.					
	Under 0.500	0.501-0.600	0.601-0.700	0.701-0.800	0.801-0.900	Over 0.900
Under 1,000,000	3	2	2	11	9	1
1,000,001 to 2,000,000	1	1	5	11	7	-
2,000,001 to 4,000,000	1	-	3	16	-	-
4,000,001 to 6,000,000	-	-	1	7	1	1
6,000,001 to 8,000,000	-	-	-	8	-	-
Over 8,000,000	-	-	-	4	-	-
	5	3	11	57	17	2

It is apparent from the above table that the range is greatest in smallest companies and decreases with scale. Although range decreases with scale, the average for each class-interval is fairly constant varying about 0.06 from the lowest to highest class-interval. The lowest cost actually is in the second class-interval (1 to 2m.) and the highest in the 4 to 6m. class interval. That is, costs vary, but not according to scale.

As there are 57 companies in the 0.701 to 0.800 cost column, it would appear that this modal column fairly represents the costs of materials in butter making. Indeed, the quantity of materials entering a given unit of butter is almost constant. That is, in a given carton of butter for export, (or pat for local consumption) there is a fairly constant quantity of salt, and also of parchment, glue, tape, parchfoil etc. It is difficult to see why, therefore, the range of costs is so considerable in such an important element as "Materials". The following reasons are suggested:-

1. Location: Cost of cartage in of materials is charged against "Materials". But with the exception of salt, most materials used in packing are relatively costly per unit of weight, so that cartage should not reflect in unit cost variations much. Isolated factories with otherwise heavy freight costs were examined and only in one case was materials high in cost.

2. <u>Percentage of Butter Manufactured Locally</u>: Butter for local markets is pounded and wrapped and packed variously in cartons and containers which may cost less than export packings.
There is some correlation, but insufficient to establish causation definitely. Of those factories making 50 per cent or more butter for local consumption the range lay between 0.447 to 0.805d. with an average deviation of 0.101d. per lb. The range of those factories making for export market was also high.

3. <u>Variation in Materials used in Manufacture</u>: There is a little variation in the quantity of salt used. Some butter has been made for overseas markets specified "unsalted" and other export butter has varied from the average 1.65 per cent by about 0.2 per cent either way. Butter made from stale, sour or feed-tainted cream does not carry the same per cent of salt that finest quality cream does.
Unit cost of parchment varies with local and export packs.

4. <u>Variation in Cost of Materials</u>: Cost, including carriage inwards does vary. Larger companies do obtain better buying terms for most materials. Some companies charge haulage on materials which are hauled in their own lorries, while others do not.
The quality of some of the materials used varies considerably, especially cartons.

5. <u>Waste</u>: There is a moderate amount of normal wastage of materials. Salt tends to become impure due to one reason and another and has to be discarded. There is a small percentage of spillage as well as spoilage. Glue, tape and nails tend to be used a little wastefully, but these tend to be a constant element and should not be a cause of variation in costs. There is some variation between companies in folding and cutting parchment, especially for local consumption.
In a few instances, losses were reported in cartons. Two companies advised considerable losses of stored cartons due to damage by water in both cases.

6. <u>Accounting Practices</u>: This is probably one cause in variation of unit costs of "materials". Some companies purchase heavily to gain the economic advantages of price, discounts, rebates and unit haulage. For example, one company making approximately 2,300,000 lbs. of butter purchased during the year over 50,000 cartons, 7 tons of parchment, 40 tons of salt, 5 tons of neutraliser, 150 coils of box wire, 40 gallons of glue and 1800 rolls of tape. Almost all this quantity of "materials" was charged against the accounting period. It is this practice of considering all materials <u>purchased</u> instead of materials <u>consumed</u> during the accounting period as chargeable that is largely responsible for variations in unit costs. Small companies especially are prone to this practice. Some larger companies (too few in fact) kept stock records and drew from this stock for manufacture, thus charging the correct quantity against actual

butter made.[23]

To test this practice of charging all materials against the accounting period, the unit costs of those small companies with considerable deviation from the group average were examined from season to season. Eleven companies were examined, and it was found that the unit costs of six companies increased by an average of 0.132d. from the 1950 season to 1951, while five companies decreased their costs by an average of 0.128d. for the same period. There is a certain kind of oscillation of unit costs from season to season which suggests that over-buying occurs one season, and is carried over to the next season when buying is lighter. Costs of materials did increase slightly from 1950 to 1951 but variations occurred both ways. Seasonal output was also a factor in causing a variation in unit costs.

Larger companies too, were not altogether free from this seasonal swing in unit costs of materials. Here is one large company's figures selected at random for 13 consecutive seasons (output was relatively constant): 0.564, 0.557, 0.571, 0.604, 0.627, 0.595, 0.626, 0.625 0.621, 0.608, 0.591, 0.863, 0.739. Here the gradual increase in price is noticeable. Kind and quality of materials changed over these 13 seasons, but some swing is also evident.

The range of costs of "materials" is the outcome then of recording practices, together with locational price differentials, export-local consumption ratio, wastage, cost variations and quantity used per unit, in this order of significance.

It was not always possible to obtain reliable data as to actual units consumed in manufacture, or in the break-up of costs of materials. Boxes or cartons account for approximately 70 per cent of total costs, parchment 14 per cent, sundries 12 per cent, and salt 4 per cent. These percentages varied from company to company, largely due to the fact that the figures referred to annual purchases rather than annual consumption.

Quantities used per unit were also examined in those factories where reliable data were kept. The range was considerable in certain lines. From two comparable factories making a large output, and where relatively accurate records were kept, the following variations were noted:-

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[23] It is fully recognised that all companies show the amount of stock of manufacturing materials on hand at the end of the accounting period but whether stock-taking or stock records are truly representative of the position (in some cases at least) is open to question for the reasons that follow.

Quantities of salt used per unit varied 6.5 per cent.
Quantities of parchment used for export varied 1.1 per cent.
Quantities of glue used per unit varied 87 per cent.
Wrappers used for local consumption varied 4 per cent.
Cartons used varied 17 per cent.
Tape used varied 29 per cent.

It is surprising in an industry, where such careful costs and checks are kept on technical efficiency and outputs, that such variations and disregard is found in purchase, storage, issue and economy of materials - the most costly element in manufacture. It is considered that costs can be kept to a minimum, by keeping and maintaining accurate stock records of materials actually consumed in manufacture distinct from stock inventories of materials on hand at a given time; by reducing wastage to minimum; by rigid control of storage, issue and records of materials; and by research at industry level into the problem of suitability, fabrication, and cost of cartons.

Sundry Manufacturing Charges - refers to certain residual items of factory expense directly applicable to the receiving and processing of milk or cream , and packing and despatching of produce. Actually when managers were asked what items were included in this element of cost, few were able to give an answer, but referred the enquiry to the Secretary of the Company. In fact, this heading has been used variously for accumulating odd elements of expenditure of a very wide range.

Many of these items of expenditure could have been charged correctly to either wages, cream collection, power or materials, but as they had different nomenclature as regards expenditure, they were charged to sundries. Under this heading many items of a suspense character were charged to be cleared later by credits. That is, in some cases, the account became a clearing house for odd charges. More often than not, the account "General Expenses" was broken up between "Manufacturing Sundries", "Office Expenses" and "Consumable Stores" in Factory Overheads.

These heterogeneous items included such charges as advertising for replacement of factory staff, printing of wrappers, tools, morning tea facilities, toilet requisites, periodicals and papers, entertainment charges, social function costs, professional and legal expenses, annual licence, sundry capital expenditure and various consumable stores.

The extent of this expenditure is not considerable. It ranges from zero to 0.069d. per lb. B/F. Eighteen companies had no charges whatever under this heading, and twenty-six had charges amounting to less than 0.010d. There appears to be no relationship to scale or size of factory apart from the fact that lowest unit costs were found in the 2 to 8 million lb. output classes. In some of the largest companies, these costs tend to increase as odd charges tend to accumulate.

Factory Overheads: Total factory overheads include charges for depreciation, repairs and maintenance, rates and land tax and insurance. Depreciation refers to sums written off factory buildings, plant and equipment used in the manufacture of butter, but excludes sums written off vehicles, office buildings and equipment, properties let or special butter-milk collection equipment. Repairs and Maintenance refers to all buildings, plant and equipment used in the manufacture of butter, and all consumable stores being those which do not enter into the manufacture and packing of butter. Rates and Land Tax refers to that apportionment of realty used in the actual manufacturing as distinct from administration buildings etc. Insurance covers those assets employed in the manufacture of butter and includes fire, earthquake, explosion, burglary and public risk policies, insofar as they refer to manufacture. Insurance does not cover those policies referable to vehicles, employers' indemnity, produce, buttermilk equipment, let properties or administrative facilities.

Factory overheads vary with the institutional character of the company and its structural facilities, its administrative efficiency and its managerial efficiency. Rates and land tax obviously vary according to the acreage and location of land held by the company; insurance varies according to the value of the assets held and the extent to which management has these assets covered; depreciation varies according to administrative policy and the age and book value of the assets; and repairs, maintenance and consumable stores vary with managerial efficiency and age of the assets themselves.

These elements will be examined and analysed separately in terms of unit costs and efficiency in the paragraphs which follow.

Depreciation as an Element of Factory Overhead Costs: Depreciation is related to assets rather than to butterfat received. It is the permanent diminution or shrinkage in value of an asset due to endogenous (controllable) and exogenous (non-controllable) causes. Endogenous causes include fair wear and tear of the asset and exogenous causes include obsolescence. All expenditure in maintaining the assets in good functioning order is charged to Repairs and Maintenance, and must be distinguished from Depreciation which represents that diminution in value which cannot be made good by repairs or renewals.

The assets normally coming under factory Overhead for Depreciation are:-

Factory buildings (relative to butter manufacture).
Factory plant and machinery (relative to butter manufacture).
Factory fittings and installations (relative to butter manufacture).
Electrical installations.
Water installations, wells, bores, artesian supplies, dams, etc.
Fire fighting equipment.
Laboratory and equipment.
Mechanics' Plant and Tools (relative to butter-making, not cream haulage).
Boiler-house and steam generation equipment.
Loading jetties and wharves, railway sidings.
Fencing, roading and other improvements to land.
Residences and furniture (as relative to butter manufacture) and not let or subject to rent.

Provision is made for Depreciation of the various assets by:-

1. Fixed Instalment System: A fixed percentage is written off the asset each year. This has been used where improvements have been erected on leasehold land in some cases. Wharves, rail-siding buildings, coal-mining erections and water installations are usually depreciated this way. For example, one company has a leasehold of property supplying artesian water. The value of the improvements has been written off on a fixed percent of original cost, so that improvements will be entirely diminished by time of effluxion of the lease.

   In a few cases plant and machinery and auxiliary buildings and erections of a temporary character have been depreciated by this method.

2. Reducing Instalment System: A fixed percentage on a reducing balance is written off each year. This method is the most common in the butter industry and is used for buildings, plant and machinery and miscellaneous equipment and installations.

3. **Revaluation System:** The asset is revalued each year. This method is employed by some companies for loose plant and tools and laboratory equipment where replacements are common.

4. **Lump Sum System:** Directors arbitrarily name a lump sum for depreciation which is apportioned among the various assets as the Secretary thinks best. While this method is practised by a number of smaller companies, it is not unknown amongst larger companies, especially where the competition for showing the best "payout" causes administration to cast round to reduce unit costs as far as possible.[24] This method is usually not recognisable from published accounts although it is obvious from accounts of some smaller companies.

5. **Replacement system:** Where the asset needs to be replaced at the end of its life, a procedure is adopted to ensure that funds are built up or accumulated and invested in order to replace the asset in due course. Some larger companies utilise this means, especially for auxiliary undertakings such as buttermilk powder plant, where it is highly desirable for funds to be available for replacement, or where the future of the auxiliary activity has an element of uncertainty. The system has been used too, for such plant as vacreators and boiler replacements.[25]

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[24] The secretary of one moderately large company advised the writer that his directors had granted him the maximum sum of £600 to write off as depreciation against all butter-making operations. The company had a relatively substantial factory, modern plant and machinery, eight fairly new vehicles and six recently erected dwellings. The obvious reason for this arbitrary decision was competition for the company's marginal suppliers.

[25] The problem of replacement is an evergreen one in the minds of most company secretaries. Here is an extract from the report of one moderately sized company addressed to the shareholders, May 1950. "Repairs & Maintenance : These are high and are likely to be so for possibly the next two or three years when we expect to have completed our replacements of worn-out plant. We have found that items of plant replaced have cost generally three times the cost of the original plant. A recent illustration: our original patting machine cost £700 in 1929 and the one installed this week £2,100.

Depreciation allowed over the years has not been sufficient to provide for the renewal of plant. The following figures will illustrate: Year ending May 1944: Land, buildings and plant were valued at £7,127. This year, £12,812; an increase in the book value of £5.685. During this period 1944-50, £7,200 was written off by way of depreciation. In 1944, Capital and General Reserve amounted to £22,504. In 1950, £29,207, an increase of £6,703.

It is therefore obvious that expenditure on buildings or plant must eventually be met by the suppliers either by way of bank overdraft, or by way of placing amounts to reserve to meet the expenditure or by the issue of more capital."

A number of considerations affect depreciation policy. In normal business concerns, there are three main considerations: the first is to record the value of profit and loss correctly by depreciating assets, and thus show the Assets in the Balance Sheet and Shareholders Funds at their right valuations: the second is to make adequate provision for replacement of the asset; and the third (a little more subtle), to minimise the taxable net profit of the concern.

In the butter industry, these considerations are not exactly identical to those existing in commerce generally, for the aim of the butter company as a co-operative concern is to maximise payout to its shareholders in the short-run. The butter manufacturing account takes the place of the Trading and Profit and Loss Account of the normal commercial firm and the object of the directors and management is to minimise expenditure including depreciation, in the Manufacturing Account as far as possible, so that the surplus of the account will be available to the shareholders and thus help to attract and retain suppliers of the company.

At the same time, it is necessary to show the appropriate asset valuation in the Balance Sheet. It is questionable whether the valuation of the assets as shown in the Balance Sheet mirror the actual value of the asset in every case. In some instances, assets are well-written down to a nominal value only, but in others, plant especially, stand in the books at considerable value.

Being structurally different from the normal trading concern, there has been a tendency to meet replacement expenditure by bank overdraft, capital issue, debentures, and even in hopeful anticipation of distribution of the surplus of the Industry Stabilization Funds.

Many directors have taken the advice of their secretaries and have made some provision for replacement through depreciation - in some cases by depreciating heavily and writing off to general reserves. But generally, depreciation has been inadequate to provide for replacement of improved and more costly plant and machinery. Moreover, there is no incentive to depreciate to the statutory limit allowed for taxation purposes for, being co-operative in structure, butter manufacturing is exempt from income-tax. Nevertheless, many companies prudently do apply for and obtain the special 30 per cent depreciation allowance to be written off over 5 years in addition to normal rates.

However, co-operative companies are liable for taxation on trading activities so that depreciation if not adequate for butter-manufacturing, is always adequate for taxable activities, for such expenditure does not appear in the butter-manufacturing account, but is brought eventually into the Appropriation Account of the Company. Further, as the expenditure of auxiliary activities (non-taxable) does not appear in the manufacturing account either, many companies invariably depreciate heavily the assets pertaining to the auxiliary activity, and allocate an undue proportion of depreciation on assets common to both butter-making and the auxiliary to the auxiliary undertaking. In this way, heavy depreciation is written off, but not to butter-manufacturing expenditure. The net results appear in the Appropriation Account: provision is being made for asset replacement, liquid funds are being conserved, payout to butterfat suppliers is being maximised and capital efficiency is being carefully screened.

Other considerations need to be borne in mind as well. The rates vary, as well as the methods of depreciation. It is common to find 20 per cent written off trucks and certain plant, 10 to 15 per cent off other items of plant and machinery, 10 per cent off equipment, 7½ per cent off fittings and furniture and rates varying from 1½ to 5 per cent off buildings. The age and date of acquisition of assets vary greatly too. Most companies have some plant entirely written off or written down to a nominal figure, but apart from this, new plant and machinery is being acquired all the time so that the schedule of assets of any factory or company is complex as regards age, values, and depreciation rates.

The rates of depreciation of the main asset classifications are given below:

1. <u>Trucks</u>:	10%	5 companies
	12½%	1 company
	15%	1 company
	20%	19 companies (4 on original value)
	40%	2 companies
	Lump Sum	7 companies.

Some companies in addition to those above had varying rates for different vehicles. Four companies availed themselves of special depreciation rates. Smaller companies favoured the 10% rate and larger companies the 20% rate.

2. Buildings: Rates were complex. Different buildings were allotted different rates depending on their age and type of construction. The following are to the nearest unit per cent:-

Written off	3	companies
Nil	2	companies
1%	8	"
2%	11	"
3%	24	"
4%	2	"
5%	3	"
6%	2	"
8%	2	"
10%	2	"
Lump Sums	13	"
L.I.T. Rates	10	"
Fixed rate per lb. B/F.	2	"

Larger companies preferred to depreciate according to rates permitted by the Inland Revenue Department, plus special rates. Smaller companies were more conservative in their rates and it was surprising how many large companies wrote off lump sums against their buildings, a few well in excess of 10 per cent. The majority approximate a little under 2½%.

3. Plant & Machinery: Rates were complex, as various machines and equipment entered the schedule at varying assessments. Larger companies again tended to have higher rates - the modal rate being 10% for larger companies and 7½% for smaller companies. Several concerns availed themselves of the special rates.

Under 5%	3	companies
5%	8	"
7½%	26	"
10%	23	"
15%	4	"
20% and over	5	"
Lump Sums	11	"
Fixed rate per lb. B/F.	2	"

4. Office and Administration Buildings and Equipment: Buildings were on similar rates as factory buildings usually. Equipment varied between 7½% and 10%. Office machines were 7½% to 10%, and furniture and fittings were 5% to 7½%.

The total amount written off to butter manufacture varied with the size of the factory, and scale of output, and age and type of plant and buildings. The following table sets out the monetary sums laid out in depreciation for butter-making.

TABLE XLI. DEPRECIATION WRITTEN OFF BY 96 COMPANIES AS A MANUFACTURING CHARGE ON BUTTER-MAKING

Output of Factory	No. of Companies in class-interval	Range of Depreciation Min. £	Range of Depreciation Max. £	Average for class interval-
Under 1,000,000	28	131	1366	461
1,000,001 - 2,000,000	25	210	1986	744
2,000,001 - 4,000,000	20	396	2725	1273
4,000,001 - 6,000,000	13	556	10950	2468
Over 6,000,000	10	1500	10306	3531

Rates of depreciation in annual accounts are related to butterfat whereas they should be related to value of assets. Smaller companies require more outlay in assets per lb. of fat then do larger companies. The relationship of assets to depreciation will be reviewed later in Section III of Part V, under Capital Efficiency.

The unit rates per lb. of B/F. for the above companies are as follows:-

TABLE XLII. ANALYSIS OF UNIT RATES OF DEPRECIATION FOR BUTTER-MAKING PER LB. B/F FOR 96 COMPANIES

Output of Factory (lbs. of butter)	Unit rates of depreciation in pence per lb. B/F.					
	Under 0.050	.051- 0.100	0.101- .200	.201- .300	.301- .400	Over .400
Under 1,000,000	-	6	11	8	1	2
1,000,001 - 2,000,000	1	7	13	3	1	-
2,000,001 - 4,000,000	1	7	9	3	-	-
4,000,001 - 6,000,000	2	4	5	1	-	1
Over 6,000,000	2	5	3	-	-	-
	6	29	41	15	2	3

The average for all companies is 0.096d. The rate decreases with scale with the exception of the 4 to 6 million class-interval where there is a marked rise due to extensive replacements by two companies. The modal rate is approximately 0.130d. (the mean 0.096d.) indicating the larger companies weight the unit rate so that the dispersion is markedly assymetrical.

Apart from depreciation being charged to butter-making, it is charged to other auxiliary activities.[26] Depreciation on all assets increases with scale, yet decreases with scale as a charge on butter manufacture. This is because larger companies charge a smaller percentage against butter relatively than other activities. These activities include transport, buttermilk powder manufacture, casein and milk powders and cheese. It must be fairly stated that many of these activities are fairly recent innovations, so that plant and buildings were acquired recently and rates were maximum. This is especially so with moderately-sized factories manufacturing buttermilk-powder, but even allowing that other activities are relatively recent ventures, the differentials are too considerable to shelter behind recency. The following schedule sets out the difference between depreciation on butter manufacturing and on other activities. In this schedule the amount charged to butter manufacture was allotted the index value of 100 in each case, and the other activities bear an index number relative to the monetary value charged by way of depreciation against butter manufacture. For example, if £600 is charged against butter and £900 against auxiliary activities, the butter depreciation index is 100 and that of auxiliary depreciation 150.

Company	Butter Depreciation Index	Other Activities Index
A	100	146
B	100	283
C	100	131
D	100	16
E	100	39
F	100	607
G	100	568
H	100	239
I	100	172
J	100	404
K	100	665
L	100	175
M	100	387
N	100	108
O	100	131
P	100	316
R	100	97
Q	100	65
S	100	164
T	100	587
U	100	251
V	100	3769
W	100	97

[26] The discussion that follows refers also to Auxiliary Activities, (cont.)

In the above companies, A to E are small companies with general store trading and other general activities, but no buttermilk manufacture. Companies F to N are moderately-sized companies (under 6 million lb. output) with butter-milk powder, store trading and other activities, but no whole-milk powders. Companies O to W are large companies with multi-activities including trading and milk powders. In each case the value and quantity of butter manufactured was several times that of the other activities combined. The extent to which other activities have been loaded is apparent.[27]

There is one other guide or test as to the appropriateness of depreciation charged to butter manufacture. If buildings are old and plant also, then repairs and maintenance will be relatively high, and insurance low. The 23 companies above were examined in the light of average unit rates for insurance and repairs and maintenance. In the case of Factory A, Repairs & Maintenance are 27% of the average of those in the same class-interval, while Insurance is 326% greater. Here is an obvious case of manipulation. Factory B bears a similar relationship, but a little less marked than A. The same applies to a greater or less extent to factories with an index over 200 for other activities, suggesting the incidence of depreciation has been shifted or manipulated.[28]

26(cont.) and may be read in conjunction with Section IV of Part V. It is included here as it discloses how depreciation is often greater than recorded manufacturing costs disclose.

[27]Some companies have carefully concealed the actual amount of depreciation chargeable to other activities by combining repairs and other expenditure in with depreciation. When requested for futher information, the reply given was evasive, or "refer to our published accounts".

[28]Relationship of depreciation to insurance, and repairs and maintenance, i no proof of shifting depreciation from butter manufacture to auxiliary activities. But where auxiliary activities claim a large share of depreciation, out of all proportion to insurance, the circumstances are highly suggestive of shifting the incidence of depreciation. In three cases, depreciation charged to auxiliary activities amount to 90, 97 and 113 per cent of other manufacturing expenditure, whereas in each case the amount of depreciation charged to butter manufacture was <u>less than</u> 2 per cent in each case. Moreover, in two of the cases, the butter factory was scarcely any older than the auxiliary plant which was bearing the brunt of the depreciation charge. In one case, the depreciation charged to the auxiliary undertaking was greater than all other manufacturing expenditure charged to the auxiliary product or well over 100 times that charged to butter.

The following observations will summarise the position of depreciation as a manufacturing charge:-

1. Depreciation as a factor in efficiency is a cost element, strictly coming within the sphere of administration, rather than management. It is related to capital efficiency rather than working efficiency for decisions concerning it are made by the directors. It has been examined in this section, as it is an important element in the structure of manufacturing expenditure and inadequate provision has long-run repercussions that are distinctly adverse to efficient management.

2. Many factories tend to under-depreciate rather than over-depreciate. This is due to the degree of competition that prevails to maximise payout, and results in wholesale diversion of depreciation to auxiliary undertakings in many cases.

3. Some larger and more efficient companies have, in their annual accounts indicated a superior method of setting out depreciation by showing the original cost of the asset, less the amount of the depreciation for the year, diminished by the accumulated depreciation fund to date. Schedules of assets have been appended, following the above lines.

4. Standardized methods of depreciation would greatly facilitate comparison of accounts and be beneficial to the entire industry.[29]

Repairs and Maintenance and Consumable Stores: Under this heading comes the largest item of factory overheads - amounting to 5.00 per cent of total manufacturing expenditure. It includes two main headings:-

(a) Repairs and maintenance of buildings, plant and equipment used in the manufacture of butter. It includes wages of workmen so engaged in repair work, and all costs of running repairs and maintenance but excludes expenditure on repairs and maintenance of vehicles, administration buildings and equipment, auxiliary buildings and equipment, or houses and accommodation let to employees.

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[29] It is understood that where loans are granted by the Dairy Industry Loans Application Committee for asset acquirement or replacement, maximum depreciation rates, plus special rates where applicable, are a condition precedent of approving the loan.

(b) Consumable stores being those used in repairs and maintenance and running the factory - other than those actually incorporated in the finished product or its containers. The main items include all cleansing materials - alkalis, basol cleaners, soap and soap powders, caustic and washing soda, brooms and scrubs; all processing chemicals such as sulphuric acid, bicarb. of soda, and neutralisers; and lubricants such as oil, grease, freezing oils, etc.

Analysed, this heading can be segregated as:-

(a) Wages charged to repairs and maintenance.

(b) Cleansing materials.

(c) Lubricants.

Wages relative to repairs and maintenance usually accumulate in off-season months when staff are employed in overhauling plant, painting buildings, etc. Larger factories have their own maintenance staff, but there appears to be a general tendency to charge quite a moderate proportion of seasonal maintenance to manufacturing wages. Most companies tend to charge all wages paid against manufacture, and then allocate a given percentage against repairs and maintenance. From an analysis of time-sheets in small and medium-sized factories, it would appear that in a number of cases wages so charged against repairs and maintenance is grossly underestimated. This arises from the fact, that in the off-season, most factories tend to make some butter for several days of the month and charge all that time against manufacture whereas quite a portion of it is utilised in repair work. Age of buildings and plant is also a factor that tends to increase cost of repairs - this being a capital outlay. Also adverse climatic conditions, in those districts where staff are kept on throughout the year, tend to a prolonged off-season during which the men must be kept occupied - thus giving rise to an environmental expense. Repairs and maintenance then is a function of management, capital and environment.

The extent of cost of consumable stores varies with:-

(a) Supervision of cleaning and cleaning stores.

(b) The number engaged in cleaning - the greater the number relatively, the greater is the consumption of stores.

(c) The type of detergent used, together with the hardness of the water, and degree to which different detergents are used for different parts and equipment.

(d) The methods employed - rinsing, washing and final rinse, or twice-daily wash-throughs and weekly dismantling.

The consumption of oils and greases tends to vary with age and capacity and degree of mechanisation of plant.

In one moderately-sized plant, the following cleansing stores were used per million lbs. of butter output:[30]

19 scrubs
7 brooms
218 lbs. of Basol
45 lbs. of soap
281 lbs. of soap powder
6 lbs. of caustic
709 lbs. of washing soda

It was not possible to obtain detailed information for the entire industry, but the following table sets out the average unit cost and deviation for each class of factory:

TABLE XLIII. ANALYSIS OF UNIT COSTS OF REPAIRS AND MAINTENANCE AND CONSUMABLE STORES FOR 96 COMPANIES

Output of Factory (lbs. of butter)	Average Unit Cost for class-interval d.	Average Deviation for class-interval d.
Under 1,000,000	0.180	0.078
1,000,001 - 2,000,000	0.136	0.045
2,000,001 - 4,000,000	0.113	0.051
4,000,001 - 6,000,000	0.098	0.038
Over 6,000,000	0.120	0.048

Unit costs range from 0.028d, per lb. to 0.621d. per lb. B/F, the average for New Zealand being 0.148d. per lb. Unit costs tend to decrease to the fourth class-interval at approximately the 4 to 5 million lb. output

[30] These should be considered as an optimum or minimum consumption - as this factory in question had very low consumption costs due to careful oversight.

level, and then increases. The average deviations too, tend to decrease until the fourth class-interval is reached, but when the deviations are measured as a percentage of average unit costs, the second-class interval has the lowest percentage (33%), suggesting that this class-interval is relatively efficient but handicapped by scale. The extent of the deviations indicate that insufficient supervision and control is exercised by management.

Rates and Land Tax: This item of expenditure refers to that property used for butter-manufacture and excludes the administration block and properties let to employees. As many companies have the administration block and butter factory etc., on the same land it has necessitated an arbitrary division amongst the various buildings concerned.

"Rates and Land Tax" is related to the value of land on which the buildings stand so that this item of expenditure relates to location or environment. It reflects the value of land. Some companies have elected to build just outside the borough or city boundary, provided they were served with a rail-siding, but others have built within the boundary but have minimised acreage held. Other factors regarding location of plant, of course, included proximity to transport and an abundant supply of good water; contour of the factory site for drainage etc; proximity to labour and being in the centre of the cream collection area.

Most factories utilised at least two acres, a few (in the cities and large towns) utilised less than one acre, some utilised up to 10 acres and a few, more than 10 acres. Almost all land was held on a free-hold basis, but some additional land was leased for building sites, or for working coal or auxiliary activities. A few companies had extensive mortgages on their land, which of course reduced the land-tax.

The average unit cost of Rates and Land Tax for New Zealand is 0.006d. per lb. output, and there is a general decrease in unit cost with scale, except round the 4 to 5 million output mark, where costs are lowest due probably to the rural location. The range of unit costs is from zero to 0.059d. The decrease with scale is largely related to greater output being spread inversely over the fixed charge. The average deviation is relatively small, but one factor was noticed - companies that have recently acquired land or erected buildings or factories, have the highest unit cost, regardless of scale or output. Those established the longest time, have the lowest cost. So that, in addition to being a function of location, rates and land-tax are also to a less degree a function of time, when measured over the years.

Insurance: Insurance refers to those assets used in manufacturing butter, but excludes vehicles, employers' indemnity, insurance of produce to F.O.B. (and locally), and insurance on auxiliary activities' assets, administration facilities, and accommodation for employees. The types of insurance covered include fire, earthquake, explosion, burglary, and public risk insurance.

Most companies take out an indemnity cover for fire and earthquake, the extent of the cover being the valuation placed upon the building by the insurer. However, a number of companies are now taking out, for an additional premium a replacement or reinstatement cover which goes further than the indemnity, and protects up to the replacement cost of the asset; so that should total loss occur, the company will not have to be their own insurers for the differential between the cost of actual replacement and the normal indemnity cover. There is, of course, a limit to replacement covers, a calculated risk based on actual building costs at the time.[31] Some companies take out Public Risk Policies, and a few, Burglary Covers also.

The extent of the premiums paid depends upon the nature of the risk, which in turn depends upon the nature of the materials out of which the building is constructed, the nearness to water supply, the proximity of other buildings and other factors. Most factories are constructed out of reinforced concrete, or brick and concrete, and so enjoy lower rates. Those near sources of potential danger or in a closely built-up area would require to pay a heavier premium. Some companies have their own efficient fire-fighting services which qualifies them for lower rates.

There is one factor that plays a big part in the cost aspect of insurance. Most companies are agents for insurance companies. Suppliers' insurance business is booked by the company who in addition usually obtain a substantial discount on all covers lodged with the parent company they represent.

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[31] An indemnity policy is usually based upon a replacement or reinstatement cover. The latter is calculated first, and then depreciated to arrive at the usual indemnity cover offered by insurance companies.

The average unit cost for insurance for all New Zealand is 0.009d. per lb. of fat. The range lies from 0.001 to 0.070d. per lb. B/F. There is a steady decrease in unit costs with scale, unit costs falling with increased output. In the smallest output group of factories (under 1m. output) the average unit cost is 0.021d. and this falls to 0.006d. in the largest output group (over 6m.). Deviations also decrease with scale, from 0.012d. in the low output group to 0.003d. in the high output group.

The fall in unit costs can scarcely be said to be due to an increase in efficiency. It is rather due to the fact that a much greater output enables a lower unit rate to be struck. Actually, smaller companies have less relative coverage than larger companies which usually take out a complete coverage at excellent rates. Unit cost differentials, then, are an outcome of differentials in location, age and type of buildings and output.

Factory - F.O.B. Charges: In published accounts, these charges appear under four headings - "Carriage and Freight", "Freezing and Storage", "Grading", and "Insurance". Carriage and Freight includes all cost of transporting butter to the grading-store, or buyer's store (for local produce). These charges include all railage, haulage, freight and coast-wise shipping and relevant charges. As a number of companies use their own vehicles, it is normal to allocate an appropriate portion to "Carriage and Freight". "Freezing and Storage" includes freezing and storage and handling charges from grading-store to ship's hold. Any haulage from grading-store is usually charged to this account, which is credited with rebates received arising from shareholdings in the freezing companies. "Grading" is the charge payable to the Department of Agriculture for this service, and "Insurance" relates to the cover on butter from leaving the dairy company's cool-store until in the ship's hold; also on butter sold locally until delivery to the wholesaler.

Factory-F.O.B. costs amount to 18.209 per cent of total costs and consequently assume importance in the framework of costs. Of these, carriage and freight accounts for 8.716 per cent, freezing and storage 7.837 per cent, grading charges 1.081 per cent and insurance 0.574 per cent.

(a) Carriage and Freight: Butter is transported from the various factories to one of the eleven grading ports: Auckland, New Plymouth, Gisborne, Napier, Patea, Wanganui, Wellington, Lyttelton, Timaru, Dunedin or Bluff. The main factors then, affecting the unit cost of carriage and freight are:-

1. The percentage of total butter manufactured for export; or conversely, the percentage entering the local market.
2. The distance of the factory from the grading port.
3. The method of transport available and the number of transhipments necessary.
4. The number of times per week in season, butter is sent forward to the grading port.

The percentage of total butter entering the local market affects all Factory-F.O.B. charges, (including Insurance to a lesser degree). The percentage sold locally for 93 companies is set out on Page 181 of Section III of this part of the work, and in Table XXXIX. (Page 181). The percentage ranged from 30 per cent in smallest output factories (under 1m.) to 4 per cent in the largest output factories (over 8m.). The greater the percentage disposed of locally, the lower is carriage and freight out, other things being equal. Smaller factories have an advantage in local sales, but it must be remembered that smaller companies usually have greater locational disadvantages, and these are only partly offset by local sales.

The distance of the factory from nearest grading port is the most important factor in shaping freight costs, together with the consideration of mode of transport. It is partly a question of what alternatives are available. For longer distances, sea-freight generally appears cheaper than rail, and rail again is cheaper than road transport. Of some 48 companies which are located at or nearby rail loading points, a small number ship by sea freight, a fair number haul by their own vehicles and some have both road and rail haulage as elements in their costs.

Finally, the number of times a week or month butter is forwarded depends largely upon the size of the cool store at the factory, and partly the frequency of mode of transport offering. The less frequent the forwarding, the lower tend to be unit costs. Of those companies forwarding by sea, the smaller companies forward butter once a week, while larger companies forward two or three times a week. Smaller companies railing butter usually consign it twice a week (depending on rail services), and larger companies rail their stocks three or four times a week in season, or even daily in some cases. Road transport tends to be more frequent (often daily), as loads are smaller and protection less efficient than by other methods.

The average unit cost in New Zealand for Carriage and Freight is 0.258d. per lb. B/F. The range of unit costs varies from 0.035d. to 0.727d. and the deviations form no pattern with scale. In the low cost group are those factories at or near a grading port - 13 factories, all with costs less than 0.1d., and all within 10 miles of a grading port. There were 7 factories with costs in excess of 0.5d. per lb., and in each case there was a long road haul either to grading port or rail-head.

When related to scale, unit costs appeared to be lowest in the smallest output factory group, but this was due to the fact that a large number of these factories are situated in Taranaki where haulage either to New Plymouth or Patea is relatively less than other districts. Unit costs then appear to increase steeply in the 1 to 2m. output group of factories to approximately 0.3d. and gradually diminish to 0.2d. in the 5 - 6m. output range, and then increase once more in the larger factories to about 0.27d.

Carriage and Freight, then, is mostly a function of location as determined by distance to grading port, type of transport available, loading facilities at the factory, and the percentage of butter sold locally. Managerial or administrative efficiency plays little if any part in these costs.

(b) Freezing and Storage: These charges arise indirectly from the charges incurred at the various grading stores and are the outcome of the expenditure incurred by the institutions concerned, which charged the butter companies using their services at virtually a flat rate per carton or box of butter. Butter factories usually hold shares in these freezing companies on a given basis and receive rebates which are credited to the Freezing and Storage Account.

Variations in unit costs arise from variations in expenditure of the freezing companies serving the butter industry. Variations in the freezing companies' costs arise from the following differentials:-

(a) Location of freezing plant. Obviously a freezing company located in a city where rents are high, will have very high establishment costs. Thus it could be expected that rates, rent, etc., in Wellington would be much higher than a similar plant situated in, say, Patea.

(b) Through-put and capacity of plant. The greater the plant, the lower tends to be operating costs.

(c) Administrative efficiency.

(d) Frequency of ships loading produce and consequent storage charges.

One point should be observed here. The value of shares held in freezing companies per unit of output of butter, tends to vary greatly in different districts. In one district, the number of freezing shares held are more than ten times the value of shares required to be held in other districts. This necessitates a greater capital outlay for those companies in that district concerned, and should be a matter for administration of those companies concerned to see that freezing charges are handled efficiently. Butter companies do have an indirect control through their share holding over the efficiency of freezing companies, and this administrative efficiency should reflect district-wise in unit costs. But it must be pointed out that freezing companies handle much more produce than butter, but nevertheless, representation by the butter industry is an important thing as costs tend to vary mostly with districts rather than scale.

The average cost for New Zealand is 0.232d. per lb. B/F., and the range lies from 0.047d. to 0.414d. From the point of view of scale, unit costs tend to decrease with scale until the 4m. output class is reached, and then they tend to increase. Dispersion of costs within the output class-intervals appear to be greatest with smaller factories and decrease with scale. From the locational angle, unit costs in the South Island are about 40 per cent of those in the North Island. In the North Island, unit costs are lowest in Wellington district, second lowest in Hawkes Bay, and fairly constant in other districts except Taranaki which have the highest average unit costs. There appears to be a distinct functional relationship between the extent of share capital invested by various companies in freezing companies and unit costs. Where share-holdings are high, freezing unit costs are high and vice versa.[32]

(c) Grading of Butter: Grading unit costs are very constant, ranging from 0.017d. to 0.039d. per lb. B/F. The New Zealand average is 0.032d. per lb., and 58 out of 96 companies were within 0.001d. of this average. Local produce and stocks carried forward in the companies' premises account mostly for these small dispersions.

(d) Insurance to F.O.B.: The average for New Zealand was 0.019d. per lb. B/F. and the range lay between 0.003d. and 0.065d. Deviations from New Zealand average were relatively small, as 53 companies out of 96 were within 0.001d. of this average. There was a slight increase of unit costs with scale, probably due to an increasing percentage of export butter with scale.

Neither insurance nor grading unit differentials are influenced to any extent by managerial or administrative efficiency.

SECTION V. ECONOMIC OR ORGANISATIONAL ASPECTS OF MANAGERIAL EFFICIENCY.

It is considered that economic measures of managerial efficiency measure largely the ability of the manager to organise, delegate and supervise. In fact, efficiency in management is that differential ability in organisation which includes delegation and supervision. Physical input-output ratios and cost data and ratios are useful, but an ordinal measurement may be obtained from the examination of the unexplained residuals and their deviations. The following elements of managerial efficiency[33] will be so examined:

(a) Wage cost function - the ability to minimise wage-costs, having made statistical allowance for scale or output, supplier density, and seasonal or environmental factors.

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[32] Often due to butter companies being compelled to invest in freezing companies owing to inefficiency or inadequate funds of freezing companies at an earlier date.

[33] Managerial efficiency is relative only. One manager is more efficient than another, when that other is used as a base or denominator for comparison. All may be efficient but some more than others, or all may be inefficient, some less than others.

(b) Labour turnover - the ability to retain staff; a measure of employer-employee relationships, with due statistical allowance for scale or output, wage differentials and housing accommodation for employees.

(c) Transport efficiency - the ability to organise cream collection to minimise costs, with due statistical allowance for time, mileage and weight of cream collected.

(d) Technical efficiency in power consumption per unit of output. Statistical allowance to be made for scale only.

(e) Technical efficiency in butter-making as measured by average grade awarded.

Wage Cost Function: In the wage-cost function, the individual estimate wage-costs of 106 factories were computed by subjecting their individual data to the wage-cost multiple regression formula. Where the factory's estimated (or theoretical) wage-cost was less than the actual wage-cost as disclosed by annual published accounts, management was assessed as relatively inefficient as regards wages-cost function because actual wage-cost exceeded the estimate considered normal when the independent variables were duly allowed for in the regressional formula.[34] The following classifications are given in absolute terms (not relative), in order to bring out their derivation. Relative evaluations will be developed a little later in the text. The results were as follows:-

Arbitrary gradings of managers of factories producing under 1,000,000 lbs. butter annually:

6 were mediocre, i.e. neither efficient or inefficient, as their individual scores were less than 0.050d. above or below their appropriate estimates.

4 were slightly efficient, i.e. their scores were between 0.050d., and 0.100d. below their appropriate estimates.

4 were efficient, i.e. their scores were between 0.100d. and 0.200d. below their appropriate estimates.

7 were very efficient, i.e. their scores were between 0.200d. and 0.300d. below their appropriate estimates.

1 was extremely efficient, i.e. his score was in excess of 0.300d. below his estimate.

1 was slightly inefficient, i.e. his score was between 0.50d. and 0.100d. above his appropriate estimate.

3 were inefficient, i.e. their scores were between 0.100d. and 0.200d. above their appropriate estimates.

2 were extremely inefficient, i.e. their scores were in excess of 0.300d. above their own appropriate estimates.

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[34] The formula is stated on p. 80, of Section V. of Part II.

Of the above, 28 managers, 16 had scores below their appropriate estimates and 6 were above and 6 approximated their estimates. The range of efficiency was 0.715d. which was considerable, indicating that in terms of unit costs for wages, some varied more than 0.300d. either way. This indicates that in the smallest size factory, there is a notable dispersion in managerial efficiency. These men have been drawn probably from First or Second Assistantships in larger factories, and some will leave their mark in the dairy industry, and others will either rise slowly or leave the industry.

Managers of Factories producing 1 to 2 million lbs. butter annually: (the same basis of classification is used as in the 1 million lbs. group).

6 were mediocre
5 were slightly efficient
3 were efficient
3 were very efficient
4 were slightly inefficient
4 were inefficient

Of the 25 managers, 14 had scores below their appropriate estimates and 2 above. The dispersion of efficiency was 0.450d. which is relatively moderate.

Managers of Factories producing 2 to 4 million lbs. butter annually:

9 were mediocre
5 were slightly efficient
4 were efficient
2 were slightly inefficient
1 was inefficient
2 were very inefficient.

Of the 23 managers, 10 had scores below their appropriate estimates and 9 above. The dispersion of efficiency was 0.444d., which is considerable when regarded relatively. The percentage of mediocre managers shows a marked increase.

Managers of Factories producing 5 to 6 million lbs. butter annually:

9 were mediocre
3 were slightly efficient
3 were efficient.

Of the 15 managers, 9 had scores below their appropriate estimates and 6 above. The dispersion of efficiency was 0.233d. which was small absolutely, but moderate relatively.

Managers of Factories producing more than 6 million lbs. of butter annually:

6 were mediocre
3 were slightly efficient
2 were slightly inefficient
3 were inefficient
1 was very inefficient.

Of the 15 managers, 5 had scores below their appropriate estimates and 10 above. The dispersion of efficiency was 0.276d. which is moderate absolutely and considerable relatively.

Managerial efficiency appears (from these absolute differential scores) to become gradually less dispersed with scale. The dispersion of efficiency tends to be considerable with smallest factories and grow less until the 5 to 6 million class is reached and then increase again with largest factories. Average ability (i.e. mediocre efficiency) also increases with scale until the 5 to 6 million class is reached and decreases. The percentage of those so classified through the scales are: 22, 24, 39, 60 and 40 per cent respectively.

A critical examination reveals that the above classification has moderate validity especially for those factories coming within the 1 to 8 million output category. At the extremes of the scale, especially those factories with greatest output, the curvilinearity of the regression has made it necessary to adjust the estimated values. Moreover, certain large factories (3 in number) have had to be excluded owing to special endogenous labour peculiarities. But apart from these features, it is considered that these gradings give a relatively valid picture of efficiency within the appropriate scale intervals.

These gradings, however, have been measured in absolute evaluations and require converting into relative terms. For example, a small factory may have an estimated score of 0.850d. while a large factory may have an estimated score of 0.300d. For the large factory to show an actual score of 0.100d. below its estimate will require much greater relative efficiency than the small factory which has to increase efficiency only 12 per cent. against the larger factory's 33 per cent, (using the estimate score as a base relative in each case). To make a valid relative comparison, therefore, it is necessary to recast all actual and relative scores by allotting indices of efficiency for each factory manager. In the following table, each individual factory had its absolute score converted to a relative index by using the estimated score as the base of 100.

TABLE XLIV. RELATIVE EFFICIENCY IN MANAGEMENT AS SHOWN BY THE WAGE-COST FUNCTION

Output in Factory (in lbs. butter)	Total	Efficiency Index Relative							
		65 & under	66-80	81-95	96-105	106-120	121-135	136-150	Over 150
Under 1,000,000	28	1	1	5	3	6	8	3	1
1,000,001 - 2m.	25	-	1	10	3	7	3	-	1
2,000,001 - 4m.	23	1	2	4	6	4	5	-	1
4,000,001 - 6m.	15	-	-	4	3	3	4	-	1
6,000,001 - 8m.	8	2	1	-	2	2	1	-	-
Over 8,000,000	7	-	2	2	2	1	-	-	-
	106	4	7	25	19	23	21	3	4

The positioning is slightly different from the absolute findings due largely to the different classification (which was devised to permit comparison.) Compared w th the absolute gradings, the above table reveals that the relative gradings have expanded the dispersions in the larger output factories and contracted the dispersions in the smaller output factories.

In class-intervals of 10, the relative efficiency of 106 managers is as follows:-

60 - 69	6 managers
70 - 79	5 "
80 - 89	10 "
90 - 99	23 "
100 - 109	19 "
110 - 119	15 "
120 - 129	11 "
130 - 139	11 "
140 - 149	2 "
150 - and over	4 "

This dispersion is slightly asymmetrical but shows the distribution of managerial efficiency for the wage-cost function, which is the most important single indicator of managerial efficiency.[35]

[35]The unexplained portion of the wage-cost function was approximately

Some 42 managers in the above distribution can be considered moderately normal in efficiency, 10 somewhat sub-normal and 2 distinctly inefficient. Moreover, 15 can be considered above normal efficiency and another 22 distinctly efficient, and again another 6 outstandingly efficient.

Managerial Efficiency as indicated by Labour Turnover: One important aspect of managerial efficiency is labour turnover. A manager may obtain a low wage-cost relative at the expense of employer-employee relationships. Low unit wage-costs may be obtained by "driving" the men, or by underpaying them. To test the position, the multiple regressional formula for labour-turnover was applied to each factory for which data were available, and actual and estimated scores compared. As each actual score in itself is a relative, the following table sets out the differentials between actual and estimated labour turnover.

TABLE XLV. MANAGERIAL EFFICIENCY OF LABOUR RELATIONSHIPS, AS MEASURED BY ACTUAL AND ESTIMATED LABOUR TURNOVER DIFFERENTIALS IN 85 FACTORIES FOR THE 1949-50 SEASON

Output of Factories (lbs. of butter)	No. of Factories.	Labour Turnover Differentials								
		Minus Values				+9 to -9	Plus Values			
		Over 70	50 to 69	30 to 49	10 to 29		10 to 29	30 to 49	50 to 69	
Under 1,000,000	22	1	-	2	2	3	12	2	-	
1,000,001 - 2m.	19	2	-	1	3	2	6	5	-	
2,000,001 - 4m.	21	1	2	4	2	5	6	1	-	
4,000,001 - 6m.	10	1	1	1	1	1	4	1	-	
Over 6,000,000	13	-	1	-	4	1	2	3	2	
	85	5	4	8	12	12	30	12	2	

In the above table, minus values signify that actual labour turnover was greater than estimated turnover, while plus values signify actual turnover was less than estimated turnover.

If a large part of the 67% of unexplained variance of the multiple regression in turnover was due to differential managerial ability, the above table has considerable significance. But it must be borne in mind that it measures objective employer-employee relationships and as such has value as a measure of managerial ability.

In the above table, the class-intervals are in relatives of 20. Some 12 managers may be considered normal, as their actual differed from their estimate by less than 10; 12 managers were somewhat sub-normal, another 12 inefficient, and yet again another 5 distinctly inefficient. On the other hand, 30 managers had above normal efficiency and again another 14 were distinctly efficient.

Wage-cost relationships to efficiency in management will now be examined in the light of labour-turnover efficiency. In 84 factories, where data were comparable, 24 managers were inefficient in wage-costs but efficient in employee relationships, and conversely 24 managers were efficient in wage-costs but inefficient in employee relationships; a total 48. Again, 10 managers were inefficient both in wage-costs and employee relationships, and 26 were efficient in both. These distributions are regular through the various class-intervals. In the six highly efficient labour-cost factories, all but one manager were efficient in employee relationships.

It would appear, therefore, that there is a small correlation between efficient labour-cost management and inefficient employee relationships, but nothing of any significance to suggest that efficiency in labour-cost management is at the expense of employer-employee relationships.

Managerial Efficiency in Cream Collection: Many companies used the contract method in whole or in part for cream collection, so that any measure of efficiency had to exclude them from the data that refer to transport efficiency. In 19 companies which used their own vehicles, data were completed and relevant and suitable for measuring differential ability, for unexplained variance amount to 10 per cent when mileage, time and weight were considered as independent variables. (See p. 165: $R = .95$ and $R^2 = .90$).

It must be pointed out that these 19 companies belong to a total of 26 companies which were utilised in calculating a multiple regressional formula. These 26 companies may represent (and possibly do) a low-stratum of low transport costs. That is, these 26 companies have a high modal rate of efficiency as their average unit costs are below unit costs for cream collection for the industry.

Nearly all would probably be efficient if compared with all factories making butter in New Zealand. Of these 19, some 10 managers were rated as efficient in labour-cost management. The following list sets out managerial efficiency in cream collection derived from differentials between estimated and actual costs in transport:-

Factory	Relative Efficiency Index
A	67
B	111
C	50
D	104
E	120
F	96
G	139
H	30
I	89
J	109
K	122
L	121
M	122
N	119
O	75
P	116
Q	109
R	90
S	99

Factories A to F produced less than 2 million lbs. butter per annum, G to L produced from 2 to 4 million lbs., and M to S produced more than 4 million lbs. Of these managers, 6 have mediocre or normal efficiency, 3 are inefficient and two extremely inefficient; 7 were efficient and one very efficient. It must be recalled that in cream collection efficiency, the ability to reduce mileage and time increases efficiency, while the tendency to increase mileage for small pay-loads (of one or two cans) promotes managerial inefficiency.

Managerial efficiency in power utilisation: Differentials in coal consumption depends largely upon boiler capacity. The following analysis refers to electrical power consumption which is dependent upon capacity only to a small degree. The figures which follow are the differentials from a regression computed from consumption of power units and factory output of butter. These differentials largely represent managerial economies, plus a measure of unused capacity (especially in larger companies in refrigeration facilities), and greater mechanisation. They are given in absolute figures as the average dispersion of all class-intervals for the number of units per 1,000 lbs. of butter is only 4.2 units. The following table sets out power efficiency management.

TABLE XLVI. EFFICIENCY OF MANAGEMENT IN POWER UTILISATION IN 78 BUTTER FACTORIES

Output of Factory (lbs. of butter)	Differentials of units of power consumed per 1000 lbs. of butter *							
	Total	Beyond Minus: 40	Minus: 30-39	Minus: 20-29	Minus: 10-19	Minus: 0 - 9	Plus: 1 -9	Plus: 10-19
Under 1,000,000	14	-	1	-	1	7	2	3
1,000,000 - 2m.	16	1	1	1	2	5	3	3
2,000,000 - 5m.	30	-	1	1	3	11	7	7
Over 5,000,000	18	-	1	2	4	3	6	2
Totals:	78	1	4	4	10	26	18	15

The class-intervals, which have been changed somewhat, conform to the pattern of electrical equipment and degree of mechanisation found in the butter industry. The range of units of power consumed was 52 points, but the distribution was slightly assymetrical as the above table indicates. Some 44 managers may be considered relatively, as mediocre or satisfactory from the efficiency point of view, as their scores lay within 9 points of the median figure for their output group. Another 15 managers can be considered efficient, 14 as inefficient and 5 as very inefficient. The dispersion towards inefficiency is considerable and marks all groups.

Collation of various managerial efficiencies: The question immediately arises; are some managers efficient in all aspects measured? or put a little differently, do some managers excel in certain directions and fail in others? Some 18 factories were examined under five headings: Wage-cost, labour turnover, transport, power and butter grading. These factories were representative of all classes, outputs and environmental conditions, and may be taken as a fair cross-section of all factories.

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* "Minus" refers to the extent to which a factory failed to measure up to the average dispersion of its class interval, i.e. exceeded the quota of its group.

It has been necessary to accord each manager a relative evaluation based upon the index of efficiency in each category of efficiency. Butter grading was the basis of Technical efficiency. Relative points above or below the mean of their class interval in butter grading, are used as an index of efficiency of technical ability to produce a quality product, regardless of facilities such as vacreation etc. Values are computed as unity for each 10 grading differential points.

TABLE XLVII. COLLATION OF MANAGERIAL EFFICIENCIES IN SELECTED FACTORIES

Factory	Total	Wage-cost Efficiency	Labour Turnover Efficiency	Transport Efficiency	Power Efficiency	Technical Efficiency
A	229	111	Plus 23	84	plus 3	plus 8.0
B	192	106	plus 17	50	plus 12	plus 7.4
C	219	126	minus 9	104	minus 4	plus 2.3
D	212	92	minus 5	120	plus 0	plus 4.7
E	232	102	plus 11	96	plus 15	plus 8.1
F	251	101	plus 1	139	plus 11	minus 0.5
G	124	71	plus 22	30	plus 0	plus 0.8
H	239	122	plus 20	89	plus 2	plus 6.3
I	246	100	plus 33	109	plus 4	minus 0.2
J	266	152	plus 1	122	minus 8	minus 1.4
K	212	114	minus 23	121	minus 3	plus 3.2
L	315	164	plus 28	122	plus 1	plus 0.1
M	173	97	minus 34	119	mius 12	plus 2.9
N	144	96	plus 4	75	mius 31	minus 0.3
O	224	106	plus 0	116	minus 2	plus 3.7
P	249	111	plus 50	109	minus 21	minus 0.1
Q	163	82	minus 17	90	plus 9	minus 0.9
R	255	93	plus 48	100	plus 11	plus 2.7

In the above table, factories A to C had outputs of under 1 million lbs. annually, D and E were in the 1 to 2 million lb. category, F to K were in the 2 to 4 million lb. category, L to O were in the 4 to 6 million lb. category and P to R in excess of 6 million lbs.

It is considered that for the purpose of comparison, Wage-Cost and Labour Turnover added together give a moderate assessment of managerial ability for labour. The transport efficiency index stands by itself as an indicator of this efficiency, but when the cost and turnover index, together with transport, power and technical efficiencies are accumulated, the total gives a numerical indicator of total managerial efficiency. The aggregation of these efficiencies have been weighted approximately according to the proportion they enter the cost structure of manufacturing costs and have a moderate degree of validity for comparative purposes.[36]

Any manager with more than 200 points may be considered to possess more than average ability over the whole range of management. Those with more than 240 points may be considered relatively efficient, those with more than 280 points very efficient, and any in excess of 320 points as extremely efficient. Conversely, those approximating 160 points can be considered inefficient, and those approximating 120 points very inefficient.

Considering index values of more than 100 as positive, then only one manager is positive in all five fields, (Manager of Factory "L"). Even this manager is only just positive in the fourth and fifth fields, indicating that real efficiency in all fields of management is rare indeed.[37] Four managers were efficient in all fields except transport. The distribution of efficiency is not affected by scale or output, for in the regressional analysis this variable has been held statistically constant.[38]

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[36] Statistically it is an incorrect procedure to aggregate evaluations that are heterogeneous. For comparative purposes it is permissible, although now discarded in pedagogic studies for statistical and logical reasons.

[37] Section V. has been (necessarily) analytical and critical, but this should not detract from the general impression of marked managerial ability in the butter industry. Many managers did excel in a number of functions.

[38] One very important quality in management has not been measured, but it is not overlooked. Personal qualities of character and leadership which are so vital and yield an intangible element in efficiency are duly recognised - but they cannot be measured.

Conclusions: the more significant aspects of management examined are related to the organization, supervision and control of the technical efficiency of certain activities including power utilization and materials utilization.

The considerable variations of cost in these elements indicate technical waste and economic maladjustments require attention.

Organizational efficiency can be achieved by careful supervision and implementation of efficiency checks against which all attainments are regularly checked, and deviations examined to ascertain the cause. These checks could include records of physical units such as power units consumed (daily meter reading), coal consumed, lbs. of detergents, cartons issued etc.

Technical efficiency can be achieved by dissemination of knowledge backed by competent instruction at industry level, increased adequate instrumentation in power utilization, and elimination of waste by careful co-ordination of processes and avoidance of peak loadings.

Economic efficiency is being achieved by factor substitution in power utilization, (more efficient machinery backed by adequate instrumentation). Thus capital expenditure is substituted for heavier power consumption and repairs and maintenance, including labour costs. The use of units of smaller plant capacities (in off-season manufacture), or replacing by multiple smaller capacity units (an increase in capital outlay) to avoid costly over-capacity, is substitution in another form, as is mechanization for labour.

In a number of factories it is probable that greater economic efficiency could be attained by balancing increased revenue from premium grade butter against increased power used for extra vacreation and cleaning.

Managerial efficiency is being impaired in a number of cases by managers undertaking certain duties of technical operatives to the detriment of the purely managerial duties of organization, delegation and supervision. This applied especially in the smaller medium-sized factories where managers had not yet adapted themselves to purely managerial duties. It appeared from an examination of technical efficiency of management, that the range of quality in management was considerable, for about 40 per cent came within the broad band of normal efficiency, leaving 60 per cent in the "infra-efficient" and "ultra-efficient" groups. Technical efficiency generally appeared to be of a much higher order than organizational ability.

The range of differential efficiency appeared to be greatest in the smallest factories, but this diminishes with scale. However, there is much to suggest that general managerial ability reaches its optimum at the 5 to 8 million level and then diminishes with further output. This may be due to the fact that continuous personal supervision tends to cease or to be delegated to subordinates after that level is attained.

PART V.

ADMINISTRATIVE EFFICIENCY

SECTION I. INTRODUCTION

Administrative efficiency is defined in terms of policy formation as determining the setting within which managerial efficiency is given scope to function. It is thus related to the results of past capital outlays as determining the nature and condition of the physical plant and equipment and the justifiable opportunities that give scope for greater managerial capacity by current capital outlays.[1]

However the approach has necessarily to be aligned to the data contained in the published Standardized Accounts, which segregates the items of administrative expenditure, balance sheet data, and auxiliary undertakings.

Administrative efficiency, therefore, has to be considered in terms of costs of office, administrative expenses, and other items entering into "General Overhead"; the structure of assets and liabilities as representing the outcome of past decisions, supplemented by observations on the nature and condition of the physical assets, and by examination of the current provision for their replacement, improvement and renewal; and the revenue from auxiliary undertakings[2] together with the way in which it is allocated.

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[1] Current capital outlays are strictly the present result of past outlays in terms of (a) the plant setting for operations and (b) the structure of assets and liabilities and the availability of liquid means to implement decisions. Current expenditure on capital items, and current provision for replacement will of course affect future managerial ability.

[2] It is not intended to include parallel activities, such as multi-branch cheese and powder factories, for they are not bound up with the broad object of butter making, even if they are correlative and influence the decisions of the directors who are co-ordinating a given policy. But all auxiliary and subsidiary activities such as buttermilk powder manufacture, store-trading, pig-farming (related to buttermilk disposal) etc., are included, as they are directly related to the main object of butter manufacture.

SECTION II. OFFICE ORGANIZATION AND ADMINISTRATIVE EXPENDITURE.

Organization of the Office: There are two broad types of organization of clerical, office or administrative work in the butter industry:-

(a) in which all clerical, accounting, secretarial and administrative work is undertaken by a practising accountant or secretary,

(b) in which the company provides all facilities and employs office, accounting and secretarial staff.

The first type is usually found in small companies, where a professional accountant, who specialises in dairy company work, undertakes on a given basis to provide office accommodation and staff and all facilities, and for a given remuneration performs all the necessary clerical and accounting work. He is the Company Secretary, and as such attends all Directors' Meetings and implements all decisions and performs all such duties commensurate with his office of Secretary of the Company. It is quite common for one professional accountant to serve two or more companies in this way.

The second type is peculiar to larger companies, although professional secretaries serve several medium sized factories. In many companies the Secretary is regarded as an executive officer ranking equally with the Factory Manager. In other companies he is subordinate to the Manager, while in others again he holds the title and rank of Secretary-Manager.

There are 31 companies which engage the services of a professional accountant, while in the rest of the companies, the Secretary is a full-time employee. The description and analysis that follows refers to this latter type of office organisation, except where figures refer to the entire butter industry.

"Administration and Office Expenses": This is the largest item of "General Overheads" and amounts to 4.493 per cent of total manufacturing expenditure, or 52.5 per cent of "General Overheads". It includes administrative salaries not directly appropriated to butter or other activities, office expenses, depreciation and maintenance of office or administrative buildings and equipment insofar as these are chargeable to butter.[3] Commission and fees received from suppliers are deducted as a contra to administration and office expenditure.

The largest item of expenditure is office salaries, which includes the remuneration of the Secretary, the Accountant (where applicable) and general office employees. The extent of the wage-bill depends on the office establishment, which is determined by a number of factors which include:-

1. The number of suppliers. Assuming output constant, the general office routine increases with number of suppliers on a pro-rata basis. Where there are 100 suppliers there will be given a number of daily entries, monthly cheques etc., but where the number of suppliers doubles, viz. 200, then the number of daily entries and monthly payments etc. double also.

2. The output of the factory. Other things being equal, the greater the output the greater the clerical work.

3. The extent of non-butter fat recording and clerical work for suppliers, including stores orders, cash orders given on outside concerns as a charge against the supplier's monthly cheques, advances to suppliers etc. The amount of work involved in this non-butterfat work is considerable and varies from nil in some companies to as much as 75 per cent in one company, where suppliers are largely Maoris.

4. The extent of other activities and auxiliary undertakings that are linked with butter manufacture. These include store-trading, transport operations, miscellaneous milk products including buttermilk powder, veterinary activities and paper and mail deliveries.

A certain amount of clerical and administrative work may be considered as a constant factor, apart from the above four variables. This constant factor includes all returns, monthly statements, and periodic reports and annual accounts, as not affected by volume, number of suppliers and other activities.

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[3] Where a company engages in parallel activities such as butter, cheese, casein and powder etc., administrative and office expenses are apportioned on the basis of time occupied with these various activities.

As scale increases, the amount of administrative work increases. Factory salaries and wages become a considerable item. Staff procurement, housing, duties, superannuation, leave etc., become a fair charge on office time. Larger administrations require to keep personnel cards for each member of the staff; schedule of duties, rosters of duty-hours for those working overtime, on shift basis, or substitutes; leave schedules, details of length of service, qualifications, promotions, medical inspections and other personnel details; group insurance scheme or pensions; records of free produce or subsidised coal, butter, stores, petrol etc; welfare and social committees, consultative committees and information bulletins. Of the larger companies, the following administrative practices were noted:-

Superannuation schemes for office staff:	Three or four instances.
Office Manuals:	Isolated and incomplete cases.
Monthly inventories of coal, containers, wrappers and salt:	Maintained in some, but not all large companies.
Time and motion studies:	Not undertaken by the companies themselves.
Cream collection routes charted:	Generally.
Location of suppliers charted:	Occasionally.
Butter churnings, overrun, fat, moisture, salt and curd tests, poundage manufactured charted:	Recorded but only occasionally charted.
Bacterial counts:	Reported occasionally in some cases.
Hardness of water:	Tested occasionally.
Power, steam and refrigeration costs:	Some daily records, occasionally charted. Only where instrumentation inadequate.

In the largest organisations, administration tends to be departmentalised as follows:[4]

Executives: Managers, Assistant-Managers and Departmental Heads.

Secretary and Assistant Secretary: Share Dept.

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[4]Departmentalization varies according to the company, its branches and activities. The above covers four or five of the largest organizations, but is not intended to be comprehensive. Note that the text says "tends to be".

Accountant and Assistants: Accounts Dept.
Chief Clerk - clerical, correspondence and general.
Internal Audit.
Butterfat Dept.
Deductions Dept.
Staff - Salaries & Wages Dept.
Costing and Statistical Dept.
Stores and Purchases Dept.
Transport Dept.
Subsidiary Activities.
Engineering, Chemists and Research Dept.

Smaller offices were staffed by a Secretary, a senior and a junior girl. Medium-sized offices were headed by the Secretary, an assistant Secretary or Accountant, and three or four girls, two of whom generally did butterfat ledger work and one typing. In larger offices, in addition to the Secretary and the Accountant, there were one or two senior male clerks (responsible for purchasing, orders, transport and statistics) and five or more females.

The quality and efficiency of administrative work usually lay with the Secretary. In 48 companies, the Secretaries were qualified Accountants with Associate or Fellow status in registered or practising affiliations. Nine secretaries were qualified Secretaries, and five had academic qualifications in addition. It was noted that where the Secretary was a qualified Accountant, office work was generally efficient.

Staffing: The following table sets out staffing establishments as related to output, time consumed in non-butterfat clerical work and suppliers.

TABLE XLVIII. STAFFING REQUIRED FOR ADMINISTRATIVE PURPOSES IN 57 COMPANIES*

Output of Company	No. of Coy's.	Average Staffing	Average percent of time devoted to stores orders advances, loans for suppliers %	Average No. of Suppliers
Under 1,000,000	8	2.25	6.5	134
1,000,001 - 2,000,000	15	2.73	27.4	189
2,000,001 - 4,000,000	14	3.89	18.4	374
4,000,001 - 6,000,000	11	4.55	7.3	452
6,000,001 - 10,000,000	6	7.50	15.8	628
Over 10,000,000	3	62.000ø	Unknown	3464

* Where companies were multi-branched, the figures apply to butter branches only.

The staffing varied from 1 to 16 per factory, and the suppliers from 60 to well over a 1,000 per factory. In the first group the maximum number of staff was 3, in the second 4; the third 8; the fourth 6; the fifth 11; and in the last, 16 per factory. In the small companies, staff was increased on account of extra time devoted to store orders, advances and loans granted to suppliers. In the third group staffing tended to increase due to increased suppliers rather than other activities, although these did influence to a degree. In the larger companies, where butterfat per supplier was considerable, the increased staffing was due to general increase in organization, auxiliary activities and diseconomies of scale. It is considered that in terms of total staffing required, the most economical or efficient size is the 4 to 6 million output level.

Where the number of suppliers is fairly constant, the administrative staff employed tends to be constant also, regardless of output. The following list, which applies to companies having from 200 to 300 suppliers, illustrates this point.

ø This figure of 62.0 refers to companies, not factories, and is considerable due to companies in this class-interval having multiple factories. Subsequent data refer to factories only.

Factory	Administrative Staff	Output ('0000 lbs.)
A	3	52
B	3	135
C	3	137
D	3	146
E	2	182
F	4	204
G	4	206
H	2	270
I	2	271
J	3	338
K	3	386
L	3	401

The above list shows that companies with 200 to 300 suppliers require approximately 3 administrative staff. Company F devoted over 50 per cent of time to stores and advances to suppliers, while Company G had one secretary and three young junior girls. Companies H and I had two senior males in each case. Output was of minor importance evidently.

The same tendency is found in the 400 to 600 supplier group:-

Factory	Administrative Staff	Output lbs. (0000's).	Remarks:
A'	5	177	Large store
B'	4	208	
C'	8	351	Loans etc. 60% of time
D'	5	424	
E'	5	454	
F'	5	458	
G'	5	460	
H'	4	494	
I'	5	513	
J'	6	536	
K'	4	568	3 senior males
L'	6	695	
M'	8	702	
N'	6	774	
O'	12	1071	Some store and other activities.

In the above list the administrative staff is again relatively constant, but the tendency is to increase staffing because diseconomies of scale[5] tend to appear.

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5 See p. 244.

These diseconomies of scale tend to increase beyond the 5,000,000 lb. output level; where the increase in staffing due to increase in suppliers, tends to move at the constant rate of one staff required for each 100 suppliers. That is, a company with 300 suppliers requires a staff of 3, one with 600 suppliers requires 6, etc., (other factors held constant). Making due allowance for excessive loans and advances etc., to suppliers and for the fact that companies with few suppliers require a minimum of one for non-butterfat work, it is possible to assess the diseconomies of staffing for scale.

From Table XLVIII, a comparison of the staffing column with the supplier column, reveals that from the 6 million lb. level there tends to be an increase in staff due to diseconomies[5] which increases rapidly when the 10 million output level is reached. The second list on the previous page (p.225) indicates that the excess over 5 administrative staff is due to auxiliary activities and diseconomies of scale in administration as seen in the 12 individual factories with outputs of over 8,000,000 lbs. per annum which have under 600 suppliers and which have an average administrative staff of 9.7. In fact, once the 6,000,000 lb. output level is reached, there appears to be needed one additional staff for each million lbs. of output in addition to the staff required due to number of suppliers.

This is set out in the following formula:-

$$\text{Staffing} = 1 \text{ plus } \frac{\text{Number of suppliers}}{100} \text{ plus } \frac{\text{output} - 6\text{m.}}{1{,}000{,}000}$$ [6]

Thus if a company has 400 suppliers and an output of 7,000,000 lbs., the clerical staff should approximate 1 plus 4 plus 1 = 6. Where suppliers are 750 in number and output is 12.5 million lbs., the clerical staff should approximate 1 plus $7\frac{1}{2}$ plus $6\frac{1}{2}$ = 15. Where the output is 4,000,000 lbs. and suppliers are 800, the clerical staff should approximate 1 plus 8 = 9.

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[5] Diseconomies set in due to added recording, checking and routine statistical work.

[6] This third variable in the formula obviously will only apply when output is in excess of 6 million lbs.

When tested on all companies, practically every one, unless there were some extenuating circumstances, approximated to within 1 of the estimate, the majority coinciding.

Office facilities: In many companies inadequate facilities tended to increase staff requirements and restrict general office efficiency. These facilities, taken on the whole, were just adequate when compared with modern accounting and office facilities of firms of the same size in industry or commerce. Filing systems and record facilities were fair, office furniture, desks, typists requisites were generally sub-standard except in a few isolated cases. Typewriters and accounting aids were usually old and in a number of offices, adding machines were antiquated and clumsy.

The average equipment for an office serving a 5 to 8 million output factory was:

3 typewriters
2 adding machines
2 calculators
1 duplicator
1 addressograph.

Only the largest offices had full accounting machines with analysis registers, and only 1 cheque-writing machine was seen in all offices. Three offices had two dictaphones each, not one had public address system or intercom. system although some had inter-office phones. Franking machines were in use in many large offices, but then there were some large offices without them. On an average, one bookkeeping-machine, adding machine, or calculator was used per 100 suppliers and one typewriter per 200 suppliers. This seemed to apply to most offices regardless of scale.

Analysis of Office Expenses: Office expenses, which varied considerably, were usually analysed under: Office Salaries, Postage and Stationery, Depreciation, Repairs and Maintenance, Power, Light and Heat, Travelling Expenses, and General Expenses: (Printing, Insurance, Rates, Rent, Donations, Annual Licence, Legal Expenses and Sundries such as Cleaning).

Salaries varied from 66 per cent to 75 per cent of total expenditure, with an average of 72 per cent. Postages and Stationery (which included

Telegrams, Toll Calls, Telephone Rentals, and Printing too in some cases), varied from 13 to 21 per cent. Travelling expenses varied from 1 to 8 per cent; Rates, Insurance and Power were about 2 per cent; Depreciation from 2 to 3 per cent; Repairs and Maintenance from 1 to 3 per cent and General Expenses and Sundries from 3 to 8 per cent. The average break-up of expenditure was:

Salaries	72%
Postages and Stationery	17%
Power, Light, Heat, Rates	2%
Depreciation and Repairs	3%
Sundries	6%

The two main items, Salaries, and Postages and Stationery, tend to vary with the number of suppliers rather than with scale, indicating that the number of suppliers is an important determinant in Office Expenditure.

<u>The relationship of Administration and Office Expenses to General Overheads, and General Overheads to Total Costs:</u>

"General Overheads" as shown in the Statutory Accounts, include the following elements of administrative expenditure:-

Administration and Office Expenses.
Directors' Fees and Expenses.
Audit fee.
Interest.
Farm Dairy Instruction.
Dairy Board Levy.

The relationship of these various elements and their place in the pattern of costs will now be examined.

Administration and Office Expenses has been calculated as a percentage of General Overheads for all companies, and also the relationship of General Overheads to Total Costs (minus Cream Collection), in order to determine change with scale, and deviation from class-interval averages.

The range of the ratio: $\frac{\text{Administration etc.}}{\text{General Overheads}}$ lay between 27.76 and 76.71 per cent for all companies. As Farm Dairy Instruction and Dairy Board Levy vary directly with output, this considerable range suggests a marked variance of two items in General Overheads, Directors' Fees and Expenses, and Audit Fees. The relationship of the main cost-ratios for General Overheads are set out in the following table, while those of unit costs will be examined in the succeeding table (No.L.)

TABLE XLIX. RELATIONSHIP OF VARIOUS ADMINISTRATION COST RATIOS.

Output of Company (lbs. of butter)	No. of coys.	General Overheads / Total Costs (av. %)	Administration etc. / General Overheads (av. %)	Directors' Fees etc. / General Overheads (av. %)
Under 1,000,000	29	13	56	12
1,000,001 - 2m.	25	12	55	12
2,000,001 - 4m.	19	12	49	10
4,000,001 - 6m.	13	10	46	11
6,000,001 - 8m.	5	8	34	9
Over 8,000,000	4	7	47	7

It will be observed from Table XLIX. that there is a general reductic in the ratio of General Overheads to Total Costs of manufacture (which excludes cream collection). This is gradual at first, and then the rate of decrease increases with increase in scale. The ratio of Administration expenditure does increase relatively in very large offices.

The way unit costs vary with degree of deviation will be examined in the following table.

TABLE L. RELATIONSHIP OF UNIT COSTS FOR ADMINISTRATION AND OFFICE EXPENSES, DIRECTORS' FEES AND EXPENSES AND AUDIT FOR 95 COMPANIES.

Output of Company (lbs. of butter)	No. of Coys.	Administration etc. d.	Directors' Fees etc. d.	Audit d.	Av. Deviation Admins. Exps. d.
Under 1,000,000	29	0.244	0.051	0.120	0.092
1,000,001 - 2m.	25	0.176	0.037	0.007	0.054
2,000,001 - 4m.	19	0.203	0.035	0.007	0.135
4,000,001 - 6m.	13	0.116	0.025	0.004	0.032
6,000,000 - 8m.	5	0.079	0.015	0.003	0.014
Over 8,000,000	4	0.071	0.012	0.002	0.012

It will be observed that the unit costs for Administration fall and then rise at the 2 to 4 million level output. This is due to the fact that in the first two class-intervals, suppliers are relatively few in number and the administration is undertaken by professional accountant whose charges tend to be less than the expenditure incurred by those companies with their own administrative office. In the third class-interval there are a number of companies that have a large number of small suppliers which add considerably to administrative expenditure.

At the fourth class-interval, unit costs fall with scale steadily until they tend to flatten out for the largest output companies. Unit costs tend to hide general efficiency for administration costs vary with number of suppliers and supplier services rendered as well as scale.

Average deviations also follow the same pattern as unit costs - there is a markel rise in the third class-interval and then a falling off until the largest output company interval is reached. The range of unit costs was from 0.042d. to 0.706d. per lb. B/F., and suggests that in spite of supplier-intensity varying, there is room for improvement in administrative efficiency in a number of companies, especially in the 2 to 4 million output group. (due to increase in "General Expenses").

Directors' Fees and Expenses:

The butter industry was served in the 1949/50 season by some 668 directors serving on the boards of 96 companies, an average of approximately 7 directors per company. The numbers serving various companies are as follows:

No. of Directors on Board	No. of Companies
5	14
6	7
7	59
8	5
9	9
10	1
12	1

The appointment of directors is governed by Company's Articles of Association, which state the number to retire annually. Some companies have two retiring annually, a few one, others three and even four. A few companies draw their directors from wards or districts so, that all suppliers are represented. Appointment of chairmen varies according to the Articles of the Company; some companies appoint a vice-chairman as well.

The functions of Directors are to control, direct and formulate policy within the Objects of the Memorandum of the Company. Most companies have regular monthly meetings at which the Manager's monthly report is received, and business arising therefrom attended to. In addition most companies have special meetings to deliberate upon any special matter of business that arises from time to time.

Directors often specialise in some aspect of the Company's affairs. Two will undertake the financial aspect, another plant and machinery, another buildings, another cream quality and butter manufacture, another transport, another store-trading or other subsidiary activity. Sometimes two or three will form into a committee to report to the board on some matter under consideration. Usually the Chairman and one or more Directors keep in constant touch with the factory manager and are never very far away from the general flow of activities, devoting much time to the Company's affairs.

Details of Directors' attendances revealed that about 60 to 70 per cent of directors attended all meetings, and about 84 per cent attended all but one meeting a year.

Enquiries were made in a broad way as to the vocations of those serving in the capacity of directors, and a broad analysis revealed:[7] -

60 per cent were farmers actively engaged in dairying.
30 per cent were retired dairy farmers, semi-retired, or had sharemilkers.
10 per cent were business men with farming as a secondary interest.

They were men of various ages, usually 40 to 65, but many were in their seventies and a few were in their eighties. Enquiry revealed that in almost every company there were one or two directors that served in similar capacity elsewhere, or took an active interest and participated in other organizations, committees or bodies. They included a sprinkling of councillors on county councils, members of road, drainage, conservation and other

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[7]Every opportunity was made to meet Chairmen and Directors of various companies. A number of special meetings were attended by special request of Chairmen and Managers. In one case after a discussion with one Manager on a Saturday morning, the Chairman arranged a meeting of all Directors later in the afternoon to discuss with the writer a special problem that was peculiar to their company. The fact that all were present, one, at least, travelling over 40 miles to be there, was evidence of the interest some directors take in their company's affairs. In a considerable number of cases the writer met the chairman a few hours after arrival at a factory - the chairman being sufficiently interested to leave other things to discuss the company's affairs.

agricultural and pastoral boards and committees; while quite a number were on school committes and other rural organisations. Their members included a number of accountants, one or two lawyers and other professional personnel.

Approximately £26,250 per annum is paid to Directors for their services, i.e. an average of about £36 per Director. This is made up of travelling expenses and emoluments, the former amounting to about 15 per cent of the total. In smaller companies, a fixed amount per meeting is usually paid directors, but the practice varies. It is worthy of note, that in some companies these services are rendered at a rate which is less than £1 per meeting per director. Fees paid, usually increase with size of company, but as revealed in Table L, there is a marked decline in unit costs with scale. The dispersion of these unit costs ranged from 0.009d. to 0.116d. per lb. B/F., which is considerable, especially as the dispersion was large in all class-intervals, indicating some marked variation from factory to factory in mode and extent of payment of emoluments.

The contribution of the Board of Directors to administrative efficiency is difficult to asses, but reflects itself in managerial efficiency, which probably mirrors fairly accurately that of administration. The following observations are made:-

1. Directors are usually keen, hard-working farmers with a real living interest in the Company's affairs.

2. There was manifested a real desire to improve in efficiency, but not always the preparedness to invest in capital expenditure for the future. This outlook of living in the present and leaving the future to posterity was often noticed.

3. Pay-outs were often maximised at the expense of the immediate future well-being of the Company.[8]

4. It is considered that much benefit would accrue to the industry if Directors met frequently at a national level to get a better perspective of the industry as a whole. Many directors are intensely loyal to, and proud of their own companies but lack grasp of over-all national problems that indirectly affect their companies.

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[8] One example will serve. The writer spent a long time with one director who said he "specialised as a financial advisor". He was pressed as to providing better mechanical facilities (roller-conveyo etc.), but persistently declined saying that this would impair maximum payout. He was quite unable to see the difference between capital and revenue expenditure, but maintained the company could not afford it. This "tight-purse" attitude was found more than once.

Audit Fee: Like Directors' Fees, Audit Fees are allocated usually on the basis of the earnings of various activities. From Table L it will be observed that unit costs fall steadily with scale. The range varies from 0.001d. to 0.027d. per lb. B/F. Actual fees vary from £6. 6.0d., £8. 8.0d., and £10.10.0d., in the smaller companies, up to £100 or more with larger companies.

Auditors usually certify that the Directors' Report and Annual Accounts are in accordance with the Dairy Industry Accounts Regulations and Amendments and exhibit a true and correct view of the Company's affairs, and certify as to overrun and unsalted butter, etc. The following comments are made:-

1. There is little doubts that the audit work[9] has been essentially a verification of vouchers supporting expenditure, plus a certificate that the payout, unit costs, and accounts are in accordance with the Dairy Industry Accounts Regulations 1950, but is is questionable whether the audit goes much beyond this.

2. It was obvious, for example, that the form of the accounts was generally correct and followed the prescribed Schedule, but in some cases this was about all, for the details set out in the Schedule had not been followed carefully:-

   (a) In some instances items had been omitted altogether.

   (b) In other cases, additional items had been added to those set out in the Schedule.

   (c) The balance-sheet, while generally well-drawn up as regards information, had failed in some cases to disclose the basis of valuation of fixed assets, or had lumped realty and plant together as one item. Shares in other companies and investments were occasionally confused.

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[9] In two cases, the accuracy of audit work was questionable. It was obvious from the examination of published accounts that errors had not been detected - errors that could not be excused on the ground of typographical or printer's error. In one case of published accounts of a large company, a sum considerably in excess of the depreciation written off all assets had been charged against one acitivity. There were other cases of computation and extension that had escaped notice. Perhaps they were printer's error, but fortunately so for the company in each case.

(d) The Appropriation Account too, had adequate information, but a number of cases had occurred in which items of expenditure had been permitted to creep into the Appropriation Account which should have been a charge on the Manufacturing Account. From investigation these included:-

(i) Premiums and payments to suppliers from cream deliveries.

(ii) Certain superannuation or pension subsidies which should have been charged to Wages in the Manufacturing Account.

(iii) Items, being discounts, rebates and allowances on purchases.

(iv) Expenditure relative to manager's house.

(v) Certain items claimed as "legal expenditure" which were essentially administrative expenditure.

(vi) Information regarding revenue and payout coming from other processes, were not always disclosed.

(e) In the Manufacturing Account a number of errors were noticed, the main ones being:-

(i) "Materials" often included such items as detergents, chemicals, and other consumable stores.

(ii) Rents, and expenditure on employee's houses. A few cases were noted of charging these to "Wages" or "Cream Collection". On the other hand, upkeep and repairs and maintenance of the Manager's house was often charged to Appropriation incorrectly.

(iii) In one or two cases, Interest chargeable against expenditure found its way into Appropriation Account.

(iv) Few charged free housing, free produce and coal etc. to "wages" account, but either wrote the amounts off through Appropriation or disregarded them.

Some of these errors, perhaps may be overlooked insofar as the Regulations were somewhat new to many Company Secretaries, but they should have been detected and adjusted by the audit as possibly many were. But the main objection to the sufficiency of the audit lies in the following:-

(f) The Schedule and Directions specify the principle of apportionment of given charges or items of expenditure. For example, wages are to apportioned to various products or activities on the basis of time, depreciation is to be allotted to the buildings used in the manufacture of the products to which the expenditure account relates, etc.

It is very unlikely that many audits questioned these apportionments carefully. There were a number of glaring cases where expenditure had been shifted away from the butter manufacturing account to other subsidiary activities. Directors' fees had been charged heavily against auxiliaries such as stores. In one case, 40 per cent of the directors' fees were so charged and yet this activity was very minor one yielding a total turnover equal to about $2\frac{1}{2}$ per cent of the value of butter. Transport costs, Wages, Power, Fuel and Steam, Repairs and Maintenance, Rates and Land-tax, Insurance, Administration and Office Expenses, and especially Depreciation were shifted, in some cases extensively.

In the light of this, it is doubtful whether the term "Efficiency" can be applied to all audits. Some clearly were carried out conscientiously and well, others moderately well, but others again left much to be desired.[10] Little need be said as to certain accounts including costs applicable to other activities such as market milk and cream sales, or the omissions from statistics, or that the butterfat as given in the manufacturing account included fat sold in other activities accounts - these faults were there, and should have been adjusted had the auditor actually carried out what he had claimed in his certificate at the foot of the published accounts.

While the accounting practice as laid down in the Statutory Regulations, and therefore Administrative Expenditure, make for efficiency, it is clear that Auditors, do not, in some cases, press for conformity, but permit accounting practices which make for, or conceal inefficiency, or condone malpractice. Thus audit has a real, if indirect bearing on administrative efficiency.

Miscellaneous General Overheads: These include Interest, Farm Dairy Instruction and Dairy Board Levy. The Dairy Board Levy is on a B/F basis and the Farm Dairy Instruction is charged on a butterfat basis plus a supplier

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[10] A number of instances of charging capital items against revenue expenditure and vice versa were noted. One Secretary of an influential company questioned the writer as to his links or affiliations with Dairy Boards, Commission, State Dept., etc., and when satisfied that there was little likelihood of individual disclosure, openly boasted that he "got away" with not charging some thousands of pounds per year to butter manufacturing, and gave examples to substantiate his remarks, adding that audit did not probe in that direction.

charge of 6/- per supplier, so that the Dairy Board Levy unit cost tends to be constant, while that of the F.D.I. varies with number of suppliers. No further comment need be made.

The item "Interest" refers to interest on Current Account charged on bank accommodation for over-draft, insofar as it applies to the manufacturing and marketing of butter. The very fact that the Current Account refers to the entire activities of the company and cannot be segregated against any activity with any degree of precision, need not be elaborated, but it is recognised, for all cheques drawn on the company's account are usually either payments to suppliers or items of capital or revenue expenditure which may or may not be considered applicable to butter.

Some 48 companies charged manufacture with interest, and the range of unit costs lay between zero and 0.223d. per lb. B/F. The range of unit costs varied both with scale and districts. Almost all small companies used bank accommodation but not extensively. Unit costs tended to decrease until the 5,000,000 lb. output level was reached at which point several companies obviously utilised bank accommodation for asset procurement. The largest companies, on the other hand, hardly used overdrafts at all. Examined geographically, South Auckland, Bay of Plenty and Taranaki used little to none, whilst North Auckland, Hawkes Bay, Wellington and South Island made extensive use of it.

SECTION III. CAPITAL EFFICIENCY

INTRODUCTION: By capital efficiency is meant the effectiveness of the outlay during the year of Shareholders' Funds as investment in fixed assets, or replacement or renewal of fixed assets, or provision for replacement, acquisition or improvement of fixed assets, in terms of their relative earning capacity.[11]

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[11] Earning capacity has both a short-run and a long-run aspect, for funds may be utilised effectively for a short-run (viz. the season under review) but when considered over a number of years are inefficient in that the fixed asset stability is impaired and inadequate for its purpose. "Effectiveness" refers to the extent to which payout can be maximised subject to the maintenance of an appropriate level of liquidity.

The outlay of Shareholders' Funds refers to (a) the actual schedule of fixed assets at any given moment, as a limiting factor on the operational efficiency of the concern - such fixed assets being the result of outlay of Shareholders' Funds in the recent or remote past; (b) current outlay during the year in respect of the addition, replacement or renewal of physical assets related to the efficiency of operations both current and prospective; and (c) the present extent of liquidity as determined by indebtedness, interest-bearing obligations, liquid investments or resources, and other claims owing to, or by the company.

The test of capital efficiency, is the effectiveness of earning capacity with reference to total Shareholders' Funds existing at the time, and the precautions taken against probable but uncertain conjunctures.

The short-term measure of capital efficiency may be indicated by a number of ratios such as Shareholders' Funds to Output of Butter to Total Payouts and Appropriations, Shareholders' Funds per supplier or per lb. of B/F, or Liquidity Ratios. But the long-term measure of capital efficiency is that of long-term financial stability, which is indicated by the Shareholders' Funds relative to Total Assets. The ultimate test, of course, is usually revealed in winding-up, which may occur during depression; or when the company is being reconstructed, or during amalgamation.

Considered along with, and implicit to capital efficiency, is financial stability. Here, the dairy company structurally, being co-operative in character, differs from the ordinary trading concern in two main respects; (a) in that liquid assets held relative to total assets are small in proportion, for a manufacturing dairy company can usually obtain its requisite immediate liquid resources by way of bank accommodation as there are no trading risks involved; and (b), the structure of reserves, appropriations and liquid assets differ from ordinary trading companies as dairy companies are not liable for income-tax assessment except on trading activities.

This section, however, will be confined to description and analysis of certain fixed assets to determine the degree of their utilization, capacity and limitations. Section IV. will examine the nature and efficiency of capital outlay and Shareholders' Funds in terms of their relative earning capacities as disclosed in the Balance Sheet. Both Sections III. and IV. are separate aspects of capital efficiency; the former emphasizes capacity, Descriptive: Some of the essential assets have already been dealt with, such as vehicles for cream-collection. This portion will deal with those assets such as land and buildings, and plant and equipment relative to butter production. It will not attempt to describe auxiliary assets or discuss technical essentials and necessary sundry plant and equipment.

Buildings and Environment: Most buildings were well-placed as regards facilities, such as access to main highways and rail-sidings, power, contour for drainage, and water supply. Most factories had tar-sealed roads skirting their boundaries, but only the larger ones had substantial tar-sealed driveways in. Too many had a shingle or metal surface which tended to pulverise and give rise to dust-laded atmosphere, especially during arrival of cream during cream reception. Some factories compromised by having concrete or sealed loading bays near reception stage, but with metal roads from main road to the factory itself. Nicely laid out lawns and gardens were rare with all but a few large companies, with one or two exceptions where the environmental influence of a carefully planned landscape gave a pleasing sense of efficiency in smaller companies. A few factories had cattle-stops, a sweeping drive-in, which was tarsealed, bordered with shrubs and lawns laid out with interspersed flowers.

The paths within the location of the factory were generally absent. Usually they consisted of metal, dust or ash, and rarely concrete or asphalt was seen. Those that did exist were seldom in good repair, but more often than not, they were non-existent. One or two factories had full-time gardeners, and others utilised the part-time service of general hands. In one case the lorry-drivers assisted in grounds maintenance.

The buildings varied. The first general appearance of each factory was noted, and classified as clean, moderately clean or dirty; paint-work as good, moderate or poor, and buildings as compact, average or straggling; and design modern, average or old. Also the type of design was noted, type of construction and materials, its approximate age was ascertained, and the architect, if known.

It was found that buildings fell into two or three broad categories regardless of scale or environment. The first was the old, small building erected many years with poor approaches, patchy concrete-work, inadequate ventilation and lighting, and generally inadequate space for the various processes inside. These were mostly timber, with brick and concrete additions, and were only moderately clean. Paint-work was poor outside and average inside, water tended to lie in the floor hollows, buildings were straggling, and boiler-houses dirty. There were 19 of these of which 10 were small, six moderate and three relatively large factories. Another four or five factories, although old, were very well kept, spotless inside, average outside, but still poorly served for light, cleaning and general organisation. It was difficult to plan for operational efficiency in this type of factory.

The second category was the reinforced building, compact in design, moderately clean inside as regards internal protection and paint-work, architectually-built, with compact unloading stages, and incorporated cool-store, laboratory and testing room, factory office, and switch control room (in larger factories). They were well set out with suitably graded floors for cleaning, metal-framed windows and well-finished concrete work. Control and supervision was facilitated by design which permitted co-ordination of functions with minimum of movement, avoiding at the same time congestion. This type of building, which covered all sizes of factory from small to large, was generally clean and well maintained inside, and accounts for the majority of main factory buildings in New Zealand - about 75 per cent.

The real test of cleanliness was usually had from one good look at the waste disposal facilities and boiler house. Many of the waste-disposal facilities were poor, odoriferous, and lacked care and attention. It was observed that where the environment was an object of care, the waste disposal and coal handling facilities were also well-maintained, and the standard of maintenance and upkeep of buildings very high indeed. Under conditions of shortage of labour and long hours in summer, some factories are a credit to their managers.

Many of this category of factories, however, had a number of additional buildings, which obviously were erected as an afterthought to the main building, due to the need for more steam for auxiliary activities. Most companies were equipped with the following auxiliary buildings:-

Administrative block.
Store, shop or trading department.
Truck and vehicle garage and workshop.
Additional or auxiliary boiler house.
Laboratory.
Ablution and toilet block.

Larger concerns had in addition, electrical stand-by plant, workmen's quarters and shower block, staff recreation room, dining room and fire-fighting facilities.

Finally, there was the modern to ultra-modern factory with its concealed conduits, pipes and equipment and tiled walls and floors. Replacement of buildings are taking place in a number of companies which are installing modern equipment and facilities. These include steel-framed glass inset windows, glass bricks, corners eliminated to prevent condensation, cambered tiled or clinkered floors, mechanical ventilation with air conditioning and humidity control, ample fluorescent illumination, varied colouring on inside walls, artificially controlled heating and fully concealed conduits - cream, steam, water and electrical.

Internally, the main factory building varies both in design and according to the percentage of floor area devoted to various processes. Most factories are provided with separate store-rooms for packing materials, salt and parchment etc., a separate laboratory and testing room, a switch control room, a factory office, separate refrigeration room and staff toilet facilities, and often a dining room.

Although the main operative part of the factory is usually kept spotless, the carton-making room, store room, and often the staff room, left much to be desired. In over 70 per cent of the factories the carton-making room was untidy, dirty and littered. In a few well-controlled factories, however, it was a pleasure to observe the scrupulous care accorded the tidiness of this part of the factory.

Allocation of floor area: More noticeable was the variation in the percentage devoted to floor area for various processes. In 14 factories it was possible to obtain reliable data as to functional floor area divisions:-

The following table sets out the variation in floor space devoted to various processes.

TABLE LI. VARIATIONS IN PERCENTAGES OF FLOOR AREA ALLOTTED TO VARIOUS FUNCTIONS IN 14 FACTORIES

Function	Min. per cent	Max. per cent	Av. Deviation %*
Cream reception	9.8	20.3	4.5
Processing	21.2	40.1	8.7
Packing butter	6.9	23.7	9.0
Boiler room	7.1	18.2	3.1
Cool stores	4.9	9.2	1.2
Refrig. equipment	4.8	9.0	1.1
Bulk store	4.1	17.4	7.1
Administration	0.4	13.0	5.0
Miscellaneous	1.2	6.0	-

In the above table which refers to factories of medium output range, processing included churning which varied from 9.2 to 23.2 per cent of total space. Miscellaneous space included test rooms, toilet, and eating rooms. Other factories varied more than those examined in Table LI, but the above variations indicate that capital is not being utilised most effectively as regards building space. Otherwise the deviations would have been much less. Output had little effect on the relative percentages devoted, but floor area per lb. of butter fell considerably with scale of production.

Plant and Equipment: Like buildings, plant and equipment tend to be relatively old, of moderate age, or new, but not to the same degree as buildings. It was observed that where buildings were old, plant also was old-fashioned, and recent labour-saving devices were infrequent.

It is not possible to enter in detail into exact range of plant, as machines vary, and a fair part of the cost is in installation and fittings that are inseparable from the plant itself. All major items of plant and thei capacities were noted, for it is the range of capacities that throw most light on plant efficiency from the point of view of capital utilization.

Details of boiler capacities have been given in "Power Efficiency", Part IV of this study. Boilers tend to be the oldest part of power and heating equipment, and while the boilers themselves were still in working condition, the boiler fixtures, brickwork etc., often were in disrepair. Modern boilers invariably had mechanical stokers, but some older plants were hand fed still. Some water softeners were installed, and other accessories were generally available but too many factories were ill-equipped for coal-handling equipment.

* i.e. % of Per cents.

Cream-stage equipment varied with age of factory generally. Dial cream scales were usually modern types and well-kept, as were the neutralising vats. Cabinets for holding cream composite samples varied greatly from crude wall-cabinet types to cleverly-designed mobile multi-tray revolving types that minimised work. Booking-in desks varied and many obsolete types were noted. Larger factories sometimes had booking offices.

Can-washers varied from manual tubs to fully mechanised straight-through washers. Many relatively large factories were equipped with rotary-can washers, most of which were reported to be substandard as regards efficiency by the managers concerned. It is considered that can-washing equipment is one part of cream reception in which efficiency varies considerably as regards time-consumption, steam-consumption, space allocation and capital utilization. Many hold-ups in flow through of cream reception were due to break-down in the can-washing equipment.

The utilization of roller conveyors in cream reception varied greatly. Some moderately-large factories had none at all, and many smaller factories could have used them to advantage. Generally they were set too low for maximum efficiency.

It is considered that stage equipment could be improved by further utilization of:-

(a) higher roller conveyors,
(b) more automatic through-can washers,
(c) mobile quality cream-sample holders,
(d) automatic weighing machines giving verified weights, and
(e) in larger factories - mechanical can-tippers, and machine-recording for cream and can weights.

Refrigeration units varied considerably with type and age of factory and motive power. The 2 to 4 million lb. output factory invariably had compressors to yield 20 tons of refrigeration and atmospheric condensors in two or more stands, or shell and tube condensors. The atmospheric condensors were usually relatively untidy in appearance owing largely to their method of operation. Other standard equipment included oil-traps, non-condensable gas extractors, expansion headers, return headers and an automatic unit cooler and evaporator for the butter cool room.

Pasteurization equipment varied according to scale or output and district. In the small output factory the stainless steel-lined Flash Pasteuriser was extensively used on the two-stage method; in larger factories, vacreators were being used extensively; whilst many medium-sized factories used flash pasteurization together with the deodorizing leg of the vacreator. Plate pasteurisers were also used, although in some factories as a cooling device only. Stainless steel water coolers, usually of the external type water cooler were employed extensively, and in the older type of factory these coolers were not always adequately protected from dust, draught and light. Direct expansion coolers, or ammonia internal tube cooler were used, also pre-heating and cooling equipment. Cream holding vats were generally the stainless-steel cylindrical direct-expansion types with mechanical agitators, but older or small factories are still equipped with oblong vats with hand stirring devices. In addition to pasteurizing and cooling equipment, is a considerable amount of auxiliary equipment such as centrifugal water pumps, rotary cream pumps, pipe spreaders, sterilisers, piping, electric motors, wash-up tubs, acidometers and neutraliser weighing scales and sundry instruments.

In the butter-room, two or more internal worker churns of a given box-capacity was the usual churn equipment, together with cream rotary pumps, butter unloading trolleys, winches, butter tables, buttermilk pumps, block butter moulders, butter scales, patting and wrapping machines, salt-crushers and sundry equipment.

Other miscellaneous equipment included checking scales, moisture scales, salt testing outfit and electric hot plate for moisture testing, carton moulding machines, tape-holders and measurers, test-room, equipment, workshop facilities equipped for all sundry mechanical repairs, and waste disposal equipment.

The above plant and equipment has been enumerated briefly, as capital efficiency is partly the outcome of expenditure in the past, wise decisions and adequate provision both for replacement, and technical advance in processing and manufacture.

Churn and Holding Vat Capacities: The adequacy and efficiency of expenditure of plant can be gauged partly by a comparison of relative capacities of major units of plant as under-capacity or over-capacity reflects uneconomic utilization of fixed assets. A factory with an output of 2 to 3 million lbs. butter could be expected, for example, to be equipped with a 60 H.P. boiler, a 20 ton capacity refrigeration plant, 5,000 gallon capacity holding vats, and 130 box-capacity churns.

But in a large number of cases, factories with double output or more, have no greater capacity than that noted as average capacity for a 2 to 3 million lb. output factory. Conversely, factories with less than one million lb. output sometimes have a greater capacity than that noted above. These varying capacities are probably the outcome of decisions made in pre-zoning days when directors acting on the best advice available made decisions about plant capacity having in mind expansion through time. Under-capacity plant is most likely the result of growth of dairying in the district, amalgamations, zoning, and the utilization of cream as a by-product from other plants, or a change from whole milk supply to cream. Over-capacity, likewise, may be the outcome of optimistic decision which may be more or less realized in years to come, zoning regulations, swing away from cream or dairying, or growing demand for whole milk in rapidly growing urban areas.

The following figures illustrate how far under and over-capacity of plant exist, as revealed by an examination of churn and holding vat capacities

TABLE LII. PLANT CAPACITIES OF CHURNS AND HOLDING VATS OF 92 FACTORIES.

Output of Factory (lbs. of butter)	No. in class interval	Churns (Box capacity)				Holding Vats (Gallons)			
		Min.	Max.	Av.	Av. Dev.	Min.	Max.	Av.	Av. Dev.
Under 1,000,000	20	40	115	65	20.8	600	3500	1710	725
1,000,001 - 2,000,000	22	50	165	107	14.6	1500	5500	2900	880
2,000,001 - 4,000,000	19	105	200	155	25.8	2000	7000	4400	1210
4,000,001 - 6,000,000	15	150	230	191	16.7	4500	8000	6670	900
6,000,001 - 10,000,000	10	240	460	307	40.2	5500	12000	8670	1280
Over 10,000,000	6	250	460	359	50.0	4000	17000	10000	3400

The range of each class-interval can be obtained readily from the minimum and maximum figures in the above table. The two significant columns are the average, and the average deviation for both churns and holding vats. Only those churns in use were included - those discarded,(although still connected up by power), were not included.

Although the average deviation of the churn capacities increase absolutely with scale, they need to be compared relatively, i.e. as a percentage of average capacity. Thus the average deviation of the first-class interval is 33 per cent of the average capacity, and in the subsequent class-intervals the corresponding relative percentages are; 14, 17, 9, 13 and 14 per cent respectively. Although the range of each class-interval increases absolutely, it would appear from these relative percentages that the 4 to 6 million class interval is the most efficient in terms of dispersion of capital utilization for churn capacities.

The absolute average deviations for holding vats vary considerably, and show greater deviations than the churns. The corresponding relative percentages for holding vats for the class-intervals in terms of increasing scale are; 42, 30, 28, 13, 15 and 34 per cent respectively. Again, the 4 - 6 million class-interval is the most efficient in terms of dispersion of capital utilization.

There is a distinct relationship between churn capacity and holding vat capacity. While the number of churnings per day affect this relationship, and the segregation of different qualities of cream also is a factor, there remains a direct relationship between these two main items of capital expenditure. While under or over-capacity can be attributed to growth and other exogenous causes, any marked deviation between churn capacity and holding vats are strictly endogenous in character and reflect immediately on capital efficiency, for such deviations are prime measures of under- or over-capacity arising from administrative miscalculations.

The following figures illustrate churn capacities related to holding vats:-

Illustration A: Where 50 box churn capacity existed, the following were the holding vat capacities:-

Case A	800 gallons
B	1,500 "
C	1,100 "
D	2,000 "
E	2,000 "
F	2,000 "
G	1,800 "
H	3,000 "

Illustration B: Where 100 box churn capacity existed, the following were the holding vat capacities:-

Case A	2,000 gallons
B	2,000 "
C	1,650 "
D	3,000 "
E	3,000 "
F	4,000 "
G	2,000 "

Illustration C: Where 165 box churn capacity existed, the following were the holding vat capacities:-

Case A	4,000 gallons
B	3,000 "
C	2,500 "
D	2,500 "
E	3,000 "
F	5,700 "
G	4,000 "
H	4,000 "
I	5,900 "
J	6,000 "

In the above illustrations, factories are ranked in order of output in each case, and include all factories in that respective category. The marked disparity is noted in each case between the minimum and maximum holding vat capacities.

Avoiding reference to monetary costs in the meantime, the following table will show the affect of scale on the relationship of average churn capacities and holding vat capacities to output, and also churn and holding vat capacities in relation to each other.

TABLE LIII. RELATIONSHIP OF CHURN AND HOLDING VAT CAPACITIES TO OUTPUT

put of Factory s.) (1)	No. of Factories in class Interval (2)	Ave. Output of class-interval ('000lbs) (3)	Ave. Churn Capacity (boxes) (4)	Churn Cap. / Output (5)	Ave. Vat. capacity (gall's) (6)	H.Vat.Cap. / Output (7)	H.Vat to churn rat (8)
er 1,000,000	20	630	65	1.03	1,710	27.1	26.3
00,001 - 2m.	22	1461	107	0.75	2,900	19.8	27.1
00,001 - 4m.	19	2821	155	0.55	4,400	15.6	28.4
00,001 - 6m.	15	4702	191	0.41	6,670	14.2	34.9
00,001 - 8m.	6	7050	280	0.40	8,000	11.3	25.0
00,001 - 10m.	4	9223	349	0.38	10,000	10.9	28.6
r 10,000,000	6	12473	360	0.29	10,500	8.4	29.2

In the above table, columns (1), (2), (4) and (6) are similar to those of Table LII, only the class-intervals are a little different in the large output factories, for relative increases were no longer being considered. Column (5) is computed from the ratio $\frac{\text{Column (4)} \times 10}{\text{Column (3)}}$, and represents the relationship of churn capacity to output of butter. Column (7) is computed from the ratio $\frac{\text{Column (6)}}{\text{Column (3)}}$, and represents the relationship of holding vat capacity to output. Column (8) is the ratio $\frac{\text{Column (6)}}{\text{Column (4)}}$, and represents the degree to which two variables, which should be constant, diverge on the average for each class interval. The churn/output ratios (in box capacity) decrease with scale, indicating that probably multi-churnings per churn are taking place each day, especially in those factories with more than 10 million lbs. output. Multi-churnings illustrate how plant capacity saturation point is postponed. The holding-vat/output ratios (in gallon capacity) also decrease with scale at approximately the same relative rate as the churn ratios.

Boiler and Refrigeration Capacities: In the same way, data were obtained for boiler capacity and refrigeration capacity, to determine the extent of capital outlay and economy in physical unit terms. These relationships are analysed below.[12]

[12] This has been analysed in Part IV, "Power Efficiency", where butter output relative to Boiler H.P. was converted into "Boiler Co-efficients".

TABLE LIV. RELATIONSHIP OF BOILER AND REFRIGERATION CAPACITIES TO OUTPUT

Output of Factory (lbs. of butter)	No. of Factories in class interval	Av. Output of class interval ('000lbs)	Boiler Capacity			Boiler Cap. Output	Refrigeration capacity			Refrig.Cap. Output
			Min. HP.	Max. HP.	Ave.		Min.	Max.	Ave.	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Under 1,000,000	22	566	12	50	26	0.46	2	10	5	0.90
1,000,001 - 2m.	22	1550	15	80	40	0.26	4	15	10	0.64
2,000,001 - 4m.	18	2772	15	100	44	0.16	4½	35	16	0.57
4,000,001 - 6m.	14	4535	18	130	77	0.17	7	40	20	0.44
Over 6,000,000	11	7940	52	300	147	0.18	9	66	30	0.37

This above table was drawn from individual factory figures, care being taken to exclude boiler capacity utilised for buttermilk powder. However, boiler capacity was not excluded where steam was used as motive power. Refrigeration capacity was drawn from figures submitted by managers and compared with other returns submitted by factories.

Column (6) indicates the average boiler capacity for each class-interval and column (10) the average refrigeration capacity. Columns (4), (5), (8) and (9) show minimum and maximum capacities for boilers and refrigeration plants respectively. Column (7) is computed from the ratio $\frac{\text{Column (6)}}{\text{Column (3)}} \times 10$ and represents the relationship of boiler capacity to output. Similarly, Column (11) is computed from the ratio $\frac{\text{Column (10)}}{\text{Column (3)}} \times 100$ and represents the relationship of refrigeration capacity to output. It will be observed that boiler unit capital outlay decreases with scale and then slightly increases after the 4 million output mark, while refrigeration unit capital outlay decreases uniformly with scale.

Capital outlay expenditure falls steadily with scale too, due to what is commonly known as the "law of increasing returns" which arises from technological advantages of increased capacity, and the relative gain in terms of cost due to increased capacity of machines costing more, but at a diminishing unit rate.[13] Tables LIII and LIV have eliminated this monetary

[13] That is, a 60 H.P. boiler does not cost twice a 30 H.P. boiler, nor does a 12 ton-ice refrigeration plant cost twice a 6 ton-ice plant. But the average boiler capacity of 40 H.P. is serving an output of 1.5 millions (2nd class-interval of Table LIV), whereas only 77 H.P. is required to serve an output three times as large in the 4th class-interval - monetary considerations aside.

cost to focus attention on administrative efficiency in terms of capital utilization.

It is considered that present capital expenditure efficiency could be increased by more careful outlay on buildings, plant and equipment by minimising over and under-capacities and regulating them to a planned anticipated future output.

SECTION IV. THE DAIRY COMPANY BALANCE SHEET

INTRODUCTION: The Balance Sheet brings together the total assets and liabilities of the Company, to reveal the extent of the Shareholders' Funds. It is a statement of the nett worth of the Company, and reveals a detailed schedule of liquid resources, present and future obligations and claims, fixed outlays, and provision for future asset acquisition.

The purpose of the examination which follows, is to disclose the effectiveness of capital outlay in terms of relative earning capacity, (output) for the current period, and the provision made for future asset acquirement or replacement.

Structure: On the Assets side of the Balance Sheet the following elements are usually shown:

Liquid Assets:	Cash and Sundry Debtors.
Current Assets:	Stocks of butter, manufacturing materials, consumable stores and trading stocks.
Investments:	Reserve or surplus funds utilised as interest-earning liquid resources.
Fixed Assets:	Shares in other companies. These are holdings in service or supply organisations correlative to the company's activities and would not be realised except in winding-up. Land and Buildings. Plant and Equipment.
Intangible Assets:	Goodwill.

Of these, liquid assets, current assets and investments are generally grouped together to form CURRENT ASSETS, as distinct from FIXED ASSETS which would include Goodwill, a minor item which should arise from trading goodwill and store-trading rather than butter manufacture.

On the Liabilities side of the Balance Sheet the following elements are usually shown:

Current Liabilities:	Bank overdraft. Sundry Creditors. Payments due to suppliers for final month. Proposed appropriations for final payments to suppliers and other provisions such as income tax etc.
Fixed-term Liabilities:	Debentures and Mortgages, which do not have to be met yet.
Shareholders' Funds:	Paid-up Capital. Reserves. Appropriation Account.

Consolidated Balance Sheets: It is not easy to analyse all the individual items of each company's balance sheet. Many companies, especially the larger ones, have composite statements of all their activities including cheese, powder and other activities. It will be necessary therefore for the purpose of completeness, to examine a consolidated balance-sheet of all companies,* compared with all companies excluding one large multi-branch company, in order to gain a relative assessment of capital structure of all companies with total assets not exceeding £400,000. Then a consolidated balance-sheet of 85 dairy companies specialising in butter-manufacture with auxiliary activities included (but excluding correlative activities such as cheese, casein, whole-milk powders etc.) will be examined and compared with the other two consolidated balance sheets.

In the 'A' section of this Consolidated Balance Sheet, the Current Assets as a percentage of Current Liabilities is 98 per cent. There is no Working Capital (as is usually found in ordinary trading concerns, but an Asset Deficit which is diminished by Investments but increased by Fixed Term Liabilities).

*i.e. All companies manufacturing all dairy products.

TABLE LV.* COMPARATIVE CONSOLIDATED BALANCE-SHEET FOR THE CO-OP. DAIRY INDUSTRY, 1949/50 SEASON.

	A: ALL CO-OPS. MANUFACTURING ALL DAIRY PRODUCTS.		B: ALL CO-OPS WITH CAPITAL UNDER £400,000 MANUFACTURING ALL DAIRY PRODUCTS	
CURRENT ASSETS:				
Cash in hand and at bank		£3,949,284		2,458,825
Sundry Debtors		1,807,727		1,461,227
Stocks: Butter, cheese, etc.	1,146,836		779,745	
Materials & Con.Stores	943,206		501,474	
Trading Stocks etc.	486,270	2,576,312	451,340	1,732,559
TOTAL CURRENT ASSETS:		8,333,323		5,652,611
LESS Current Liabilities:				
Bank Overdraft	422,799		422,799	
Sundry Creditors	777,985		708,900	
Due to suppliers final month	805,801		628,945	
Final payments to suppliers	6,404,387		4,384,071	
Other appropriations	75,673	8,486,645	75,673	6,220,388
DEFICIT OF CURRENT ASSETS OVER CURRENT LIABILITIES:	153,322			567,777
Offset by Investments	134,147			132,607
	19,175			435,170
Increased by Fixed-Term Liabilities	450,585			355,130
TOTAL DEFICIT:	£469,760			£790,300
PLUS FIXED ASSETS: Share in other Coys.	1,269,293		857,838	
Land & Bldgs. Plant & Equipment	6,713,645		4,083,577	
Goodwill	29,404	8,012,342	29,404	4,970,819
TOTAL NETT ASSETS:		£7,542,582		£4,180,519
These are REPRESENTED BY SHAREHOLDERS' FUNDS as follows:				
Shareholders' Funds:				
Paid-Up Capital	3,787,277		2,441,529	
Reserves	3,594,536		1,578,221	
Appropriation	160,769	£7,542,582	160,769	£4,180,519

* Data adapted from unpublished N. Z. Dairy Board Statistics and Company Balance Sheets.

The effect of removing one diversified organisation from the Consolidated Balance-Sheet is important for it shows the dairy industry in its true proportions apart from the mitigating effect of that influence. In the 'B' portion of Table LV, the Current Assets were 91 per cent of Current Liabilities - (previously the percentage was 98). The deficit moreover has increased to over half a million. The influence of other manufactures except butter will now be removed in the following table:-

TABLE LVI. CONSOLIDATED BALANCE SHEET FOR 1949/50 FOR 85 CO-OP DAIRY COMPANIES MANUFACTURING CREAMERY BUTTER

CURRENT ASSETS:		
Cash in hand and at bank		1,398,100
Sundry Debtors		1,057,834
Stocks: Butter	381,748	
Materials & Con.stores	230,328	
Trading stocks etc.	388,966	1,001,042
TOTAL CURRENT ASSETS:		3,506,976
Less Current Liabilities:		
Bank Overdraft	350,148	
Sundry Creditors	536,925	
Due to suppliers final month	347,264	
Final payments to suppliers	2,699,389	
Other appropriations	48,471	3,982,197
Deficit of Current Assets over:		
Current Liabilities	475,221	
Offset by Investments	103,263	371,958
Increased by Fixed-Term Liabilities		174,093
TOTAL DEFICIT:		£546,051
Plus FIXED ASSETS:		
Shares in other Coys.	402,423	
Land,Bldgs.,Plant & Equipment	2,368,443	
Goodwill	15,154	2,786,020
TOTAL NETT ASSETS:		£2,239,969
These are represented by Shareholders' Funds as follows;		
SHAREHOLDERS' FUNDS:		
Paid-Up Capital	1,354,192	
Reserves	776,437	
Appropriation A/c.	109,340	
		£2,239,969

In Table LVI, the influence of other dairy companies not manufacturing butter were excluded, and it will be observed that the Current Assets were only 88 per cent of Current Liabilities. The Total Deficit has increased relatively being 24 per cent of Total Nett Assets (or Shareholders' Funds), whereas in Portion B of Table LV, the Total Deficit was 19 per cent and in Portion A only 6 per cent. That is, the butter industry is in a relatively worse position financially (1950) than the entire dairy manufacturing industry, for it would appear that other dairy products and diversified organisations tend to mitigate the severity of the position. The position of the butter industry will now be examined further.

The Current Assets minus the Current Liabilities denotes the Working Capital of the Industry, which is negative in the case of the butter industry, being a deficit. The Current Ratio,[14] which is less than unity (0.88), is a prime test of measure of solvency and indicates short-term financial instability. This is the outcome partly of drawingheavily on bank accommodation, knowing that being a non-trading concern, advances will be more readily accorded a co-operative where trading risks are a minimum factor. But as the Bank Overdraft is only 25 per cent of Total Cash at Bank, (it must be remembered that we are examining a composite balance sheet in which some companies have overdrafts and others substantial cash resources at the bank), there are obviously other causes of the relative short-term instability of the butter industry. These causes will become apparent from further analysis and examination of Table LVI.

Long-Run Financial Stability: The financial stability of the industry in the long-run will now be examined. The significance of long-run stability lies in the capacity of the company to meet probable or uncertain conjunctures, or

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[14] The current ratio is found from the ratio $\frac{\text{Current Assets}}{\text{Current Liabilities}}$. The banker's so-called "acid test" is the Liquidity Ratio which is found from $\frac{\text{Current Assets minus Stock}}{\text{Current Liabilities minus Overdraft}}$. This is even worse, being only 0.69.

finance asset replacements or additions. This stability can be achieved by building up liquid reserves. One indicator of long-term financial stability is the Proprietary Ratio which is found from $\frac{\text{Total Shareholders' Funds}}{\text{Total Assets}}$. The greater the ratio the more stable the long-term position tends to be within certain limits,[15] for it indicates the magnitude of potential resources especially where the Reserves plus Undistributed Funds form a large percentage of the Shareholders' Funds. The greater the Reserves and Undistributed Funds, the less has been the tendency to distribute to the maximum, profits or surpluses appearing in the Appropriation Account. Linked with long-term stability is the question of under-capitalization. In under-capitalization, the capital is disproportionate to its operations and the Proprietary Ratio is low as a consequence, and immediate liquid resources are scarce. Trade Creditors and borrowings and sums due to suppliers are relatively high to capital, capital is generally insufficient, there is usually difficulty in acquiring or replacing fixed assets, the Current Ratio is low, but returns per share are high.

In the butter industry, the Current Ratio is 0.88, the Liquidity Ratio is 0.69, the Proprietary Ratio 0.35, the Fixed Assets To Shareholders' Funds is 1.24 (indicating by its excess over unity that the industry is dependent on outside Creditors for finance and too much is financed by current liabilities), and the payments to suppliers due are 2.25 of the paid-up capital. These figures all tend to indicate a state of long-term instability and under-capitalization which mark the industry as a whole.

Being co-operative in character, it is important to see that this state may not be as serious as in a trading concern, because liabilities include sums owing to shareholders (suppliers), as well as to external creditors. The Liability Ratio which is measured by $\frac{\text{External Liabilities}}{\text{Shareholders' Funds}}$ is 0.395 for current external liabilities and 0.442 for total external liabilities. This tends to mitigate a little what would otherwise appear to be a serious financial position.

Short-term liquidity: Day-to-day funds are required to effect payments to suppliers, meet creditors' claims for supplies or services rendered, and to meet orders drawn on the Company by suppliers. Demand for cash, when plotted

[15] These limits refer to a degree of under-capitalization and liquidity.

in a time series, reveals recurring monthly peaks with one abnormal peak at the time of final payment to suppliers.

Immediately available liquidity is important to the smooth internal running of the organization, to promote general confidence of the credit-worthiness of the company, and to enable the purchasing department to obtain maximum cash discounts or incentive quantity discounts. Lack of liquidity arises generally from over-trading in auxiliary activities, and financing fixed assets by overdraft finance.

The use of Index Numbers will be used to review short-term liquidity. Taking Shareholders' Funds (that is, Total Nett Assets) as an index of 100, the current assets and liabilities of Table LVI are shown in the form of index relatives below:

Current Liabilities	(Index Relatives)	Current Assets	(Ind.Rel.)
Due to Suppliers (final month)	15	Immediate cash	47
Suppliers' final payments	120	Sundry Debtors (deferred cash)	47
		Butter stocks (deferred cash)	17
		Liquid asset deficit	24
	135		135
Liquid asset deficit	24	Materials & Con.stores	10
Creditors	24	Trading Stocks	18
Other appropriations (tax etc.)	2	Current Assets deficit	22
	50		50

It will be observed that Cash in Hand has an index of 62, (which is strictly 47, when offset by Bank Overdraft).

Sundry Debtors is also 47 - an item made up from sums due from butter sales, export and local, sales from auxiliaries and suppliers' contra accounts (when not off-set). Total stocks in hand have an index of 45, comprising Butter in Store 17 points, Materials and Consumable Stores 10 points, and Trading Stocks 18 points. The present cash position can be reckoned as Ready Cash minus Overdrafts, plus Debtors and Butter Stocks (47 plus 47 plus 17) i.e., 111 points of fluid assets to meet Sundry Creditors 24, Amounts due to Suppliers 135, and Miscellaneous 2, a total of 161. Sundry Creditors consist of payments due for supplies of materials and stores and services largely, and tend to be offset by Materials and Consumable Stores and Trading Stocks on the Assets side.

On balance day, it is considered that 47% of the Total Nett Assets is immediately available in the form of cash to meet the final months' payments to suppliers (15%), leaving 32% to meet final payments. In the course of the next two or three weeks, a large part of Sundry Debtors and Butter Stocks would be realized in the form of cash to meet Sundry Creditors. If we could assume all, then 64 plus 32 per cent (96%), is available to meet 24% (creditors), leaving a balance of 72% to meet the final payout to suppliers. Assuming Consumable Stores and Trading Stocks to offset Creditors, likewise butter sales to offset payments to suppliers, we have the factual 48 per cent to find for final payment to suppliers (with an additional 2 per cent deferred to a later date again). This 48 per cent would be met by way of bank accommodation (overdraft), and arises partly from time-lag between current receipts for manufactured produce and prior current payments, partly from other auxiliary activities which includes Trading Stock, 18 per cent, and partly from the accumulation of fixed asset indebtedness financed out of liquid resources. It is this 48 per cent which embarrasses the smooth operational efficiency of short-run financial operations.

Fixed Assets and Shareholders' Funds: Still in terms of index numbers, in which Shareholders' Funds = 100, the break-up of Fixed Assets is:-

Shares in Other Companies	18	
Land, Buildings, Plant etc.	106	
Goodwill	1	125

Of these, shares in other companies must be considered as an extension to the land, buildings, plant and equipment of a given company, for it is realty and improvements of other companies servicing or affording correlative services to individual dairy companies. Goodwill is largely fictitious, being essentially a carry-over from trading activities and amalgamations from earlier times.

Offset against Fixed Assets are Shareholders' Funds made up of Paid-Up Capital, Reserves and Appropriation Account as follows:-

Paid-Up Capital	60	
Reserves	35	
Appropriations Account	5	100

Two other items are Fixed Term Liabilities, which stands at 8%, and Investments which stands at 5%.

In reviewing the Shareholders' Funds, Paid-Up Capital stands at 60. The total Authorized Capital for all companies making butter is £3,915,200; Issued Capital at £3,150,349 and Paid-Up Capital at £2,875,328. Paid-Up Capital, then is approximately 74% of Authorized Capital, which represents the extent to which the Capital of the industry can go without increasing Share Capital or financing by other means. The Issued Capital is 81 per cent of the Authorized Capital and represents the extent of the butterfat basis on which shareholding is taken up. The difference between the 81 and 100 per cent measures the extent of expansion of butterfat able to be taken up before the basis of capitalization needs to be reviewed. Actually some companies increase their nominal capital (one company did in the 1949/50 season) while others take out debentures as a means of increasing nominal capital.

Making allowance for non-butter auxiliaries, the extent of capitalization is 2.65d. per lb. of B/F or £87 per £1,000 of produce. In terms of suppliers, the average total capital in the butter-making industry was approximately £64 per head in terms of Shareholders' Funds, plus £87 per supplier as creditors for payments due of a short-term character. To this must be added other creditors (banks, firms, service companies and the State, debenture-holders and mortgagees) £32, per supplier. Taking paid-up capital, reserves and creditors (not suppliers' payments due), the total capital invested is £96 per supplier.

The range of Paid-Up Capital to Nominal Capital as a percentage varies from 27.7 to 99.6 per cent for the industry. There are 20 companies whose Paid-Up Capital is under 50 per cent of Nominal Capital - mostly in the 3 to 4 million output group, but most companies find the extent of their Issued and Authorized Capital somewhat inadequate for replacement of existing assets and for expansion. The Company with the smallest Paid-Up Capital had £876, and another with an output of nearly 1,000 tons per annum had a Paid-Up Capital of only £929. It was observed that the low-capital group were old-established companies in certain districts. Taranaki had the lowest capital structure of all provinces or areas by quite a margin, and those companies serving districts recently opened up had the highest capital structure.

Next to Paid-Up Capital is the item, Reserves, accounting for 35 per cent of the Shareholders' Funds. Reserves consist of appropriations of moneys available for distribution which have been transferred from Appropriation Account and consist of General Reserve, Reserves for surrendered, forfeited and depreciated Shares, Sinking Funds, Asset Depreciation, and Stocks, and miscellaneous reserves.

Reserves are the most strategic item of Shareholders' Funds. By making adequate appropriation for Reserves, administration can improve the Company's liquidity at the same time as making provision for asset replacement. When a given sum is placed to reserve, that precise amount is not available to be paid away to suppliers in cash. This means that asset-liquidity is improved by increasing the Working Capital (or reducing the working deficit). Both the Current Ratio and Liquidity Ratio improve for either the cash holdings of the company concerned are reduced or the bank overdraft increased when cheques are paid to suppliers. At the same time, the item "Final Payment due to Suppliers" is not increased, but "Reserves" are increased by that amount. The final result is that Current Assets (cash) is not depleted, current liabilities reduced, and Reserve increased by the amount so placed there. This,

(a) Improves Liquidity Ratio.

(b) Increases Shareholders' Funds relative to Fixed Assets and thereby reduces the extent of under-capitalization.

(c) Improves short-term financial stability and increases the Proprietary Ratio, thereby decreasing the extent to which the company must depend upon outside creditors for long-term finance.

(d) By increasing cash resources, it makes finance available for purchase or replacement of assets without further dislocating the proper ratios between current and fixed assets and liabilities.

The extent to which companies place sums to reserves varies with size of company and district. In certain districts, production has increased through time, share capital has not increased relatively, but reserves have been built up, but not sufficient to replace assets. In Taranaki, for example, the total reserves are 186 per cent of the total paid-up capital for the province. Conversely, in the north of the South Island (Nelson-Marlborough-Westland) total reserves are only 29 per cent of the paid-up capital; (the Dominion figure is 58 per cent). When examined in terms of scale, there is no regular pattern either for individual companies or for scale class-intervals. Broadly classified, those companies producing under 1 million lbs. had reserves equal to 43 per cent of paid-up capital, those producing from 1 to 2 million lbs. had 67 per cent, those in the 2 to 4 million lbs. had 61 per cent, and those over 4 million lbs. had 35 per cent equivalent in reserves. Length of operation and corresponding degree of limitation of paid-up capital tended to determine extent of reserves, not scale.

The Appropriation Account accumulates the surplus from Manufacturing Account, and income from interest, dividends, rents, commissions and other profits from trading etc; and offsets all reserves, provisions, appropriations and advances to suppliers to arrive at a balance which appears in the Shareholders' Funds in the Balance Sheet. This balance, then, represents the un-distributed surpluses, and varies according to district rather than according to scale.

It was noticed that wherever competition is intense for suppliers, the balance of the Appropriation Account is relatively considerable, for it acts as a reservoir to draw on for "window-dressing" the total pay-out to suppliers for the season under review. Thus in North Auckland, due to natural geographical location and lack of cheese competition, the Appropriation Account was less than one per cent of Shareholders' Funds. However, in Taranaki where factories are not separated by geographical features, and where competition for whole milk is considerable, the undistributed profits carried forward in the Appropriation Account, amounted to 16.3 per cent of the total Shareholders' Funds.

In the structure of Fixed Assets, the two important elements are Shares in Other Companies, and Realty and Plant. Shares in Other Companies should be regarded as fixed capital extensions, and their dispersion or distribution are related to geographical location. These shareholdings vary from district to district and are not correlated with scale. In Otago-Southland, for example, these shareholdings amount to only 11 per cent of Land etc., whereas in Taranaki they are over 50 per cent. This is partly because land and buildings acquired early, are shown in the Companies' books at a relatively low figure, and partly because companies in certain districts had to finance extensively the auxiliary service companies. A comparison of these is set out in Table LVII, where shareholdings according to districts vary from 8.9 to 37.5 per cent of total Shareholders' Funds.

Land, Buildings, Plant and Equipment have an index of 106, included in Fixed Assets which are 130 per cent of total Shareholders' Funds. This suggests that the industry is under-capitalised, that Fixed Assets are being financed out of Current Assets, thus increasing Current Liabilities and adversely affecting the Current Ratio and Liquidity Ratio, and that depreciation and/or appropriations to reserves are inadequate to meet the rate of asset requirement and replacement.

Inadequacy of reserves had been touched on, and the same argument applies to inadequate depreciation which is suggested by the Fixed Asset index of 130 of which 106 points pertain to Land, Buildings, etc.

But this inadequacy cannot be entirely charged to lack of sufficient provision made for depreciation and by way of reserves. The inadequacy arises partly from the fact that improved techniques requiring modern equipment are increasing at a rate that is in excess of depreciation provisions. Improved technique necessitates greater mechanisation and improved plant, and therefore relatively greater capital outlay. Replacements, technical refinements and improvements, and fall in the value of the pound through time, have together augmented this inadequacy of capital.

However, these facts do not condone inadequacy. They rather insist on greater provision being made both in reserves and depreciation. Although depreciation of manufacturing assets amounted to approximately 3.25 per cent of total manufacturing expenditure, it must be affirmed that the £149,000 written off by way of depreciation as a manufacturing expense is 6.3 per cent of the value of total Land, Buildings, Plant and Equipment, and as such is scarcely adequate as a replacement fund especially in times when money is constantly depreciating in terms of purchasing power.

In an industry whose Total Fixed Assets amount to £6,000,000 and whose annual distributions channeled through the consolidated Appropriation Account is more than £40,500,000, the fact that only £51,000 was placed to Reserves in addition to Depreciation, would appear to be quite inadequate to meet replacements.[16]

Adequate depreciation reduces the total of the Fixed Assets and thereby reduces under-capitalization by helping the Fixed Assets to approximate Shareholders' Funds, and by assisting the current position in that the greater the depreciation written off, the less will be the sum available for appropriation and the demand on liquid cash resources.

Geographical Consideration: An analysis of consolidated balance-sheets classified by districts is given in Table LVII onP. 280. It will be observed that the Current Ratio varies considerably from district to district, from 71 to 117 per cent. The Current Ratio tends to move in an inverse relationship to the amount expended in Land, Buildings etc., suggesting that Fixed Assets have been financed partly at the expense of Current Assets instead of Shareholders' Funds. The Current Ratio also has an inverse relationship to Paid-Up Capital but a direct relationship to Reserves. This is probably related to location rather than administration and illustrates the fact that those companies commencing some decades back with adequate capital, found in the course of time, that the capital supplied by shareholders originally, was inadequate to meet asset requirements and endeavoured to meet the position by increasing reserves.

This spatial analysis throws light on the structural character of individual companies and suggests that practices are peculiar to districts rather than to differing scales. Variations in stockholding, for example, can be explained by geographical distribution - the Bay of Plenty factories holding just double those of Taranaki. This arises from the practice of holding considerable trading stocks for suppliers. Sundry Debtors and Sundry Creditors tend to move together suggesting that credit and trade practices

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[16] The problem of depreciation is adequately covered in "Managerial Efficiency", Section IV of Part IV, see Pages 189-197. See footnote on P. 190 of this section for an example of the problem as it appeared to the secretary of one company, which made fairly adequate provision for both depreciation and reserves.

TABLE LVII. CONSOLIDATED BALANCE SHEETS FOR 1949-50 SEASON FOR 85 CO-OP. DAIRY COMPANIES MANUFACTURING BUTTER ANALYSED BY DISTRICTS*

ITEMS:	S.Auck. (1)	N.Auck. (2)	Bay of P. (3)	Taran. (4)	Wegtn. (5)	HB-G. (6)	N.M.W. (7)	Canty. (8)	Ot-S. (9)	Dominion (10)
CURRENT ASSETS:										
Cash in hand and at Bank	50.1	56.3	43.4	109.2	74.4	43.4	28.1	111.0	60.0	62
Sundry Debtors	63.8	51.3	37.6	15.2	57.8	37.6	40.4	87.0	38.2	47
Stocks: Butter	16.1	3.9	20.6	23.3	19.0	18.2	40.4	18.2	21.1	17
Materials & Con. Stores	15.0	12.3	18.6	7.1	13.0	8.8	12.6	14.3	11.2	10
Trading Stocks.etc.	16.9	23.1	33.0	6.4	11.1	9.4	14.6	11.7	28.9	18
FIXED ASSETS:										
Investments	2.5	2.5	0.9	3.5	7.2	9.9	2.6	7.8	18.4	5
Shares in other Coys.	8.4	14.4	11.3	20.5	37.5	17.1	22.5	18.2	8.9	18
Land,Bldgs.,Plant & Equip.	168.9	119.4	129.4	40.1	89.9	65.3	109.9	70.2	79.4	106
Goodwill	-	-	-	-	0.3	2.8	6.0	-	-	1
TOTAL ASSETS										
CURRENT LIABILITIES										
Bank Overdraft	52.0	13.2	20.4	-	3.6	2.3	14.6	-	6.7	15
Sundry Creditors	31.3	20.9	20.8	13.8	15.4	10.2	14.6	87.0	72.8	24
Due to Suppliers final m.	13.4	3.7	14.0	18.5	36.6	16.0	15.6	18.2	6.7	15
Final Payt.to suppliers	128.1	129.5	133.5	90.5	151.8	70.7	122.5	126.0	77.7	120
Other appropriations	3.0	2.4	2.7	0.7	0.6	1.7	4.0	5.8	0.1	2
Fixed Term Liabilities	13.9	13.1	3.2	1.8	2.2	12.2	6.3	-	1.7	8
SHAREHOLDERS' FUNDS:										
Paid-Up Capital	71.4	70.0	76.0	29.3	48.2	61.3	74.8	57.8	42.2	60
Reserves	25.9	29.1	21.7	54.4	50.0	36.5	21.9	28.6	40.0	35
Appropriation Account	2.7	0.9	2.3	16.3	1.8	2.2	3.3	13.6	17.8	5
Total of Shareholders' Funds	£367058.	536280.	221445.	283332.	332444.	180946.	150689.	77388.	90387.	£2239969
Ratio: Current Assets / Current Liabilities	71%	86%	80%	131%	84%	117%	80%	102%	97%	88%

* In the above table, the total of the Shareholders' Funds have been given to the nearest £. and used as the base of the Index. Other values have been related to this index and can be read as index numbers or as percentages of Shareholders' Funds which equals Total Nett Assets. The districts according to the ten columns are: S.Auckland, N. Auckland, Bay of Plenty, Taranaki, Wellington, Hawkes Bay,-Gisborne, Nelson-Marlborough-Westland, Canterbury, Otago-Southland and the Dominion. The districts have been classified similarly to the classification used by N.Z. Dairy Board.

and facilities have their own spatial characteristics. This is borne out by the nature of the Cash at Bank and Bank Overdrafts, which of course, are partly the outcome of financing fixed assets from current resources.

The spatial variations suggest historical associations have shaped the str cture of the industry. In long-established districts, factories tend to be small, numerous and stable. In more recently developed areas, factories tend to have larger initial capital reso rces, but more auxiliary activities and less reserves and immediately liquid funds, and appear to be less stable financially.

Scale: When examined from the point of view of scale, there is a distinct relationship between output and capitalization, both in terms of non-butter produce and butterfat. The following table sets this out:-

TABLE LVIII. RELATIONSHIP BETWEEN CAPITAL AND SCALE OF 82 BUTTER COMPANIES

Output of Factory (lbs. of butter)	No. of Coys. in class-interval	Capital (Paid-Up) per lb. B/F. d.	Fixed Assets per 1,000 Lbs. butter (£.)	Shareholders' Funds per £1,000 of produce (£.)
Under 1,000,000	23	4.7	14.1	167
1,000,001 - 2m.	22	3.2	13.3	139
2,000,001 - 4m.	17	2.2	12.7	128
4,000,001 - 6m.	12	2.4	11.0	108
Over 6,000,000	8	1.6	9.3	90

In the above table all variables decrease with scale. Paid-Up Capital decreases at the fastest rate, then Shareholders' Funds and then Fixed Assets. It is to be noted that there is a slight recession in terms of paid-up capital at the 4 to 6 million scale level, which was due to some new factories being built at this scale level. The conclusion is clearly that scale permits more effective utilization of capital, in that outlay decreases per unit of product as scale increases. Lower nit capital expendit re should permit greater operational efficiency, facilitate asset acquisition, and promote greater flexibility and stability. Apart from the consideration of scale, capital outlay in terms of unit output appears to be more effective as output increases.

Sources of finance for future expansion and replacement of assets: The following sources of finance are suggested both for expansion and for building in stability into the financial structure of the industry.

1. Maximum rates of depreciation on all assets. This will increase manufacturing expenditure, reduce the amount available for appropriation, conserve Liquid Funds and assist in maintaining a correct balance between Liquid Assets and Liabilities, and between Fixed Assets and Shareholders' Funds.

2. Increasing the amount placed to Reserves from Appropriation Account. Increased reserves will perform the same function in conserving liquid resources as does Depreciation. Sums placed to Reserves can be adjusted according to the requirements of the company at the time, but should be at a reasonably constant rate, otherwise shareholders of one decade are providing assets for a later decade. This is one of the difficulties in finance of long-term requirements in any co-operative - to apportion fairly a levy that is not a burden on the participating shareholders over a limited period of years. The point is, most companies are not placing to reserves adequate funds to meet future replacements, and this burden will have to be met at a later date. In other words, inadequate reserves means that the participating shareholders are receiving part of their fixed assets back at the expense of posterity.

3. Levy on a butterfat basis. This is a reasonable approach where the charge is placed fairly on present participating shareholders. It would not be fair to make a levy on shareholders for a long-term fixed asset, e.g. a new building, as the incidence of the burden falls on shareholders covering a relatively short span of years.

4. Increasing authorised capital. This is fair and equitable where a new area of supply is being opened up, or where the outlay will result in immediate improved techniques resulting in commensurate income for the outlay.

5. Mortgage finance. Where replacements are in mind, or where the capital outlay is for considerable duration it is better to finance by mortgage to spread the amortization over a number of years by gradual incremental levies, sinking funds, or other depreciation fund method.

6. Issue of Debentures. This is preferable in many ways to No.5 above, especially when the debenture holders are suppliers. Conversion or redemption is simpler and the method is suitable for replacement of plant or equipment.

7. Application of Stabilisation Funds. The rightness of this source is apparent when the question of incidence of replacement cost, falls on present suppliers for the excess appropriations of past suppliers.

To sum up, where an asset has to be replaced, and that asset is of durable character, it is more equitable to present shareholders to finance by mortgage (for realty and improvements), or debentures (for plant and equipment), and spread the amortization over a long period. At the same time, it is essential to increase reserves, depreciation, and possibly capital-rating, to meet the current position of under-capitalization.

This present position of under-capitalization can only be met by the constant ploughing-back of what has been disbursed in past times as distributions from the Appropriation Account. Increased Reserves and maximum Depreciation will achieve this as a corrective measure, together with the avoidance of financing fixed capital expenditure by overdraft finance and the building up of Shareholders' Funds until they equate Fixed Assets.

Summary: The butter industry is undercapitalised, and as such, the operational efficiency is impaired in that there tends to be inadequate financial resources to acquire, improve or replace fixed assets to match a growing industry with improving techniques. Undercapitalization has arisen from inadequate provision being made by way of depreciation and reserves to augment an initial capital position. Growth of output, and increase of activities and services have increased further the demands on disposable liquid resources, and together have augmented financial instability to the point that asset replacements have to be achieved through increased bank accommodation. This practice tends to distort further the financial equilibrium of the industry as indicated by the lack of resources to meet current obligations and adverse liquidity ratios. The outcome in the short-run is lack of operational efficiency, and in the long-run is lack of flexibility, and financial instability.

SECTION V. AUXILIARY ACTIVITIES AND THEIR EFFICIENCY.

INTRODUCTION: The extent of the various activities[17] that are complementary

[17] Those company officials in charge of auxiliary activities are usually answerable directly to the Board of Directors (especially in larger companies), rather than to the factory manager. Moreover, as these activities were the outcome of distinct policy, they will be examined under the heading of Administrative and Capital Efficiency rather than Managerial Efficiency.

and auxiliary to butter making, have already been set out in Part I, p 15, of this survey.

There are five main motives lying behind all these auxiliary activities. They are:-

1. Service Motive: To serve suppliers better and retain their patronage.
2. Profit Motive: To augment the distributable funds appearing in the Appropriation Account.
3. Efficiency Motive: To utilise more effectively plant, equipment and labour and convert waste products into revenue-earning by-products. To reduce under-capacity to a minimum.
4. Camouflage Motive: To divert actual costs of manufacturing butter to auxiliary activities and thereby present a more favourable pay-out for competitive purposes.[18]
5. Competitive Motive: To offer similar advantages or facilities as other companies both in service and by-products.

Range of Auxiliary Activities: The number of companies manufacturing various products considered both as complementary and auxiliary are set out in the following table:

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[18] See Appendix G.
"ESTIMATE OF EXTENT OF DIVERSION OF BUTTER COSTS".

TABLE LIX. COMPLEMENTARY AND AUXILIARY PRODUCTS MANUFACTURED BY CO-OP. DAIRY COMPANIES HAVING BUTTER AS THEIR MAIN PRODUCT

Type of Product	No. of Companies manufacturing same	Quantity	Value (where applicable).
Cheese (made in conjunction with butter only)	5	3,267 tons	-
Whey butter (made as a by-product in dual plants or from whey cream received from cheese factories)	14	1,205 tons	-
Buttermilk powder	20	3,982 tons	£60,328 (net rev.)
Skim milk powder	7	1,026 tons*	-
Whole milk powders (including reduced milk and cream)	3	21,704 tons*	-
Casein	9	5,594 tons	-
Ice-cream	2		£1161 (net.rev.)
Butter-milk	81		£14,049
Cream	31		£92,632
Whole-milk (a) bottled (b) bulk	1) 7)	16,535 434 galls.	£15,334

* One company included quantities of skim powder made in with whole milk powders.

Buttermilk Production: As buttermilk is playing an increasingly larger role in the butter industry, it will receive more detailed consideration, than otherwise would be accorded it. Eighty-one companies produced buttermilk as distinct from making buttermilk powder, and of these, six companies were in the stage of transition, in that they partly produced powder and partly supplied buttermilk to purchasers.

Thus seventy-five companies[19] disposed of their buttermilk in its unprocessed form as analysed in the following table:

TABLE IX. DISPOSAL OF BUTTERMILK IN 95 COMPANIES

Output of Factories (lbs. of butter)	Unprocessed	Processed	In Stage of Transition
Up to 1,000,000	28	-	-
1,000,001 - 2,000,000	23	1	1
2,000,001 - 4,000,000	17	2	2
4,000,001 - 6,000,000	5	5	2
6,000,001 - 8,000,000	2	3	-
8,000,001 - 10,000,000	-	-	1
10,000,001 - 12,000,000	-	1	-
Over 12,000,000	-	2	-
	75	14	6

The total revenue derived from sale or disposal of butter milk amounted to £14,049, while revenue derived from seventy-five companies (thus excluding those companies in a stage of transition) was £12,415 or £165 per company. On an average, for every pound (£) of net revenue earned from the disposal of buttermilk, nearly 10,800 pounds of butter were manufactured. (I.E. 133.7 million pounds of butter were made by the 75 factories).

[19] A few companies, however, combine or, pool their supplies to a separate company for the purpose of manufacturing buttermilk powder.

In other words, the by-product buttermilk earned on an average a little more than 1/9d. from each 1,000 pounds of butter made.

It is necessary to compare this 1/9d. with the nett earnings of buttermilk powder made from the same quantity of butter, having in mind the very heavy initial depreciation written off butter-milk powder plant as a safeguard against possible market contingencies. From the eleven companies that processed buttermilk alone (i.e. did not make casein or other powders), the sum of £37,025 was earned.

It took 1,622 pounds of butter to yield sufficient buttermilk to furnish £1 of revenue. Or, each 1,000 lbs. of butter earned 12/4d, which was about seven times that earned by unprocessed buttermilk.

The following table analyses buttermilk revenue-earning capacity of factories of various sizes:-

TABLE LXI. SEVENTY-NINE FACTORIES CLASSIFIED ACCORDING TO SIZE AND REVENUE EARNING ABILITY FROM BUTTERMILK

Output of Factory (lbs. of butter)	Revenue -: as indicated by the quantity of butter made per £ of net revenue from buttermilk ('000 lbs.)					
	Under 10	11-20	21-30	31-40	Over 40	Total
Under 1,000,000	8	8	6	3	3	28
1,000,001 - 2m.	8	7	8	1	-	24
2,000,001 - 4m.	3	10	1	2	1	17
4,000,001 - 6m.	5	1	1	-	-	7
Over 6,000,000	2	1	-	-	-	3
	26	27	16	6	4	79

From the above table there appears to be little direct correlation between output of factory and ability to earn revenue from disposal of buttermilk. Nevertheless it does appear that the larger factories are more successful in disposing this product to advantage. This is possibly because of multiple offers to take buttermilk, or the decision of the directors to run a pig farm if the contract price for buttermilk is inadequate.

Relationship between factory size, output of buttermilk powder and revenue: There were twelve factories whose figures permit comparison. These factories ranged from under 1,000,000 lbs. of butter output to over 8,000,000 lbs. Of these, 1 factory earned under £10 per ton of powder made, 7 factories earned from £11- £20, 2 factories earned from £21 - £30, 1 factory earned from £31 - £40, and 1 factory earned over £40 per ton of powder made. The revenue ranged from £5 per ton of powder made to £43 per ton, with an average of £16 per ton.

There appeared to be a significant relationship between output of powder and butter made, in that more powder per unit of butter was manufactured as scale increased. From every 10,000 lbs. of butter made, an average of 4.1 tons of powder was made, with a dispersion of 2.2 to 5.5. tons.

This increase of technical efficiency is illustrated in Figure 14, p. 289, where ratio of Butter/Powder is plotted against butter output, and the trend denoted by a broken line.

It was difficult to establish any relationship between Net Revenue or costs and scale, as different factories allowed varying costs to be absorbed as powder costs. For each 1,000 lbs. of butter made, the net revenue ranged from 1/11d. to 21/10d, with a weighted average of 12/4d.

The future of powder will be determined largely by price realizations and the development of fresh markets overseas. Large-scale manufacture has developed mainly since 1946, and the output of powders had doubled by 1950, and each succeeding season has shown a marked increase, especially in skim milk powder produced by spray techniques. Unfortunately, reliable costs were not available in sufficient quantity for analysis purposes.

Revenue from the sale of cream: For the year, thirty-one companies supplied cream for sale to various organizations, institutions and individuals. Various practices in the sale of cream exist. Some companies supply small lots to individuals; some supply regular quantities to institutions such as hospitals, others again dispose of considerable quantities for municipal consumption on a contract basis.

The total of £92,632 was received from the sale of cream for the year, and the following table analyses the revenue so earned.

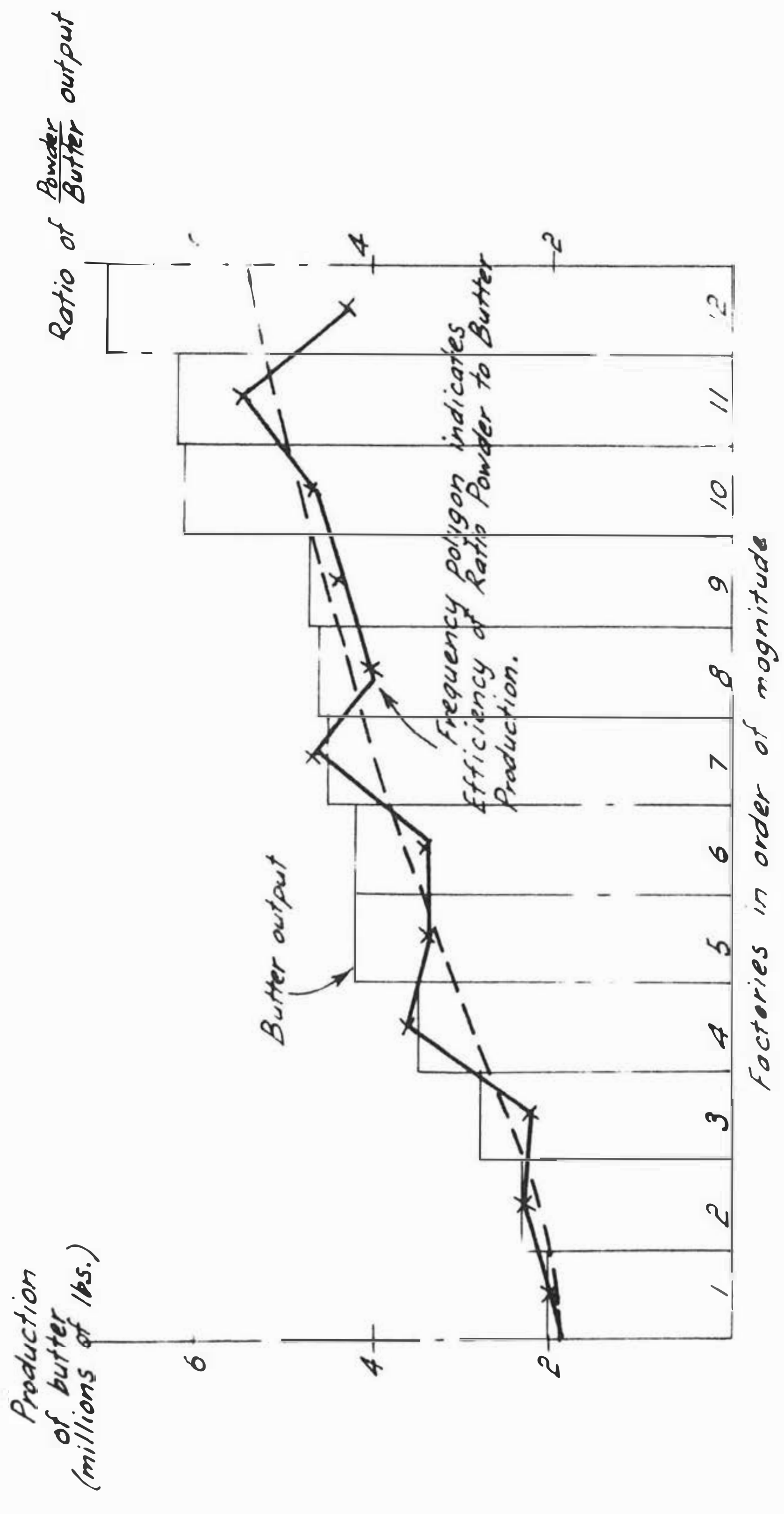

Figure 14. Twelve Factories Ranged in Order of Output of Butter, to Illustrate that Relative Productive Efficiency of Buttermilk Powder is Conditioned by Size of Factory.

TABLE LXII. THIRTY-ONE COMPANIES CLASSIFIED AS TO REVENUE EARNED FROM SALE OF CREAM AND SIZE OF FACTORY

Output of Factory (lbs. of butter)	No. of Factories	Revenue earned from sale of cream				
		Under £10	£11-£100	£101-£1,000	£1,001-£10,000	Over £10,000
Under 1,000,000	6	1	-	5	-	-
1,000,001 - 2,000,000	7	1	2	1	2	1
2,000,001 - 4,000,000	8	-	5	1	1	1
4,000,001 - 6,000,000	4	-	1	1	-	2
6,000,001 - 8,000,000	4	1	-	2	1	-
Over 8,000,000	2	-	1	-	-	1
	31	3	9	10	4	5

Sale of Whole Milk: One company supplied municipal bottled milk ($16\frac{1}{2}$ million gallons), while seven others supplied whole milk in bulk - almost all of which was utilised to implement local milk distributions.

For the year, £15,334 was received from sale of bulk milk from seven companies.

Five companies received under £100, one under £1,000 and one company accounted for the balance.

Sources of Revenue: The four main elements of revenue earnings are:-

Commissions
Dividends
Interest
Rents

These capital earnings are usually disclosed under one general heading in the Appropriation Account.

Considerable commission is earned from various sources, the chief one being commission on insurance agency work. As agency work of various kinds is usually undertaken by one of the stores staff, or by one of the office staff, it has become usual in some companies to include this item under store-earnings.

Dividends usually consists of dividends received from investments in various subsidiary companies or from shares held in auxiliary concerns. These dividends must be distinguished from rebates from such companies.

Interest consists of earnings of loan capital borrowed by suppliers and from other sources.

Rents: These arise largely from houses held by the company, but occupied by non-employees. Often it happens that an employee leaves the company but still occupies the house or accommodation provided - so that the rent payable must be taken into account in the form of revenue. Also, rents consists of excess of income over expenditure of housing schemes taken into the appropriations of the company concerned.

All companies do not show these items separately, but as credits in various accounts, such as administration expenses account, in order to minimise the unit cost of this section of the Manufacturing Account.

The total capital earnings of 75 companies was £47,880. Of this:-

Commissions accounted for	22%
Dividends	27%
Interest	22%
Rents	29%

The following table analyses the revenue earnings of 72 of these companies.

TABLE LXIII. SEVENTY-TWO COMPANIES CLASSIFIED AS TO OUTPUT AND REVENUE EARNED FROM COMMISSIONS, DIVIDENDS, INTEREST AND RENTS

Output of Factories: (lbs. of butter)	No. of Factories	Revenue earned				
		Under £100	£101-£500	£501-£1000	£1,001-£10,000	Over £10,000
Under 1,000,000	21	16	5	-	-	-
1,000,001- 2,000,000	19	8	10	1	-	-
2,000,001 - 4,000,000	14	7	4	2	1	-
4,000,001 - 6,000,000	7	-	4	3	-	-
6,000,001 - 8,000,000	5	-	3	1	1	-
Over 8,000,000	6	1	4	-	-	1
	72	32	30	7	2	1

From this table it will be seen that 62 companies have earned under £500. It will be observed too, the larger the company the greater tends to be the revenue earned.

Of those companies which kept separate returns, 25 indicated that £1,682 was earned from commission; 14 indicated that £660 was earned from dividends, 14 earned £849 from Interest and 11 earned £1,059 from Rents. In addition, 39 companies indicated they earned £43,630 from capital earnings which included the above four types.

Farming Activities: These vary, but pig farming is carried on in conjunction with the disposal of buttermilk. Eight companies run pig farms, and one company runs a dairy farm in addition to their pig farms, while another company runs store sheep in conjunction with their pig farm. Of these eight companies, four are producing over 5,000,000 pounds of butter per annum but three of these latter are in the process of changing over to the production of buttermilk powder.

One other company undertakes contracting work on farms, and yet another undertakes fertiliser spreading contract work.

Engineering Activities: These activities include blacksmithing, general repair work, general garaging (service and maintenance and repair work), plumbing and electrical work. Plumbing includes well-boring work which one company has undertaken for suppliers.

There are six companies that undertake such work, all of whom, with two exceptions, produce over 8,000,000 pounds of butter per annum.

In addition many companies do odd repair work for their suppliers, but show these as credits in Repairs and Maintenance Account or through Wages Account. These engineering activities are separate from, and in addition to engineering, repair and servicing undertaken as an adjunct to transport work.

Several companies also run a service station in conjunction with their transport work or engineering activities.

Auxiliaries to Transport and Stores: Transport and Stores activities will receive separate treatment. There are, however, certain auxiliaries to these activities which will now be dealt with.

Petrol: Many companies sell petrol and oil to their suppliers. Some companies show these sales as contras in their suppliers' Ledger accounts, and some show them as an auxiliary to Garage and Repairs Account; others again incorporate them in the Transport Account.

Some companies have Benzine Agencies and at least one company runs a fully equipped Service Station. Of five companies that kept separate accounts, the aggregate amounted to over £18,000 revenue earned from this source. All but one were large companies.

Passengers and Mail etc.: While certain companies have goods licences, others have incorporated passenger services and/or mail contracts. Two companies have bus passenger licences and one company has a launch passenger licence. Two have mail licences, another delivers goods not originating from the company, and others have newspaper deliveries.

The sums earned by these activities are relatively small, being under £1,000 per annum. They are usually found in relatively isolated localities and function as a valuable service to the district, rather than as a revenue-earning activity.

Manures, etc.: Seven companies have large lime, manure and fertiliser auxiliaries. A few companies operate their own lime crushing works, sometimes at a loss, thus revealing the motive is utility-service, not revenue making. Many companies apart from the seven indicated, have extensive dealings in manures etc., but incorporate them in their stores activities, so that it is quite impossible to get accurate data concerning the magnitude of the sales.

Most of the companies are large butter producers, and consider that any facilities provided in procuring manures, lime, etc., for their suppliers will result in an increase in butterfat. The revenue earned from such activities amounted to more than £80,000 for the season.

Miscellaneous: Minor activities or services often are obscured in the accounts being offset as contras. Thus drainlaying, earthwork, supply of coal etc., have come under this heading. For example, one company supplies water, netting over £200 for this service.

Professional services: These include accounting services and veterinary assistance. Many companies give professional service in accountancy free - two companies have a large connection in preparing annual accounts, tax returns and run a Loans and Securities Department. Two companies obtain a revenue of over £17,000 by this means.

In addition, 22 companies subsidise veterinary groups, and three run herd testing facilities.

Two companies run their own coal mines.

<u>Auxiliary Transport Activities</u>: Those companies utilising their own vehicles for cream collection, invariably perform some general haulage work apart from other haulage directly chargeable to butter, such as truck running chargeable to cream collection.

It is difficult to assess the revenue that arises from auxiliary transport activities as a number of companies offset such revenue against the total cream collection costs in order to minimise these unit costs. This is the usual practice, but where separate transport departments are maintained, or where analysis of accounts permitted, it was possible to calculate the revenue so derived. From seven such companies engaged in general haulage, a total gross revenue of £118,430 was derived. Against this revenue were charged all running costs, overheads and administrative expenditure.

As such transport activities were operating for profit, they were subject to tax, and in order to minimise taxation, these activities were saddled with items of administrative and general overhead which otherwise would never have appeared under this heading.

Auxiliary transport then absorbs butter manufacturing costs in two ways:-

(a) by off-setting revenue against cream haulage costs,
(b) by charging undue proportions of manufacturing overhead costs in the segregated transport accounts.

Whichever way it is used, the same end is achieved, only it is possible to obtain more detailed information from the second method.

The total expenditure charged to cream collection was just 33.8 per cent of total transport expenditure. That is, approximately one-third of total transport expenditure was charged against cream collection in the seven companies from which this information was derived. The range was considerable - from 6 to 73 per cent, indicating that one company at least considered that cream collection costs were less than 10 per cent of total haulage expenditure.

An analysis of items of expenditure showed that Wages varied from 36 to 50 per cent, Repairs and Maintenance from 16 to 23 per cent, General Overhead relative to vehicles from 12 to 22 per cent and Administrative Charges from 1 to 22 per cent. Petrol and Oil, however, varied only from 17 to 19 per cent. It would appear that Petrol and Oil in being consistent, is a correct charge, but the variations of other items suggest loading.

Moreover, Directors' Fees etc., varied from nil to 132 per cent of the same charge appearing in butter expenditure, Audit from nil to 75 per cent and Administrative Salaries from nil to 64 per cent.

Auxiliary transport then, plays a considerable part in the diversion of butter costs.

Trading in Stores: This activity is probably the most wide-spread of all subsidiary activities found in the butter-producing industry. It is not found to any extent in the cheese-making industry, because suppliers had their own milk, so that transport is not required, and therefore vehicles are not available for deliveries.

The degree of trading varies from company to company, and arises from a number of factors. These factors have already been outlined, of which, the profit-motive, the service-motive, and then the cost-motive are probably the most important.

The diversification of trading also varies considerably from company to company. Some deal with farming supplies only, the service-motive being the main factor. Others extend into groceries, whilst others again have large departmental stores.

Of the 96 companies surveyed, 21 engaged in a very minor way, handling only a few of the essentials of dairy farming supplies such as inflations, cans etc.

There were 39 companies that engaged in store work, which ranged from farmers' supplies to the more common grocery lines. In this group, one of the factory staff places purchased stores in the cans to be delivered the following day the order was taken. Most of the orders are taken over the telephone or given to the lorry-driver operating on the cream collection route. From the point of view of organization, this type of store work is undertaken apart from direct customer-salesman technique. That is, the goods are not selected from a range of substitutes; nor are stocks displayed; nor are the usual retail selling facilities available.

Finally, 36 companies engaged more-or-less extensively in store trading. Stocks were held in considerable variety to assist selection, and in many cases fully equipped stores were run on lines identical to well-established shops in large centres. Quite a few companies in this group enter into active competition with other stores in the district, engage in advertising and make daily deliveries. Consequently, these trading departments have built up quite a connection apart from their normal suppliers, who have been encouraged to deal exclusively with the company which uses the means of offering a substantial rebate on goods purchased. Of these 36 companies there are 15 that have Stores Managers with a stores staff that are answerable solely to the Board of Directors. While other companies have stores managers, these come partly under the secretary or general manager who may direct the general policy of the store.

Extent of Trading: While full information was obtained from the larger stores, many small stores were able to afford only the minimum of data.

Consequently, some 36 companies operating stores, and representing over two-thirds of the retail trade in the industry, were selected for analysis. These 36 companies carried stocks at the end of their accounting period, amounting to £290,234. Total stocks carried by the 96 companies amounted to £434,651, meaning that some 60 smaller companies carried stocks forward at the end of the financial period valued at £144,417.

Analysis of 36 largest companies - regarding stores:

In terms of percentage statements, the position was as follows:-

TRADING ACCOUNT

Opening stock	10%	Sales	100%
Plus Purchases	91%		
	101%		
Less Stock on hand	11%		
Cost price of goods	90%		
Gross Profit	10%		
	100%		100%

PROFIT AND LOSS ACCOUNT

Total Expenses	6.2%	Gross Profit	10%
Rebates & Discounts	3.4%		
Reserves [20]	.0%		
P. & L. Appropriations	0.4%		
	10.0%		10%

The total sales amounted to a little over £2,659,000 per annum for the 36 companies, and Gross Profit was slightly more than 10 per cent of this amount, viz. £267,839.

It would appear from this that the write-up on most goods was not much more than 10 per cent. Actually, most grocery lines were written up 10, 12½ and 15 per cent. Other lines such as hardware were written up 20 per cent or more, depending on the current practice in these lines.

As Opening Stock and Closing Stock were similar, and stock sheets were valued on the same basis between the two periods, it may be assumed that provided freight or carriage-in on purchases was not high, then 12½ per cent may be taken as an average write-up on cost of goods. Write-up is kept to a minimum, because profits on store-trading are taxable, so that policy generally dictates a minimum nett profit by granting rebates on purchases.

Actually carriage-in varies with the actual location of the factory store. In some cases, factories were situated as favourably as competing stores in the district. In other cases, they were more favourably situated in that the lorries that carried bulk butter to rail-head returned with stores to the factory, thus minimising freight-in.

Of 6 companies that kept reliable data as to inward freights, the percentage of inwards freight to purchases was 2.4 per cent. These companies reflect wide scattering geographically and can be taken as fairly representative. They ranged from 0.8 per cent to 6.5 per cent.

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[20] Reserves actually amounted to 0.06 per cent.

These figures confirm that with a write-up of $12\frac{1}{2}$ per cent on Purchases, clients are receiving a very favourable selling-price in comparison with what exists in the trade today.

The relationship of Gross Profit to Sales: Sales amounting to £2,659,690 were classified as follows:

Extent of Sales	Number of Companies
Under £20,000	5
20,001 - 50,000	13
50,001 - 100,000	12
100,001 - 200,000	5
Over £200,000	1
	36

There is a very close correlation between annual sales and annual output of butter per company. This correlation is a little closer than that of annual sales and number of suppliers. This interesting fact points out that sales tend to increase with purchasing power of suppliers as measured by annual gross receipts for butterfat supplied to the company. This may be interpreted as an indication of a high degree of co-operation and support by the suppliers.

It must not be supposed that trade is exclusively with suppliers. Some companies have built up considerable goodwill in the district in which they operate, to the extent that in a few cases the suppliers deal with the store of one company and supply their cream to another. Moreover, there are quite a few companies which supply goods to dairy-farmers that supply cheese factories. Again some companies have a number of customers that continue to deal with them, which were once suppliers, but have gone over to non-dairying farming.

The extent of cash trade, from non-supplier customers as distinct from credit trade varies from company to company, but from reliable sources it would appear that cash trade is about 4.7 per cent of total trade. In some districts this cash trade is almost exclusively non-suppliers and largely non-farming custom.

Other factors, apart from the number of suppliers and the extent of their patronage enter into the picture. These factors include the ability of the stores manager, the degree of service given the individual customer, the extent to which delivery facilities are given, the extent of credit given in relation to protracted orders upon cream cheques, the rebates and discounts allowed, the range of stock maintained and the selection available, the number of agencies and service opportunities that are run cojointly by the store, the degree of energetic competition in the district, the general reputation of the store for quality and price, and the preparedness of management to obtain hard-to-get supplies such as cement, galvanised piping, etc., for the customer. All these and others reflect in the picture of the extent of patronage bestowed.

The relationship of Sales and Suppliers: The average expenditure per supplier for 33 companies[21] is just £160 per supplier per annum.

The relationship between suppliers and gross sales may be seen from the following data:-

GROSS SALES PER SUPPLIER

	No. of Companies
Gross sales of up to £100 per supplier	9
" " of £101 - 150 " "	5
" " of £151 - 200 " "	7
" " of £201 - 250 " "	7
" " of £251 - 300 " "	1
" " of over £300 " "	4
Total	33

From the above classification it will be seen that there are four or five companies at least that have extended trade into non-supplier territory.

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21 One large company, whose total sales amounted to over £800,000 has been omitted in order to retain a truly comparative basis.

The average expenditure on stores per ton of butter made is £31. The average quantity of butter manufactured per supplier per annum for the companies under this survey was 4.9 tons of butter per supplier (or 4 tons B/F).

The maximum amount expended at any company's store was £88 per ton of butter manufactured, and the minimum amount £8. Further distributions are illustrated by the following data:

Gross sales per ton of butter manufactured	No. of Companies
Gross sales of up to £20 per ton manufd.	4
" " of £21 - 30 " " "	7
" " of 31 - 40 " " "	9
" " of 41 - 50 " " "	6
" " of 51 - 60 " " "	4
" " of Over £60 " " "	3
	33

The Gross Profit: The ratio of gross profit to sales varied from company to company as follows:-

	No. of Companies
Up to 5%	3
From 6 - 10%	14
" 11 - 15%	10
" 16 - 20%	6
Over 20%	3
	36 Coys.

The relationship between (a) Gross Profit and Sales, (b) Sales and Suppliers, and (c) Sales and butter manufactured, as outlined above, are shown diagramatically in Figure 16 for 35 companies.

In this diagram, the Gross Profit to Sales relationship, (a), is measured as a ratio from the right-hand ordinate, while (b) and (c) relationships are measured as money relatives from the left-hand ordinate.

The following points should be observed:-

There is a distinct inverse relationship between Gross Profit to Sales Ratio and Sales to Suppliers ratio. Of the 35 cases examined, there are 17 which are markedly inverse in degree of magnitude. This can be expected, for it is obvious that suppliers will increase their patronage to the extent that the relative prices of commodities are lower than those obtaining in competing firms.

One point of interest is to be noted here. Suppliers tend to increase their patronage on the basis of marked prices, rather than on the basis of the extent of rebates offered by the company. It means more to the supplier to purchase keenly-priced commodities than to pay such prices as may be obtaining in the trade in the district together with a substantial rebate. Keen prices attract more trade than do rebates.

This raises a point of policy. From figures submitted on page 300, it would appear that some 17 companies prefer to attract trade by keenly-priced goods, 10 companies follow the trade practice of setting prices on a par with those that exist in the district, whilst the remaining 9 have a substantial write-up on the cost price of their goods. Obviously, those companies selling low-priced goods cannot show substantial rebates or discounts, but they do show a large Sales to Suppliers ratio. Conversely, those companies with a high selling price are able (other things being equal), to show a high percentage rebate on sales, but the extent of patronage per supplier is much lower.

The intermediate class insist upon moderate write-ups, and moderate rebates are normally given. Companies that follow this practice assert, and rightly so, that they are able to make a valid comparison with competing firms, and moreover, can demonstrate to their suppliers and patrons that co-operation in the retail distribution of stores pays the supplier as measured by the 3, 4, 5 or greater percentage allowed in rebates on purchases.

It must be noted, that certain other elements enter into the determination of the degree of write-up in the individual companies. In the first place, certain companies have an element of monopoly due to location and the lack of direct competition. Where no competitors exist, there is a marked tendency for companies to exploit the resulting location-monopoly element in the form of excessive write-ups. This exists in truly rural areas in which the factory and subsidiary store are located more than 10 miles from a populated area supporting competitive firms.

Another peculiar element in so-called co-operative trading should be observed. The degree of monopoly that has arisen is a result of moderate price-wars that have been waged through theyears between the company's store and existing competitors. In more than one case, the company followed the practice of keenly-priced goods for a number of years until the substantial part of the trade had been captured, then price-discrimination having done its work, the write-ups gradually increased until a quasi-monopoly emerged. Meanwhile the competing firms were driven out of the district, shut down, or were bought out.

Yet another characteristic exists - the company is in a monopsonistic position as sole purchaser of cream in the district, and at the same time, often in a monopolistic position as regards store-trading.

Many suppliers have received financial assistance from the company in depression times. Accommodation was readily granted, not only in stores purchased, but also in working and real capital requirements on the farm. Orders were received on monthly cream cheques, and during the off-season especially, extensive credit was granted for groceries, clothing, farm supplies, posts, wire, implements etc.

Bills of Sale were often taken over stock in addition, and gradually the farmer became dependent upon the company to an increasing degree. Partly due to obligation, and partly due to habit, the suppliers has become so completely dependent on the company store, that a strong monopoly element exists. This has been strengthened by the environmental factor whereby only the company is enabled at a reasonable cost to deliver stores to the supplier, and offset the debits against his monthly cream cheque.

On the other hand there are those companies that have a small write-up, and in almost every case this can be traced to the fact that there is a measured degree of competition in the district, or as has been stated earlier, it is an indicator of price-war that is quietly being engaged.

A further feature needs to be mentioned at this point. The question may be asked: - What is the advantage of the company obtaining a monopoly in retail stores distribution? The answer lies in the motivation. Some companies desire to serve their suppliers fully, some are activated by the profit-motive, some by the competitive-motive and some by the power or aggrandisement-motive. All motives may exist in some degree.

To summarize: Trading Stores have found that by keen prices resulting from small margins have maximised sales, rather than by offering rebates. It has been advantageous to companies to reduce profit margins to zero to avoid taxation. This practice has resulted in increased patronage from suppliers, and strongly entrenched monopolistic conditions in dairy company stores distribution.

The general over-all pattern of expenditure of 25 companies examined is:-

Wages	64%
Transport	10%
Administration	11%
Capital	3%
General Overhead	12%
	100%

It is considered necessary to examine these broad divisions in detail:

Wages: Whereas wages accounted for 64 per cent of the total expenditure of 25 companies, this item can be expressed as 40 per cent of all debit items appearing in the Profit and Loss Account (all items of expense, all appropriations for reserves, rebates and net profit), or 40 per cent of the Gross Profit, or 4 per cent of total sales. That is, for every £100 of goods sold, the wages expended amount to £4.

The number of full-time employees engaged in stores work for the 25 companies numbered 121 - this number includes stores managers. In addition to the 121, an additional five employees were engaged on other duties part-time. In many companies office staff are engaged full time on clerical duties that refer to the stores department, but in each case these have been included. In addition to this number of 121, it is usual in most companies for transport workers (viz. lorry drivers) to delivery stores together with returning empty cans. In some cases this amounts to a considerable percentage of the time - in other cases only a small portion of the time is taken up, because stores were inserted in the empty cans beforehand.

Of the 25 stores examined under this heading the aggregate staff engaged was 121 employees giving a mean of 4.8 employees per store. Distribution is as follows:

No. of stores engaging	1 employee[22]	6
" " " "	2 - 4 employees	9
" " " "	5 - 8 "	6
" " " "	9 - 12 "	2
" " " "	Over 12 "	2
		25

The total wages shown in accounts paid to these 121 employees is £63,128 which indicates an average of £522 per employee.

In thirteen companies where actual records of individual gross earnings of employees was available, the following distribution existed:-

Employees earning	over £700	gross per annum	1
" "	£601 - 700	" " "	3
" "	501 - 600	" " "	8
" "	401 - 500	" " "	20
" "	301 - 400	" " "	11
" "	201 - 300	" " "	5
" "	101 - 200	" " "	8
" "	Under £100	" " "	1
			57

The average salary of the 57 employees shown above computes to be £379, a considerably different sum from £522 above.

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22 Includes part time workers as well.

The difference arises from wages of factory employees charged to stores-trading for inserting parcels in cans and other work in delivery and clerical work.

Wages as a percentage of Sales varied from 1.43 to 13.60 per cent with an average deviation of 1.8 per cent for 34 companies. This deviation is considerable when the mean was 4.0 per cent. There were 12 companies whose deviations were more than 50 per cent dispersed from the mean.

The only conclusion that can be drawn is that the item "Wages" in some cases (17 in fact), do not represent the actual sum chargeable to labour expended in earning store revenue, but have been manipulated for competitive reasons to reduce factory wage costs.

Cartage out of Stores.

In four selected companies, a minute examination of the amount time absorbed in delivery of stores was made. Two of the four companies delivered a moderate amount of supplies by lorry-drivers. Although no trading store was maintained, quite a fair amount of farming supplies was handled in the nature of oil, machine parts, cans, rubberware, seeds, stock-feed etc. The other two companies maintained a large store each, and both had extensive deliveries.

With the first company, 12 per cent of the cans had supplies inserted by lorry-drivers when they assisted on the cream reception stage by receiving cans from the can-washer and inserted cream tally dockets. The stores had been prepared for delivery by a member of the factory staff. Cream collection averaged 1,653 minutes, and of this 3 minutes 7 seconds were taken in connection with stores. In each case, the time was taken in noting down messages, or orders, or requests for stores or parts.

In the second company, which handled only a very small quantity of stores, 5 per cent of the cans had supplies inserted, and the total time attributed to stores was 4 minutes 10 seconds out of a total collection time of 491 minutes.

In both these cases, less than 1 per cent of time was consumed in handling stores from the lorries. This point is being stressed a little because it is not uncommon for companies to charge anything from 5 per cent upwards of cream collection costs to stores; this being based largely (usually almost entirely) on weight of stores rather than time consumed handling stores.

In the first company it was difficult to obtain an idea of the weight of the supplies delivered, but from observation, the total daily suppliers did not appear to be more than 2 or 3 cwt. at the most. As the daily load of cans with cream totalled 38,392½ lbs., it would appear that the actual weight of stores was less than 0.1 per cent.

In the third and fourth companies the number of cans that had supplies inserted varied from day to day. During the course of two weeks, from 46 to 65 per cent of the cans received insertions of stores. In addition to insertions, bulk stores were also carried. In one company, each lorry averaged 2.4 44-gallon drums of petrol, 4.3 large sacks of produce besides smaller articles such as 12 gallon drums, smaller sacks, parcels, galvanised iron and piping, and machinery.

The third company averaged a total time out on cream collection of 851 minutes per day, and of this, 24 minutes 2 seconds was attributed to stores handling. This is under 3 per cent of total running time. The average distance of each supplier from the company's store in this case was 14.9 miles.

The fourth company averaged a total time out on cream collection of 795 minutes per day, and of this 15 minutes 54 seconds was attributed to stores handling. This is approximately 2 per cent of total running time. The average distance of each supplier from the company's store was 11.8 miles.

These last two companies are typical companies, and may be taken as a fair representation of what exists in relation to store deliveries throughout the larger dairy company stores in New Zealand.

It must be pointed out that many companies charge against "Cartage Outwards", (of Stores), a sum that is considered equitable to what freight would have cost the supplier, had the commodities been delivered under normal transport rates. But this attitude rather belies the issue that is raised. Being a co-operative enterprise, the cartage out should reflect only the expenditure actually incurred.

An analysis of items actually charged to "Cartage Outwards" is now given, and conclusions will be deducted:-

Twelve companies were examined and it was found that aggregate store cartage amounted to 18.04 per cent of total cream collection costs. Of these eleven companies, 5 had store cartage costs amounting to less than 10 per cent of total cream collection costs, 3 companies were from 10.1 per cent to 20.0 per cent; 2 companies were between 20.1 and 40.0 per cent, and the remaining two above 40 per cent.

It would appear therefore that certain companies have purposely charged stores expenditure with cream collection costs in order to reduce the latter. It must be pointed out, however, that this term "cartage out" includes certain store-truck running expenses and miscellaneous other expenses. In most cases the store-truck running is partly chargeable to inward freights (which are added to purchases), because the vehicle was utilised in transporting purchases into the store. But this item does not materially alter the diagram that follows.

Figure 15 compares cream collection costs with store haulage costs in twelve companies, and illustrates the extent to which cream haulage costs have been reduced by "shifting" them partly to stores expenditure; and the probable effects of the comparative costs of each company's nearest neighbour.

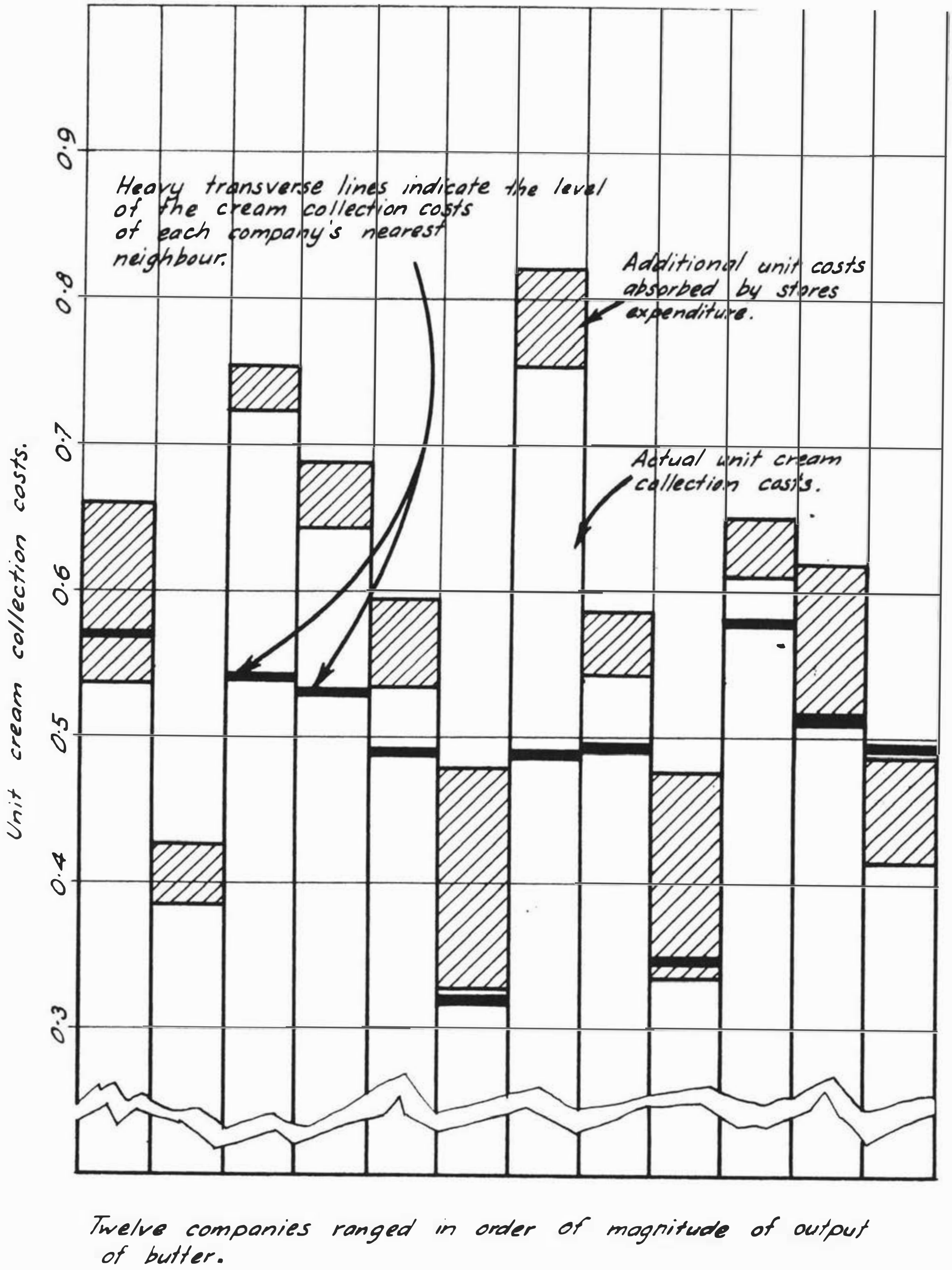

Figure 15. Graph (Frequency Polygons) Illustrating the Difference Store Cartage Appropriated to Cream Collection makes to Cream Collection Unit Costs.

Included in the diagram are heavy transverse lines that indicate the level of the nearest neighbouring company's cream collection costs. It is evident that in some cases there has been a conscious effort to equate costs to the level of the competitor.

Administration: Twenty-three companies charged part of their Directors' Fees and Expenses against store expenditure. In one company, Directors' Fees etc., amounted to 15 per cent of total expenditure, which is exceptional, while another company's charges for Director's Fees and expenses were just two-thirds of that charged against butter manufacture. However, when other companies' charges exceeded this, varying from 66 2/3rds to over 134 per cent of that charged against butter making, it is clear that store expenditure had become a "clearing-house" for butter expenditure.

Other Expenditure: Office Expenses too, bore more than its fair share in a number of cases. In no less than five companies, the Office Expenses of the store exceeded the total of Administration and Office Expenses for butter-making which included secretarial duties, but in no case did the secretary report more than 10 per cent of office time was devoted to stores, orders etc. In fact, the 5 companies averaged 142 per cent of the sum charged against Administration and Office Expenses for butter manufacture, whereas the time devoted to stores orders in these five cases averaged 3 per cent, while the average store business (i.e. gross sales) was just 19 per cent of their total activities.

Audit likewise, in a number of cases attracted a fair portion to stores expenditure, there being four cases in which the amount charged to stores exceeded that charged to butter. In one case (an extreme example), some 160 per cent more was charged to stores than to butter, but this mal-practice appears worse when the extent of the stores activity is disclosed - it was just 6 per cent of total activities in terms of sales of stock compared with butter manufactured.

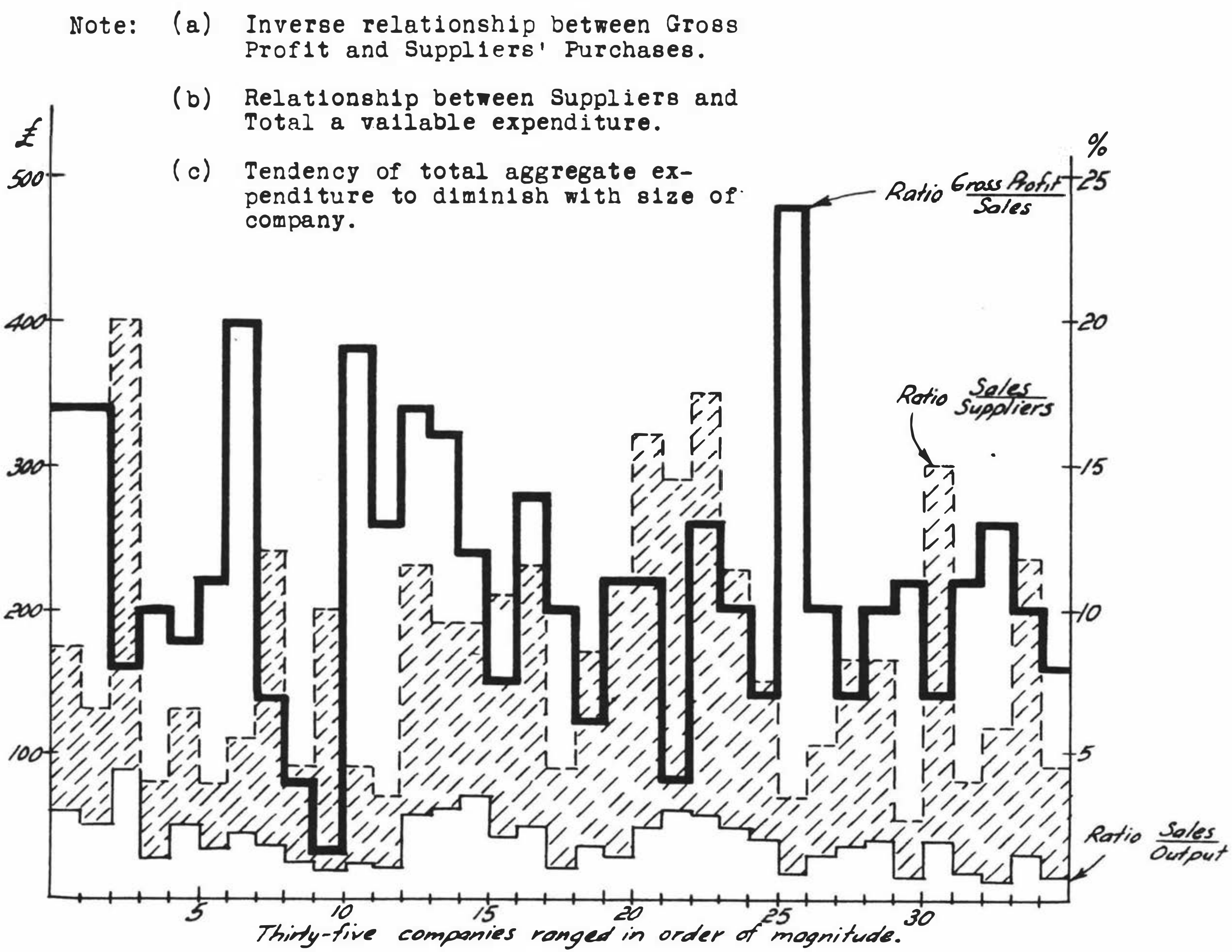

Figure 16. Relationship between Gross Profit, Sales, Suppliers, and Output of 35 Companies in Relation to Store Trading.

Other items of expenditure also bore in a few isolated cases an undue proportion of store expenditure. It was observed that most companies charged at least one item a little heavily, while about one half of the companies charged at least one item extremely heavily, whilst in two or three cases store expenditure was used in a way that left no doubts as to the intention of those responsible for the allocation of expenditure.

Conclusions: The problem emerges: Are the auxiliary activities efficient and do they promote efficiency in butter manufacture?

In the first place, the problem of efficiency is difficult to determine due to the way in which true costs are manipulated to absorb butter manufacturing costs. In the second place, it is true they are fulfilling an important role in the structure, organisation and scale of the butter industry because:-

(a) They serve to attract and retain the patronage and goodwill of suppliers.

(b) They afford a real service, not only to actual suppliers, but also to the farming community.

(c) They serve to utilise more fully, capital, plant, equipment and labour, thus enabling, in measure, manufacturing costs to be minimised by utilising economic capacity to the full.

(d) They augment the total distributable funds available to suppliers.

Granted these advantages, auxiliaries tend to become more efficient with scale. For example, the total expenditure in stores-trading diminished with scale from expenditure being approximately 9 per cent of total sales per company, to approximately $2\frac{1}{2}$ per cent with the largest stores. That is, selling and administrative costs per unit of sales, diminished with scale. The same result was found with the manufacture of butter-milk powder, where not only did unit costs fall steadily with scale, but also the quantity of powder increased per unit of butter manufactured. Results varied with casein, but there was no marked decrease in costs with scale. Rather, unit costs were constant, but with marked individual deviations from the average, for deviations ran from £20 to £71 per ton. The same remarks apply to the various milk powders which ranged from £38 to £79 per ton for a given type.

Whereas store-trading and buttermilk powder were generally operated under relatively efficient conditions as revealed by trend and smallness of unit deviations, casein and powders were often inefficient as revealed by range and deviations. This inefficiency was the outcome of lack of capacity, technical skill, waste, and maladjustment, and inferior quality in certain cases.

The above remarks refer to functional or manufacturing efficiency. As regards capital efficiency, it would appear that in the smaller companies where by-products are manufactured and auxiliaries undertaken, there is a smaller capital outlay per unit of produce manufactured than where only butter is made. The same applies to larger companies generally, where there appears to be some degree of capital efficiency resulting from auxiliaries, but not so marked as with the smaller companies.

Generally speaking, therefore, auxiliaries do fulfil an important role in the butter industry for they permit more efficient utilization of capital, labour and resources in butter making, and provide certain sources of revenue and services for suppliers. Relatively speaking, efficiency marks most auxiliaries although casein and whole-milk powders are open to question in some cases. Store-trading is generally well-run and efficient, and provides approximately £90,000 in rebates* (which are disclosed in the appropriation accounts) and also absorbs approximately £60,000 of expenditure which should be a correct charge on butter manufacture.

Thus auxiliary activities play an increasingly important part in the economic aspects of the butter industry. They permit more effective and complete utilization of all factors of production (including waste products) encourage diversification and flexibility of resources, supply a range of specialised services to suppliers, and augment the revenue of an already undercapitalized industry.

* Refers to <u>all</u> butter factories.

PART VI.

SYNTHESIS

SECTION I. INTRODUCTION:

Part VI will attempt to synthesize the analysed data of Parts II to V. Whereas these earlier sections measured the relationship between output and cost for their various functions and indicated at what point in an array of successive outputs unit costs were at a minimum for these functions, cost-size relationships of the aggregate of functions and processes will now be analysed and optimum scale determined for the industry. Section II will measure cost-size relationships and Section III optimum scale.

Other relevant considerations affecting the internal (or endogenous) efficiency both of individual companies and the butter industry will be reviewed in Section IV. These elements, which may be controlled or affected directly by managerial decisions in the individual company are:

(a) the problem of waste,
(b) the problem of fluctuations,
(c) the problem of capacity,
(d) the problem of maladjustments.

Section V will consider those external (or exogenous) factors which influence industrial efficiency as a whole, and which cannot be directly controlled by individual companies. These factors include:-

(a) institutional considerations,
(b) environmental considerations,
(c) structural considerations,
(d) dynamic considerations.

The final section will then briefly restate the factors affecting economic efficiency and make certain conclusions.

SECTION II. COST-OUTPUT FUNCTIONS

INTRODUCTION: The purpose of this section is to measure cost-size relationships of factories (plants). To achieve this, it is desirable to select concepts of cost and scale that are theoretically relevant and empirically measurable.

There are two distinct problems of size-cost relationships - (a), a given fixed plant and variations of cost associated with it having to handle varying inputs within a given upper limit, and (b), different sizes of fixed plant, each with its own set of short-run variations.

Factors that are peculiar to the butter industry: In the butter-making industry, factors affecting costs and scale vary from the usual theoretical model of a manufacturing unit in a number of ways. In the first place, the intake of the main raw material (cream) cannot be increased at will, but is subject to the fluctuating physical productivity of a given limited region or area. Secondly, the main input factor (cream) is not constant throughout the year, the seasonal character of supply being determined by climatic and geographical conditions. This causes a plant to operate under conditions of maximum physical capacity at the height of the season, and at gross under-capacity in the off-season. Thirdly, the price paid for the main input factor does not affect materially the amount of cream offered in the short-run. In the long-run however, the over-seas realizations of the finished product and other allied dairy products have a marked influence both on the quantity of whole milk produced, and the amount devoted to butter as distinct from other dairy manufactures. Fourthly, selling expenses do not enter the pattern of costs of the individual plant (factory) or firm (company), while the distribution expenses of each unit can be determined in advance for a given output.

Fifthly, in the butter industry, the determination of the optimum size or scale of plant, (that point in an array of alternative fixed plant capacities, at which unit production costs are a minimum), is of greater significance to a co-operative processing industry than to a manufacturing unit producing and distributing under varying demand conditions. In the latter instance, it is not the lowest cost of the unit produced that is significant, but the maximization of the present value of future expected earnings. But the dairy manufacturer aims to minimise his annual processing costs (and thereby maximise his payout to suppliers) for his present and prospective supply is determined for him by his supply area, by seasonal variations due to climatic conditions, and the strategic possibility of holding or attracting other marginal suppliers.

There are certain factors that simplify the measurement of cost-size relationships. Firstly, the data are relevant to one homogeneous product manufactured only, so that prorating of costs between multiple products does not apply. Secondly, the stage of technology is such that, broadly speaking, the same technique, plant, equipment, organization, and even pattern of buildings are generally employed by factories in their own appropriate output bracket. Thirdly, the observed values of output and costs apply to the same period, so that corrections for lag are not necessary. The period selected (a year) covers the complete cycle of activities and consists largely of recurrent fixed costs, the only outlays expected to contribute to more than one accounting period, being depreciation and other methods of fixed assets replacement in certain instances.

The Problem: The problem is to derive a functional relation between output and cost. The notion of a cost function implies that all other considerations that determine costs are impounded in ceteris paribus. These considerations include factor prices, selling costs, the stage of technology, rate of utilization[1], managerial ability and scale.

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[1]The rate of utilization refers to the extent, (or rate) or degree of intensity of use (utilization) of factory plant and equipment. It is related to Output, for total output is the aggregate of the daily rates of use applied to the input factors available. As such, rate of utilization, is closely related to seasonal variations, for the intensity of use varies hourly, daily, weekly, monthly and yearly. Thus the choice of a unit of time is pertinent to the concept, and as the annual period is the unit of time logically employed (owing to the seasonal character of the industry), the rate of utilization as a concept loses its significance.

Limitations: It is very difficult to build on an existing theoretical foundation, a pattern of costs which will be the theoretical counterpart of a static fixed-plant model, for, apart from confusing ex ante and ex post costs, it would be necessary to assume that plant and equipment was fixed, prices of input factors were constant, and that technology, skill of workers and managerial efficiency remained unchanged.

To build on an existing theoretical foundation would necessitate the use of short-run and long-run concepts, whereas any cost function clearly goes beyond both, although both short-run and long-run adjustments may be used. The statistical approximation of the short-run cost function involves the elimination of those factors other than output variations which impinge on costs (those expenses of production which are incurred in operating a plant or factory). The money costs or expenses of production depend on prices and quantities of factors employed. By assuming price constant (or by use of deflation or regulation of prices), the cost function will be determined by the quantities of factors employed. "Thus the underlying determinant of cost behaviour will be the pattern of change in the factor ingredients as output varies."[2] This changing pattern is, (assuming fixity of plant), determined by the extent to which the fixed production facilities can be segmentized into small units to avoid or postpone rising marginal costs.

Further, the theory of costs deals only with real costs, viz. those factors made available, whereas the data used in empirical costs are derived from accounting records which deal with contractural or imposed costs. There will be some divergence, moreover, of empirical from theoretical cost functions, for all real costs cannot be included. The typically ideal conditions of a theoretical model cannot be reproduced in practice due to changing conditions, managerial inertia, structural rigidities and the roughness (inaccuracy) of the data available. Further, statistical data are always taken from situations which may be undergoing dynamic change, so that the statistical conditions of theory can never be fulfilled, only approximated.

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[2] Joel DEAN: The Relation of Cost to Output for a Leather Belt Shop: Tech. paper 2: 1941, National Bureau of Economic Research, New York, p. 4.

The short-run cost curve of theoretical economics is a curve plotted from the varying costs related to alternative outputs of a given plant with fixed scale at a given point (or for a unit) of time. The theoretical short-run curve then, cannot be constructed practically and refer to one plant, unless the given unit of time is long enough to enable the alternative outputs to be of sufficient quantity and variety to compute the data required. If the span of time is sufficiently long to obtain a variety of data, then those factors which, by definition require to be constant or fixed, tend to change; if sufficiently brief to avoid change, then the data are inadequate in terms of variety.

The long-run cost curve of theoretical economics, traces the lowest possible cost of producing any output, when the plant or firm has had adequate time to make all desirable adjustments. This requires holding constant technology, managerial efficiency, factor prices, and skill of workers through a sufficiently long period to permit adequate adjustment of fixed factors in a given factory. Practically, owing to the fixed character of the supply area, there are no cases available of long-period planning or growth or expansion of sufficient magnitude to obtain an "envelope" of short-run A.C. curves. While there are cases of expansion, these are usually the outcome of technical development rather than increase of scale. The only instances are those of merger, and in these cases, a discrete expansion occurred with immediate change in managerial efficiency and technology. The very long periods of time over which other fixed factor changes have occurred, have been complicated by other factor changes including technology.

<u>Selecting an Approach to the Problem</u>: To obtain adequacy of data, it is necessary to include both short and long-run adjustments to the cost relationships, selecting the most effective way to minimise theoretical and empirical differences. The following ways were available:

(1) To analyse the changes in a single factory whose output was suddenly increased due to merger, other factors remaining constant.

(2) To analyse the changes in one factory over a given period of years.

(3) To analyse the changes in differences in actual costs of factories of different sizes for one season (a year).

(4) To analyse the difference in actual cost of different output factories owned by one company for a season.

Only one small factory was able to meet the theoretical requirements of short-run criteria to any marked extent. This small isolated factory, which was making less than a third of a million lbs. annually, suddenly at the close of the season was obliged to absorb the suppliers of a cheese factory which ceased to operate. As management, labour complement, factor prices and technology, as well as plant remained the same, any change in unit costs could be ascribed fairly to output alone. That is, taking the given point or unit of time as one year, two alternative cost-output data were available in terms of short-run criteria. The following cost differences resulted: (in terms of unit costs)

	1949 season	1950 season
Lbs. of butterfat ('000s)	323	595
Cream collection	1.077d.	0.852d.
Wages	1.007	0.737
Total Manufacturing Charges	2.228	1.837
Power, Fuel, etc.	0.351	0.275
Depreciation	0.018	0.079
Factory to F.O.B. charges	0.428	0.392
Overhead charges	0.681	0.376
Total unit costs	4.631	3.739

Total unit costs dropped to 81% of the previous season. Wages dropped to 74%, Administration to 55%, Cream collection to about 80% and F.O.B. charges to 91% of the previous season. Depreciation arose - meaning that previously it had been minimised, but now with reduced costs more could be appropriated to this provision. This latter element illustrates an outlay expected to contribute to more than a single accounting period - an arbitrary method of fixed asset replacement, which may not relate to the accounting period under review.

Total costs, when plotted against output, revealed a much shallower regression gradient than that of all factories, or of the 14 factories, which were examined. It was considered that the data were quite inadequate to derive statistical relationships, although approximating the theoretical requirements.[3]

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[3]The following graph shows that the actual outputs may be like the (cont.)

(2) The data for one factory operating over 14 years was available. During this time, plant was relatively fixed, managerial efficiency was assumed to be constant (the same manager covered this period), there was a degree of change in labour utilization and technology, and factor prices varied considerably. Output variations were moderate, and theoretical conditions were approximated by deflating factor prices by using the Locally Produced Commodities Index of Wholesale Prices. Plant was assumed constant, and although there was some modification in technology, it was insufficient to disqualify technology as a short-run component. However, when plotted, the relationships between costs and output were irregular and showed no statistical trends. It was considered that the 14 year period covered (it included the war years), was too short and a-typical to indicate any true short-term relationships.

(3) When all factories are examined for one season, differences in scale alone disqualified this approach as a short-term one. As a long-term approach, certain factors may be held constant, such as factor input prices (by using standardised factor prices to remove the effect of locational differences). But other factors such as managerial efficiency and rate of utilization vary and thus impair the approach as approximating long-term criteria.

These latter short-comings could be "corrected" by a "cross-classification" of data which included in one group only those factories almost identical in plant and technology, provided all factor prices were standardised and the

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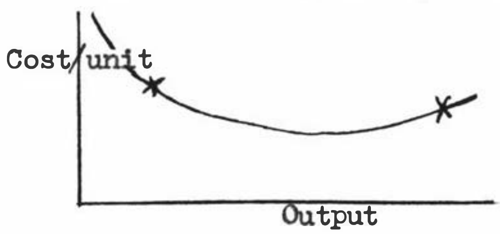
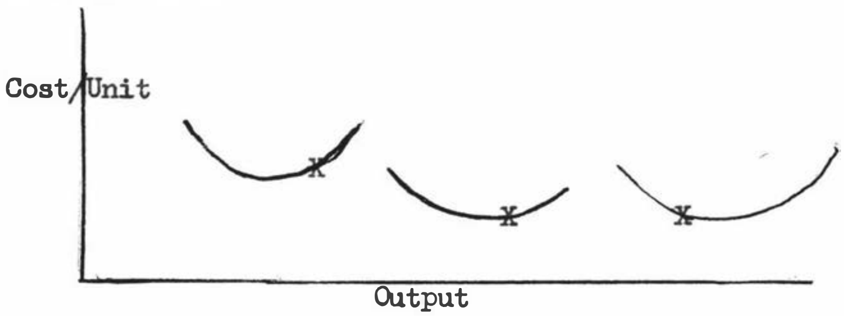
3(cont.) points "X" in that they refer to dissimilar points on one fixed plant curve for the two periods of output. A line through the X's tells us little owing to the inadequacy of data.



factories were located in similar geographical (climatic) areas. But such cross-classification would tend to fragmentise the data to the point where the number of observations would be too small to ensure statistical reliability. Such cross-classification would still require correction for managerial ability. The following graph shows how inadequacy of data arising from cross-classification may be misleading, for the actual outputs collected may be like the points X, and refer to dissimilar points on the various fixed plant curves of the different factories. A line through the "X's" is only misleading.



(4) Where a number of factories come under one administration, with standardised methods and procedures, it is considered that any variation in technology, skill of workers and managerial efficiency, would be at a minimum and would not require correction. Being in the same area geographically, the rate of utilization of plant (seasonal throughput), would be similar, so that provided all factor prices were standardised, the only element requiring consideration would be that of scale.

Some 16 factories met the above requirements, but as two of them had dissimilar techniques from the others, they were deleted from the data. The 14 remaining factories ranged from medium to large output, and as such provided an approximation to long-run conditions, but even so, were not free of the disabilities of the "cross-classified" factories in that the number of observations were inadequate. These 14 factories, moreover, could be divided into three types of similar scale, and as such would provide short-run conditions, and could be used as such, apart from their inadequacy.

It was therefore decided that a functional relation between cost and output should be obtained (a) from an analysis of the data of 14 factories administered by one organization, and (b), from the data of all factories. In this way the theoretical and empirical differences would be minimised.

Average or Total Cost: In earlier sections of the study, average cost relations were used to bring out changes in various functions. Although average costs "highlight" changes clearly, and are useful for denoting the optimum scale of operations of any function, they have certain weaknesses which detract from their usefulness in regressional analysis.

Some of these weaknesses are aptly stated by Joel DEAN as: "First, selection of the most suitable specification for the average cost function is more difficult. Second, slight errors in the choice of the function produce magnified errors in the derived marginal cost function. Third, since average cost is a quotient of two variables, each of which is subject to error, the statistical distribution of the quotient may be less likely to conform to the assumptions upon which multiple regression analysis is based."[4] In his pioneering study of empirical costs, Dean found that "analyses in the form of total rather than average cost yields more convenient and reliable findings".[5] Although Dean probably found linear regression simpler (therefore more "convenient") to compute, his observation is especially true when the Total Cost is linear, for the Marginal Cost is simply the coefficient of the net regression of Total Cost on Output. This is borne out by Ruggles, who says: "The findings are almost universally linear total cost-output relationships, and therefore the Marginal Cost derived from such linear functions are naturally constant over the observed range of output".[6] Other workers confirm these remarks.[7]

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[4]DEAN, Joel: The Relation of Cost to Output for a Leather Belt Shop. Tech.Paper 2. National Bureau of Economic Research, Dec. 1941. New York. Footnote 27, p. 20.

[5]Loc. cit. p. 20.

[6]RUGGLES, Richard: "Concept of Linear Total Cost Output Regressions": Am. Econ. Record. Vol 31, 1941. p. 332.

[7]See DEAN, Joel: "Statistical cost functions of a Hosiery Mill", Studies in Business Administration; School of Business. Univ. (cont.)

Another shortcoming arises from the mathematical bias which is present when average costs are related to output statistically. Average costs are sufficiently logical as a concept, but represent the ratio of $\frac{\text{Total Costs}}{\text{Output}}$. When Average Costs become the mathematical function of output, a curvilinear bias is introduced. This may be seen readily when Average Costs are correlated with Output, for $\frac{\text{Total Costs}}{\text{Output}}$: Output, is strictly Total Costs: $(\text{Output})^2$, which is a quadratic expressed mathematically. This may be seen from any two series of observations that are perfectly correlated, by squaring one series - which reduces the correlation coefficient. Although the bias is not great statistically, it exists.

It was decided then, to use total cost data related to output of varying fixed plant capacities to determine the cost function. It cannot be claimed that the function is strictly a long-run cost function, but it is an adaptation of long-run techniques in that the theoretical model refers to one firm adjusting its scale through time, whereas the following approach used examines a multiplicity of not dissimilar factories with varying scales for a given (brief) period.

THE COST FUNCTION

Procedure: The general procedure followed was (a), subjecting all data to graphical reconnaissance, (b), considering other independent variables which might contribute to the total cost function, (c) plotting selected data on simple, partial and double logarithmic scales, and (d), submitting data to regressional analysis. As preliminary scatter diagrams suggested linear relationships between total costs and different variables, other possible independent variables were then considered.

7(cont.) of Chicago, Vol II, No. 4 (Chicago, 1941) pp. 19 ff; Philip LYLE, "Regression Analysis of Production Costs and Factory Operations" Oliver and Boyd (1946), Edinb. pp 3-5, 107-111 and p. 184; K.H. Wylie and M. Ezekiel, "The Cost Curve for Steel and Industry", Journal of Political Economy. Vol 48 (1940). pp 777 ff.

Other independent variables: In addition to Output, the following independent variables were examined:

Seasonal function.
Supplier function.
Rate of utilization.
Transport.
Labour Turnover.

It was considered that any independent variable to be included should satisfy the following tests: (a) contribute to a significant part of the cost variation, (b) be independent of other variables by indicating little inter-correlation, and (c) have a relatively low standard error of estimate. It was assumed that the dependent variable (cost) alone was subject to error, as the main objective was to determine or estimate costs from independent elements rather than discover mutual functional relationships.[8]

The first two independent functions were considered as elements affecting total wage costs[9] for the industry in Part II, Sect. V.., and as seasonal costs in Section VI, pp 46-50,and by multiple regression analysis in Section

They (called "Seasonal and Supplier coefficients" in the multiple correlation analysis), were scrutinised by the criteria of goodness of fit (multiple correlation coefficients), absence of multicollinearity (by bunch map analysis), and significance of estimates of parameters (standard errors).

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[8]It is recognised that all variables are subject to error, and that to obtain reliable statistical relationships it would be necessary to employ confluence analysis. But although errors do exist in the independent variables, it is the dependent variable which is more subject to error due to inaccuracies of accounting data, omission of certain allocated overheads, and other correction devices.

[9]It is more accurate to consider seasonal and supplier influences as affecting Wage costs than Total Costs as other influences are excluded.

While showing sufficient statistical correlation to be significant, these variables were markedly inferior to the other variable Output. The measures of Partial Correlation and S.E's of Regressional Coefficients suggested that the Seasonal and Supplier functions failed to contribute significantly to Total Costs. Moreover, bunch map analysis confirmed sufficient intercorrelation of these variables to warrant their exclusion from the present cost function analysis. Although the Supplier coefficient could be considered as a useful regressor for other purposes, its inclusion in the present cost function would be superfluous. The Seasonal coefficient, moreover, was even less significant that the Supplier coefficient in all respects. This fact, then, also ruled out the third independent variable (Rate of utilization), for the extent (or rate) of utilization of factory plant and equipment is a direct function of the Seasonal coefficient.[10]

The fourth possible independent variable, Transport, has been considered at length in Section III, where certain elements were analysed by multiple correlation analysis. Owing to such a high percentage of contractors' costs entering transport cost structure, the true character of transport costs are obscured and do not permit comparison for the full range of factories concerned. Further, as Transport costs are a function of geographical location, it was considered that this element of cost should either be held constant or eliminated from total costs.

Labour Turnover, the fifth possible independent variable is a function of Labour Costs and was examined by multiple correlation analysis in Section V, of Part II. pp 76-83. Wages, itself proved to be of no statistical significance in the multiple regression. Accommodation appeared to be related, but is a function of location and scale. The remaining independent variable, Output, with which Labour Turnover shows a distinct statistical relationship is significant by way of its high negative correlation. That is,

[10] Although not statistically significant, these coefficients nevertheless are important elements in economic theoretical argument. See the principle of "Frequency of collection" which is amplified in Part III, pp. 121-123.

Labour Turnover is highly correlated negatively with Output, and as such must be excluded from the cost function.

There remains one function which possibly is related to the total cost function - the managerial function. Managerial ability is that differential efficiency in organization seen practically in planning, delegation and supervision. It is most difficult to measure this function, as cost ratios may or may not be related to managerial ability. Some attempt has been made in Section V, of Part V, pp. 206-216, to assess managerial ability in terms of unexplained residuals of various elements of costs. But it defies precise measurement, and may be related to the deviation of individual factories of the linear regression of total costs (other factors held constant). Clearly, it cannot be included as a measurable factor in the cost function. Accordingly, it was decided to use Output and Total Cost as the Independent and dependent variables for cost regression.

The data: This consisted of (a) the data covering 14 factories owned by one company, and (b) the output and cost data of 108 factories including and excluding (a) above.

The following classification shows the output of each of the 14 factories in annual lbs. output together with total cost corrected for the factor prices of wages, power and materials.*

Factory Output in Lbs.	Corrected Cost in £'s.
15,461,309	71,325
13,509,793	60,937
10,276,667	46,655
9,763,418	50,333
9,321,485	45,367
9,031,660	43,384
7,354,144	36,300
7,039,674	33,033
6,105,013	30,552
5,556,478	28,499
4,035,422	21,001
3,484,713	17,597
3,454,521	19,165
2,895,536	16,795

* These factory costs included Wages as actual man-hours per factory calculated at the average hourly rate for all 14 factories; Materials (cartons and manufacturing requisites) as physical consumption per factory at average standard rates; coal as actual physical consumption at average cost per ton for the 14 factories, and electricity as actual units consumed

at average rates. Factory Overheads (Depreciation, Maintenance, Overhead Wages, Consumable Stores, Rates Land Tax and Insurance, and Sundry Expenses) were calculated at constant rates. Cartage in and Administrative expenditure were not taken into the calculation.)

The data for (b) covering the 114 factories were adapted from the unit costs of all factories, as analysed in Table LXIV of P. 334.

The findings: The following data are the statistical results of simple correlation of the data of 14 factories for cost and output.

Summary of correlation analysis of 14 factories:

Y = Total Cost of Manufacture - the dependent variable.

X = Aggregate output for 1949/50 season.

Statistical constant etc. (N = 14)	Normal data: Crude	Normal data: Corrected
Correlation coefficient	.974 ± .014	.995 ± .003
Coefficient of Determination	.948	.991
Constant a	9.353	4.026
Coefficient b	0.375 ± 0.024	0.432 ± 0.011
Std. Error of Estimate (£'000)	3.367	1.584

The regression equation of the "crude" data is:

$$Y = 9.353 + \underset{(0.024)}{0.375X}$$

That for the corrected data is:

$$Y = 4.026 + \underset{(0.011)}{0.432X}$$

With n = 12, and P. at the 0.01 level of significance, both correlation coefficients were highly significant; (P. = .661, with n = 12). The b. coefficients were both significant at the 0.01 level, (at which "t" = 3.055). The corresponding values for the "crude" coefficient were, t = 15.4, and 39.3 for the corrected coefficient.

The b. constants give the gradient of the regressions and the a. constant (the Y-intercept), defines the distance from the origin to the point of the intersection of extrapolated regression and the Y-axis. The b. constant indicates that for each 100,000 lb. increase in output, costs will at the constant rate of £375 ± £24 for the "crude" data, and £432 ± £11 for the corrected data. It is thus a measure of constant marginal cost.

The same data were converted to logarithms for both variables, with the following results:

Statistical constant etc. (N = 14)	Data for Log. X and Log. Y Crude	Corrected
Correlation coefficient	.990 ± .006	.997 ± .002
Coefficient of Determination	.979	.994
a in Logs.	0.2481	$\bar{1}$.9390
b in Logs.	0.7122 ± 0.028	0.8690 ± 0.019
Syx	0.0237	0.0157

The regression equation for the "crude" data is $Y = 1.771X^{0.7122}$ and that for the corrected data, $Y = 0.115X^{0.869}$. Again, both the correlation coefficients and the regression coefficients are highly significant with P. at 0.01 level, (P. = 0.661 for r., and t. = 3.055 for b.). The t. values for the "crude" b. was 304.5, and 389.3 for the corrected b.

The conversion to logarithms gives a closer fit than does the normal data.

It would appear from the statistical evidence presented above, that the marginal cost is constant within the range of output of the 14 factories. The observations are too few, in spite of the high degree of reliability, to conclude a high degree of linearity, for even a barely perceptible degree of curvilinearity would cause the Marginal curve to be curvilinear rather than constant. Besides, a number of these factories appear at the upper extremity of a range of factories, rather than in the centre of a range. As such, the confidence limits are wider and therefore less reliable. "Since extremes in the volume of output seldom occur as frequently as 'normal' values, and hence do not offer as many points of observation, less confidence can be placed in the shape of the derived cost function at its extremes."[11] Otherwise, with the high correlation coefficient, relatively small Standard

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[11] Cost Behaviour and Price Policy: Nat. Bureau of Econ. Research, New York, 1943; p. 84.

Error of Estimate, and closeness of fit, the results do suggest considerably linearity, but a small degree of curvilinearity is evident from the improvement shown by the use of logarithms, indicating imperfect linearity. The degree of linearity was then examined for 108 factories, from the following statistical findings:-

Statistical constants etc. (N = 108)	Normal data.	Converted to logarithms.
Correlation coefficient	.958 ± .007	.970 ± .015
Coefficient of Determination	.919	.946
Constant a. and a. in Logs.	8.358	.3727
Constant b. and b. in Logs.	0.9974 ± .028	.8329 ± .018
S_{yx}	9.5321	.085

The regression for the normal data is $Y = 8.358 + 0.9974X$, and that for the data converted to double logarithms, $Y = 2.361X^{0.8329}$. With Probability at the 0.01 level of significance, the correlation and regression coefficients were highly significant (P. = .254 for r., and t. at 2.00), the t. values for b. being 32.0 and 43.8 for the normal and logarithmic data respectively.

Again the logarithmic data shows closer fit than that of the normal data for all factories, indicating imperfect linearity. The extent of dispersion from the regression is about three times greater than with the uncorrected 14 factories (which however, have had the influence of geographical location, managerial efficiency, and rate of utilization held constant.)

The 108 factories examined above included the 14 examined earlier, It was decided to exclude these 14 and compare the results (normal data). The correlation coefficient therefore improved from .958 to .9814 ± .004, and the coefficient of determination from 0.919 to 0.963. The b. coefficient moved from 0.9974 to 1.2124 ± .025, indicating the regression had a steeper gradient without the 14 factories. Further, the Standard Error of Estimate had dropped from 9.5321 to 5.673, indicating that the 14 factories had affected linearity and dispersion by their relatively lower cost structure (as a result of a much lower pattern of overheads).

As the 108 factories were compared regardless of scale, they were again classified according to scale and output into small, medium and large size factories, with the following statistical results, (using logarithms):-

Statistical constants etc.	Small	Medium	Large
	N = 27	N = 48	N = 33
Correlation coefficient	.847 ± .079	.832 ± .085	.855 ± .075
Coefficient of Determination	.717	.692	.731
a. in Logs.	0.0154	0.4817	0.3756
b. in Logs.	1.0046 ± .061	0.7500 ± .049	0.8108 ± .050
Significance of t. (=2.00)	16.4	15.3	16.2
S_{yx}	0.0441	0.0631	0.0454

All coefficients are highly significant at the 0.01 level of probability, but certain characteristics distinguish these data from that of the 108 factories. The correlation coefficients are all lower, but the deviation measures indicate a closer fit to the regressions. The slope of the regressions all differ, suggesting the impact of scale has distinguished three linear regressions, the average slope of which has been indicated in the data of the 108 factories. But this relatively small variation in the gradients of the regressions seem to indicate that the segregation of scale has added little if anything to the statistical findings, apart from the change in gradients, which indicates of course, that marginal cost is not constant throughout the range. Other groupings were made, one covering 25 factories of the smallest and intermediate groups, and another covering 23 larger factories. The b. values were 0.9945 and 0.8001 respectively, indicating that the pattern of the gradient varies with the different individual observations included.

The data of the 108 factories were plotted in Fig. 21.

<u>Conclusions</u>: It would appear from the statistical data submitted, that the total cost function hints of slight curvilinearity in all cases and that the marginal cost tends to be/constant otherwise within the limits of the range covered by the data.

These observed relationships are limited in their validity by certain inadequacies which have been discussed and partly allowed for in the findings. The following considerations affect the reliability of the findings however: (a) the adequacy of the sample of the 14 factories, and the extent to which they are representative of large output factories, (b) certain cost elements in the 14 factories were deleted, administrative overhead and cream haulage, (the latter clearly affecting constant marginal cost), (c) the assumption that the 14 factories had similar rate of output, managerial control and technology may be questioned on the grounds that this is so approximately rather than precisely, and (d) the stringency of the criteria that excluded other independent variables from the final analysis.

It is recognised too, that the statistical data may not have been purged adequately of the influence of extraneous variables of factor prices, seasonal input variations, dynamic influences, managerial inertia, labour output variability, and outlays not included in the accounting period. These may be broadly grouped as inaccuracies arising from "roughness" of the data employed, and while their influences tend to cancel out, they must be recognised as short-comings in the attempt to approximate the requirements of theoretical criteria.

Further, the small sample of factories showing constant marginal cost does not imply that the balance of the range of factories necessarily has constant marginal costs too.

The analysis of the 108 factories affords an interesting comparison. It suggests in the first place, that the refinements and adjustments demanded by the criterion of theory (however necessary) do not contribute extensively to the results of unadjusted empirical findings. It suggests in the second place, that scale has probably been over-emphasized as a factor affecting costs. In this investigation, the effect of scale has been reduced by the technical organization of plant and equipment whereby they have been segmentized into a number of similar operating units, any one of which was withdrawn from operation according to the intake of cream at any given time.

To summarize, the derivation of the cost function indicates that the relationship between total costs and output in the butter industry is linear[12] in character with constant marginal costs within the range of output examined.

The above section is of more than academic interest in that all previous known studies of butter manufacturing have assumed curvilinearity and therefore increasing and decreasing marginal costs. It is recognised that each separate function or element of cost varies both in cost gradient and degree of linearity (according as it varies from economic capacity, other things being equal), and that average cost curves show efficiency trends more clearly than do total cost curves, and it may be for this reason that other studies have employed the unit-cost relationships. At any rate, they are of sufficient importance, especially where efficiency is being examined, to be surveyed in a separate section as they throw light on the problem of optimum scale in the butter industry.

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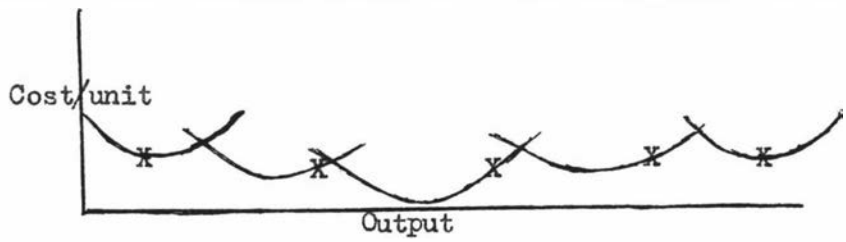
[12] It is recognised that the linear character and constant costs may be an outcome of each factory having only a single output and cost combination. Were alternative outputs available for each factory, a "family" of short-run cost curves could be projected with its "envelope" curve having a minimum point and rising beyond this. Especially where managerial skill does not relate to its own appropriate level is this possible (i.e. curvilinearity). The following diagram shows how linearity could arise in conceivably curvilinear data.



The X's refer to the single output of a factory, while the curves refer to possible outputs. The single output position of the X, could be the result of the factory manager (for example) compelled to work at the level of the skill appropriate to the scale of the factory concerned (as happens in the second, third and fourth cases in the diagram above).
It is recognised too, that curvilinearity of average costs is possible even if total costs rise linearly; and that the slightest degree of curvilinearity in total costs (as is the case above) reflects in some curvilinearity in marginal costs. The summary is a general statement of tendency.

SECTION III. THE OPTIMUM SCALE.

Introduction: The previous Section derived a cost function between Total Costs and Output. Owing to the stringency of the criteria adopted, certain possible independent variables were deleted from the process and other analytical methods deferred. Some of these processes and methods will now be utilised in deriving the optimum scale for the industry.

The meaning of Optimum Scale: By optimum scale, is meant that point in an array of alternative fixed plant capacities, at which unit production costs are a minimum.

Scale is fixed in the short-run, but volume can, and does vary. Volume refers to actual throughput at a given moment or for a given (short) period, and corresponds to the flow or rate of output, or plant utilization. Capacity must be distinguished from volume. Economic capacity refers to the theoretical minimum point of the short-run average cost curve, but in practice, owing to large seasonal variations two other kinds of capacities must be distinguished. First, the maximum physical capacity which relates to the maximum possible output related to a given technology and plant but without reference to a permissible cost limit; second, a technological maximum output related to a given time interval, and also a permissible cost limit. It is in this latter sense that "maximum" capacity is used. Thus with each given scale, there exists a given theoretical economic capacity, a maximum capacity, which is generally reached at the height of the season, but also unused capacity which exists whenever capacity falls below the economic capacity level.

Optimum scale refers therefore, to that scale related to minimum unit costs of alternative fixed plant economic capacities. Such a concept cannot refer to short-run theoretical analysis (where scale is fixed), but to the long-run average cost curve of theoretical analysis, which indicates the lowest possible average cost of producing any output, when the factory has had adequate time to make all desirable adjustments. But the long-run curve is based on short-run curves assuming constant factor price, homogeneity of factors and no change in technology or management (to name a few static conditions), together with the theoretical envelope of tangency points. Now it is practically impossible to locate the tangency point empirically for the statistical observations (if available) would lie above the theoretical cost curve, (except at the minimum point), so that there is an inevitable discrepancy between theoretical and empirical long-run cost curves. Accordingly another approach was attempted - that of cost-output relations based upon average (or unit) cost data from which regressional curves are derived.*

The Difference between Regressional Curves and Theoretical Cost Curves: The regresional curve[13], which traces a cost-output relationship, is a curve plotted from an array of differing average unit cost data of a multiplicity of factories, (arranged in order of output), with varying scale covering a given unit of time.

The essential difference between the regressional curve and the short-run theoretical curve is the latter is derived from alternative outputs associated with different variable costs(but constant fixed costs), whereas the regressional curve is associated with differing variable and fixed costs of all plants or factories for a given (short) period of time. The long-run average curve moreover, refers to one factory or plant adjusted through time as regards scale to trace the lowest possible average cost of producing each possible output. Briefly then, the regressional curve is a practical application of cost-size relationships of all factories with varying scale ranged in output order for a short period of time, whereas the theoretical curves refer to one factory either with alternative outputs related to costs in the fixed-scale short-run, or to alternative scales in the long-run.

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[13] "Graphs of this type have been called Accountants' Cost Curves, Particular Expenses curves (Marshall), and Bulk Line Curves (Taussig)." Jacob VINER, (1931); Encyclopadeia of the Social Sciences, Vol. IV, Macmillan Coy., N.Y. in an article "Cost", p. 472.

* Cost can only be discussed in relation to size, without undue complications, by concentrating on annual average cost as being the short-run cost for the given output with given plant. That is, the seasonal pattern is regarded as given, as any monthly cost allocation cannot be given any firm basis, apart from requiring a varying appropriate fixed plant. It is recognised too, that the actual factory data contain elements of different seasonal distribution intensities, due to varying locations.

Procedure: The point of optimum scale will be located first of all on regressions derived from uncorrected unit cost data. These regressions will then be adjusted as far as possible for other exogenous and endogenous factors.

The following table summarizes unit cost data of the industry. Each class-interval statistic is computed from relevant total costs divided by relevant total output for that class-interval.

LE LXIV. UNIT MANUFACTURING COSTS OF 114 FACTORIES FOR 1949/50 SEASON.

ctory Output ' Butter in lbs.	Unit costs in pence per lb. butterfat										
	Cream haul.	Wages	Mat.	Power	Sdry.	Total Mnfg.	Deprec.	R. & M.	Rates	Insur.	Total Fact. O/Head
der 1m.	0.667	0.952	0.708	0.248	0.023	1.931	0.183	0.182	0.010	0.027	0.402
000,001 - 2m.	0.604	0.672	0.729	0.122	0.014	1.537	0.185	0.128	0.009	0.013	0.335
000,001 - 4m.	0.633	0.570	0.718	0.140	0.017	1.445	0.120	0.113	0.006	0.012	0.251
000,001 - 6m.	0.516	0.433	0.772	0.108	0.007	1.320	0.159	0.096	0.007	0.009	0.271
000,000 - 8m.	0.477	0.375	0.757	0.125	0.005	1.262	0.093	0.105	0.004	0.008	0.210
000,001 - 12m.	0.432	0.315	0.761	0.108	0.018	1.202	0.095	0.088	0.001	0.002	0.186
er 12,000,000	0.419	0.267	0.759	0.151	0.020	1.197	0.067	0.187	0.003	0.005	0.262

nt'd:	Admin.	Dir. Fees	Audit	Interest	Total Costs	No. of Companies
der 1m.	0.245	0.049	0.013	0.019	3.990	29
000,001 - 2m.	0.176	0.036	0.008	0.008	3.191	25
000,001 - 4m.	0.193	0.028	0.007	0.010	3.177	20
000,001 - 6m.	0.116	0.024	0.004	0.020	2.885	13
000,001 - 8m.	0.079	0.013	0.003	0.000	2.874	5
000,001 - 12m.	0.084	0.015	0.002	0.001	2.638	2
'er 12,000,000	0.059	0.010	0.002	0.000	2.828	2

The above table does not include all elements of manufacturing costs. It excludes those elements making up the total charges to F.O.B., and Dairy Farm Instruction and Dairy Board Levy, as these elements are relatively constant apart from scale. The "Total Costs" column, however, includes every element of manufacturing cost, whether excluded or not.

The data from the above table were plotted in the following diagrams, the abscissa measuring the output in millions of lbs. of butter, and the ordinate the cost in pence per lb. of B/F using the weighted averages in the above table. In Figure 17A. the variable elements of General Overheads are plotted on an ordinate which has been magnified to show costs to three places of decimals.

The regression of Administration shows a typical asymptotic curve. The variables themselves, when plotted, yield the typical saw-tooth pattern of a jagged curve decreasing with scale, suggesting in the smaller companies, the effect of discrete incremental factors on the shape of the curve. The curves for "Directors' Fees and Expenses" and "Audit" both show slight asymptotic characteristics with increase in scale. The other cost elements in General Overheads were considered constant - not varying with scale. When aggregated, the General Overhead tends to level out at the 16 to 18 million output level, for the two elements of Directors' Fees and Audit strictly, reach a minimum point at about 11 and 13 million lbs. respectively.

Factory Overheads were also plotted on an ordinate magnified to show unit costs to three places of decimals. "Repairs and Maintenance" appear as a typical U-shape curve with its minimum point at about the 7 million output level. Were more examples available of higher output factories, the extreme of the curve would probably tend to increase at a less steep rate than that shown in the regression. The Depreciation curve shows a typical asymptotic curve with the minimum point levelling out at a point somewhere near the 24 million output level. "Insurance" and "Rates and Land Tax" are of relatively small influence, and both curves reach their minimum point at about the 12 million lb. level and begin to rise slowly. When aggregated, Factory Overheads would appear as a moderately shallow U-curve rising at a much slower rate than the descending

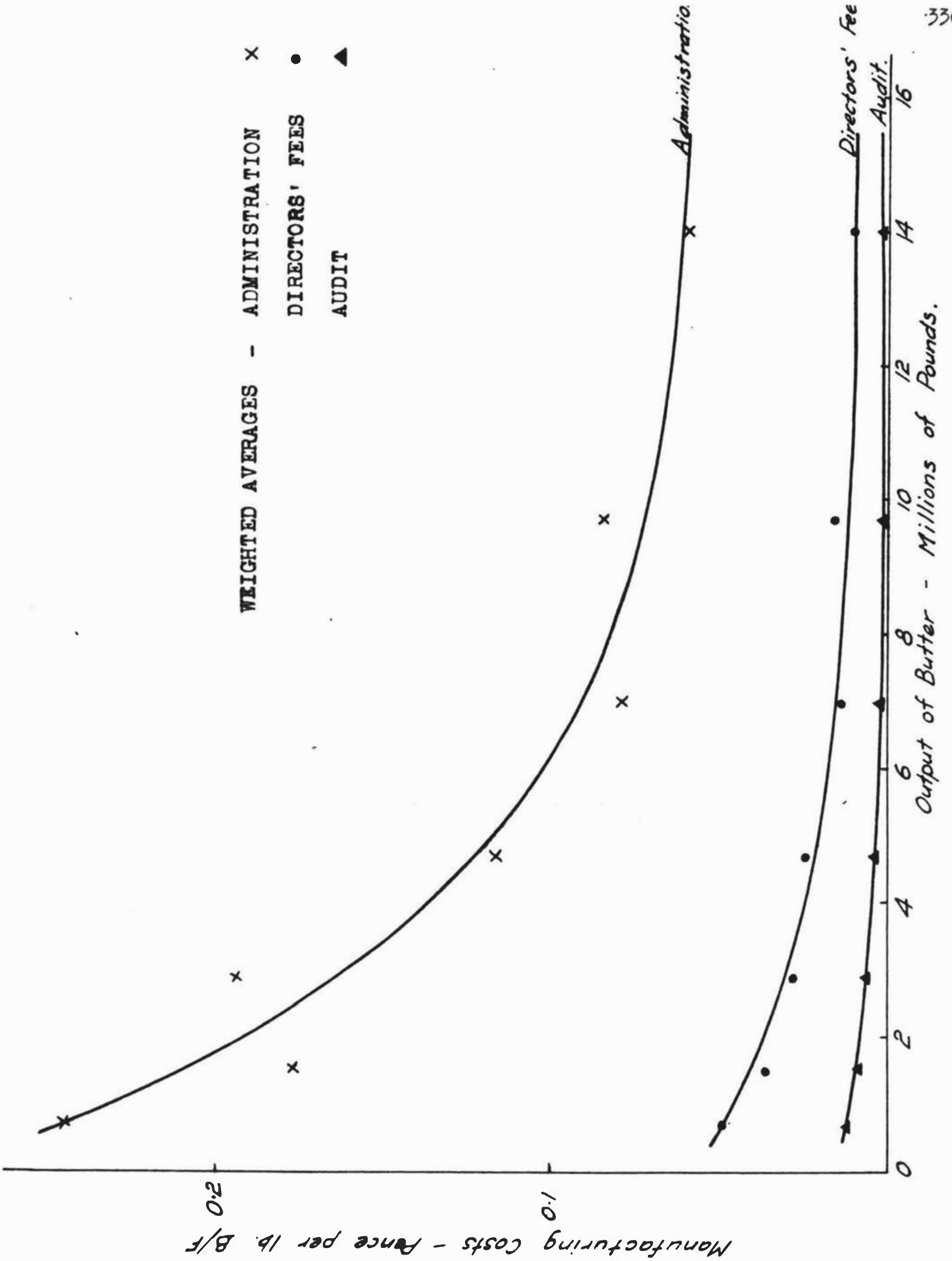


Figure 17A. Relationship of Volume of Production to General Overhead Costs per lb. B/F in all Butter Factories - 1949/50 Season.

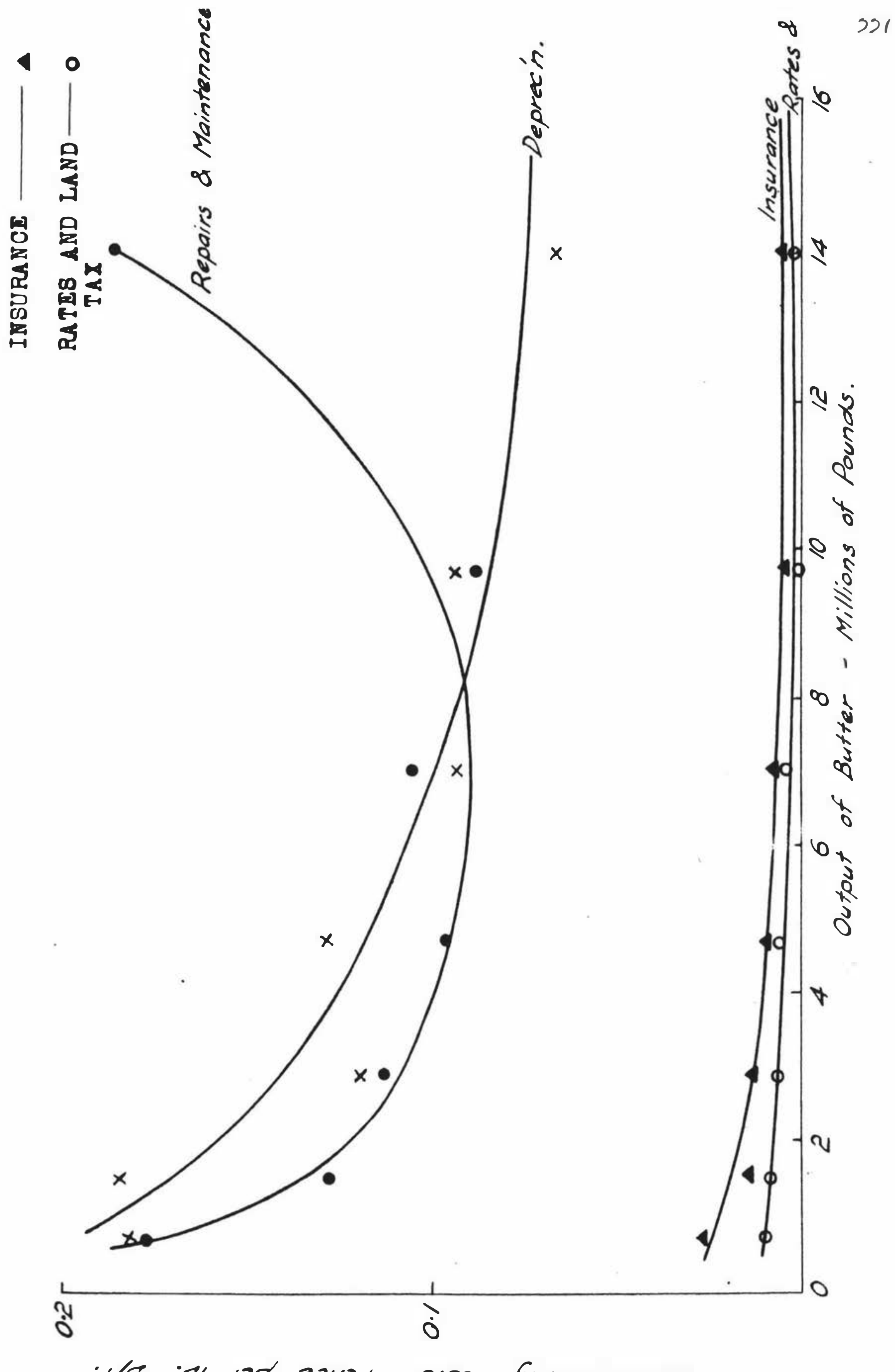


Figure 17B. Relationship of Volume of Production to Unit Factory Overhead Costs per lb. B/F in all Butter Factories - 1949/50 Season.

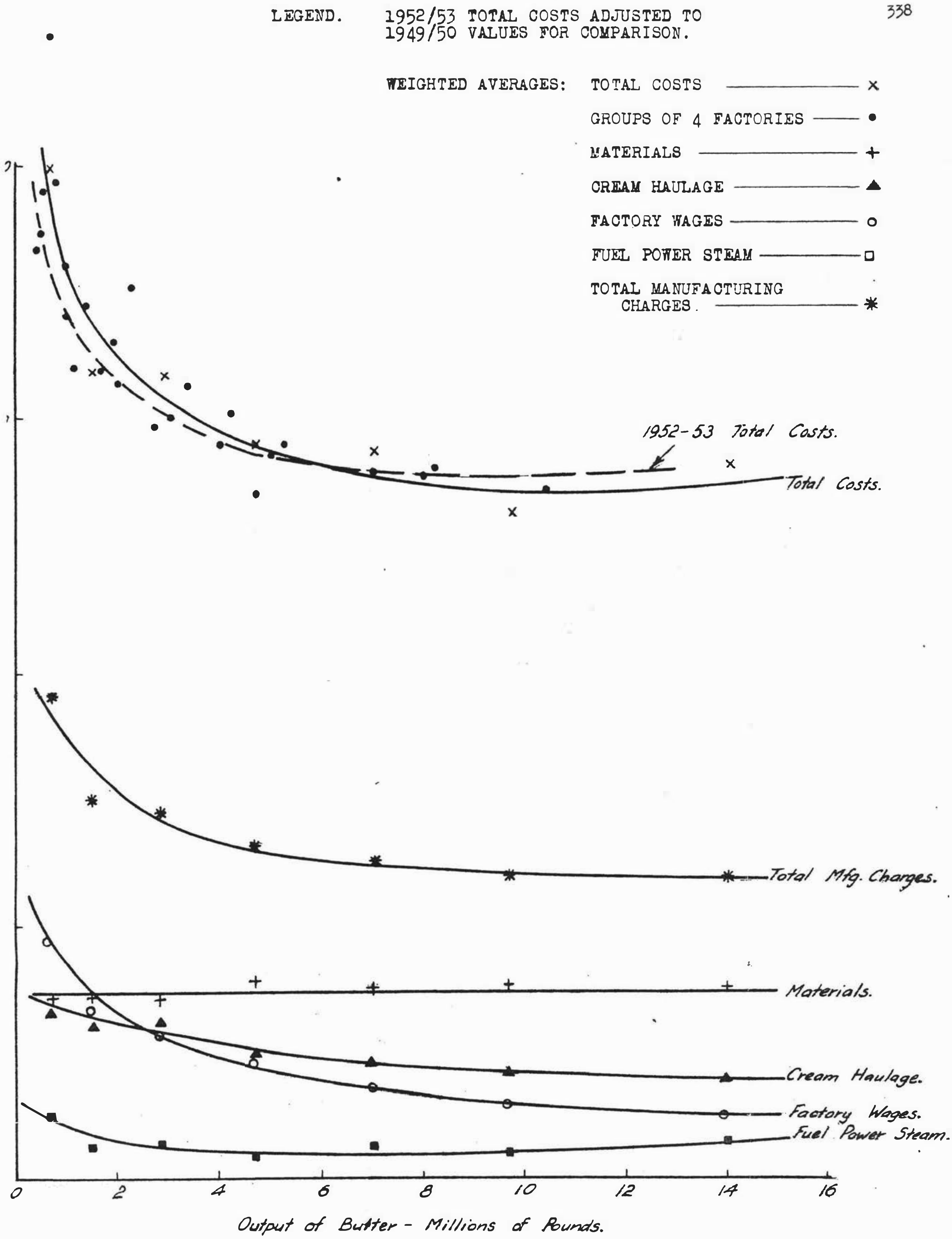


Figure 18. Relationship of Volume of Production to Unit Manufacturing Costs per lb. B/F in all Butter Factories - 1949/50 Season.

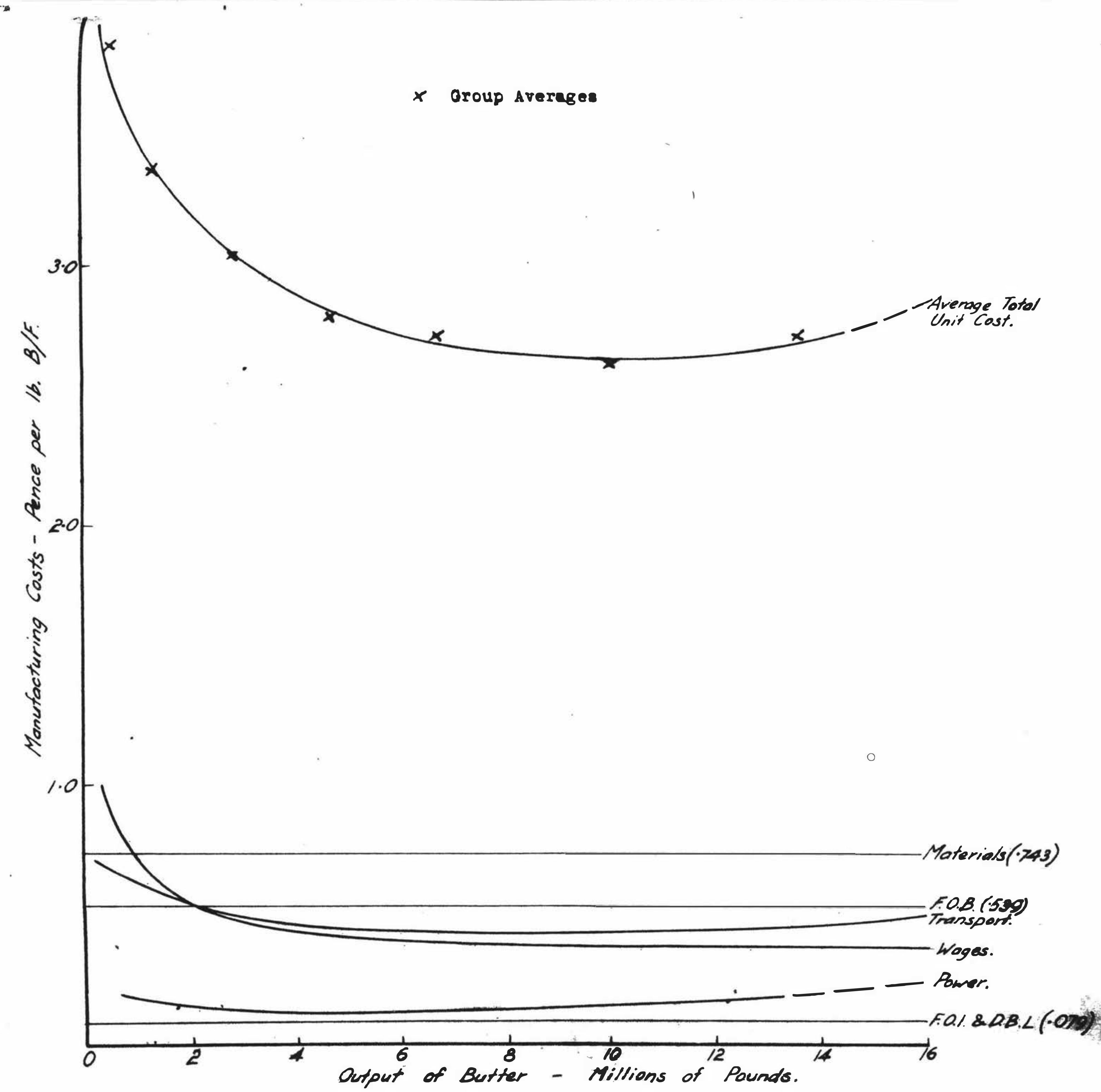


FIGURE 19. RELATIONSHIP OF VOLUME OF PRODUCTION TO UNIT MANUFACTURING COSTS PER LB. B/F IN ALL FACTORIES 1949/50 SEASON - CORRECTED DATA.

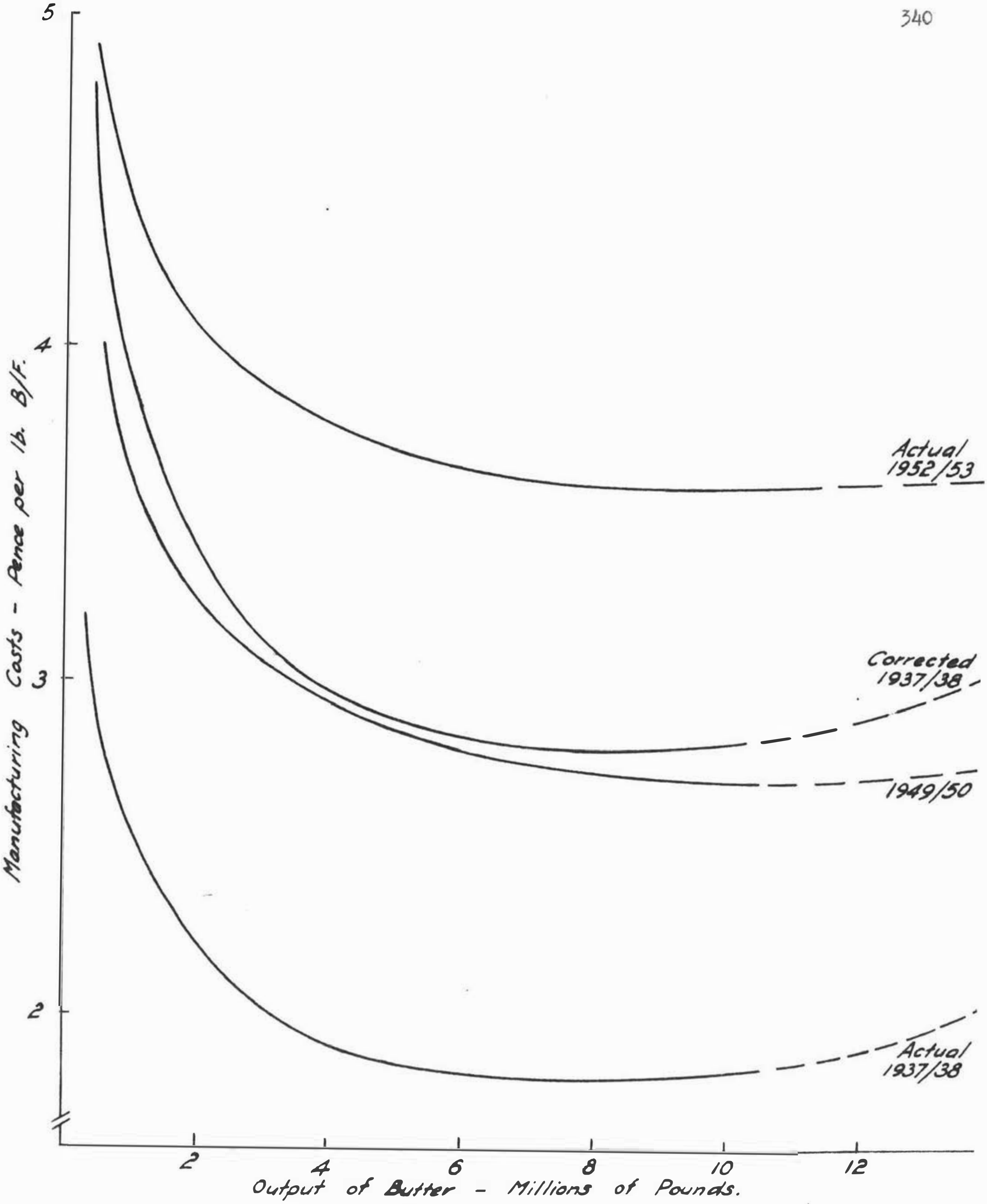
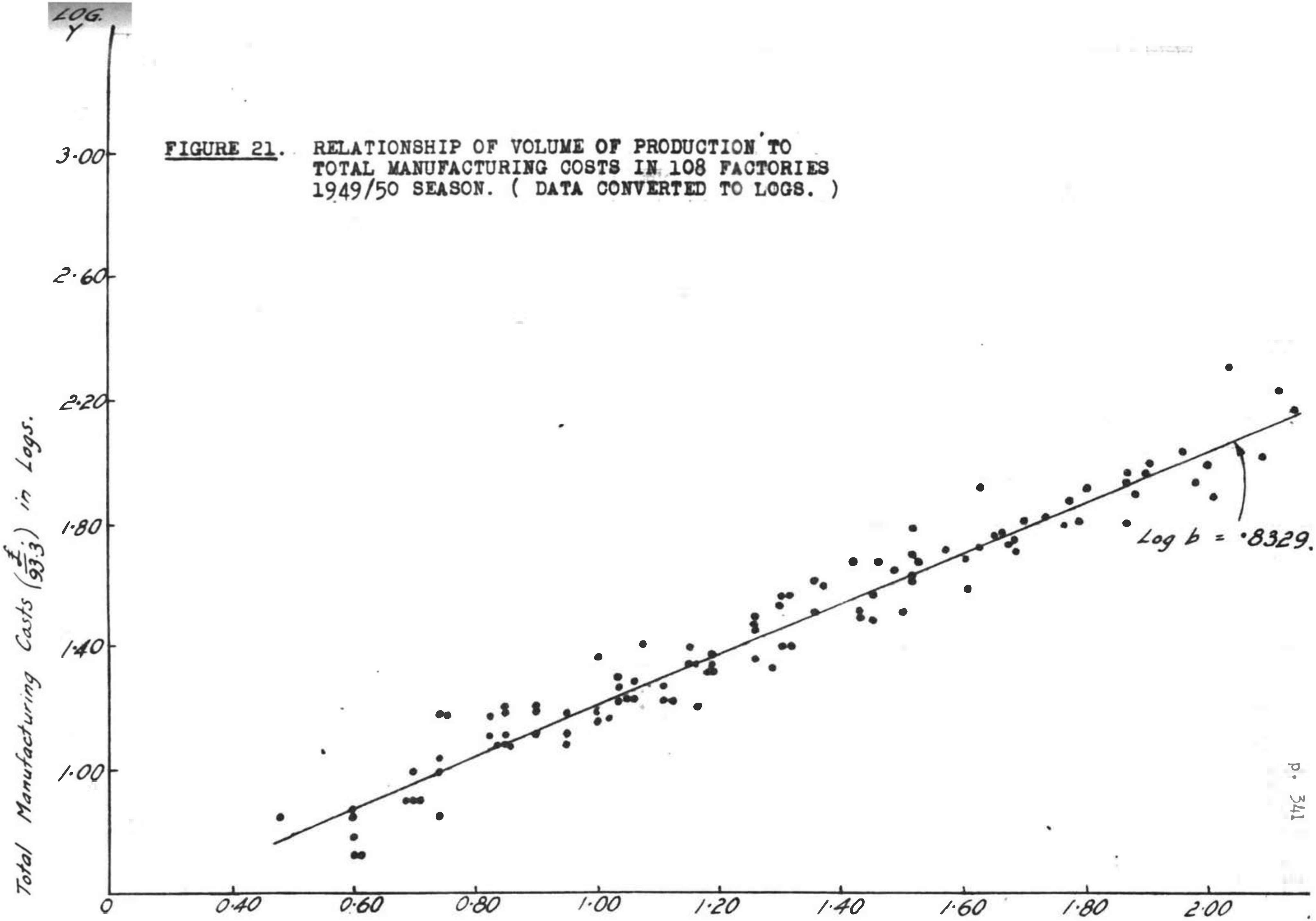


Figure 20. Comparison of Relationship of Volume of Production to Total Manufacturing Costs per lb. B/F for all Factories for 1937/38, 1949/50 and 1952/53 Seasons. (1937/38 Season Corrected to 1949/50 Values.)

FIGURE 21. RELATIONSHIP OF VOLUME OF PRODUCTION TO TOTAL MANUFACTURING COSTS IN 108 FACTORIES 1949/50 SEASON. (DATA CONVERTED TO LOGS.)



portion of the curve.

Figure 18 shows the elements of Manufacturing Charges and Total Costs on an ordinate scale which is one-tenth that of Figure 17.

Factory Wages, although asymptotic in character, if extrapolated would probably tend to rise. As they are, they tend to level out and would probably reach their minimum point at about 22 to 24 million lbs. output level. Cream Haulage is much shallower and probably would reach its minimum point at about 20 million lbs. output. Materials is constant, but Fuel, Power and Steam is U-shaped, reaching its minimum point between 7 and 8 million lbs. Sundry Charges, if plotted, would appear as a shallow U-shaped curve with its minimum point at the same level as the Fuel, Power and Steam curve, but rising a little more steeply after that point. When aggregated, the Total Manufacturing Charges tend to level out at about the 14 million lbs. output level.

All manufacturing costs were then aggregated and plotted in the same figure. All factories were placed in order of magnitude of output and each group of four were averaged and plotted and the curve fitted to the weighted averages so determined. The minimum point of the curve is reached at approximately the 10 million lb. output level and then tends to rise gradually. If extrapolated it is likely that this rising curve would be relatively gradual in slope.

This total regression curve is important for it indicates that the optimum output level would appear to be in the vicinity of 10 million lbs. output level.[14]

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[14] Factory-F.O.B. charges are not shown here. When plotted, they revealed a widely-dispersed "Carriage and Freight" scattering, but constant as regards scale; a rising regression for "Freezing and Storage" which, however, tended to level out at the maximum output level of the scale; and a slightly rising "Insurance F.O.B." curve. When aggregated, Factory-F.O.B. costs tend to increase with scale.

The factors that tend to cause the regression to rise are, Fuel, Power, and Steam, Repairs and Maintenance, and Factory-F.O.B. charges. Those that tend to cause the regression to fall, are Wages, Cream Haulage, Depreciation, Administration and Directors' Fees etc. Those that are relatively constant are Materials and certain minor elements. When the total cost curve is examined, it is clear that costs tend to fall sharply with scale up to the 4 million lb. level. From 4 to 16 million lbs. the curve is realatively shallow, indicating that within this range of output average total unit costs will be at their lowest or minimum. Cost efficiency, then, (from uncorrected data), will be located at its optimum point at approximately 10 million lbs. output, which is therefore optimum scale in the butter manufacturing industry.[15] It must be stated however, that caution is needed in defining the optimum point, because the infrequency of observations around the 10 million level causes less confidence to be placed on the reliability of the shape of the curve. The confidence limits are much wider at this point, meaning it is statistically possible that the curve may be still falling. Any extrapolations are therefore unreliable.

Corrected Cost Data: Corrections were then made to the data given in Table LXIV. The Wages cost curve data were derived from Figure 5 which is the curvilinear multiple regression for labour costs corrected for both supplier density and seasonal coefficients, so that the influence of both location and season were removed. The cream haulage data were derived from Column 8 of Table XXVIII in which those factories whose cream haulage costs were affected by exogenous or endogenous causes were removed, so that the unit costs reflect input-output ratios measured in monetary costs rather than an arbitrary aggregation of cream haulage disbursements.

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[15] This statement is subject to what follows, bearing in mind that the data from which it was drawn has not been corrected for certain exogenous factors. Moreover, the data itself can be challenged, as has been indicated in previous sections, but in a number of instances these manipulations of data tend to cancel out.

Power data were derived from Tables XXXVI and XXXVII in which input-output ratios for both electrical units and coal consumed per unit of butter manufactured were converted into monetary costs by weighting units of electricity and coal consumed by uniform monetary rates and adjusting them (by interpolation) to each respective class-interval. Depreciation was based upon a fixed percentage of the capital value of buildings, plant and equipment in each class-interval as given in Table XXXVIII, and thus tends to eliminate the effects of arbitrary rates of depreciation and the shifting of depreciation to other accounts, and other questionable accounting procedures.

The following elements of expenditure were included from the annual accounts and are therefore similar to those elements appearing in Table LXIV:

Sundry Charges.
Repairs and Maintenance.
Rates and Insurance.
Administration and Office Expenses.
Directors' Fees and Expenses.
Interest.

It was considered inexpedient to attempt to correct these elements to any degree, although many General Overheads were manipulated to some extent.

Certain items were held constant for all class-intervals, because their unit costs should not vary with output. These were:

Materials.
Total Factory-F.O.B. charges.
Dairy Board Levy.
Farm Dairy Instruction.

It was considered that the Factory-F.O.B. element of cost structure was largely exogenous and locational in function and could be treated fairly as a constant element in spite of it being a cost that increases with scale.

Although cream collection has a geographical and environmental aspect, it was not considered as a constant factor, as elements of economic and managerial efficiency enter largely into, and affect the dispersion of individual factories when plotted in a scatter diagram. They have been held constant, however, for comparative purposes, in view of the fact that they possess an environmental function which is exogenous in character. Both types of data are shown - cream haulage costs as a variable with scale, and held constant.

The following table summarizes the corrected cost data.

TABLE LXV. UNIT MANUFACTURING COSTS OF 114 FACTORIES ADJUSTED FOR EXOGENOUS AND ENDOGENOUS INFLUENCES*

Factory Output (lbs. of butter)	Cream haulage d.	Wages d.	Power etc. d.	Depreciation d.	Total Costs d.	Total costs with cream collection held constant d.
Under 1,000,000	0.61	0.91	0.19	0.14	3.791	3.689
1,000,001 - 2m.	0.65	0.62	0.15	0.13	3.312	3.170
2,000,001 - 4m.	0.60	0.49	0.12	0.13	3.091	2.999
4,000,001 - 6m.	0.48	0.41	0.13	0.11	2.780	2.808
6,000,001 - 8m.	0.46	0.40	0.15	0.09	2.691	2.739
8,000,001 - 12m.	0.41	0.39	0.17	0.08	2.633	2.731
Over 12,000,000	0.43	0.38	0.19	0.06	2.715	2.793

* In the above table corrected unit costs have been taken to two places of decimals only because of the possibility of spurious accuracy had they been taken to three places. Elements of cost not shown are the same as those in Table LXIV. Constant costs were included: Materials 0.743, Factory-F.O.B. 0.539, F.D.I. 0.017 and D.B.L. 0.072d.; a total of 1.371d. Cream collection costs when held constant were evaluated at the average of all unit costs for the industry, viz. 0.508d.

The data of the above table was plotted in Figure 19. The total unit cost curve shows a similar pattern to that of the uncorrected data, but the curve is to a slight extent, less steep for the positioning of the low output factories which lie nearer the abscissa. The minimum or lowest point of the curve is more defined, being clearly in the vicinity of the 10 million output level, and the curve tends to rise more steeply with scale after the optimum point is reached. The effect of holding Cream Haulage constant was but to pivot the whole curve slightly at about the 4 million output point -

the high-cost (left) portion of the curve swinging slightly downwards, and the low-cost (right) portion of the curve swinging upwards. The degree of swing was relatively slight and did not alter much the positioning of the curve.

There is one other element of cost that does not appear in a general sense in the total manufacturing costs. Interest on capital is not shown as an element of cost, (although in a limited sense it is reflected in some cases as interest on bank overdraft, assuming that this method of finance was used to finance fixed capital). Nor has the element of replacement cost been taken into account. If, however, the depreciation rate is doubled, or even trebled, as adjusted in Table LXV, this correction makes very little difference to the shape of the cost curve, apart from elevating it slightly and shifting the optimum output point a little along the scale.

Conclusion: The optimum scale for the butter industry, after making due allowances for known corrections, is in the vicinity of 10 million lbs. output.[16] Those larger factories which show an apparent efficiency in excess of this level, have economies arising from other sources such as large-scale administration in multi-branch companies, cost manipulations, or bulk cream etc. Further, the corrected data shows that there is a constant reduction in costs up to about the 7 million lb. output level, so that the range of 7 to 14 million lbs. output can be considered the most economical and efficient range of output for the industry.

[16] Subject, of course, to possible statistical variations within the confidence limits.

SECTION III. ELEMENTS AFFECTING EFFICIENCY. (Essentially Endogenous)

Introduction: The internal problems affecting efficiency include problems of waste, fluctuations, capacity, and maladjustments. Such may be either technical or economic in character. Where any problem can be eliminated or reduced in isolation without affecting other processes, operations or functions, it is technical, but where substitution arises, the problem is economic. For example, waste occurs in productive labour, but can be eliminated by careful attention (say) to better organization of materials and flow of work (as a result of time-motion studies). Such a problem is technical if labour costs can be reduced without affecting any other costs, (assuming no further outlay in administrative planning). But where waste in heat and power generation is due to lack of adequate instrumentation, the problem is economic in character, for an added capital outlay will reduce power costs. The two types tend to overlap or merge.

The Problem of Waste: By waste is meant that directly preventable loss arising from ineffectively utilised, discarded or lost factors or resources. Waste in any industry will tend to increase costs and restrict output. Whereas monetary costs tend to hide cost, physical units are useful for segregating causes of waste. The greater the waste the less efficient will be the industry or factory, the steeper will be the average cost curve and the higher will be the optimum point in an array of outputs.

Waste is caused by faulty management of plant, labour, raw materials and equipment, with secondary exogenous causes such as failure of external productive services. Faulty management increases cost and limits production. Limitation of production (affecting volume and therefore unit costs) arises in four ways.

(a) Low production output due to faulty planning, co-ordination and supervision, of men, materials and equipment,

(b) interrupted production giving rise to idle men, materials and equipment arising from breakdowns of equipment, poor co-ordination of functions, failure of material, supplies and other exogenous causes, climatic, power failure, visitors,etc.

(c) restricted production - unintentional due to inherent nature of materials, equipment, or labour (onset of fatigue, age or illness); intentional, arising from go-slow policies, disputes or by arrangement with management in off-season, and

(d) lost production; due to breakdowns, spillages, power failures, ill-health, inferior quality cream etc., or failure to fully utilise by-products.

Wastage is essentially a managerial problem, but is by no means entirely free from administrative causation. It was observed in the butter industry in a number of instances.

1. In trained personnel: There is a marked diminution of personnel available for responsible posts in the higher age-groups. About four-fifths of the personnel of the butter industry have not attained the age of 45, with one-fifth only over the age of 45, whereas one-third should be over the age of 45. Too many experienced employees are leaving the industry due to various causes, meaning there is a considerable wastage in experience, probably the hardest thing to acquire in any industry. In addition to experienced personnel, there is a considerable wastage in skilled or trained personnel. The sudden increase in turnover of Second Assistants (see Table V. Part II) suggests separations arising from lack of adequate promotion and recognition in the industry.

2. In general labour or unskilled personnel: The wastage of new entrants into the industry is high. Five per cent leave the first week, ten per cent leave the first month, and 22 per cent leave the first three months. Wastage arising from replacement costs, training, spillages etc. must be considerable.

3. In general turnover of labour: Allowing for normal wastage of staff due to retirements, illness, death, promotions and transfers, etc., the high incidence of turnover with resultant wastage of time and expenditure can probably be met on a number of fronts - managerial, administrative, industrial, and especially, by the employee himself. Causes and remedies have already been elaborated, apart from observing that labour turnover

wastage and time-wastage (which follows) are the two main sources of waste in the industry, and it is probable that they are not uncorrelated.

4. In time: Both unproductive and lost time amount to considerable proportions - approximately 75% additional time being required to meet this cardinal form of wastage. The main features or causes arise from breakdowns in plant, "accidents" such as spillages (due to lack of experience, carelessness, lassitude or fatigue, and sometimes to lack of managerial planning and consideration), idle time or interrupted time arising from lack of planning (for example, lack of co-ordination of arrival of cream lorries which should arrive at scheduled intervals), congestion or poor equipment, and the inherent character of labour seen in abnormalities of protracted warming-up, slowing-down, or go-slow tactics or other resistance (apart from managerial causes of exhaustion due to poor physical posture or other nervous distraction. (See Fig. 1 Part II.)

Restricted production arises from poor lay-out of equipment - (cans, scale, sample-holder, washer, receiving vats, cartons, etc.), excessive body movement (taking samples, loading on washer, weighing, sorting cans off lorry, feeding cartons while packing etc.); variations in can sizes, bottlenecks in team organizations for reception and packing; and lack of adequate facilities (e.g. roller conveyors).

5. In statutory costs of labour: There is insufficient control in many cases of excess overtime and penal rates. In some factories management does not supervise adequately labour employed at such times, and an avenue of wastage tends to be used. Statutory and penal rates amount to a large per cent of the total wage bill (45%), and it is considered that this could be lessened by careful planning, and in some cases, refusal of excessive overtime and direct supervision and control of all time booked at penal rates.

6. In utilising contractors for cream haulage: In some cases, it is apparent that contractors have been demanding and getting expensive rates for cream haulage. Occasionally monopoly conditions have enabled the contractor to charge almost double the amount of the actual costs which

would have resulted from self-service. The very extent of the considerable overhead element in contractors' costs plus profits should cause management to consider alternatives each year when reviewing the haulage contracts.

7. In handling cans during cream collection haulage: Wastage of time in cream collection occurs in numerous ways, and is caused by various complex factors including route-planning, condition of roads, weather, truck, supplier co-ordination and personal factors. These have been elaborated in Part III fully, but one or two aspects require stressing. Size of can-load and can-grouping and homogeneity of can-size are important elements requiring attention. The main exogenous factor causing wastage is condition of roads, then loading conditions.

8. In excess mileage in cream collection: The fact that the last 10% of cream costs one-half of cream haulage expenditure points to a serious leakage of costs. While the number of "dead-miles" run indicates lack of co-ordinated planning to some extent, the problem of distant suppliers is one for the industry to face unitedly. Cream accepted from beyond a certain limit should be at the suppliers' expense (in whole or in part), or be brought to within a reasonable distance of the factory at the suppliers' expense.

9. In power utilization: Considerable power and heat wastage occurs throughout the industry. Over- and under-capacity of power units is one cause. Lack of instrumentation is another, together with lack of adequate technical knowledge.

10. In materials: There is a moderate amount of normal wastage of materials entering into the finished product due to inadequate storage and supervision. Consumable stores tend to be wasted also, especially cartons, gl[illegible] tape, etc. Deviations in cost suggest careful checking is required in some companies to avoid what is excessive expenditure on materials.

11. In management: Waste of managerial ability may occur when a manager undertakes the work of a functional operative, for a manager's duties are planning, co-ordination, supervision, delegation and decision-making.

12. In fixed assets: Although under-capitalised as an industry, capital efficiency is impaired by wastage arising from excess capacity in buildings, plant and equipment. Table L. of Part V. indicates the extent of variations of floor area, for there appears to be excess floor area devoted in many cases to processing, packing and bulk storage. Table LI. of Part V. reveals such variations in churn and holding vat capacities, and that excess capacity has therefore indicated capital wastage also. The same applies to boiler capacity.

It is difficult to make an estimate of the extent to which wastage could be held responsible for the structure of costs. In certain factories labour costs could be halved, in others transport costs could be reduced one-third, in many, power costs could be reduced by 10 to 20 per cent. Wastage does not occur in all factories, all the time, in all functions and processes. Probably up to 15 per cent saving in costs could be achieved by greater self-discipline internally and another 5 to 10 per cent by industrial attention to certain features of wastage arising from personnel losses, transport direction and dissemination of technical knowledge and assistance in power utilization.

In the most efficient organization, there is always some waste some of the time, and most concerns however efficient, seldom work at peak efficiency. Probably a 20% reduction by waste elimination is highly possible in the industry, but it is not intended that this percentage should necessarily be construed as an indication of inefficiency.

<u>The Problem of Fluctuations:</u> Whereas waste may be considered as a directly preventable loss, certain leakages or changes may be recognized but are not directly or immediately preventable. Fluctuations are such, and are the outcome of exogenous causes which may be controlled rather than be removed, for such variations arise from supply of cream or seasonal fluctuations and are thus the outcome of environmental and geographical location or other structural or social causes. It is not always possible to draw a straight line between waste, fluctuations, capacity and maladjustment - they over-lap and they are all similar in that they are partly technical and partly economic in character. The main features of this problem are:-

1. Fluctuations in supply of cream: Individual suppliers may tend to decrease cream offerings due to a number of reasons apart from climatic or seasonal reasons. Lack of finance, change of patronage, economic competition for productive services etc. may sap supply. Management tends to be constantly alert to any "personal" cause affecting quantity supplied. Excellent auxiliary services provided by the factory, personal interest in the suppliers and their problems, and a be-stirring of the co-operative team spirit in everyone by appropriate means all aid in stimulating volume. Oftentimes a supplier takes offence easily and diverts his patronage elsewhere. The problem is not an easy one, but there is an urgent need to rekindle the motive - spark of co-operation in all suppliers, many of whom regard the co-operative company as a processing institution, and their interest goes only as far as the extent of their final pay-out cheque.

Dividing the supply-zone into wards and having ward committees elected under the chairmanship of a director helps to sectionalize interest. Sub-committees to report on environmental problems, topics such as herd improvement, veterinary societies, pasture development, soil surveys, drainage and roading problems, top-dressing, can-grouping etc., will go a fair way to stimulate volume and improve factory "tone". A substantial prize could be offered annually to the suppliers who shows the highest percentage increase in cream supply, or some other suitable motivation could be utilised.

Fluctuations of cream supply due to climatic or environmental causes, lead to another set of problems which may be met best on a collective front. Drought would be the problem of an irrigation sub-committee, and finance or relief could be subsidized in part by the company. Disease or epidemics amongst the herds could be handled similarly.

2. Seasonal fluctuations: Prolongation of the lactation period is highly desirable. Indeed, any collective organizing is desirable which would spread voluntarily the lactation period over the year. This is not always economically possible for a number of reasons, but some degree of lactation distribution is always possible.

3. Fluctuations in factor services: There is always local and seasonal competition for certain productive services, especially labour. Wherever seasonal work pays a higher rate of pay than that obtaining in the butter industry, certain employees will be drawn away. Labour turnover always fluctuates more when the factory is situated near a densely populated industrial area. Detaining incentives such as housing, alleviate this tendency rather than monetary increments. Prices and supply conditions of other factors such as coal tend to fluctuate a little as demand increases at different times of the year.

4. Cost fluctuations arising from exogenous causes: Excess rainfall and wind-drag increase truck running costs considerably - also condition of roads. Bank accommodation rates also vary.

The most important aspect of fluctuations refers to supply of cream, and possibly inadequate attention has been paid by management to the problem of maintaining and increasing procuration technique. Much of the national increase in milk production has been the outcome of research and national policy, but increase of volume could be brought about apart from exogenous influences with unit costs falling as a result.

The Problem of Capacity: This problem is closely linked to that of fluctuations, for much excess capacity has been considered necessary to cope with seasonal fluctuations. While it partly derives from fluctuations, under and over-capacity conditions need to be met on a different basis. Waste needs to be eliminated, fluctuations controlled or minimised, but with capacity the answer appears to lie in means of utilization of excess capacity by diversion whenever it arises in various ways. It is primarily a problem of managerial co-ordination.

1. Over-capacity of labour: All productive services in a highly seasonal industry are subject to alternate conditions of over and under-capacity, and labour is no exception. In a few factories the labour establishment is considerably in excess - marked by over-capacity, so that overtime is quite unknown even at the flush of the season. The great range

of personnel employed, for example, in the smallest factory output class-interval, viz. 2 to 9; or 4 to 12 in the one to two million output range indicates that over-capacity tends to mark certain factories, and possibly under-capacity others. If certain factories require two to three times the establishment of others producing the same quantity of butter, it would appear that the dual problem of excess-labour capacity and inadequate utilization of labour are in evidence.

(a) Different ways have been used to meet this problem: Retaining "key" personnel and supplementing with casual labour where competitive seasonal work exists in the locality.

(b) Making the establishment adequate for the beginning of the flush period and hiring casual labour for butter packing and/or letting out carton-making on a contract basis. It is questionable if the female labour market has been exploited sufficiently in many districts for part-time work.

(c) As in (b), with definite programmes of part-time female labour for "pounding", wrapping, and carton-making. Many women are glad to accept 3 to 4 hours work daily and prefer it to full-time employment.

(d) Using female office labour for cream recording.

(e) Utilising lorry-drivers more fully by having them bring their cans with lids off ready for grading and sampling.

At the other end of cream reception, drivers can be utilised for tipping cans, sorting, stacking and inserting grading dockets. Drivers can also be utilised for cool storage stacking and loading. It is contended that union rules would forbid, or other employees would object, but in certain establishments it is the answer to full utilization of labour and under-capacity. It is a question of outlook and viewpoint, and has been met successfully in a number of factories; (i) by engaging men on the basis and understanding that their range of duties will be extensive, (ii) by the practice of changing duties inter se, (iii) by hiring men as general hands and extending their duties and compensating them accordingly, and (iv) by fostering a right "esprit de corps".

The above methods may be described as intensive utilization of key personnel supplemented adequately to reduce under-capacity. Such methods have the advantage of minimising overtime and reducing labour costs.

Especially are they necessary in smaller output factories which are subject to a higher seasonal co-efficient than larger output factories. (See Table XX, Part II, for seasonal co-efficients). This peculiarity is also evidenced by the labour cost co-efficient which measures Fixed Costs to Variable Costs in labour. Fixed Costs are proportionately higher for small output factories than large output factories, and these Fixed Costs can be attributed largely to the practice of maintaining over-capacity labour through the off-season. Small factories can mitigate the effect of over-capacity by supplementing their establishment as described above and by more intensive utilization of duties. Extensive diversionary methods which are described below are rather for larger output factories which are not faced with the problem of marginal discrete increments to their labour force.

Extensive diversionary methods apply especially to larger establishments where management is unwilling to dispense with labour during the off-season. The eseentials of these methods are:-

(a) Full utilization of staff on maintenance, repair, painting, overhaul and installation work during the off-season.

(b) Utilising staff in subsidiary activities and undertakings so as to maximise utilization of each individual's capacity. Much auxiliary activity correlates with butter-making as regards peak periods, etc. Buttermilk powder output follows butter output, but there is considerable maintenance and repair work that can be spread for winter months even in departments such as buttermilk. However, certain activities can be developed during the off-season, general haulage work, engineering and jobbing work, farming activities, stock-taking for stores trading, etc.

(c) Capital expansion activity. During the winter months is an ideal time for extension of building and construction activities. Few establishments are devoid of men who have not had some experience of building and general construction duties. Houses for employees can be built by engaging a suitable carpenter or builder and supplying the necessary labour. Paths can be laid down, roadways built, gardens laid out, artesian wells dug or dams constructed - all largely with labour that is "on the spot". Again objections may be raised as to violation of unions etc., but again the answer is a broad liberal outlook, fostered by right leadership and good team spirit will not be inhibited by such considerations.

Minimising excess capacity and maximising utilization of labour are difficult organisational problems for management under any circumstances, but high ideals need to be presented, for once the principle of diversification is recognised, management itself will find adequate and profitable outlets for off-season labour utilization.

2. Over-capacity in cream-haulage: This is one aspect of capital utilization and over-capacity of capital equipment. The problem is two-fold, correct size of vehicles, and maximum utilization.

(a) The tendency is to use over-capacity lorries. Five to six-tonners are used where three to four-tonner would be adequate, and articulators where small capacity lorries would suffice. Over-capacity lorries usually carry too many cans in terms of economic time-consumption, and time is lost due to excess handling and sorting. It is more economical to have frequent smallers loads. One factor determining the capacity of lorries is the character of general haulage offering in the district.

(b) Maximum utilization of all vehicles is necessary to spread the overhead burden of vehicle cost and depreciation. Most factories achieve this end well. Many use their lorries for all haulage out of finished products and for back-loading of consumable stores, materials, and coal. In well-organised companies, lorries bring in cream in the morning and are utilised for general contract haulage in the afternoon.

One argument that can be rightly levelled at tanker collection, is the inability to utilize fully this type of expensive equipment to advantage. Tankers are marked by excess capacity as regards time-utilization. They may be used only for two or three hours a day for 300 days in the year, whereas lorries may be used eight hours a day all the year around.

(c) Incorrect route-planning is partly the cause of over-capacity in cream haulage. Routes should be planned to maximise the load in the minimum of time at the flush of the season. Excess running is one aspect of poor route-planning and is marked by a high percentage of "dead-miles", overlapping, much backing, and too many stoppages en route. Many factories have as many lorries as routes, and the lorry has returned to the factory within two hours, meaning that there is congestion of cream for reception, apart from over-capacity of vehicles as a whole. It would be more economical to reduce the lengths of the routes and have the lorries covering 2, 3 or 4 routes per day, thus spreading and lengthening the cream reception time.

(d) Excess petrol consumption: This is due to wind-drag caused by canvas awnings etc., condition of roads, speed fluctuations, excessive stopping, use of reverse gear, and mechanical deterioration.

3. <u>Over-capacity of plant:</u>

(a) Electrical equipment. This was obvious from different capacity motors used for similar motivation in different factories. The dispersion of H.P. rating for similar equipment was considerable.

(b) Boiler capacity varied considerably for similar requirements, as evidenceed by one to two million lb. output factories which varied from 15 to 80 H.P. capacity in boilers.

(c) In some cases over-capacity of power was occasioned by the practice of using a common power-take-off shaft from which a belt drive was employed to furnish the power of some process requiring but a fraction of the power supplied.

(d) Over-capacity of churns and holding vats was also noted. Larger output factories managed with the same capacity for churning as smaller factories by increasing the number of churnings per day. There is a limit to the number of churnings, but there can be little excuse when plant capacities are out of proportion, as seen in the ratio of churns to holding vats.

4. <u>Over-capacity in administration:</u>

(a) Owing to the discrete character of office personnel, especially in the smaller companies, there appears to be over-capacity in staffing. This can be mitigated by utilizing the services of professional people or by minimising work on cash orders and non-butterfat work.

(b) Number of directors: In some small companies it is questionable if the large numbers of directors are warranted.

5. <u>Under-capacity in capital:</u> This is a problem of finance, and can best be met by increasing depreciation, reserves and utilising short and long-term finance for replacement of assets in the form of mortgages and debentures.

<u>The Problem of Maladjustments:</u> By maladjustment is meant any element or productive service or factor instrumental in inhibiting the smooth running or functioning of any process or aspect of the butter industry. Certain elements are wasteful or even costly but do not necessarily impede production. All impediments, frustrations, hindrances etc. or other obstructions which check or retard the flow of work or output are maladjustments. The term is not intended to cover institutional, environmental or structural factors unless they can be adjusted to function smoothly. The chief types are:-

(a) Employer-employee relationships: Labour turnover as one source of economic wastage, is partly the outcome of labour maladjustments. Vocational maladjustment is often the outgrowth of emotional maladjustment with its roots in socio-psychological soil. So many employees claim dislike of employer as a reason for cessation, that maladjustments in the important relationship of employer and employee call for close scrutiny.

Staff selection is not an easy problem for any dairy factory manager, for choice is limited. Some general hands are the products of emotional maladjustments and intellectual deficiency or technical incompetency - elements which are not easy to handle or reconcile with efficiency. One or two such employees in a team of operatives can lower the standard of efficiency and do much to undermine cordial relationship between management and staff. Having a measure of collective protection in the form of union cohesion, such men cannot always be summarily dismissed even for overt acts of disobedience, absenteeism or trouble-making without increasing any tension which may exist, if such is the case. Most factories have had their problem employees at some time.

The following suggestions may assist:

Managers are now realising that they may be expecting too much from new beginners who require time for settling in and orientation. Where new hands are given the cleaning and other laborous or dirty work for moderate periods only, and are addressed discreetly by foremen instead of being corrected publicly, employer-employee relations have improved. Some managers have been very successful in fostering and promoting recreational facilities of all kinds, and cultivating a team spirit in and out of working hours. In addition, many maldjustments have been overcome by the preparedness to show teach, instruct or demonstrate any process or job any number of times.

(b) Maladjustments arising from working conditions: Apart from employer relationships there are a number of contributory features which include: heterogeneity in can size, reception facilities (poor lay-outs of men, materials, cans, scale, sample-holders, receiving vats, recording desk, roller-conveyors, testing equipment, cleansing facilities,); butter analysis facilities, coal-handling facilities, and lay-out of factory and proximity to transport, water and drainge.

(c) Maladjustments in cream haulage: Improved roads are necessary when high cream density occurs. It seems strange that tar-seal roads are constructed in areas where traffic is relatively light, but in certain intense dairying areas third-class roads are condoned. Further, it is questionable whether compulsory coverage by awnings of lorries is necessary.

(d) Managerial maladjustments: Managers appear to have different responsibilities in different districts or areas. In some, the Manager is solely responsible to his Directors. In others, a Factory Manager is responsible directly to his General-Manager. In some areas Secretaries have status correlative with the Manager, and in others they are subordinate. In some companies, Directors handle certain administrative functions themselves, while in others they are delegated to management. In some companies, Managing-Secretaries are held responsible even for purely technical results. Although scale and structure affect the type of management, the lack of uniformity in defining responsibility has been known to inhibit movement of managers from one job to another.

(e) Regulatory maladjustments: This term is intended to include all regulations enacted, and other control exercised directly or otherwise over butter manufacture. Most regulations have been introduced after mature and considered reflection and benefit the industry as a whole. A few anomalies are bound to arise and exceptions or evasions occur. It is not intended to cover these maladjustments except to indicate a few points. The extent of remits submitted to appropriate controlling bodies hint at the possible extent or re-adjustment necessary in many cases.

For example, the definition, scope and responsibilities of co-operativ dairy companies need reconsideration, with careful attention paid to the term "co-operation" in order to limit and define its meaning. The basis of shareholding, voting powers, share surrender, forfeiture and resumption of shares, and basis of reissue require reviewing. In view of broadening practices, Directors' powers, qualification, responsibilities, disqualifications, rotation and eligibility might well be adjusted.

Again, irregularities could be reduced by enforcement of standardized accounts and regulations with especial attention to audit responsibilities, allocation of expenditure to auxiliary, subsidiary and correlative activities, control of short-crediting and other anomalies including zoning infringements.

Owing to certain changes through time, the general structure of the industry tends to alter. Consequently it is necessary to consider the redefinition of constitution, representation, power, functions, authority and responsibilities of all boards, commissions, councils, institutes, and other auxiliary or subsidiary authorities, for such may require strengthening or their powers broadened.

SECTION IV. OTHER CONSIDERATIONS AFFECTING EFFICIENCY (Essentially Exogenous)

1. Institutional Considerations: A glance at any manufacturing account will reveal that the control and extent of a number of items of expenditure is dependent upon the efficiency of auxiliary or correlative institutions in a direct way. For example, Freezing and Storage, Grading Charges, Farm Dairy Instruction and Dairy Board Levy are direct charges imposed, reimbursed or levied by various institutions. Again, much expenditure is governed indirectly by institutions or productive services, and it depends to some degree on the efficiency of such institution, organization or productive service, whether butter manufacture can minimise its expenditure. Indirect contributories include contractors for cream haulage, roading authorities, railways and other transport authorities; Electric Power Boards and their auxiliaries, Rating Authorities, Professional Accountants, (for both Secretarial and Auditing services) and Trading Banks.

The most important institutions, are of course, those directly allied with the well-being of the butter processing industry - the State, and in particular, the Department of Agriculture with the specialised services of Dairy Division, the New Zealand Dairy Board, the New Zealand Dairy Products Marketing Commission, the National Dairy Association and the Dairy Research Institute.[17]

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[17]The Dairy Division is responsible for the inspection, sampling, grading and analysis of butter and exercises a close supervision over moisture content, weights and chemical analysis. Dairy farm premises and butter factories are inspected and instruction imparted. Herd-testing is promoted, and a system of semi-official testing of pure-bred dairy cows is in operation.

The N.Z. Dairy Board besides compiling valuable statistics and functioning as the industry's representative in negotiations with the Government, administers and directs or is associated directly with Dairy Herd Improvement, Artificial Breeding, Extension and Investigation work, Bobby Calf control, Dairy Industry Loans Administration, Dairy Factory Managers' Registration, Dairy Research Institute, Superannuation of Dairy Factory Workers, Veterinary Services, Butter Container distribution, Zoning, Quality Promotion by competition, guidance in Reconstructions and Amalgamations, Provision of Scholarships and Bursaries, Herd Recording, Pig Industry Development, Vells, and other allied activities. (Cont.)

The efficiency of butter processing, apart from its own internal structure, is determined in part by these institutional factors which affect technical efficiency and quality of product, economic efficiency in production, managerial efficiency and lastly, and probably the most consequential, the volume of cream offering.

Expenditure directly controlled by various institutes amounts to 10.5 per cent of total manufacturing expenditure. That indirectly controlled (supply services, products, materials) comes to 40.1 per cent of total manufacturing expenditure. That is, approximately one-half of the total expenditure is largely dependent upon the efficiency of other organizations. It is true that Dairy Factory Management can and does control this expenditure, especially that of an indirect character, but

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17 (cont.) The New Zealand Dairy Products Marketing Commission negotiates with overseas buyers of dairy produce regarding contract prices and quantities; acquires and provides for the handling of dairy produce, determines the guaranteed price to be paid for dairy-produce and regulates the marketing of butter in New Zealand.

The Dairy Research Institute, which is equipped with an experimental dairy, along with other activities, investigates and conducts research into technical, chemical and engineering problems related to butter manufacture and its auxiliaries.

The New Zealand Dairy Associations cover broadly the interest and welfare of the whole dairy industry and in particular supply dairy companies with machinery and other requisites.

Other institutions indirectly related to the dairy processing industry are the Department of Scientific and Industrial Research, the Department of Agriculture with Live-Stock Division, Animal Research Division and Fields and Rural Development Division, the Cawthron Institute and the Agricultural Colleges, Massey and Lincoln.

Affiliated organizations and companies that provide productive services for butter manufacture, and in which most dairy co-operative companies hold shares, are: Co-operative Freezing companies, National Dairy Associations (as indicated above), Co-operative Milk Supply Associations, Co-operative Rennet companies, Dairy Industry Insurance Agencies, Box Companies, Lime and Fertilizer Companies, Co-op. Farm Products Companies, Motor Vehicle Requisites Supply Companies, Dairy Produce Distributing Co-operatives, Pig Marketing Co-operatives, Haulage Co-operatives and interests in Coal and Timber Syndicates.

the fact remains that efficiency internally in the industry is partly dependent on the ability and efficiency of other institutions.

To this must be added the dependence of the industry upon a sustained volume of butterfat to maintain a standard of efficiency, for unit costs immediately rise with a fall in volume of butterfat received for processing. This means, in dynamic terms, the industry must depend upon the State's continuance of a policy that is favourable to milk production in terms of research, development, subsidies, land utilization and development, farm production equilibrium costs, marketing and price stabilization.

Although efficiency is measured in terms of input-output ratios, monetary costs are important and significant. The following considerations are named as possible cost reductions:

1. Contractors' charges of Cream Haulage: These vary from district to district according to local factors and it is questionable whether it would not be an advantage to have all annual contracts approved by a central authority to prevent undue charging. Up to 10 per cent reduction of haulage costs could be obtained in this way.

2. Materials and Consumable stores: The considerable range in unit costs is in part due to variations in factor prices. Butter cartons and parch-foil have been purchased at different rates, but in view of the fact that 25 per cent of total expenditure is consumed in Materials alone, a more pertinent question would be an investigation into costs, fabrication, quality and distribution, in view of reducing the magnitude of this outlay.

3. Carriage and Freight is of considerable variation and magnitude - sufficient to warrant investigation. Whereas many managers are vigilant regarding cream haulage, they tend to accept as a datum the rates and charges of freight out.

4. Freezing and StoragePossible causes of variations have been examined in Part IV, and it is probable that in view of the variations that cannot be explained by location and volume, it is high time the efficiency of these auxiliary services received a competent overhaul.

5. Professional Services (Secretarial and Audit): These vary. A centralized scale of charges would be an advantage, especially where such a scale was based on a schedule of requirements setting out what was required for audit regarding the completeness of the service rendered.

6. Insurance: Although probably under-written by allied institutions at a minimum rate by the N.Z. Dairy Board, in view of utilising Stabilization Funds economically, could not the industry underwrite its own insurance, building up its reserves through the assistance of temporary guarantee amortized over a given period? In the long-run, the saving would probably well worth while.

2. Environmental Considerations: Geographical location or environment has a direct effect on manufacturing costs. Labour turnover is affected by concentration of population or nearness to competing industries; the price of coal also is a function of location and transport facilities, while cream haulage, carriage and freight, rates and land tax, and other items of expenditure, are directly a function of location. By environmental considerations, is meant those structural and organizational features that are peculiar to a district or province that characterize the industry in that area, and thereby influence its relative efficiency.

It is obvious to the casual observer that cost differentials in the various production districts are due to other factors besides scale. For example, in one province or district, factories tend to be small, devoted to butter or cheese, with no auxiliaries, with suppliers in close proximity to the factory, and a close spirit of co-operation prevading. In another district equal in milk potential, both horizontal and vertical integration appear to be going on, and scale and volume with maximum mechanization mark the outlook of those responsible for administration. Some localities favour cream haulage by contractors, others use their own vehicles, others again prefer to use mixed methods. Some districts have built up considerable stores services, others have provided service facilities, others again subsidiary manufactures. Some districts organize labour on a functional basis, others on a process basis, others again on an "all-in" basis.[18] Some areas prefer the services of Professional Accountants for administration, others employ their own administrative staff. In some districts, advances, loans and orders on behalf of suppliers are extensive, in others the practice is rare.

The roots of these different outlooks are often entrenched in historical associations. Capital structure, for example, in the early days of the beginnings of the industry was governed by such circumstances as roading facilities and transport. Factories were built to cater either for a closely settled dairy population or a scattered area.

These variations of outlook and historical association have borne their own typical cost pattern according to districts. Some attitudes may be considered beneficially economic, some otherwise. In a few districts there appears to be almost an attitude of stagnation as regards industrial progress, an air of "laisser-faire" or administrative conservatism in spite of technical competency and keenness. Although managers are alert to developments, it is highly desirable that directors of certain districts should move round more in other localities and observe the gains from structure, organization, auxiliary activities and subsidiary undertaking, and be prepared to adjust their own companies and neighbouring concerns to levels of higher structural competence. If this were accomplished, there would be little doubt that the cardinal order of costs analysed according to Production Districts would conform more closely to the order of output of butter coming from those districts.

3. Structural Considerations: By structural considerations is meant those features relative to the form or framework of the organization or enterprise, both individually and industrially, and their bearing on the promotion of efficiency.

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[18] That is, all participating in every activity, as distinct from specialization.

(1) Co-operation: The fact that the butter manufacturing industry is co-operative in character requires consideration.

Co-operatives should be born of necessity; be instituted in an area which is substantially homogeneous as regards population, income, resources and farming type; be limited in scope of operations; be available to all suppliers in the area on an equitable basis, and be controlled by democratic principles in which all members share in the responsibility.

The tests of co-operation are: Is social cohesion and confidence in economic, technical and social progress being promoted? Is co-operation voluntary, local, and self-controlled by members on the basis of equality? Is the association formed for a joint enterprise that is being conducted in the spirit of unselfishness, so that all share in its responsibilities as well as its rewards in the degree to which use is made of the association?

Whether a company is co-operative or not, is rather a question of the spirit that prevails, than of the framework or rules and regulations into which the organization fits. Its real strength lies, not in the magnitude of its assets, but in the loyalty, participation and understanding of its members.

Co-operation may be nominal or actual, and in New Zealand, the degree of co-operation varies. In larger organizations, due to the degree of delegation of responsibility, there is a tendency for co-operation to become nominal rather than actual.

(2) Flexibility of structure: By flexibility is meant the capacity (ability) to adapt to change.

Of 114 factories covered by this survey, 89 can be described as specialised (making butter only), and the balance to some degree are diversified. Ten of these latter were dual plants making butter and cheese, (or casein or supplying market-milk). Many companies have some auxiliary or supplementary activities, and thereby have some measure of flexibility. In others, while the capacity to adapt to change is probably limited by structural limitations, flexibility tends to be inhibited by factors described in the following paragraph.

Plants that have been constructed for butter manufacture from cream on a given pattern, are at a considerable disadvantage when technical progress in the shape of invention or new processes renders present methods obsolete. One important element in efficiency is adaptability, for efficiency is not a static concept, but dynamic. New ways of processing cream, pasteurising, pounding, packaging, and transporting are being developed all the time; so that flexibility must be recognised as an important element of industrial efficiency.[19] In addition to processing techniques, is the impact that a changing market demand makes on the various dairy products. A substitute for butter, an increase in the price of meat, or increased purchasing power in an area of dense population, could all be instrumental in upsetting the balance of quantities of butter, cheese and dried milk being produced. In other words, the equilibrium of the dairy industry could be easily disturbed by exogenous causes. And change in demand arising from changing consumption patterns can alter usually at a more rapid rate than can production.

Tests of flexibility are:

(a) Can the raw material, such as milk, cream, or skim be diverted within the general productive area from one specialised plant to another?

(b) Can diversified plants alter the proportions of products with minimum change in unit costs?

(c) Can milk and cream be diverted from current manufactured products to fluid or dried or dehydrated forms, or vice versa?

(d) Would a major processing innovation seriously handicap adaptation, or cause such a strain on the company's resources that survival would be jeopardised?

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[19] The technical developments of the past 10 years in New Zealand dairy industry indicate considerable flexibility. However, structural considerations need to be borne in mind constantly as these tend to limit the speed with which change may take place.

It may be argued that in New Zealand, with its overseas demand, that flexibility is a minor consideration for even specialised plants in the aggregate can supply the changing demands that may arise. Such an outlook can be dangerous, for it assumes static conditions both as to markets and methods. Or it may be objected that diversification would offset the advantages accruing from scale which have been the outcome of specialization of product. To the contrary, diversification would probably mitigate the problem of over-capacity. Finally it has been claimed that diversified plants such as dual plants cannot operate as cheaply as specialised plants such as those making butter only.

Of the 28 smallest factories (making less than 1,000,000 lbs. of butter per annum), six were dual plants making butter and cheese. The average total unit cost for butter manufacture was 3.317d. for the dual plants, and 4,182d. for specialised butter plants. Larger dual plants also had lower costs than comparable butter plants. It may be objected that the dual plants really were much larger in scale and had the advantage of a larger organization. This is partly true, because overhead can be spread over a greater range of activities at lower unit cost. But it is interesting that these six dual plants have a lower average unit cost than butter factories making double the output of butter. Moreover, the total revenue in terms of capital outlay is less for dual plants than specialised one-product plants. Some managers contend that power costs are greater for dual plants owing to peak loading being heavier, but even here unit costs do not bear out this contention. When larger multi-branch companies are examined, there is generally a lower unit cost than similar output butter factories. But one interesting fact remains: the two lowest cost factories are both single-product factories with the minimum of auxiliary activities, one producing 5 million lbs. of butter, and the other almost 4 million.

But flexibility does not mean that butter output would necessarily fall - but it does make room for greater development of diversified products which must come with increased population and more intensified production of whole milk. The range of diversified products contemplated in the long-run would include (and does in some cases): Cooking butter (whey), types of cheese (e.g. blue vein, cottage, processed, etc.), ice-cream, condensed skim milk, evaporated milk, condensed unskimmed milk, non-fat dry milk solids, dry whole milk, dry skim milk (for animal feed), dry buttermilk, dry whey, casein, concentrated, condensed or evaporated buttermilk, whey or skim, milk sugar, malted milk powder, processed baby foods, and dehydrated butter.

(3) The small factory: The small factory is often claimed as uneconomic and should be absorbed by larger factories in the interests of scale. It is true that there are some very uneconomic small factories, but at the same time, there are many very economic units. There are, for example, eight small factories with unit costs less than 3.0d. per lb. while two or three of the largest factories have costs over 3.0d. per lb. B/F.

Many of the small factories are severely penalised by their location and heavy haulage costs. Their costs are a function of location and climate and cannot be attributed to inefficiency at all. It is true that there are a few grossly inefficient small factories, but the same is true of one or two very large factories also. It is highly significant that two small factories with an output midway between one and two million lbs., have both lower unit costs than any company producing more than 5½ million lbs. output.

Small factories definitely can be justified on the grounds of efficiency, for efficiency is relative. Only is a few cases, where a larger company is competing for suppliers in a homogeneous district are they uneconomic, - that is - the two companies are together uneconomic. The smaller company some-times (it is peculiar how often) has lower unit costs than the larger company that would desire to absorb it. Smaller companies are often situated in isolated districts and their unit costs are high because the volume is low on account of the limited extent of dairy-farming in that district. But in terms of cost opportunity, the factory can be reckoned uneconomic only if "there were available for suppliers some more profitable means of earning an income from the land, or if there were inefficiency in the conduct of manufacturing operations."[20]

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[20] Report of the Dairy Industry Commission, Govt. Printer, Wellingto 1934. p.104.

(4) Integration and Rationalization: The butter processing industry structurally may be described as consisting of:-

(a) A number of small specialised factories serving isolated districts tending towards vertical disintegration for cream haulage and secretarial services.

(b) A number of moderate-sized factories with subsidiary auxiliaries, but tending to specialise and move away from the vertical disintegration that marked the smaller factories.

(c) A number of large-output factories, essentially specialised and localized with little or no vertical disintegration but some lateral integration in the shape of auxiliary and subsidiary undertakings.

(d) A number of large companies, some multi-branched, utilizing whole milk in diversified products to yield cream to supplement butter manufacture, with considerable lateral integration and some vertical integration in the largest companies, having moved forward to secure marketing advantages in years past, but now moving backwards to secure supplies of productive services.

Vertical disintegration has marked the industry as a whole more than integration, except in the largest companies who utilise both. Vertical disintegration is seen in the employment of specialist services in transport, accountancy, quality product control, insurance, haulage to F.O.B., grading, freezing, shipping and marketing. Vertical integration is displayed by some companies who generate their own power, run their own transport, service and engineering departments, produce their own coal, make their own containers, construct their own buildings and do their own research work. Horizontal integration is seen in factories tending to combine and pool resources. This has been aided by the rationalized process of zoning some years back.

By rationalization is meant that process by which it is designed through the instrumentality of a more orderly and centralized administration of the industry to secure the minimum expenditure of effort and materials in maximising productivity. Such a process necessitates the scientific organization of labour, the standardization of materials and products, and the simplification of manufacturing processes, procurement, and marketing. To achieve these ends an authority equipped with adequate power would need to marshall the technical, managerial, commercial, scientific and financial forces of the industry and secure efficiency in procurement, production, and distribution. Such a lead would mean the reorganization of the relationships of the individual company to the industry as a whole, without sacrificing the special advantages accruing to the co-operative structure of individual factories or dissipating the motivation of competition; but at the same time concentrating production with those companies best equipped for it, and where necessary, closing down inefficient factories.

Indeed, the industry can be said to be rationalized in some respects already, especially in marketing. To succeed, rationalization, and the spirit of it, needs to spring from within rather than be imposed from without. It is significant, that in one district, integration and rationalization to some extent is continuing, while in another district where the density of the milk volume is comparable, small individual specialised units have persisted.

Integration and rationalization are necessary to minimise costs in the long run, and are dynamic processes, not a static concept.

4. Dynamic Considerations: To isolate a given factory as an optimum firm under static conditions is misleading. An optimum factory must be such, that under the existing conditions of technique, organization and structure, it has the lowest average cost of production per unit, when long-term costs are included.

In the butter processing industry, a factory to qualify as an optimum unit must be optimum not only in the short-run elements of procurement of butterfat, processing (manufacture) and management, but also in the long-run aspects of finance and risk-survival. Procurement, processing and management are short-run aspects, and efficiency as measured in earlier sections is short-run efficiency, for the efficiency of long-run factors were not been taken into consideration.

These long-term costs include the dynamic elements of finance and risk-survival. Finance includes the obtaining, retention, conversion, control and replacement of fixed assets while maintaining liquidity. It is considered that inadequate measures have been taken in the industry in this respect and present unit costs need to show a much greater allowance for adequate provision for replacement and renewal of fixed assets. Risk - survival goes further than adequate financial provision. While adequate insurance may provide cover for destruction of fixed assets, insurance does not provide relief against shrinkage of supply of raw materials, changes in market demand, new innovations, technical inventions in processing and other unforeseeable fluctuations which disturb equilibrium. The best provision against loss arising from hazards of any kind whatsoever lies in flexibility - adaptability of plant, persons and products in the minimum of time at a minimum cost.

Certain characteristics of change through time were apparent from an examination of earlier regressions for unit cost curves. For example, Tasker J.F.[21] obtained a similar type of regression for wage costs twelve years earlier. But Tasker found that the wages curve flattened out in the region of four thousand tons, (compared to 12,000 lbs. in 1950) indicating a technical and managerial advance since that time.

In capital replacement provision, it was observed that although depreciation tended to increase, the rate of technical innovation together with the rapid fall in the purchasing power of money, had brought about through time, a position of increasing under-capitalization - a dynamic characteristic.

A comparison will now be made of the dairy industry (butter), as in 1937/38, 1949/50 and 1952/53 seasons.

Unadjusted data for total unit costs for the industry were plotted from class-interval averages for the three seasons examined, and

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[21] TASKER, J.F.: New Zealand Creamery Costs and Pay-outs for 1937-38 Season; N.Z. Jnl. Sc. and Tech., Vol. 26, No.4, pp. 204-213, 1944.

smoothed regression curves plotted. Owing to decrease in the purchasing power of money, the average cost curve for 1937/38 season reached its minimum point at 1.8d. level while that for the 1952/53 season reached its lowest point at a little under 3.6d. Corrections were then made, using Locally Produced Commodities Index of Wholesale Prices for computing adjustments. It was found that the index for 1949/50 had increased 56% since 1937/38, and that the 1952/53 index had increased 30.2% since 1949/50, (or unit costs of 1952/53 if diminished by 23.185% would yield a corresponding index to 1949/50). Weighted averages were adjusted accordingly and replotted in relation to the 1949/50 average cost curve.

The results are shown in Fig. 20. As the corrections were made on unadjusted data, considerable caution is needed in comparing these periods. The 1937/38 corrected curve lies above the 1949/50 curve. It will be observed that the Minimum Cost Point is in the region of 9 million lbs. output, and when extrapolated appears to rise more steeply. Moreover, the earlier curve is much steeper in the low-output section, suggesting that it is in the smaller output factories that the greatest gain in efficiency occurred over the twelve years' survey. At the optimum level, moreover, there has been overall reduction in costs of approximately 0.12d. per lb.. It appears that during twelve years the industry has increased efficiency in every respect.

The 1952/53 average cost curve is shown as plotted in Fig. 18 (against the uncorrected average cost curve for 1949/50). After three years the curves lie close together. Factories with output of less than 4 million lbs. output have improved in efficiency, while larger output factories would appear to have increased costs slightly. However, the curve has become shallower suggesting greater uniformity and an improvement in over-all industrial cost efficiency. The lowest cost level or Optimum Point is a little further to the right also and extrapolations would appear to show a smaller gradient of increasing cost with increasing scale.

From the shape and level of these cost curves, it appears that efficiency has improved through the period examined. Further improvement can be achieved from change in structure or radical innovations in processing and procurement, but under the present stage of technology, it is considered that efficiency has almost reached its limit.

SECTION V. SUMMARY AND CONCLUSIONS

1. The Efficiency of Labour: Labour is one of the most costly elements in butter manufacture and will be increasingly so through time. The shape of the labour regression curve shows a relative initial gradient which is steeper than other functional cost elements. This suggests that the efficiency of labour relatively is not at the same high standard as other functional costs. This is due to the indivisibility of the function being controlled, and the calibre of the personnel entering the industry. The quality of those entering the industry, their initial training, and organization and managerial qualities all help to determine relative standards of efficiency. The degree of scattering of individual factories from the regression, too, is indicative of the problems met by management in control of the efficiency of labour.

When compared with other industries (from objective data available), there can be little doubt that the butter manufacturing industry is as efficient as any, but the fact remains that labour is the least efficient, or one of the least efficient aspects of the industry.

This can be assessed from the range of personnel comprising the establishments of different levels of output, and the extent of lost and unproductive time, the deviations of unit wage costs and the degree of labour turnover.

Technical efficiency of labour improves as time-consumption per operation is reduced. This is achieved by planning the arrival of the cans at pre-determined scheduled times, mechanising reception facilities, improving lay-out, making the size of cans as uniform as possible, and improving sample-holders and bottles. Mechanised recording of weights in larger factories reduces time-consumption, while maintaining and uninterrupted flow of butter, cartons and parchfoil achieves this end in butter packing. The following observance of simple time-motion principles, viz. right physical posture, lay-out of men, tools and supplies to economic movement and body action eliminates waste of time and conserves energy.

Granted a relatively efficient time-economy, the main factors increasing labour efficiency in large factories is increased mechanization and concentrated team activity on the various processes in smaller factories.

Much is gradually being done to minimise labour-turnover. Increased accommodation, social facilities provided, recreational diversions, promotion of "esprit de corps" among workers, selection and grading of workers for jobs, training, educating and follow-up of staffing methods are paying good dividends in terms of employer-employee relationships. Adequate incentives in the form of greater wage differentials between skilled and unskilled ranks, and organised detailed dissemination at frequent intervals of all vacancies occurring in the industry would increase the general stability of labour. To assist stability too, it will be necessary to grade systematically all levels of work, especially in the unskilled ranks, and to grant suitable increments after evidence of satisfactory service just prior to critical periods of employment.

Where labour was carefully organised and planned in detail, so that functions and processes were co-ordinated and successive operations synchronized, it was observed that waste, maladjustments and unproductive time were at a minimum. The substitution of mechanization for the labour-intensive elements (cream reception, butter packing, cleaning and carton-making), has reduced total costs, but there is still considerable scope for innovations, inventions and structural changes in this respect. This is an economic problem, and as the cost of labour tends to increase at a greater rate than that of machinery, the substitution of machinery for labour will tend to increase.

2. <u>The efficiency of Cream Haulage</u>: Transport, like labour, is costly and varies considerably from unit to unit. While the regression curve is not as steep as the labour curve in its initial section, yet individual factories show considerable scattering. Cream haulage cannot be said to be inefficient exactly, it tends to be <u>extravagant</u>.

It is extravagant for three reasons, (a) frequent collections to maximise quality is practised; (b) collection is performed by contractors at times when it should be done by the factory itself, and (c) excess running to collect distant offerings.

Efficiency can be improved by minimising time-consumption by bringing cream stands nearer to the vehicle. Effective supplier co-operation, can-grouping, the practice of optimum loading (60 to 80 cans only), route-planning, minimising stoppages, delays and dead miles, and the reduction of length of routes to reasonable proportions to facilitate the staggering of arrival-times, all promote technical efficiency.

Economic efficiency can be improved by the balancing of the costs of more frequent collections against quality, of greater administrative costs (organization and supervision) against higher contractors' costs, and especially the curtailing of distant offerings against reduced processing costs.

In high density areas, the added costs of tanker collection may be offset against reduced labour (reception costs), but in areas of low density, the problem can best be met by organising distant suppliers to bring their own cream to pre-arranged collecting points.

3. <u>The Efficiency of Power Utilization:</u> The problems of power efficiency are problems of capacity and technical knowledge. Given correct capacity and increased technical knowledge, the considerable individual dispersions from the power regressional curve will diminish and efficiency will increase.

It is considered that greater instrumentation should be installed throughout the industry, technical research be increased, and recommendations arising therefrom be disseminated and implemented by an itinerant technical team equipped with facilities for measuring, recording and adjusting plant.

Internally, many plants require more mechanization, closer attention to avoid waste in its many forms, constant checking of consumption and daily reading, recording and interpretation of electrical and steam meters.

4. <u>Technical Efficiency:</u> Technical efficiency throughout the industry is high as reflected by average grade and the consistency of grading throughout the year, 1949/50 being the highest grading yet recorded. However, there is a tendency for technical efficiency to be obtained at the expense of

economic efficiency, a point that requires watching for there is a marked temptation for managers of smaller factories especially, to produce premium quality butter, but only by increasing unit manufacturing costs. Revenue and yield do not reflect technical ability, for short-crediting has been resorted to to hide technical incompetency, with the result, that the technical ability to reduce butterfat losses to a minimum cannot be assessed.

To obviate these malpractices, it is considered that the recent measures instituted to disclose the extent of short-crediting should be implemented throughly and followed up, that weighing-in by mechanical means be increased, that blind-grading be enforced, and that monetary unit costs be related to the finished product rather than to butterfat received.

Incorporation of materials in the finished product is the largest single item of expenditure, and instead of being constant, the range lay from 0.329 to 1.020d. per lb. B/F. suggesting considerable inefficiency of a technical and/or managerial character. Where companies institute and maintain a strict system of records, controlling issue and storage of all materials and consumable stores, waste and incorrect stock-taking are seldom found.

5. Managerial Efficiency: The true function of management consists of planning, organisation, delegation and supervision and this involves making decisions, taking responsibility and co-ordinating activities. The capacity to affect this in terms of output, unit costs, quality and security is the measure of managerial efficiency. It covers technical competency, ability to control all elements of manufacturing expenditure and overheads, and the intangible but very important quality of positive leadership.

The range of managerial efficiency is considerable, for there are a number of men of outstanding ability and capacity in the industry who have won a place by diligence, technical competency and leadership; men of good average ability; and men who do not measure up to the normal requirements of average efficiency.

It is considered that too many managers undertake the work of functional operatives to the detriment of organization. It was observed that really efficient managers were always checking progress by attainment ratios, and continually examined, investigated and eliminated any deviations that arose. With them, input factors such as coal, power, man-hours, petrol, materials etc. were recorded with the same interest, precision and consistency as output of butter. Such men were influential with their directors and always insisted on adequate depreciation of all assets, and recommended sufficient reserves to avoid the temptation of diverting overhead costs elsewhere.

Technical efficiency was at a high level, but is considered that organizational ability was only moderate, while, in many cases, personnel management left much to be desired. The wide range of efficiency is probably a reflection of wide differences in innate ability and capacity. It is questionable whether men of sufficient calibre are being attracted or retained in the industry.

6. Administrative Efficiency: Administrative efficiency can be measured by the extent of the deviations from the General-Overheads regressional curve. This curve, however, measures only Office Administration, and other expenditure connected with Directors, Audit and other fixed costs. It does not measure dynamic efficiency which is the outcome of prudent policy and sound administration, and is reflected in the growth, development, and security of the company through time.

The following observations summarise the position:-

(a) Professional (secretarial and accounting) efficiency is high, especially where the Secretary is qualified professionally. Administrative costs tend to be lower when the services of practising professional men are engaged.

(b) Although administrative costs decrease with scale, it is probable that a fair extent of this expenditure is diverted so that increasing costs tend to set in at a more rapid rate than published accounts indicate.

(c) Although directors are keen, hard-working men with a lively interest in the well-being of their companies, they generally tend to be biassed by the magnitude of pay-outs and competitive criticism, with resulting adverse provision made for capital replacement.

(d) It is considered that the industry would benefit considerably if directors met from time to time at a national level, for directors tend to have a parochial outlook and fail to grasp the overall problems that confront the industry.

(e) It is doubtful whether all audits are sufficient. Many have failed to cause management to submit accounts in accordance with the prescribed regulations, for the number of misinterpretations or errors can scarcely be described as occasional. Although expenditure vouchers have been verified, the apportionment of charges or expenditure amongst other activities has been accepted without verification.

7. Capital Efficiency: When measured in terms of the effectiveness of the relative earning capacity of Shareholders' Funds to aggregate appropriable surpluses, the capital efficiency is very high. But this measure is static not dynamic, and is based on short-term yield, and not long-term stability. In terms of short-term yield, the capital outlay is highly efficient, but in terms of long-term financial stability and capacity to meet cyclical stringencies or asset replacement, the capital position is inadequate and grossly inefficient.

The industry tends to be characterised by under and over-capacity even in the same company, while the use of overdraft accommodation to acquire fixed assets, impairs short-term stability. Long-term stability is impaired by marked under-capitalization and inadequacy of reserves for replacement of fixed assets. Indeed, the amount set aside by way of reserves and depreciation is insufficient to meet current replacements, let alone the need of capital outlay arising from technical advancement and increased mechanization.

On the other hand, Shareholders' Funds and Fixed Assets per unit of output fall steadily with scale indicating that capital is more effectively and efficiently utilised with increasing scale.

The following observations are made:-

(a) The present position of under-capitalization can only be met by adequate and constant ploughing-back of appropriable funds together with the avoidance of financing fixed assets out of liquid funds, or by bank overdraft.

(b) On the grounds of fairness, it is more equitable to present shareholders to finance Fixed Assets by a levy which will not fall unduly on present shareholders, such levy being utilised to amortise the mortgage or debentures.

(c) Any resorting to Stabilization Funds to finance replacement or extension of durable buildings, should be staggered to preclude a sudden demand for productive services at a time of over full-employment.

(d) Maximum rates of depreciation, and increasing amounts placed to reserves should be the constant practice of all companies regardless of other asset requirements.

8. The Efficiency of Auxiliary Activities: A three-fold question arises as regards the efficiency of auxiliary activities: Are they efficient in themselves? Do they promote efficiency in the butter factory? Do they promote efficiency in the industry?

As regards the activity itself, in certain manufactures some inefficiency was noted but, generally speaking, efficiency prevailed. It was observed that efficiency increased and unit costs decreased with scale. With buttermilk powder production and stores this was especially so.

As regards the individual butter factory itself, there is no doubt that auxiliary activities serve to add to the general well-being and efficiency, for they serve to attract and retain patronage and good-will of the suppliers, besides helping the farming community who are not suppliers. Also they increase the appropriable revenue, and assist in reducing costs by enabling economic capacity to be utilised to the full.

As regards industrial efficiency, there are two ways in which auxiliaries detract from general efficiency. Firstly, being financed generally by overdrafts they tend indirectly to intensify the under-capitalised position of the industry. Secondly, costs are manipulated in such a way that many auxiliaries are used to absorb butter manufacturing costs so that the auxiliary costs are unduly saddled with butter expenditure.

The purpose or motive of allowing auxiliaries to absorb a portion of butter manufacturing costs is to present a more favourable pay-out for competitive purposes. This competitive motive[22] may be extremely dangerous to the industry, apart from depriving the supplier of a portion of his reward.[23]

9. Industrial Efficiency: A discussion of the efficiency of the butter industry may be made in relation to the shape and position of the industry regressions[24] from season to season.

The nearer the curve lies to the abscissa, the more efficient will be the industry in terms of cost pattern. After making due allowance for factor prices (to hold them constant), the regressions appear to move closer to the abscissa, indicating some cost efficiency has arisen from factor substitution, technical advances, organization and increased butterfat supplies.

The regressions tend to tilt or pivot slightly about the modal output level, the lower output portion of the regression being nearer the abscissa. This arises from a drop in unit costs, both in absolute and proportionate terms, of the smaller factories which appear to have gained relatively. These gains are the outcome of adopting technical innovations (previously used only by larger factories), increased butterfat, and the fact that many small isolated factories are now at a lesser disadvantage in relation to larger factories in terms of haulage and transport costs.

The regressions tend to be flatter, in that the initial steepness of the curve becomes less owing to the reduction in the number of small-output factories arising from amalgamations and rationalization. Some of these very small units, which were penalised due to their limited territorial supply, become absorbed by other factories, so that the optimum point on the regression curve shifts to the right. General industrial efficiency arising from any cause whatever reduces the general unit cost dispersions between smaller and larger output factories which helps to flatten the regression.

General industrial efficiency is also the function of exogenous and institutional elements. Climate, location and the degree of efficiency of those institutional services play a large part in aggregate of costs -

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[22]By "competitive motive" is meant that propensity or incentive to compete for supplier patronage by the means of showing competitive pay-outs made possible, largely by allowing auxiliaries to absorb more than their fair share of their costs of collection, manufacture and overhead.

[23]See Appendix G. for fuller treatment.

[24]Regressions which denote average cost-output relationships.

about one-half of total costs, so that any improvement in institutions serving the industry, will reflect in industrial efficiency. Improvements in structural and organizational aspects would increase adaptability of factories provided that diversification is permitted to a greater degree.

Diversification would involve integration and a further measure of rationalization. This would be necessary if any marked improvement in the shape of the cost curve should be desired, for the industry is already at a fairly advanced stage of efficiency under the present structural framework.

In other words, a different type of industrial structure would probably result in an entirely new curve which would be flatter, more extended and with a lower optimum point than the present one. To achieve this more efficient curve certain changes would be desirable:-

(a) Factories (or companies) would need to integrate themselves in economic groups as proximity to one another permitted.

(b) Utilization of whole milk should be regarded as the governing principle of the industry for areas of a given milk density coming within a given zone from the processing plant.

(c) Integration and rationalization should be applied to achieve more concentrated production, greater diversification, and elimination of uneconomical units or waste together with more efficient utilization of fixed assets, power, labour and organization, and greater control over factors of production and correlative services.

Integration or combination in small workable groups would preserve the necessary elements of co-operation and competition at the optimum level in district patterns of organization.

Utilization of whole milk would permit optimum capacity, diversification of production, and greater flexibility. It would assist to eliminate excess capacity and permit greater economies of scale, and reduce unit costs especially in labour, transport and power. It is recognised that smaller isolated factories would need to continue to operate as previously, but these, although numerous, provide only a fraction of total output, besides tending to specialize on local market requirements.

Butter would tend to become a by-product of whole milk utilization, the supply of cream being supplemented by offerings coming from outside the whole milk zone.

Such changes as envisaged above could only come about gradually, as a process of reconstruction energised from within the area and not imposed from without. But at the same time such reconstruction would need to be guided and controlled as a part of an overall rationalized plan to serve the better interests of all concerned.

In conclusion, increased industrial efficiency can be achieved only by attention to certain technical, economic and structural aspects. Technically, it is necessary to eliminate waste, maladjustments, fluctuations and excess capacity. Economically, factor substitution could be used to greater advantage throughout the industry. Although some use has been made of it, especially in the form of increased mechanization in processing and packing, it is considered that, even on the basis of present factor costs, there is considerable room for further profitable factor substitution. Structurally, efficiency can be increased by utilising whole milk from zoned areas of high milk-density, by the integration of factories in high density areas to eliminate competitive waste, by rationalization of procurement, processing and distribution, and increasing the efficiency of the institutional elements serving the industry.

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* See Appendix A: Related Studies and References pp. 392-395.

APPENDIX A.

RELATED STUDIES

Very little analytical research has been conducted in New Zealand into the efficiency of the dairy processing industry. Although data are available in the form of reports, compiled statistics and articles, they are descriptive in character, or mere compilations. As such they fail in the important task of analysing, diagnosing and throwing light on the conditions they describe.

TASKER, J.F. (1), in two papers attempted a pioneering study of creamery costs in New Zealand. In his first paper he analysed the working costs per lb. of butterfat of North Auckland Creameries, together with an analysis of the balance sheets of the companies operating in that area. He showed that both manufacturing expenditure and capitalization costs diminished in terms of unit costs with increased scale of production. In his second paper, the manufacturing costs of forty-nine creameries in the North Island were analysed, and cost curves were shown for the various elements of the Manufacturing Account and also for pay-outs. He concluded that the reduction in unit costs arises mainly from the fall in costs of manufacturing wages. His data were derived from annual reports and manufacturing accounts, and his regressions depict the various unit costs in terms of output. While he recognised the limitations of accounting data, the gradients of the cost curves shown did indicate the avenues of possible future research.

Hamilton, W.M. (2) summarized manufacturing cost differentials and indicated the cause of differentials.

A few unpublished theses touch on relevant points, but usually in a descriptive manner. Hampton (3) elaborated historical and institutional aspects of the subject; Larsen, H.F. (4) gave a descriptive account of dairy company organisation in New Zealand and included some pertinent analytical material on finance, capital structure, and investments; Mc.Allister, R.D. (5) examined cost and scale relationships in other New Zealand Industries; Rowley, R.G. (6) analysed factors affecting the guaranteed price; and Heward, H.R. (7) described in an historical approach, New Zealand's largest co-operative dairy company.

Other sources of information and data on New Zealand conditions are obtainable from official statistics and reports. The Annual Report of the New Zealand Dairy Board affords much relevant data suitably classified. The monthly reviews of trends in production issued by the same Board amplify the Annual Report, giving further details. The Dairy Industry Commission's report (8) includes a section of the economies of collection, processing and distribution. Further details, but still descriptive and statistical rather than analytical, are afforded in a report (9) of the Executive Commission of Agriculture. Other useful reports are those of the Department of Agriculture, issued annually, and the New Zealand Dairy Products Marketing Commission.

Research workers, particularly in North America and Scandinavia, have made valuable analyses of economic efficiency in butter production.

In countries of the British Commonwealth certain research can be considered of importance. A report on the Alfa butter-making process (10) gives interesting comparative data on functional operating costs of selected typical creameries in Australia.

From South Africa, the annual reports of the Dairy Industry Control Board afford useful statistics, while a report (11) issued by this Board on the costs of butter production can be considered as a typical, useful, early research on the problem of operating costs. An auxiliary report was subsequently issued by the South African Department of Agriculture.

Canadian research has been extensive. Foremost, Misner, E.G. (13), in a 725 page report went into the costs of butter manufacture in Saskatchewan. Although giving much space to other branches of the dairy processing industry, he examined fully and interpreted costs of operating butter factories. In this study is incorporated an interesting multiple correlation analysis upon the scale of output, monetary returns, cost and efficiency.

Three other studies of Canadian conditions merit attention. Stewart, A. (14) analysed methods of cream collection in terms of cost; Patterson H.L. (15) gave a full analytical account of non-creamery aspects of the dairy industry in Alberta; and Parker, C.V. (16) analysed operating efficiency including technical and transport problems.

Other useful research from Canada includes the following :- The Ontario Department of Agriculture (17) made an adequate analysis of milk transport problems; the same province issued a very full report some time later in which one chapter was devoted to creamery efficiency (18); a further analysis was undertaken in Quebec (19); another in New Brunswick (20); and yet another in Saskatchewan (21) in which very full schedules were utilized to obtain full information of creamery operation. In addition, the Dominion Bureau of Statistics issues annual reports giving considerable information, and recently in collaboration with Dominion and Provincial Departments, issued a valuable analytical work on dairy factories (22). These are but some of the more important research publications on this subject from Canada.

The most detailed studies have come from the United States. Only the more important can be briefly named. Tinley, J.M. (23) and associates analysed creamery operations in considerable detail with special reference to labour costs. Black and Guthrie (24) published a pioneering study on the subject; Quintus and Stitts (25) analysed butter marketing; Montgomery and Caulfield (26) studied the administrative aspects of co-operative creameries in Kansas; Giese and Mortensen (27) devoted themselves to the problems of organization; Mighell and Quintus (28) examined financial problems; and Ullyot and Hollands (29) analysed accounts and methods of presentation of balance sheets.

Marketing margins and costs were studied by Howe (30); and operational flexibility by Cowden and Trelogan (31). Transport and butterfat procurement problems have been thoroughly analysed by a number of research workers the chief studies being those of Dow, G.F. (32) in Maine, Quintus and Robotka (33) in Iowa and that of Matzen, E.H. (34) in Indiana. A work that is important because of its minute cost analysis is that of Bartlett and Gothard (35), in which they measured operational efficiency in milk plants.

Studies from European countries, although of a different character, are no less important than the Americal studies. They differ in that more attention is devoted to methodology of research, choice of suitable units, carefully defined concepts, and the use of regressional methods. The most important collection of research work is found in the report of the XIIth International Dairy Congress (36). It must be pointed out, however, that all these studies deal with multiple-products, so that economic problems differ from those obtaining in American and Australian factories where often one major commodity such as butter or cheese is produced. European research is important nevertheless, because considerable attention has been successfully focussed upon the optimum utilization of whole milk in the manufacture of various milk products. Consequently most units are multiple-product units, manufacturing a range of commodities, the range of which depends upon existing economic factors.

Hilding, A. (37) in his paper on the rating of production economies elaborated the need of organization at the national level, the advantages that derive from nationalization of certain aspects of the dairy industry and the need for through organization of every detail for functional control. He analysed different types of efficiency, showing how productive efficiency depends partly upon technical factors and partly upon cost contro

Green, E. (38) illustrated the possibilities of regressional analysis to estimate economic performance where multi-products are being manufactured He pointed out that "the income of a dairy is a function of the operational type and the costs*". The income (which is the independent variable in the regressional formula) can be determined from combination of the dependent variables represented by the various commodities produced (butter, whole milk, cheese etc.). He pointed out that as the intake of whole milk increases, the income can be maximised only by adherence to the regressional

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*Green, Eric: An Estimation of the Economic Performance of Dairies with the Aid of Regressional Analysis, XIIth. International Dairy Congress, Vo.. IV (1949) pp. 33.

formula. Thus in order to maximise net returns, it is essential that the components of the regression be determined.

Maximum utilization of factors of production were discussed by Ruhne, H. (39) in his analysis of employment of factors. He carefully distinguished between employment and capacity and indicated that the degree of employment of factors varies with the type of the producing unit. Statistical treatment was used to determine the extent of full employment in order to eliminate sources of waste and maladjustment of factors.

The relationship of costs and attainments was examined by Kaukonen, L. (40) who defined costs as the total "consumption of utilities estimated in money, that occurs in the enterprise during the process by means of which the attainments are brought about".* He pointed out that dissimilar unit costs arose from the inability of units to utilize effectively their economic capacity. This was especially seen in effective utilization of labour and transport capacity.

The effect of scale and capacity were analysed by regressional methods by Joost, K. (41). All dairies were classified according to output and type of commodity produced, and regressional calculations made according to the class of dairy. The various regressional lines indicated the change in costs derived from scale and utilization of the raw product for various commodities.

An even more penetrating study was undertaken by Maider and Bagstam (42). All dairies were classified on a two-fold basis; output and commodities produced. Complex costs were then analysed on a given pattern with special attention paid to capital costs. It was pointed out that capital costs vary enormously owing to the arbitrary way in which depreciation is handled. Larger companies manipulated depreciation according to their general financial policy. Accordingly, a correction of recorded capital costs was undertaken to give a true reflection of actual, not paper capital costs. By these methods a refinement has been introduced,

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* Kaukonen, Lauri: Running Costs and Yield of Different-Sized Butter Dairies in Finland, XIIth International Dairy Congress, Vol. IV, (1949) pp. 108.

probably possible only because of the degree of co-operation and the care taken by the members of the Swedish Dairy Association in keeping accurate and detailed records which were readily made available.

A number of interesting studies were undertaken in cream (or milk) collection problems. Rautavaara, H. (43), by time-motion Studies, regressional calculation and careful cost analysis, compiled precise information on transport. Emilsson, E. (44) probed the question of costs as affected by distance of suppliers from the factory, and Green, E. (45) by regressional analysis analysed the elements of distance, weight carried, and time as functions of cost. Horelli, E. (46) devised elaborate formulae, derived from regressional studies, to show that the element of time is basic in collection costs.

It must be abundantly evident, that, in order to conduct research on the scale just described, detailed uniform data must be kept by all manufacturing units which make available such data to competent organizations for compilation and analysis. Considerable space has been devoted to research work throughout the world to bring out into bold relief the extent to which other countries have taken up economic research into the production of dairy commodities.

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APPENDIX B.

FORM OF STANDARDIZED ACCOUNTS USED IN THE BUTTER INDUSTRY*

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* Extracted from THE DAIRY INDUSTRY ACCOUNTS REGULATIONS, 1950, Government Printer, Wellington, pp. 6-7.

(FORM OF BALANCE-SHEET)

(The Balance-sheet of every dairy company shall show the information set out hereunder, but the actual form of presentation may be varied as desired. Shillings and pence may be omitted from the published accounts if desired.)

The ....Co-operative Dairy Co.Ltd.
BALANCE SHEET AS AT.. ....19...

CURRENT LIABILITIES	£ s. d.	£ s. d.	£ s. d.
Bank Overdraft (Current Account		....	.....
Sundry creditors		....	.....
Other demand or short-term liabilities		....	
Amount due to suppliers for supply in final month		....	
Provision for proposed appropriations		....	
Dividend or interest on shares		....	
Final payments to suppliers		....	
Total current liabilities			....
FIXED-TERM LIABILITIES-			
Debentures		....	
Mortages		....	
Other fixed-term liabilities		....	
Total fixed-term liabilities			....
CAPITAL AND RESERVES-			
Authorized capital: ...shares of	£ s. d.		
Unallotted shares	.....		
Surrendered shares	.....	....	
Issued capital		....	
Less unpaid capital		....	
Paid-up capital		....	
Reserves-			
General	.....		
Specific	.....	....	
APPROPRIATION ACCOUNT			
Total Shareholders' Funds		....	.....
			£........

CONTINGENT LIABILITIES (Specify).

CURRENT ASSETS-	£ s. d.	£ s. d.
Cash in hand and at bank	....	....
Sundry debtors	....	....
Stocks -	....	
Butter	....	
Cheese	....	
Other dairy-produce	....	
Manufacturing materials and consumable stores	....	
Trading stocks	....	
Other stocks	....	
Total current assets		....
INVESTMENTS		....
FIXED ASSETS -		
Shares in other companies (at cost)	....	
Land and buildings (giving basis of valuation)	....	
Plant and equipment (giving basis of valuation)	....	
Total fixed assets		....
		£........

(FORM OF CREAMERY (or WHEY) BUTTER MANUFACTURING AND MARKETING ACCOUNT)

CREAMERY (Or WHEY) BUTTER MANUFACTURING AND MARKETING ACCOUNT FOR THE YEAR ENDED......................19....

COVERING PRODUCTION FROM.........lb. butterfat.

Pence Per Pound of Butterfat.			£ s. d.	£ s. d.
	.....	CREAM-COLLECTION		....
		MANUFACTURING CHARGES-		
....		Wages	....	
....		Materials	....	
....		Fuel, power and steam	....	
....	......	Sundry	....	....
		FACTORY OVERHEADS-		
....		Depreciation	....	
....		Repairs, maintenance and consumable stores	....	
....		Rates and land-tax	....	
....	.....	Insurance	....	....
		CHARGES, FACTORY TO F.O.B. (INCLUDING CHARGES ON PRODUCE SOLD LOCALLY)		
....		Carriage and freight	....	
....		Freezing and storage	....	
....		Grading	....	
....	......	Insurance to F.O.B.	....	....
		GENERAL OVERHEADS-		
....		Administration and office expenses	....	
....		Directors fees and exps.	....	
....		Audit fee	....	
....		Interest	....	
....		Farm Dairy instruction	....	
....	......	Dairy Board Levy	....	....
	......	Total costs		....
	......	Surplus on Buttermaking, Transferred to Appropriation Account		....
	======			£========== ======

MEMO.- Cream-collection charged to suppliers (not included above)

Pence per Pound of Butterfat.		£ s. d.	£ s. d.
	SALES AND STOCKS OF BUTTER-		
	Export	....	
	Local	....	....
			£========

APPENDIX C.

BRIEF DESCRIPTION OF BUTTER MANUFACTURE

On arrival at a butter factory, cream is weighed and graded, and a sample taken for testing for butterfat content at the end of the testing period.

Cream grading is performed by a certified cream grader by sight, taste and smell, and classified as finest, first or second grade. Cream below second grade in quality is coloured violet and returned to the supplier.

A docket showing the details of weight, grade and test is sent to the supplier in his empty can, a copy of this docket being a prime entry for dairy company records.

Finest-grade cream is usually segregated from first and second-grade creams by pouring it into separate neutralising vats.

When sufficient cream of a type has been received, the process of neutralization is begun. After stirring the cream in the vat, and diluting with good water if necessary, the cream is tested for acid content and a suitable neutralising agent, such as bicarbonate of soda, added.

Following neutralization, the cream is pumped to the pasteurising equipment, the main types of which are the Flash system, the Plate pasteurizer or the Vacreator system. In this last type, live steam is brought into direct contact with the cream, which is heated, purified from odours, and partially cooled under a vacuum. Many factories use the Flash or Plate pasteuriser in conjunction with the deodorising unit of the vacreator.

After pasteurization, the cream is cooled rapidly to inhibit the breeding of bacteria which may have survived pasteurization. Cooling is achieved by passing the cream over one or more water coolers and then over a direct expansion cooler (external or internal) which uses (normally) ammonia as its cooling agent.

At this stage, more tests for acid content are made, and the cream is pumped to stainless steel holding vats of the direct-expansion type equipped with mechanical agitators. The cream is further cooled in the holding vats until required for churning the next day.

The buttermaker, commencing very early in the morning, first stirs all the holding vats, checks the cream temperatures, tests for acid content and fills the churns with cream to the correct level. After revolving for 30 to 40 minutes, the cream begins to "break" in the churn, which is kept moving until the butter granules are about the size of peas. The buttermilk is then run off, and a sample tested for fat content loss. Chilled water is then added to the butter for washing and then drained off. Salt is then added and worked slowly into the butter. It is at this stage that body and texture of butter (and its quality) will result from the skill and judgment of the butter-maker.

A sample of butter is then tested for water content and saltiness, and checked to ensure that body, texture, colour and sheen is adequate.

Packing commences with unloading the butter from the churns onto unloading trolleys which convey the butter to the butter moulder, from which the extruded butter is cut into 56 lb. blocks for export, weighed, wrapped, inserted into cartons, which are sealed, numbered and dated. Many factories pat butter in 1 lb. blocks for local consumption as well.

Prior to being sent to the nearest grading store for grading and freezing, the cartons of butter are stored in the cool chamber adjacent to the churn room. Butter is held sometimes for several days in the cool chamber at a temperature of 30 to 40 degrees F. before being despatched to the grading store.

APPENDIX D.

TIME-MOTION STUDIES - LABOUR

The need of planning in labour:

One real test of labour efficiency is the extent to which labour-planning is in evidence. Labour may perform its various functions in a haphazard way, or as the result of conscious organization, in which every detail of each job is carefully planned and co-ordinated. The test of labour-planning can be seen from:-

(a) the extent to which the average time for a given operation differs from the time taken for the same operation carried out in a different factory under similar conditions,

(b) the extent of the fluctuations of average time for that operation within the factory itself.

To test how far labour is planned, it was necessary to conduct time-motion studies in the labour-intensive sections of the industry.[1] These time-motion studies revealed the extent of planning in synchronising operations, processes, and teams; in the lay-out of plant and equipment; in the elimination of waste or non-productive (not legitimate) time; and in the substitution of machinery where elements of the work are repeat process operations, or where

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[1] There are three labour-intensive activities in butter manufacture. They are:

Cream collection
Cream reception
Butter packing.

Other labour-consuming activities are:

Cleaning
Carton-making
Boiler attending
Cream testing.

time-consumption was high.[2]

Cream Reception: Time-motion studies were conducted in more than 60 factories. In most cases a run of 20 cans was taken. Where accidents or delays occurred, the timings being vitiated, were discarded. Usually 4 to 5 runs or timings were taken and averaged out. A period of time was allowed to elapse for warming-up to take place before actual timing was commenced. This was conducted in such a way that the operatives themselves were unaware that they were under the scrutiny of the stop-watch.[3]

The main operation of cream reception was divided into nine movements, and for each movement the position of the operative was noted, the number and character of motions per movement recorded, the time per movement, and the distance in feet covered by the operative in each repeat process.

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[2] There is one sphere, in which planning, or rather, lack of planning was abundantly evident, - that of the arrival of the cream at the factory. Much time is lost and organization tends to be disrupted where cream does not arrive at scheduled intervals of time. Waste of time is minimised, intensity of work is spread, congestion and spillages avoided, and working conditions are improved where cream is planned to arrive at short intervals e.g., at 10 a.m., 10.20, 11 a.m. and so on. The means whereby scheduled arrival of cream can be attained is dealt with in the time-motion studies of cream collection in Part III. of this work.

[3] Two stop-watches were employed, one of which was fitted with a special cumulative device to time certain operations in the run itself. It was found necessary to conduct the timings secretly for two reasons: (a) the men tended to speed up when they became aware of the activity, (b) certain employees who considered the object of the timings was to step up production, were hostile.

The number of movement were classified as:-

1. Removal of cans off lorry to reception platform.
2. Removal of lids from cans.
3. Stirring.
4. Sampling.
5. Grading.
6. Weighing.
7. Tipping of cans.
8. Loading of empty cans on can-washer.
9. Disposal from can-washer.

The number of employees engaged in actual cream reception varied from 2 to 9, depending on the size of the factory and the organization of labour in the particular factory and the total number of hands available for this work, together with the equipment used. In order to compare the various cream-reception organizations, it was necessary to reduce the figures to a common denominator, and to do this, all timing was converted into compound units "seconds per man-can".

For example, suppose Factory A. has a team of 6 employees averaging 8 seconds per can, and Factory B. has a team of 8, averaging 7 seconds; then the relative units of time consumed would be:-

Factory A: 48 seconds per man-can.

Factory B: 56 seconds per man-can.

The aggregate time of the total movements timed separately was taken for the purpose of calculating non-productive time in each operation. The aggregate of these movements was always less than the time for the total operation, due to the fact that certain operatives were idle at certain stages in the cycle of cream reception. The extent of this unproductive time correlated highly with the number of major motions per movement, and the distance covered by the operative measured in feet.[4]

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[4]It is not intended in a study of this type to go too deply into the technical character of time-motion technique, nor to record unnecessary data relative to movements, motions and distances, apart from indicating excessive and unnecessary movements, unproductive time, waste and maladjustments.

One point needs to be stressed before quoting time-motion data. The size of can has an important bearing upon the time consumed in the operation. Although cans are regarded for statistical reasons as a homogeneous factor, they vary considerably in shape, size and capacity. The more varied the can sizes, the greater is the time-consumption and the higher the percentage of unproductive time recorded.[5]

The results of time-motion studies are as follows:-

Number of men engaged in the operation	The minimum time recorded per man-can (secs.)	The maximum time recorded per man-can (secs.)
2	76	112
3	60	114
4	46	102
5	51	113
6	40	90
7	48	85
8	36	76
9	49	63

[5] Small cans take much longer to handle than large cans. Few employees take the trouble to sort the size of cans before commencing operation, as it is not always realised that a flow of cans of differing capacities can reduce operational time up to 50%. In one large factory, where conditions were ideal for measuring this aspect, of time-motion, it was possible to observe and time the handling of 100 small cans followed later by 100 large cans by the same team of operatives.

The following results were noted:-

Average time for handling small cans (1 to 2 gall. size) was 15.0 seconds per can. Average time for handling large cans (10 to 12 galls.) was 7.4 seconds per can.
Average weight of cream in small cans was 4.3 lbs., and in the large cans 61.2 lbs.
That is, the large cans contained approximately 14 times more cream than the small cans.
Thus in terms of pounds of cream, it takes more than 28 times as long per pound of cream to receive small cans than large cans - and unit costs would be 28 times as great.
The reasons are: (a) small cans had to be placed carefully on a special steam jet for cleansing, (b) the smaller can aperture required more time for stirring and sampling, (c) greater care was taken in weighing, (d) the men became more fatigued by having to stoop further. Furthermore, it is interesting to note that 15% of the small can lots were graded finest, whereas over 90% of the large can lots were finest.

In these figures, all abnormal runs were excluded. Wherever an accident, delay or spillage etc. occurred, the timings were discarded. Moreover, these timings are average timings of 4 or 5 runs, not individual runs, so that the first record of 76 seconds refers to the average (in this case) of five timings.

Abnormal runs include those of excessive times which were not typical, but reflected poor organization, lassitude, poor equipment with excessive movement and other causes. Thus 8-men teams recorded in more than one instance timings from 156 to 170 seconds, but as they were due to abnormal conditions, they were not included in the maximum time recorded, which refers to normal timings. They are mentioned solely to indicate just how time can be consumed.

The general pattern of time is evident, especially from the maximum data. Less time tends to be consumed when more men are engaged in the operation due to specialization of motions, which in turn, promotes less movements by operatives and greater dexterity. The organization of labour in small teams was of two types, (a) where each employee carried out a number of separate movements, (b) where all employees engaged in each movement successively, i.e. all assisted in removal of cans, taking lids off, stirring etc., until the operation was completed.

The timing of each run usually took between 2 and three minutes. The average time per can thus was calculated, but it was necessary to time each movement separately to calculate unproductive time per run.[6]

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[6] In the time available, it was only possible to select representative factories for timing movements, taking distances and motions.

The variation in time consumed was traced to be due partly to organization and facilities available, and partly due to unproductive time which is largely the outcome of the former. As the number of operatives in the team increased, the percentage of unproductive time decreased. The percentage of unproductive time was much greater in the recordings.

The following figures indicate the extent of unproductive time recorde

Number of Operatives	Average Time recorded per can (secs.)	Percentage of Unproductive time* (%)
2	48	65
3	32	58
4	24	50
5	15	47
6	11	46
7	9	42
8	7	36
9	6	31

* Thus four-man teams were idle (unproductive) for 50% of the time, larger teams one-third of the time and two-men teams almost two-thirds of the time due to unnecessary movement on the part of some largely, whilst other operatives were marking time doing nothing.

Not only did factories of similar output and facilities vary considerably in their timings, but the same team varied considerably within the course of short periods time - such as 20 minutes. In each case these variations were not due to any delay or mishap, although some were otherwise abnormal.

The following variations are quoted:

Number of Operatives	Percent. variation in short runs
3	55%
4	21%
5	102%
6	112%
7	22%
8	151%
9	37%

Excessive variations appeared to be related to the lack of conscious organization.

In addition to minimum and maximum timings, unproductive time and variations, the total time devoted to cream reception for each factory was taken in order to calculate the percentage of time "lost" during the entire period of daily reception.

For example, a given factory might take two and one-half hours over cream reception, using six operatives handling 600 cans. Time-motion studies might reveal for 4 or 5 runs the average time of 10 seconds per can, or 60 seconds per man-can. But at the rate of six cans per minute, the entire job should take only 100 minutes, whereas 150 minutes is average time devoted to this work per day.

Obviously 50 minutes "lost" time has occurred, or, put differently, 50% more time is required due to "lost" time. This "lost" time must be clearly distinguished from "unproductive" time. "Unproductive" time is largely the outcome of maladjustments in the co-ordination of the team during the actual process of cream reception. If one operative, for example, requires 8 seconds to take a sample of cream (due to poor cream containers, obsolete stoppers, distance of sample-holder from cans etc.), whereas stirring of cream takes 2 seconds, weighing 5 seconds, tipping 4 seconds, recording 6 seconds etc., it will be obvious that the unproductive time will be (8-2)+(8-5)+(8-4)+(8-6) or 15 seconds per can. This "unproductive" time is hard to eliminate especially for smaller teams, and probably is much higher than that shown.[7]

It would be difficult to reduce "unproductive" time much below 30% apart from a detailed time-motion study of each separate movement in which each motion was carefully analysed in technique.

[7] The reason for this is, that those movements requiring less time are hard to detect, for the operative is enabled to work in a relatively leisurely fashion. Hence the need of putting the most skilled man on that movement requiring the most time.

"Lost" time, however, is the result of:-

(a) Breakdowns in plant or equipment,
(b) "accidents" such as spillages during the peak of reception or filling butter moulder (in packing),
(c) idle time arising from failure of cream lorries to arrive at scheduled time,
(d) congestion of cans due to too many lorries arriving simultaneously, and
(e) abnormalities due to slow "warming-up", interruptions, or slowing down due to physical posture, exhaustion and nervous distraction.

"Lost" time was calculated for each factory at which time-motion studies were taken, with the following results:-

Average time per man-can.	Actual "lost" time % (averaged)
31-50 seconds	14% extra time needed
51-70 seconds	45% extra time needed
71-90 seconds	76% extra time needed
91-110 seconds	97% extra time needed
111-130 seconds	124% extra time needed
Over 130 seconds	165% extra time needed

The best recording was 7% extra time needed, and the worst was just over 200%. Approximately 75% additional time was needed on the average on account of "lost" time.

Some twelve receptions were carefully followed throughout the entire procedure to determine what extent the various causes contributed to "lost" time, with the following results:-

Accidents 6%, can congestions 10%, breakdowns 13%, idle time due to failure of lorries to arrive 32% and abnormalities 39%.

These timings were taken at essentially the flush of the season, and it is probable that lost time and unproductive time would increase when the cans decrease in number. While the "abnormalities" are difficult to control, there still remains some 60%, which by careful planning would be considerably reduced. Especially is this true where lost time is due to irregular can arrivals.

The causes of "unproductive" time may be summarized as due to:

(a) Poor lay-out of men, cans, scale, sample-holders, washer, receiving-vats and recording desk.

(b) Excessive movements - especially - taking samples,
loading on washer,
weighing,
sorting cans off lorry.

(c) Variations in size of cans.

(d) New employees, being slower than other members of the team, causing bottle-necks to arise in a particular operation.

(e) Operatives engaged in movements consuming different periods of time, due to too few men being in the reception team.

(f) Lack of adequate facilities - especially roller-conveyors.

Factors assisting in reduction of time-consumption:

1. Cans arriving on time in a steady flow throughout reception.

2. Cans numbered clearly - and unloaded in numerical sequence in order to obviate unnecessary hunting for sample bottles and place in recording book. [8]

3. Use of roller-conveyors from stage to receiving vat. Usually rollers are set too low, necessitating undue stooping and onset of early fatiguing. Roller-conveyors reduce spillages, make for more orderly can sequence and permit minimum movement. They should be set in a straight line from edge of stage to reception vats with scales clearly in view of recording clerk.

4. Cans should be of uniform and large size. Where cans are heterogeneous they should be numberes so as to segregate cans in uniform size categories.

5. Rotary sample-holders with suspended trays - bottles clearly marked in coloured paint, with quick-action spring top. Sample bottles should be so placed that the operator needs only to move body from the waist.

6. Recording desk to be elevated above scale level to ensure clear and horizontal vision.

7. Where team is few in number, less time is consumed by all operatives sorting cans, removing lids, stirring, sampling, and then dividing the work of testing, weighing, tipping and recording.

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[8] Although it is customary in many factories to allot numbers based on district, lorry collection, or chronological basis, it is strongly recommended that the sequence of numbers should be based on can-size, e.g. one-gallon cans from 1 on, 2 gallons cans from 100 on, 3 gallon cans from 200 on and so forth, classifying runs by different colours.

8. Where the team is adequate and the number of cans uniform and considerable, mechanical calculators are recommended as machine recorders. The cans should be so placed that gross and tare weights can be seen by the machine operator who can mechanically subtract the tare weight and thus obviate the necessity of the weighing operator adjusting the tare bar of the scale. A good operator can operate the recorder comfortably at the rate of 3.5 seconds per can - a little less if necessary - meaning that the worst bottleneck (weighing) can be reduced permitting cans to flow through at the rate of 18 to 20 per minute. (Two men may be required on sampling). Moreover, by using this technique, a legible record is made mechanically.

9. Straight-through can-washers are best - preferably the endless belt type with automatic can tipping device at the distant end.

10. Use of telegraphic wire for transferring dockets to waiting cans.

<u>Butter Packing</u>: In most cases a run of 20 cartons was taken. Only normal runs were included, and methods and precautions similar to those applied to cream reception were adopted.

Again, each operation was divided into nine movements, and for each movement the number of motions was noted, the distances the body of the operative had to travel, the accessability of the equipment and the individual timings of component movements taken.

The movements were classified as:-

1. Cutting butter.
2. Placing in butter moulder.
3. Cutting into blocks.
4. Weighing blocks and adjusting.
5. Wrapping with parchment.
6. Boxing (with carton).
7. Printing.
8. Sealing and finishing.
9. Removal to cool-room and stacking.

Unloading of butter from churn was not included in butter-packing timings owing to the time-lag between this activity and the actual packing itself. The results of the time-motion studies made on teams ranging from 3 to 14 employees were as follows:-

Number of employees engaged in the operation	Average minimum time per box-man	Average maximum time per box-man *
3	159 secs.	198 secs.
4	162	192
5	137	205
6	136	182
7	129	142
8	132	171
9	114	153
10 to 14	89	154

*Time per box-man" refers to the compound unit in seconds of number of employees per carton packed. Thus if 8 men packed a carton in the average time of 15 seconds, the compound unit resulting would be 120. In a number of teams female employees were used, whereas only men formed cream reception teams with the exception of recording clerks.

Many abnormal runs had to be excluded. As with cream reception, both unproductive time and lost time were recorded, but it was much more difficult to distinguish between abnormal runs (which had to be discarded) and unproductive and lost time. Quite often recordings were made which timed up to 325 seconds per man-box, the magnitude being due to poor organization, lassitude, and one or two operatives performing movements which absorbed up to three times the normal time required by others.

TABLE LXVI. UNPRODUCTIVE TIME, LOST TIME, AND VARIATION PERCENT IN SHORT RUNS FOR BUTTER PACKING:

Number of operatives	Av. time per carton	% due to Unproductive time	Actual time lost (% required as extra time) (a) %	(b) %	Percent.variation in short runs %
3	61	35	37	310	25
4	44	38	35	295	32
5	34	45	35	245	45
6	28	40	32	187	41
7	23	36	26	94	35
8	18	32	23	66	28
9	14	25	20	53	30
10 / 14	12	21	20	49	35

In the above table, abnormalities were excluded for unproductive time, but were included in the second column of Actual Time Lost. There are two columns shown for time lost, the first (a), recording the optimum figures recorded for time lost, the second (b), the pessiumum recordings. In fact in two or three cases the actual time lost lay between 500 and 600 per cent due to extremely abnormal conditions.[9]

The average time per carton gives a fair picture of how on the average, there is a saving of time as the team increases in size. One of the best timings was recorded by a 7-man team, and some very fine results came from a 3-man team packing small quantities.

Unproductive time arose mostly from poor lay-out of equipment, excessive movement of men, inaccessible empty cartons, undue body-movement, because supplies were badly placed and bottle-necks occurred in one or two movements.[10]

Lost time arose from butter spillages, renewing supplies of parchment, gummed strips, cartons and glue, adjusting weighing machine, hold-ups in butter arriving (occasional), change in personnel or diversion to other duties and general abnormalities which could be traced to interruptions, posture and general fatigue.

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[9] It was most difficult to obtain "normal" runs due to many reasons. Abnormalities often arose from hands being diverted temporarily for other pressing duties. Extreme abnormalities include a major injury and a "snowball" fight with butter arising from an argument amongst employees.

[10] It was not uncommon for an operative to have to walk 10 to 15 feet to procure each empty carton. Facilities were lacking in many factories - one even used bricks as carton weights after glueing. The chief bottle-neck in larger teams was weighing the block of butter - often undertaken by the manager himself in many factories. Figures recorded are optimum - for many timings were disappointing, for they displayed disregard of the most elementary rules in scientific motion study.

Attention to the following factors would assist in reducing time-consumption in butter packing:

1. Use of butter hoist and efficient moulder.
2. Adequate team to minimise movement from station to station and to specialise motions and movements.
3. Supply of cartons fed on overhead conveyor or by other suitable gravity device.
4. Parchment wrappers in easy access preferably at head level.
5. Printer held in position by overhead spring device.
6. Automatic weight clamps with pedal release.
7. Automatic strip-length cutters.
8. Roller conveyors right into cool room moving in straight line down slight gradient.
9. Number and date of churning etc. to be affixed prior to being oonveyor-fed.

Butter pounding: Automatic machines ranged in speed from 0.75 seconds to 1.13 seconds per pound in operation.

Hand-wrapping timings ranged from 3.8 seconds to 11.8 for runs of 20 pounds of butter. When the number of pounds per hour were calculated, these ranged from 212 lbs. to 595.

Time lost through fatigue was considerable, and change of work is recommended if hand-wrapping is extensive. Those factories which had the best timings, were those with 3 or 4 hands wrapping as a team.

Carton-making: Timings varied according to the type of carton used at the moment, also with the facilities available for measuring the correct length of tape. In some factories carton-making was a spare-time occupation of youths and elderly hands - often with a resultant loss of time to a marked degree. A few factories had music relayed to the workers, but timings in these cases were very slow.

Some factories employed girls on hourly shifts with excellent results. One or two factories included carton-making as part of the chain of butter-packing, so that cartons were made in time with butter packing with excellent results.

At least one factory had cartons made on a contract basis of 1d. per carton. Others relied on casual, part-time workers.

A run of 10 cartons was usually taken. The timings ranged from 23 to 131 seconds per carton.

Time range:	No. of instances observed:
Under 30 secs.	5
31-40 secs.	7
41-50 secs.	11
51-60 secs.	15
60-120 secs.	6
Over 120 secs.	3

Conclusions: A study of movements and body-motions revealed that certain points required checking to ensure optimum results in repeat processes in butter factories.

Physical posture left much to be desired due to poor positioning of tools, equipment and supplies. Muscle-group economy was not being practised, for the finger-wrists-forearm-upper arm-trunk-body technique was not understood, with resulting early onset of fatigue. Stooping, bending, reaching and walking about seemed excessive.

Suitable rest periods were not always incorporated in the sequence of processes. Nor were operations and movements changed from time to time to reduce monotony.

Material was infrequently fed automatically to pre-determined positions in chain assembly processes. Tools required pre-positioning, and general lay-out of work could be improved to assist rhythmic movement in repeat operations. Too many movements were being performed by either right or left hand alternately instead of concurrently, whilst pedal levers were seldom seen as auxiliaries to the hands.

A large number of motions appeared to be redundant, for they could have been eliminated by mechanical means or reduced by reorganising plant or operatives. In some cases, operations could have been combined, while components such as cartons and papers etc. could have been fed automatically. The use of different colours for identification were used to some extent in can segregation, but further use could be made of colour for identificatio of sample bottles and suppliers' records.

It is considered that time-motion studies could be used most profitabl in butter manufacture.

APPENDIX E.

STATISTICAL DATA:

Note 1. Correlation data: The following computations are given from which correlation regressions were derived:

Mean Deviations	Labour Turnover Regression	Wage Cost Regression	Transport Regression
S (x_2^2)	+75,899	+112,868	+560
S (x_3^2)	+100,086	+39.939	+8,743
S (x_4^2)	+642,649	+11,686	+754
S (x_1^2)	+162,710	+8	+381
S (x_2x_3)	- 25,667	+27,553	+2,046
S (x_2x_4)	+59,979	-2,826	+557
S (x_2x_1)	- 36,189	- 630	+419
S (x_3x_4)	+48,381	- 973	+2,346
S (x_3x_1)	+68,291	- 183	+1,693
S (x_4x_1)	+45,916	+40	+502

Note 2; Labour Turnover:

Simple correlation coefficients	Partial correlation coefficients
$r_{12} = -0.326$	$r_{13.4} = +0.537$
$r_{13} = +0.535$	$r_{12.4} = -0.404$
$r_{14} = +0.134$	$r_{12.3} = -0.563$
$r_{23} = -0.289$	$r_{12.34} = -0.240$
$r_{24} = +0.272$	$r_{13.24} = +0.445$
$r_{34} = +0.151$	$r_{14.23} = +0.133$

Note 3: The Method of Successive Approximations used in Curvilinear Regressions:

The method of "successive approximations" used is that outlined by EZEKIEL, M., in his METHODS OF CORRELATION ANALYSIS, op. cit. pp. 222-255 and 479-485. Briefly, this method consists of:-

1. Scatter diagrams are made of every combination of the four variables, and linear partial regressions computed.

2. A first approximation curve is prepared (for X_1 and X_2) by eliminating the linear effect of X_3 and X_4 on X_1. To do this:-

   (a) Compute the linear multiple regression: $X_1 = a + bX_2 + cX_3 + dX_4$.
   (b) Calculate the estimated value of X_1 for all 107 observations by substituting the corresponding values of X_2, X_3 and X_4 in (a).
   (c) Obtain the residual values z. (Actual minus estimated values).
   (d) Plot the net regression line for X_1 on X_2, (X_3 and X_4 held constant).
   (e) Plot the residuals z of X_1 from the net regression line as zero base against corresponding X_2 values.

3. Other first approximation curves are prepared similarly for X_1 on X_3, and X_1 on X_4.

4. Second approximation curves for each set of relationships are then prepared:

   (a) The values of X_1 as residuals are computed as deviations from the regression curves of the first approximation for each separate observation.
   (b) The residuals are plotted as deviations from the first approximation curves, and second approximation curves drawn in through points determined by averaging the residuals in groups.

5. X_1 is again estimated from second approximation curves, and used to revise the regression curves until the residual deviations are relatively constant.

6. The shape of the final net regression curves are shown in Figure 5, in which X_1 corrected for X_3 and X_4 ($X_1 - b_{.13.24}X_3 - b_{.14.23}X_4$), is plotted against X_2 to yield the net regression line.
   The less significant independent variables X_3 and X_4 are shown as correction curves, which indicate the extent to which X_1 will alter from variations in X_3 and X_4 respectively. The legend shows the effect of the supplier coefficient on X_1 holding X_4 constant, as shown in the inset correction curve for the Supplier coefficient.

Note 4: Use of Multiple regressions for estimating costs: This is done by substituting X_2, X_3 and X_4 for known quantities as in the following example of Total Wage Costs. Assume Factory M. has an output of 5,000,000 lbs. of butter per annum, 700 suppliers, and recorded 1,000,000 lbs. in the month of the greatest output and a total of 200,000 lbs. in the three lowest months. Then the Output factor will be 50, the Supplier factor 7.14 and the Seasonal factor 5. Then substitute in the regression for X_2, X_3 and X_4, to determine Total Wage Costs.

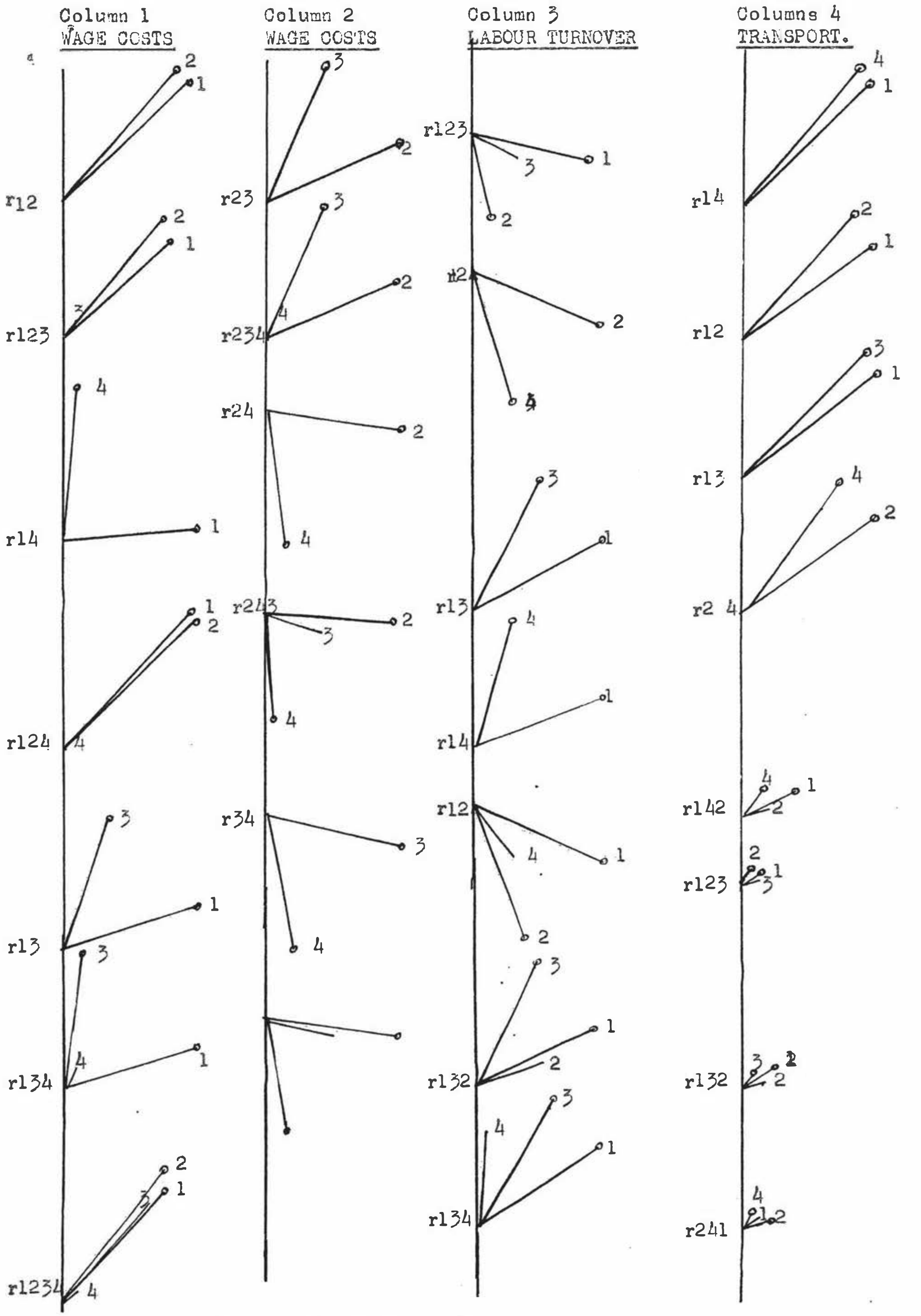
$$X_1 = 1.8851+(50)(0.15931) - ((7.14)(0.14454)+(5)(0.0061)$$

$$= 1.8851 + 7.7655 - 1.0320 + 0.0305$$

$$= 8.8491$$

With X_2 measured in '00,000 lbs. and X_1 in '000£s., and the S.E. -0.989; the total wage cost would be £8,849,± £989, or statistically there are 68 chances out of 100, that Factory M's total wage bill will range from £7,951 to £9.747, or 95 chances out of 100 that the wage will range from £7,053 to £10,645. (The unreliability of X_3 and X_4 regressors has been disregarded for the purpose of illustration.)

Note 4: Bunch map analysis: The following pages illustrates samples of bunch maps of different combinations of variables. In Column IV illustrates an interesting example of multicolinearity.



EXAMPLES OF BUNCH MAPS.

APPENDIX F.

TIME-MOTION STUDIES - TRANSPORT

Some 25 routes of all kinds were selected from various parts of the North Island and were subjected to time-motion analysis. The method consisted of accompanying the driver for the day, and to time and record the following data:-

(a) Total length of time on the route away from the factory in minutes.

(b) The total time the vehicle was at rest and in movement.
(c) The time involved in:-

- (i) handling stores,
- (ii) sorting and dropping cans,
- (iii) waiting for cream,
- (iv) time held up due to truck or roading conditions,
- (v) unproductive time.

(d) Net time leading cans onto truck.
(e) Length of the route in miles.
(f) All variations in change of speed - noted each 30 seconds.
(g) Number of suppliers on the route.
(h) Number and identity of the cans picked up, (so that quantities of cream, and grade could be recorded).
(i) Number of times the vehicle stopped for cans.
(j) The distance between each stop.
(k) Length of time in seconds required to load cans at each stop.
(l) Height cans were lifted and distance carried to truck.
(m) Number of trips to off-side of lorry.
(n) Condition of roads:

- (i) Type:- Tarseal; metal, first-class; metal, second-class and unmetalled;
- (ii) Gradient: - Flat, undulating or hilly.

(o) Cream shelters and condition classified as:-

- (i) Excellent condition,
- (ii) very good,
- (iii) satisfactory,
- (iv) roughly made,
- (v) dangerous or unsatisfactory,
- (vi) stand only,
- (vii) no stand or shelter,
- (viii) number of shelters painted.

(p) Can grouping: Two's, Three's, Four's, Five's, Sixe's, Seven's etc.
(q) Use of reverse gear.
(r) Length of time engine was left idling.

In addition, the following points were recorded for each route:-

The weather.
Temperature at 9.30 a.m.
Details relative to the truck - age, make, mileage, capacity, horsepower, servicing conditions.
Protective device used for cans: Uncovered, canvas cover, tarpaulin, awning, or covered in.
Details re driver: Age, length of service, previous work, other duties.
Acceleration data of truck: Empty and loaded.
Stores carried in addition to cream.
Classification of route: Urban, suburban, close rural, sparse, rural.

Method: Transport conditions were discussed with management and their consent obtained to conduct time-motion studies. It was usual to explain fully to the driver concerned why the study was being undertaken, the methods employed, the nature of the results to be derived, and to assure him that the findings would make his work simpler and that individual recordings would not be disclosed to the manager. In addition, managers would corroborate these statements. It was essential to get to know the driver the day before the study and gain his confidence, and encourage him to be careful to follow through his normal procedure at his normal working pace.[1]

A Route Control Record was prepared the day before, and consisted of some 30 sheets ruled up into suitable columns, with horizontal spacings for each 30 seconds of the control period. Two stop-watches, one of which had an accumulative device, were employed. The recorder sat in the cab

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[1] In two or three cases, the findings had to be discarded as the operative began to speed up when he knew the stop-watch was taking his relative times. To safeguard this, the usual length of time for the route was ascertained from management beforehand, to check possible speeding up.

with the driver, who co-operated by calling out the numbers on the cans as he loaded them onto the tray of the truck. The Route Control Record showed the following columns:-

(a) Maximum speed every 30 seconds with increasing or decreasing speed shown by the usual < > signs.

(b) Number of miles travelled. Each time the speedometer registered a new mile this was shown positionally on the time band of the control chart.

(c) A remarks column for recording stoppages etc.

(d) Three route columns for noting type, population, density and contour of road.

(e) Two supplier columns for recording number of cans and cream supplied; (obtained later from factory records).

(f) Loading conditions: Three columns showed the height can was to be lifted in feet, the distance from the cream stand to the tray of the lorry in yards, and the time consumed in seconds from the moment the lorry ceased to move until it commenced to move on again, i.e. the gross can-loading-time per stop. [2]

(g) The number of cans per stop.

(h) Three columns describing conditions of cream shelters.

On completion of a route, the distances of each supplier from the factory in route miles was calculated, and cream weights were obtained later from factory records.

<u>Time-consumption analysed:</u> Twenty-five routes were analysed as follows:-

	Mins.	Percent.
Total time away from factory on collection routes	3867	100.0
Total time lorries "at-rest"	1382	35.7
Total time lorries moving	2485	64.3

[2] The height the cans were lifted were estimated in each case, (from cream stand or ground to tray-level.) Before the time-motion studies were commenced, some hundreds of actual measurements were taken both for height and for distance cans were carried to tray of lorry. After the actual recordings were made, a number of follow-ups were carried out to check on the estimates made for both height and distance cream was carried. It is considered that a reasonable degree of accuracy was obtained, for this portion of the study by this method.

The above figures refer to the aggregation of all routes for one typical day. The aggregation for all times was calculated to the nearest second, but is shown for statistical purposes to the nearest minute. Time was calculated from the moment the lorry left the factory until it returned to the factory, but excluded any waiting time until cream was received at the reception stage. The lorry was considered "at rest" the moment the wheels ceased to move and was usually determined by the sharp application of the hand-brake. The "at-rest" position included all stoppages regardless of the reason.

The average time per route for the above figures are:-

Average length of time taken per route.	154.7 mins.
Average time "at-rest" per route.	55.1 mins.
Average time lorries moving per route.	99.4 mins.

It will be observed that approximately one-third of the time away on the route the lorry is "at -rest", loading cream, sorting cans or held up for other reasons. Less than two-thirds of the time the lorry is in movement.

The dispersion of total time taken varied considerably from route to route, ranging from 40 to 279 minutes. It is as follows:-

Length of time per route.	Number of routes
60 mins. and less	2
61 to 120 minutes	6
121 to 180 minutes	8
181 to 240 minutes	6
Over 240 minutes	3

The percentage of time the wheels of the lorries kept moving was fairly consistent regardless the length of time per route. The smaller routes (under 60 minutes), however, did reveal that the lorries were moving 81 per cent of their total time[3], whilst the other four groups showed a tendency for the "at-rest" position to increase with size of route, (with resulting increase of costs).

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[3]The small routes revealed that no time was lost in sorting cans and unproductive time was negligible. Time consumed in the "at-rest" position was due almost entirely to loading cream cans, and this fact reveals one great advantage of small cream loads - that of minimising non-productive time, (i.e. time serving no useful purpose in cream collection).

An Analysis of "at-rest" position:

TABLE LXVII. TIME-CONSUMPTION ANALYSIS OF THE "AT-REST" POSITION OF 25 CREAM COLLECTION ROUTES

	Total time consumed (mins.)	Average time per route (mins.)	Per Cent
Loading cream cans onto lorry (including returning empties).	738.4	29.5	53
Sorting and adjusting cans	248.9	9.9	18
Preventable non-productive time lost *	208.0	8.3	15
Handling stores	67.5	2.7	5
Waiting for cream to arrive	100.4	4.0	7
Time lost due to condition of road traffic, stock or repairs on route	18.7	0.8	2
Total time "at-rest"	1381.9	55.2	100

* See P. 430 for description.

Anything assisting to reduce any of these elements contributing to the "at-rest" position, will serve to reduce oosts. Some of these elements could be reduced by driver education (in loading), self-discipline, supplier co-operation, or route improvement.

Analysis of can-loading time-consumption: A little over one-half of the time "at-rest" is consumed in loading cans onto the lorry. The modal time of the various movements involved is as follows:-

Movement	Per cent of time consumed
Opening door of cab, walking to tray of lorry and lowering side etc.	12
Locating empty cans	9
Carrying cans to cream shelter.	19
Placing empty cans in shelter.	8
Placing lids on full cans.	5
Carrying full cans to truck side and lifting onto tray	28
Replacing side of truck or batten and alighting	8
Returning to cab.	6
Mounting, shutting door and releasing handbrake.	5
	100

The actual time clocked against loading cream varied according to the number of cans loaded per stop. In all, the lorries stopped for loading cans some 1,062 times for 1832 cans belonging to 1232 suppliers; that is, the average supplier had 1.5 cans and the average loading per stop was 1.72 cans.

The average total time per stop was 78.1 seconds and the average total time per can was 45.5 seconds.[4] This 45.5 seconds includes the total "at-rest" time, and when adjusted for the non-loading time elements, the net average loading time per can was 24.2 seconds per can.

It will be observed that almost one-half of the time is consumed in moving from the lorry to the cream stand and back again. Anything reducing the distance between lorry and cream stand would reduce loading time. Other elements affecting loading time include nature of terrain, length of tray of truck, heterogeneity of cans, and the energy of the driver.

Deviations from average loading times were considerable and varied from route to route and from oan to can in the same route. Over the 25 routes the range for average net loading time lay between 15.71 and 44.63 seconds. On six routes the average time was under 20 seconds; on 14 routes the time lay between 20 and 30 seconds; and on five routes the time was in excess of 30 seconds. The same pattern of dispersions obtained for gross loading per time per stop and per can. The lowest times were recorded on the shortest routes where the number of cans lifted were relatively less than average.

For individual cans lifted, the times ranged from 7.4 to 66.8 seconds for distances under 30 yards. The standard deviation for single cans on one typical route was 9.7 seconds per can. One significant feature on this route was the way the time increased per can as the onset of fatigue increased. Th

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[4] Average time per stop includes all stops whether for cream or otherwise. In fact, some 28 per cent of total stops were not to load cream - a rather high peroentage. This 28 per cent is due to stopping in relation to stores, sorting cans, and personal non-productive reasons.

first half of the route averaged 20 seconds per can, and then the time gradually increased until the last 25 per cent of cans took 32 seconds per can.[5] Deviations also became more marked with onset of fatigue.

These deviations were caused by other factors than the energy of the driver, and the number and heterogeneity of the cans. The type of truck used - short-tray, long tray or articulator - added to the distance that had to be covered on foot. Articulators added to the height the cans had to be lifted - as did the type of road.[6] The distance of the truck from the cream stand was the most important factor in time-consumption in loading cream.

The range of average distances cream was carried varied from 5.9 to 18.8 yards for 25 routes. Fifteen routes averaged under 10 yards, eight routes lay from 10 to 15 yards and two routes were in excess of 15 yards. The median route was 9.5 yards. When it is noted that two yards per second is an average time-consumption for walking to the stands and 40 per cent more for returning with full cans, the importance of positioning of stands will be seen.

The range of average heights cream was lifted varied from 0.8 to 4.0 feet. Two routes averaged under one foot, eleven routes from one to two feet, five routes from two to three feet, and seven routes were in excess of three feet. The median height was two feet, and increased when articulators were used.

The factor of weight did not appear to be of functional importance in time consumption. An analysis was made of single cans loaded from a distance of 8 to 12 yards from shelter to lorry tray in order to focus attention on the variables of time and weight, (the other variables being regarded as constant.) The results of this analysis are shown in the following table:-

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[5] This result was taken from a route operated by a driver who had been promoted to foreman driver on account of his diligence. He lost no time whatever apart from general slowing up due to fatigue. This slowing up was apparent on all routes loading more than 60 cans. Deviations were greater on all big routes than small ones.

[6] Where roads were narrow, the shoulders of the road were usually too steep for the trucks to run alongside of the cream stands. Often the shoulders were built some two or three feet above the cream stand's level, which necessitated a much higher lift of cream cans onto tray of turck.

TABLE LXVIII. RELATIONSHIP OF WEIGHT AND TIME IN LOADING 287 SINGLE CANS FROM CREAM SHELTER TO TRAY OF LORRY

Cream weight (in lbs.)	Total No. cans in class interval.	Time in seconds to load individual can classified				
		0 - 15	16 - 31	31 - 45	46 - 60	Over 60
0 - 20	139	28	79	28	3	1
21 - 40	49	5	34	9	1	-
41 - 60	34	3	18	12	1	-
61 - 80	35	2	20	12	1	-
81 - 100	19	1	9	7	1	1
101 - 120	8	1	3	2	1	1
Over 120	3	-	1	1	1	-
Total	287	40	164	71	9	3

The use of reverse gear is a factor which adds to actual running time but is off-set by time saved in loading cans. Over the 25 routes the frequency of use of reverse gear was as follows:-

No. of times Reverse gear was used per route:	Frequency:
Not used at all	6 routes
Under 10 times	2 "
11 - 20 "	6 "
21 - 30 "	7 "
31 - 40 "	3 "
Over 40 "	1 route

(Average per route = 16.5 times)

One other factor in time-consumption was the number of times the driver made trips to the off-side of the lorry to lift cream - that is, went round the front of the lorry to the left hand side of the truck to unload empty cans. Some 354 trips were made - one-third of the total stoppages. These off-side trips involved some 15 to 20 yards further walking with consequent extra time consumed. A few drivers, whose times were relatively lower than the rest, had organised their loads in such a way that off-side trips were kept down to a minimum. Three drivers with average net times less than 20 seconds, all had off-side trips down to less than 15 per cent of total loadings.[7]

The factors that assist in reducing time-consumption of net loading time can now be stated:

1. Minimum distance of cream stands from lorry; Where stands are built back on the fence level, a road siding should be built in to the stand and out again. Letter boxes should not be built in front of the stand level, as this prevents the lorry drawing alongside the stand. On narrow tertiary roads the stand can be built close to road edge.

2. Optimum number of cans per lorry: No precise number can be given but time-consumption increased progressively beyond 60 cans due to extra time required to locate empty oans, resorting oans every few miles, and onset of fatigue.

3. Organization of can-load: It was observed that where cans are placed in some sequence on the tray for off-loading, can-location is minimised, and off-trips are reduced to a minimum.

4. Type of tray on truck: Trays with a single low batten around to retain the cans obviated time lowering sides etc. Double deckers consumed extra time. Articulators due to their extra height and distance from cab consumed more time than normal.

5. Actual size of truck: The smaller the truck, the less time was consumed, other things being equal. The following figures illustrate this:-

Average net loading time per can for articulators:	30.4 secs.
Ditto for 4 to 6 tonners	23.5 "
Ditto for 3 tonners	19.3 "

6. Can-grouping: Wherever a number of cans were loaded from one stand, the net time taken per can was less for obvious reasons. There were 131 instances in which more than one can was loaded per stand, a total of 314 cans being loaded for 131 stoppages.

7. Heterogeneity of oans: The greater variety of cans loaded, the longer the time required. Small cans are harder to locate than larger cans and tend to slide round on the trays.

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[7] Further time was consumed by the practice of backing the lorry to the stands. One driver backed his lorry 17 times out of a total of 40 loadings and this increased his gross loading time by 5 minutes 23 seconds.

8. The personal factor: A few drivers went at the double, some walked at a brisk pace, others sauntered. It was noticed that those in the first two categories lost little time through unproductive causes, whereas the latter category tended to waste considerable time in this respect.

Time-consumption of other non-loading factors in the "at-rest" position:

These factors in order of magnitude are sorting and adjusting cans, preventable non-productive time, waiting for cream to arrive, handling stores and time lost due to miscellaneous reasons. Of the 18 per cent of total time devoted to sorting cans, about one-half of this time was taken in dropping off empty cans on the way out. Of the longer routes the average lorry stopped 11 times to drop cans (without loading any on), and three times to sort cans. The deviations of all routes for can sorting ranged from zero (in four instances) to 38 minutes 6 seconds. Ten routes required less than 5 minutes, five routes required from 5 to 10 minutes, six routes required from 10 to 20 minutes and four required more than 20 minutes. With one exception, those requiring zero time were short routes with less than 60 cans, and those requiring more than 20 minutes were lorries handling more cans than the tray could reasonably accommodate.[8]

Preventable non-productive time lost amounts to 15 per cent of total time and includes the following elements:-

1. Talking (i.e. "yarning" to suppliers).
2. Refreshments.
3. Shopping.
4. Personal comfort.
5. Taking a spell.
6. Miscellaneous.[9]

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[8]The exception was a 6 tonner which carried over 120 cans of homogeneous size. The driver loaded his cans following a definite order.

[9]Miscellaneous reasons includes time taken by one driver to conduct his "book-making" business with certain of his suppliers. Two drivers did quite an extensive bit of shopping for "their wives". One "slippe in home" for 20 minutes to get the dinner on. Several went in to the homes of suppliers for a "morning cuppa", and more than one slipped into a hotel for a"quick one".

Four routes showed nil time lost under this heading whilst the maximum time lost was 34 minutes 43 seconds. Sixteen routes were under 10 minutes, five routes took from 10 to 20 minutes and four routes were in excess of 20 minutes. Incidentally, the longest time recorded were on routes in which management forbade any stopping whatever for refreshments, morning tea or meals. Lost time increased with length of route, and occurred largely in the last quarter of the round, suggesting onset of fatigue. Non-productive time often occurred where the manager was not aware of the nature of the route being covered.

Waiting for cream to arrive occurred on 17 routes, the maximum time recorded being 16 minutes 54 seconds. Drivers reported that certain days were worse than others. The highest recordings occurred on a Monday. Certain factories refuse to allow their drivers to wait for cream under any circumstan

Handling stores, (purchased from trading departments of factories), took place on 12 routes with a maximum of 22 minutes 4 seconds. Stores included parcels for non-suppliers, bags of coal, sacks of fertiliser, machines and newspapers.

Time lost due to miscellaeneous reasons occurred in 14 instances, no of which was in excess of 5 minutes. Traffic hold-ups arose where the lorry had to wait for its turn on a one-way bridge, (which happened several times). Stock on the road caused a number of short hold-ups, also road repairs and mud; and there were three cases of brief stoppages due to engine trouble; (one due to a dirty carburettor, one due to a loose wire, and another due to empty radiator).

Comments on these non-loading factors from a time-consumption point of view are hardly necessary except that time consumed increases with length of route. On the short routes it should be noted that time so lost was less than 5 per cent of total "at-rest" time recorded.

<u>Time-consumption of the lorries in movement:</u> As 64.3 per cent of time away from factory was absorbed in actual running time, it is important to analyse the variations of running time and speed differentials. The main factors affecting running time are:-

1. Condition of road survace.
2. Road gradient.
3. Weather.
4. Weight of cream hauled.
5. Mechanical condition of truck.
6. Number of stoppages per mile and number of "dead" miles.
7. Speed truck is driven and consistency of driving speed.

The condition of surface and gradient of road has been described in Seotion II in which causes of hold-ups and slow speeds have been discussed sufficiently to indicate that roading conditions are a major factor in speed retardation. On hilly gradients (6%) speed was reduced over 50 per cent, and on undulating routes (12.5%) there was a retardation of 25 to 33 1/3 per cent. Metal roads (53%) caused up to 20 per cent reduction of speed, this percentage increasing with narrow roads. It is considered that between 15 to 20 per cent of running time on the average can be attributed fairly to inferior roading conditions and gradients.

There is a general retardation in wet weather because of poorer visibility, frictional drag in metal, rougher road surfaces, and hazards in frosty weather.

The weight of cream hauled had a retarding effect on steep gradients when a low gear had to be engaged and speed was reduced to 10 to 15 m.p.h. The rate of acceleration was also affected adversely, also time taken to brake when stopping. Acceleration rates were taken for all trucks when empty and full. Some 5 to 8 seconds longer were required when fully loaded to accelerate from standstill to 30 m.p.h. as compared with the same truck when empty.

The mechanical condition, type of truck, age, mileage, length of time since overhaul, all affected speed and acceleration rate. It usually took from 15 to 20 seconds for an empty truck to accelerate from standstill to 25 m.p.h., and up to 200 yards were required before the lorry attained 30 m.p.h.

Some drivers were erratic in their driving, braking hard and accelerating hard. Others were more consistent, braking steadily and accelerating steadily and holding their truck at a constant speed, (30 to 35 m.p.h. was the usual).

TABLE LXIX. SPEED VARIATIONS OF SEVEN DRIVERS OVER SIMILAR ROUTES

Route	Length of route (miles)	No. of stops	No. of times speedo rose from under 30 m.p.h. to: 31-35 m.p.h.	36-40 m.p.h.	41-45 m.p.h.	Over 45 m.p.h.
A	67	65	12	-	-	-
B	74	81	39	19	1	-
C	37	53	35	62	1	-
D	64	73	17	32	-	-
E	26	42	12	17	16	7
F	65	99	22	71	5	-
G	73	113	43	57	1	-
			180	258	24	7

The above table should not be interpreted necessarily as erratic driving, for the countour of the road, number of bends, number of stops, etc. all tend to increase the fluctuations of speed. Two of these routes, (D and F), are illustrated on route control charts, (pages 126 - 131).

The greater the number of stoppages per mile, the greater is time-consumption. The number of stoppages can be reduced by eliminating non-productive stoppages or reducing time to a minimum, and by minimising off-loading of empties. Can-grouping also reduces time consumption.[10]

The average speed over the 25 routes was 23.45 m.p.h.
The total length of the 25 routes was 983 miles.
Total stoppages for picking up cans were 1,062 times.
Total stoppages for all reasons were 1,182 times; (exludes the use of Reverse Gear).
Total number of "dead-miles" covered was 236 miles. (This was made up of 161 miles on outward trips and 75 miles on the return trips).
Total number of times Reverse Gear was used was 416 times.
Total number of times lorries were changed down to a lower gear was 252 times.

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[10] An experienced driver was selected on a given route and the recordings of 85 stoppages for single cans and two cans were made under identical conditions. The average time for loading single cans of similar size, weight, lift and distance was 22.6 seconds. The average time for two cans per stop under identical conditions was 40.2 seconds which yields a difference of 17.6 seconds between single and two-can stops.

From the above figures the following calculations have been computed:-

(a)	Average length per route	39.3 miles
(b)	Average "dead-mile" coverage per route	9.4 "
(c)	Average length per route less "dead miles"	29.9 "
(d)	Average number of cans per miles for total mileage	1.96
(e)	Average number of cans of net mileage, (i.e. length of route minus "dead-mileage")	2.45
(f)	Average distance between each stop	0.93 miles
(g)	Average distance between each stop, (corrected for "dead-miles")	0.70 "

Any reduction of (a), (b), (c), (f), or (g) and/or increase of (d) and (e) by better organization, route planning, or supplier cooperation, will reduce time and collection costs.

STATISTICAL DETAILS

This section will deal with certain statistical data derived from the route surveys (mainly), and is distinct from time-motion study insofar, as the element of time is not a function. It will cover an analysis of cream shelters, grades and weights, together with relevant comments.

Cream Shelters: Each cream shelter, or provision for loading cream was carefully noted for each supplier over the 25 routes. Details obtained were; the number of cans per shelter, the materials of which the shelter was constructed, its functional condition, and the protection if afforded the cream from sun, dust, flies and animals.

The number of cans per shelter was measured by the means of can grouping - that is the number of times more than one supplier used one cream shelter. In this respect the following details were noted:-

Number of times two suppliers used one shelter was 100 times.
Number of times three suppliers used one shelter was 19 times.
Number of times four suppliers used one shelter was 7 times.
Number of times five suppliers used one shelter was 2 times.
Number of times six or more suppliers used one shelter was 3 times.

Shelters were invariably constructed from wood. Some, (under 10 per cent), had a corrugated iron roof, five had a tiled roof, and a few, (under 2 per cent), had a concrete base. More important, however, was the functional condition of the shelter. These were classified[11] as:-

Condition:	Frequency:
Excellent	56
Very good	120
Satisfactory	133
Roughly made	108
Dangerous or unsatisfactory	30
Stand only	254
No stand or shelter	304
	1,005

A total of 97 of the above shelters were painted, and less than ten were fully protected from flies and rodents. Less than 20 per cent were oriented to afford shade; most were constructed with the opening facing the road, often in a northerly direction giving shelter from rain rather than from sun. Some of these had dirty sacks over the opening, but generally speaking, protection from sun had not been considered thoughtfully.

Few suppliers had considered the lorry driver. Most had built their shelters on the fence-line, or straddling a drain near the fence. Some suppliers had built steps up on the fence side of the stand, to help them load cream onto the stand, but seemed unconcerned as to the facilities for loading cream from the stand; a few, however, have gone to considerable trouble in constructing steps onto the stand, or a suitable platform, or a graded track alongside the stand itself. Eleven cases were noted where the driver had to either cross a low fence, cross a style, or go in through a gateway and unhook the can from the bough of a tree, or obtain it from under a hedge. Smaller suppliers generally provided poorer facilities than

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[11] To be classified as excellent, a shelter needed to be painted, soundly constructed in timber and/or concrete and provide shelter from sun, dust, and animals. To qualify as "very good" the shelter had to be well constructed and provide adequate protection from sun and straying animals. "Roughly made" shelters were usually boxes on stands. "Dangerous" embraced rotten woodwork, decayed timber and rickety stands. The writer witnessed two losses of cream on one route due to unsatisfactory shelters - in one case, a 12 gallon can full of cream crashed through the stand as the supplier himself lifted the can on to the stand.

larger suppliers. This is borne out by the following table which classifies shelters according to weight of cream and functional condition of shelter.

TABLE LXX. RELATIONSHIP OF 568 CREAM SHELTERS ANALYSED ACCORDING TO WEIGHT OF CREAM SUPPLIED AND FUNCTIONAL CONDITION OF SHELTER

Cream weight (lbs.)	Excel.	V. Good.	Satisf.	Rough	Dangerous	Stand only	No stand or shelter
0 - 20	2	20	13	46	3	10	100
21 - 40	3	18	12	16	-	10	31
41 - 60	2	14	9	12	2	7	9
61 - 80	3	15	6	11	1	13	9
81 - 100	3	12	5	6	1	14	10
101 - 120	3	8	7	4	-	11	5
121 - 140	3	6	8	1	-	9	2
141 - 160	-	6	1	-	-	9	2
161 - 180	1	7	2	2	1	4	-
181 - 200	-	1	-	-	-	3	1
200 Over 200	-	4	1	1	-	7	-
Total	21	111	64	99	8	97	168

The placing of the cream shelter is an important factor in time-consumption in the loading of cream. Where stands were built right up to the edge of the road, it reduced the height the can had to be lifted and the distance the can had to be carried. In both cases, larger suppliers were more considerate than smaller suppliers as illustrated by the following tables, which classify the data of Table LXX, (with a few additional observations) according to height can was lifted and distance carried.

TABLE LXXI. RELATIONSHIP OF 603 CREAM SHELTERS POSITIONALLY TO LOADING PLACE OF LORRY , ANALYSED ACCORDING TO WEIGHT OF CREAM SUPPLIED AND HEIGHT CREAM WAS LIFTED

Cream weight (lbs.)	Total	Lift - measured to the neares foot					
		Nil	1	2	3	4	5 and more
0 - 20	211	17	7	22	42	55	68
21 - 40	105	7	5	19	28	11	35
41 - 60	58	4	5	11	22	10	6
61 - 80	67	5	6	13	25	8	10
81 - 100	52	2	11	14	11	6	8
101 - 120	38	4	2	8	13	8	3
121 - 140	26	3	6	5	10	1	1
141 - 160	16	-	1	5	8	1	1
161 - 180	16	1	5	2	7	1	-
181 - 200	4	1	1	1	1	-	-
Over 200	10	2	1	3	4	-	-
Total	603	46	50	103	171	101	132

TABLE LXXII. RELATIONSHIP OF 603 CREAM SHELTERS POSITIONALLY TO LOADING PLACE OF LORRY. ANALYSED ACCORDING TO WEIGHT OF CREAM SUPPLIED AND DISTANCE CREAM WAS CARRIED TO LORRY.

Cream weight (lbs.)	Total	Distance carried one way from stand to lorry				
		0 - 5:	6 - 10:	11 - 15:	16 - 20:	Over 20
0 - 20	211	66	38	42	43	22
21 - 40	105	26	26	23	16	14
41 - 60	58	19	8	13	15	3
61 - 80	67	29	10	12	12	4
81 - 100	52	18	13	10	10	1
101 - 120	38	12	9	8	8	1
121 - 140	26	8	4	4	10	-
141 - 160	16	4	2	5	4	1
161 - 180	16	8	4	2	2	-
181 - 200	4	2	1	-	1	-
Over 200	10	3	2	2	3	-
Total	603	195	117	121	124	46

APPENDIX G.

ESTIMATE OF EXTENT OF DIVERSION OF BUTTER COSTS

Considerable attention has been drawn to the tendency of diverting actual butter costs elsewhere.

These elements of diversion are brought together in the accompanying appendix together with an estimate of the extent to which this occurs in the aggregate.

A number of examples have already been given, and some of these are repeated for the sake of completeness.

It is the economic significance of these manipulations that are important rather than a precise measurement of their magnitude.

Manipulation of true costs is managed in a number of ways apart from allowing auxiliaries to absorb butter manufacturing costs. These practices are extremely short-sighted, and if they continue they will do considerable damage to the industry apart from depriving the supplier of a portion of his reward.

Firstly, the true nature of unit costs is distorted, and thus capital resources and accompanying enterprise tend to be diverted to, and be retained in less profitable avenues of investment. Secondly, competition for payouts is intensified, which dislocates relative true values and costs, especially administrative and capital costs. In the long-run this must reflect in the true value of shareholders' funds, which will be probably realised only by the unfortunate supplier upon the realization of the assets on winding-up. Finally, the supplier may be deprived of the full amount accruing from the guaranteed price, because calculations for costs of manufacture in assessing the basic guaranteed price structure are derived from figures which, unfortunately, have already been minimised for competitive payout reasons.*

* The Guaranteed Price is not based on production costs alone, as the price may be varied by pence per lb. between seasons, and still have complied with the terms of the Act. Moreover, the effect of diverting costs is to some extent, one of allocation between products and not of total industry earnings. However, some costs are diverted outside the industry; such as stores delivered to suppliers.

Whatever method of estimate is used, the result will necessarily be subject to a high degree of statistical error. One method is to examine each element of expenditure and assess or measure known diversions. The first element examined is cream haulage.

Actual cream haulage costs have been absorbed by devious means - especially in larger companies. Companies manufacturing milk powders and casein seldom appropriate to butter making the full costs of hauling whole milk. In fact, some companies follow the practice of allowing casein and powders to absorb the haulage costs of whole milk while others charge only the actual costs of transferring the by-product cream (usually by pipe) to the churns. It is true that no company is in the fortunate position of receiving its entire supply of cream by these methods. But where a considerable percentage of cream supply is received at a nominal cost only, and cream collection unit costs are calculated on the entire output of butter, obviously these unit costs are grossly understated.

One way to estimate the extent to which this has occurred, is to calculate the net differential between companies of similar scale, but hauling cream similar distances under comparable conditions and those companies receiving bulk whole milk for processing. Although this method is full of statistical pitfalls it nevertheless does yield a result of some magnitude.

One company of considerable scale admitted that its cream collection costs had been diminished by 0.330d. per pound by various means. Apart from this interesting admission, it is estimated that a number of companies manufacturing some 40.4 per cent of the national output have managed to reduce their cream collection costs by 0.212d. per lb; that is, the true collection costs for New Zealand should be 0.591d. per lb. This figure is subject to a moderate statistical error.

The above calculation does not take into account other means of minimising haulage costs. It makes no allowance for bulk cream hauled at relatively low unit costs from other dairy processing companies, winter cream from cheese companies or cream from municipal milk depots etc.. In each case the haulge of whole milk has been borne elsewhere, so that the true cost of cream haulage is not shown.

A considerable percentage of haulage costs actually incurred are permitted to be absorbed by auxiliary products and services. Whenever haulage in or out is undertaken by the company's lorries, it is usual to charge that haulage against the service or by-product in question. Thus in the cream haulage account, which aggregates the total running expenses together with wages of lorry drivers, and sometimes (as should be) a percentage of general overhead, there appear usually a considerable number of credits. These credits are sometimes based on hourly rates that have been struck, and sometimes by mere estimates which in some cases appear to be but an "educated guess". Whatever method or methods are used, these credits are usually inflated. Part of the charges are thus absorbed by various milk powders manufactured and part by other services rendered such as delivery of stores, (as described in Auxiliary Activities, Part V.). A further reduction of costs is affected by suppliers being charged with cream collection. This sum must be shown in the annual manufacturing account and in the annual report of the company concerned. Although these sums are a moderate percentage, it is very doubtful if all these charges are shown in the accounts. In some companies it was apparent that although suppliers were being charged with cream collection costs, there were no charges so designated in the annual accounts. On further enquiry it was revealed that these items merely were treated as contras in the monthly pay-outs and consequently did not appear in the annual accounts.

Wages especially have been diverted elsewhere. Wherever factory hands are not fully utilised in butter production but have part time duties on auxiliary products and services, it seems to be usual to charge as much as possible to these auxiliaries. This is especially seen with senior employees engaged on supervision etc. This has arisen when excessive time was devoted to new auxiliary ventures during the inaugural period. Managers and foremen had to keep a constant check and help out in these new ventures during their first year, and the large percentage of time allocated to them has tended to be carried on in subsequent years.

Administration and general overhead have also been unduly appropriated to auxiliary activities. Directors' fees and expenses, audit fees, insurance and power have been allocated in such a way as to allow other activities to absorb real butter costs.

There is one item that tends to be abused more than most - depreciation. It is only necessary to go through the annual accounts of certain large companies to see the disproportionate amounts of depreciation charged against auxiliary products, in spite of the claim that it is the policy of directors to write off such auxiliary plant as quickly as possible. Thus one large organization wrote off 2.76 per cent of its depreciation against butter - the balance 97.22 per cent was charged against powder! The only explanation that can be given is that while the directors prudently insist upon adequate depreciation they ensure that it certainly is not charged against butter.

It may be argued that only a few large companies resort to such practices and that the above is not true for the majority of medium and small-sized factories. But the five largest companies alone produce over 43% of New Zealands creamery butter, and whilst it is not implied that these companies are necessarily resorting to such devices, the fact remains that these companies are certainly cost-leaders in the industry and whether their costs are the outcome of economies of scale or otherwise, smaller companies certainly make every endeavour to approximate the relatively lower unit costs of the larger companies by every possible means.

In the second method, a rough estimate can be made from the survey of total manufacturing costs of auxiliary products relating these to butter costs. The total costs of manufacturing butter amount to some £3,758,000 whereas those of auxiliary products come to £1,865,000 which is almost one-half those of butter costs. It is estimated that between one-seventh and one-seventh and one-eighth of these costs are probably butter costs. Service auxiliaries would augment these conclusions, but owing to statistical difficulties were omitted.

The following estimate is at the best an approximation but it has been made conservatively. It is considered that the underestimate of unit costs in butter production for the 1949/50 season was:-

Cream collection costs	0.14d.	per lb.	B/F.	
Manufacturing charges	0.11d.	"	"	"
Factory Overheads	0.03d.	"	"	"
F.O.B. Charges	0.01d.	""	"	"
General Overhead	0.04d.	"	"	"
	0.33d. ± 0.16d.			

Using the above figures as a basis, it is estimated that the value of net national product (in exported butter) was being under-valued to the extent of approximately £440,000.