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A SIMPLE
WOOL MARKETING
SIMULATION MODEL

A Thesis Presented in Partial Fulfillment
of the Requirements for the
Degree of Master of Agricultural Science
at Massey University

by
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A C K N O W L E D G E M E N T S

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CHAPTER 1

INTRODUCTION

1.1 Introduction

The New Zealand Wool Marketing Study Group was set up in December, 1964 to investigate and report on all relevant aspects of wool marketing. The terms of reference of the Wool Marketing Study Group included the requirement that they should examine methods of containing wool price fluctuations whilst retaining the existing auction system as the basic method for the disposal of wool.

The present study, supported in part by the Wool Marketing Study Group, examines what the effect would have been if alternative Wool Commission floor and ceiling price policies had been in force at New Zealand wool auctions for the historical period 1952/53 through 1965/66.

1.2 Aim of the Study

The aim of the study was to develop and test a wool marketing simulation model which would describe and summarise the performance of the New Zealand wool market, at auction, under a variety of demand conditions and Wool Commission floor and ceiling price policies.

This involved:

- (a) The construction of a simulation model which would incorporate some of the more important features of the New Zealand wool market, with sufficient flexibility to allow for;
 - (i) the implementation of different decision rules (policy parameters) for the purchase and sale of wool by the Wool Commission, and
 - (ii) the inclusion of structural parameters to indicate the magnitude and direction of the responsiveness of the wool trade to price movements and to the various Wool

Commission policies.

- (b) Inclusion in the model of measures, such as average price and variance in price, which would be important in summarising the outcome of each Wool Commission policy (or simulation run), and in indicating if and how these policies were significantly different from what actually happened over the historical period being considered.
- (c) The conversion of the model to computer programmes.
- (d) Running the simulation programmes for a variety of parameter (value) combinations, (representing Wool Commission policies and market demand conditions).
- (e) Attempting to infer from the simulation runs, for the period being considered, what Wool Commission policies would have been viable, and what would have been the effect of changes in demand for wool brought about by the Wool Commission's policies.

The aim of the study was not to estimate or conclude what values of the parameters are the "right" ones for the New Zealand wool market, rather it was to make "if ..., then ..." statements; if these had been the conditions ruling, then this would have been the outcome.

1.3 Thesis Guide

This section indicates the manner in which the thesis is presented.

Chapter 2 is primarily a review of some of the literature on wool marketing. The aim of the chapter is to acquaint readers with the context of the present study. The chapter reviews studies which have documented the extent of wool price fluctuations at auction in New Zealand, and studies which have attempted to summarise or explain the relationship between the demand for wool and wool prices.

Chapter 3 describes in some detail the operations of New Zealand wool auctions. The chapter also includes a consideration of price stabilisation

schemes, particularly floor and ceiling price policies, which could be superimposed on the wool auction. Measures which would summarise the performance of auction under alternative floor and ceiling price policies are then discussed. A number of simulation studies which investigate the effect of alternative floor and ceiling price policies have been carried out within the context of the Australian wool auctions, and Chapter 3 concludes with a review of these studies.

Chapter 4 discusses the salient features of the use of simulation in research. The chapter demonstrates how simulation under certain conditions can enable the researcher to generate information which would otherwise be difficult or impossible to obtain. A description of important aspects of the construction and operation of a simulation model, together with the method of drawing conclusions from the numerical results obtained, is also presented.

Chapter 5 details the construction of the Wool Marketing Simulation Model used in this study. For the purposes of presentation the three parts of the model are described individually. The first part to be presented is the quantitative balance which accounts for all wool sold at auction in a given week by calculating first the price at which the market will be cleared, and then the amount of wool bought by the wool trade and the residual bought or sold by the Wool Commission. The second part to be described is the inclusion of financial or revenue implications of the quantitative balance. Finally, ten summary measures are described in terms of variables in the model.

Chapter 6 comments on the realism of the model, in particular the quantitative balance.

Chapter 7 provides an analysis of the results obtained from running the simulation model for various parameter combinations. Two methods of inference are used in interpreting the results from a series of simulation runs. The chapter can be divided into two distinct parts. The first part discusses the theoretical background to the two methods, while the second part records the

empirical results obtained by using them.

Chapter 8 concludes the thesis by summarising briefly the inferences which can be drawn from the study.

CHAPTER 2

THE WOOL MARKETING SYSTEM: A REVIEW OF LITERATURE

2.1 Introduction

This chapter provides a review of the literature on the wool marketing system. All topics reviewed have been dealt with more fully by other authors elsewhere. No claim to originality is made, other than the particular way the review material is presented. The aim of this review is to provide the reader with a brief survey of the setting within which the thesis attempts to contribute to our knowledge of the wool market.

Five main topics are dealt with in this chapter. The first topic is a description of the physical processes wool goes through between the auction room and the final consumer. This indicates the complexity of the technological processes through which the market has to guide wool to the consumer.

The second set of studies reviewed is also descriptive, and examines the degree of fluctuation in wool prices which have characterised the wool market since the collapse of the Korean War boom. These studies were commissioned by the New Zealand Wool Marketing Study Group and refer exclusively to New Zealand wools.

A third important line of research involves the estimation of price and income elasticities of demand for wool. The price elasticity is a crucial statistic for any evaluation of the merits of alternative marketing strategies. Econometric estimates of price elasticity of demand imply that elasticity is constant over time.¹ This is an assumption which also underlies the simulation study reported in subsequent chapters of this thesis.

The fourth group of studies of the wool market provides an analysis of the degree of market penetration likely to be achieved by the synthetic fibres.

1. If this assumption was not made it would not be possible to obtain any estimates of price elasticity, using conventional econometric methods.

Two approaches to this topic can be distinguished. The first, typified by the work of Lipson, attempts to evaluate the relative technological competitiveness of alternative fibres. Another group of workers, including Powell, Polasek and Burley, have attempted an empirical estimation of the speed and extent of market penetration likely to be achieved by synthetics, by fitting appropriate logistic curves. These studies have been unable to demonstrate that the price of wool relative to the price of synthetics has had a significant influence on the process of market penetration by synthetic fibres.

The final section of the chapter summarises a study of wool price fluctuations which has been made using the "reference cycle" approach. This approach emphasises the interdependence of all types of economic activity, and isolates economic variables which hopefully explain wool price movements, and certainly move closely with wool prices.

The chapter concludes with a brief summary of the main ideas contained in the review.

2.2 Technological Aspects of the Wool Marketing System

This section provides a brief description of the manufacturing processes involved in converting raw wool into the final product. New Zealand wool is used in a variety of end products. For the purposes of this thesis, however, two major categories of end products are distinguished, namely garments and carpets. These are now discussed in turn.

2.2.1 Preparation of Wool for Processing

The initial preparation of wool for the production of both garments and carpets has much in common. The first step in manufacturing both products is scouring. (This may take place before the wool is sold at auction.) Scouring is designed to remove as much of the grease, swint and contaminants as possible. The wool may also be:

- (a) sorted - putting fleeces into general lines,

- (b) blended - different wools and other fibres are mixed for repeatability, colour, uniformity, reduction in cost, and to produce special effects,
- (c) opened - tearing cotted fleeces apart, and
- (d) bleached or carbonised - the latter to remove vegetable material.

2.2.2 The Production of Garments

In the early stages of the manufacture of garments, two distinct processes exist for the production of yarn; these are the woollen and worsted processes.

The Woollen Process: Rainnie (43) notes that the first, and most important step in the woollen process is the blending of different fibres to produce special visual and tactile effects in the yarn. The blends may include raw wool, reused wool, waste wool from the worsted industry, cotton, hair and synthetic fibres. The operation which follows blending is carding, the functions of which are:

- (a) to disentangle the wool, and to increase the uniformity of the blend,
- (b) to produce a rough alignment of fibres, and
- (c) to remove any remaining contaminants.

The wool comes off the carding machine in the form of a sliver which is then spun into woollen yarn. Spinning involves drawing the sliver into a more attenuated form, imparting twist to it (to give the yarn tensile strength) and, if necessary, doubling to produce a thicker yarn.

The Worsted Process: In addition to being carded as in the woollen process, the wool, or blend, is also combed. The functions of combing are considered by Rainnie (43) to be:

- (a) to make the fibres parallel,
- (b) to remove the shortest fibres (giving noils), and
- (c) to remove any remaining contaminants.

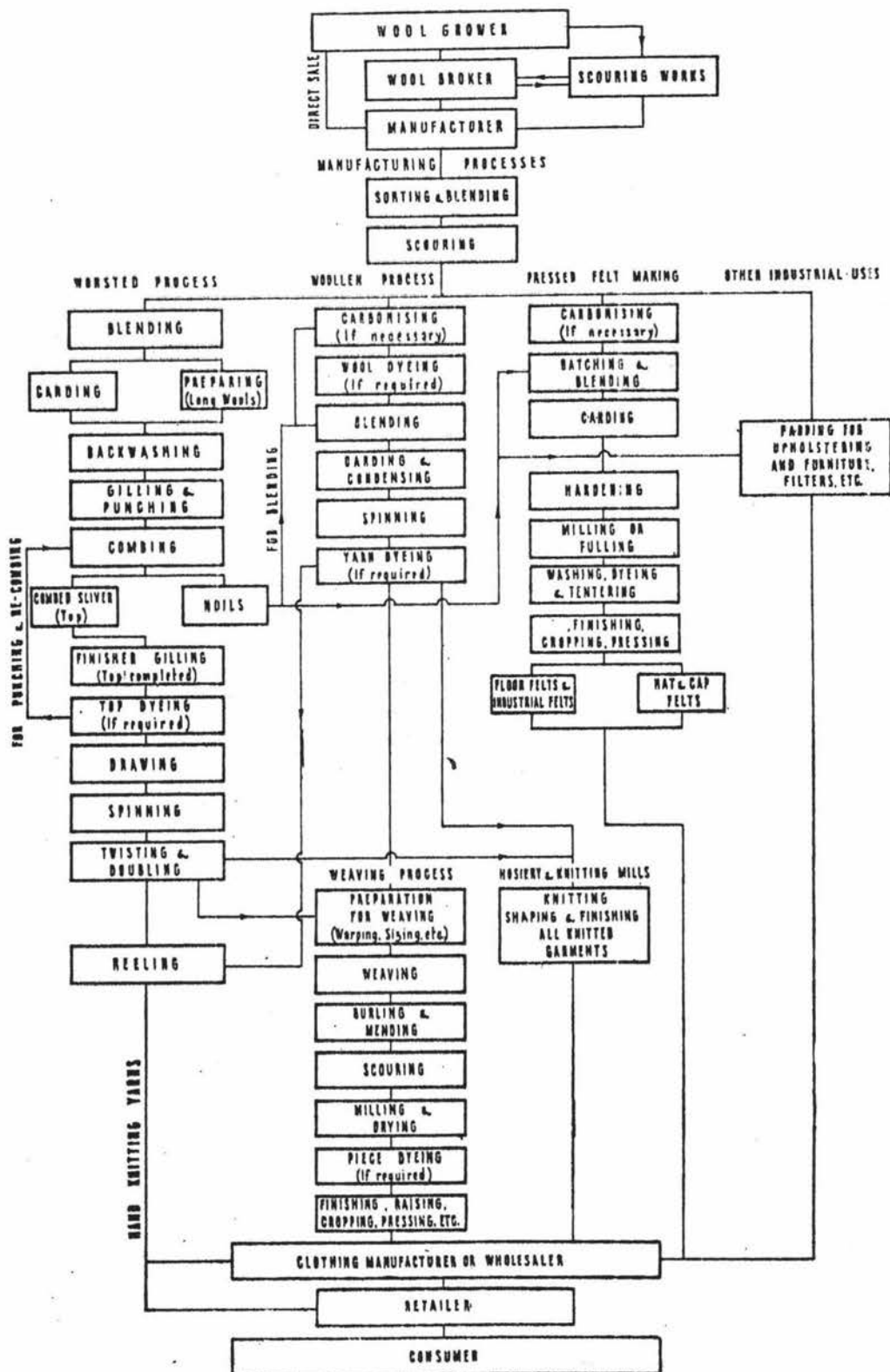


FIGURE 2.1 FLOW CHART ILLUSTRATING THE MAIN MANUFACTURING PROCESSES OF THE WOOL INDUSTRY

Source: Bureau of Agricultural Economics (2)

The result of the combing operation is a continuous sliver of wool which is generally termed "top". The final stage of the worsted process involves drawing, twisting and, if necessary, doubling the slivers to produce worsted yarn.

In woollen yarn the various fibres are deliberately mixed and crossed in order to impart to the yarn its characteristic looseness and rough appearance. By contrast, the tighter and smoother appearance of worsted yarn is achieved by processing longer fibres so as to make them lie parallel to each other.

Some yarn is sold directly to the final consumer for knitting purposes.

Formation of Cloth: Two processes exist for the formation of cloth, namely weaving and knitting. After the process of knitting or weaving the cloth is "finished". This involves inspecting and mending the cloth, and washing the cloth to remove oil and dust, and to produce felting and shrinking effects. The cloth may also be dyed at this stage.

A certain amount of cloth is sold directly to final consumers.

Garment Manufacture: A large proportion of the cloth, in the knitted or woven form, is made into garments. Garment manufacturers are usually very conscious of trends in fashion, and order appropriate cloth from the weavers and knitting mills.

A flow chart illustrating the main processes involved in the production of cloth is given in Figure 2.1. In this flow chart the process of felting is mentioned. The main operation in manufacturing felts involves agitating wool in a hot water bath.

2.2.3 The Production of Carpets

The initial stages of carpet production are similar to those in the production of garments; the wool is scoured, blended, oiled, carded, spun and finally dyed. The manufacturing stages specific to the production of carpets include designing, weaving and finishing.

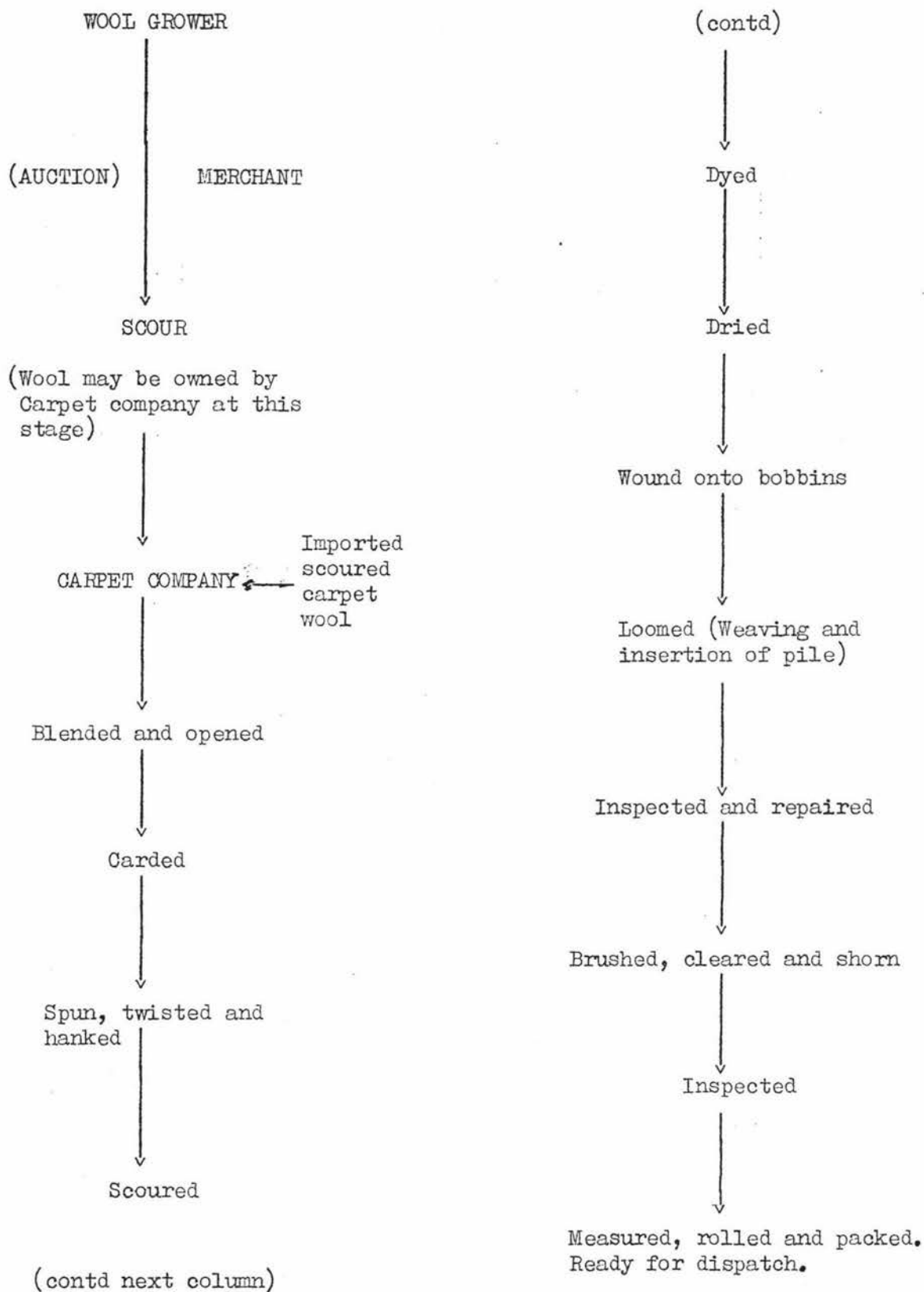


FIGURE 2.2 FLOW OF WOOL IN CARPET PRODUCTION

Source: Candler and Riseborough (6),
p. 28, 29.

Designing involves selecting the colour pattern for the carpet.

Considerable differences exist in the construction of major carpet types, particularly in the method of inserting the "pile" into the "backing." In some carpets (e.g. Axminster) the backing is woven and the pile is inserted by looping the pile yarn around the threads of the backing. In other carpets (e.g. Dalton) the pile yarn is pushed into the backing, which may or may not be woven, and is held in place by some form of glue.

Finishing involves repairing defects in the carpet.

A flow chart illustrating the main processes involved in the production of carpets is given in Figure 2.2.

2.3 Fluctuations in Wool Price

This section reviews studies which have documented the extent of wool price fluctuations at New Zealand auctions. In general, the reasons for these fluctuations have not been analysed.

Initially, the results of an analysis by the Wool Marketing Study Group are given, indicating the extent to which the price of one wool type has varied on one day. Two studies by Candler are then reviewed; the first describes the degree to which the prices of wool types move together, and investigates whether any discernible pattern in average price movements over time exists, while the second compares fluctuations in the average price of wool at auction with fluctuations in the prices of related wool futures, tops and yarn. Finally, a study by Candler and Yap is reviewed which evaluates the extent to which price fluctuations at auction can be attributed to variations in demand, and to variations in supply.

Candler (3) has suggested a number of reasonably distinct time periods for the purpose of examining wool price fluctuations:

- (i) Fluctuations occurring in successive lots at auction,
- (ii) Fluctuations over the period of a week, and
- (iii) Fluctuations over longer periods, i.e. from a number of weeks

up to several seasons.²

Information on price fluctuations at wool auctions occurring within one day has been provided by the Wool Marketing Study Group (49). The standard deviation of prices paid for individual lots of the same wool type on the same day were recorded for a series of wool types, and were related to the corresponding seasonal average price for each wool type. The standard deviations ranged from 1.0 to 1.5 cents. If the prices paid for a particular wool type were normally distributed and if, for example, the standard deviation of lot prices was 1.3 cents, then 68% of the prices would fall between the range of Av. Price \pm 1.3 cents/lb.. Similarly, 95% of the prices paid would fall within the range Av. Price \pm (1.95 x 1.3) cents/lb.. The percentage of the variance in price which could be explained by yield differences varied from 10 to 50% for the different wool types, but was usually between 20 and 30%. It was therefore apparent that substantial fluctuations in price did occur for the same wool type on the same day.

The first study by Candler (3) was concerned with the third kind of price fluctuations mentioned above, that is fluctuations over periods longer than a week. In dealing with price fluctuations between wool types, a number of measures were used. One measure was the degree of correlation between the movements of the prices of eight different wool types for the period 1952 to 1965. (If the correlation coefficient, r , is equal to +1 the prices move perfectly together, if $r = 0$ there is no tendency for price movements to be related to each other, and if $r = -1$ then the prices move in perfectly opposite directions.) The information which was obtained on the correlation between the weekly average prices of selected wool types is recorded in Table 2.1. Reading across the top line, the correlation coefficient between wool type 86 and wool type 100 was 0.901, and the correlation coefficient between wool type 86 and the sale average is 0.888.

2. These price movements would be superimposed upon the long term trend of wool prices.

TABLE 2.1 : CORRELATIONS BETWEEN WEEKLY AVERAGE PRICES OF SELECTED WOOL TYPES
(1952/3 TO 1964/5)

Correlation of Wool Type	With Wool Type							
	100	107	114	128	506	E695	739	Sale Av.
86	.901	.907	.899	.900	.957	.952	.968	.888
100		.991	.989	.980	.871	.972	.953	.860
107			.998	.995	.843	.976	.953	.885
114				.997	.833	.976	.957	.871
128					.832	.973	.953	.894
506						*	*	.916
E695							.957	.925
739								.944

* Wool Commission Type 506 was not offered at the same sales as E695 and 739.

Source: Candler (3), p. 12.

A similar table was constructed giving the range of correlation coefficients obtained in different seasons. The table indicated the maximum and minimum correlation coefficients between any two wool types in any one season from 1952 to 65. The range of correlation coefficients was from -1.0 to 0.80 for the minimum correlation between two wool types in any one season, and from 0.9 to 1.00 for the maximum correlation between two wool types in any one season. In only a limited number of cases were the minimum correlation coefficients between wool types for any one season negative, and, in general, it can be concluded that the weekly average prices of the selected eight wool types tended to move together.

Candler also considered fluctuations in the weekly average price for all wool, or weekly average price for a particular wool type over time. The sort of information which was provided on this subject was: the week and the price at which a peak or trough occurred, the time (in weeks) to the preceding or succeeding peak or trough, and the price at these points. For some indication of the magnitude of price movements involved, Table 2.2 shows the number of peaks and troughs which represent movements from the last peak or trough of less than 2d, 2d to 5d, 5d to 10d, and 10d or more.

TABLE 2.2 : NUMBER OF PEAKS AND TROUGHS REPRESENTING PRICE MOVEMENTS OF LESS THAN 2d, 2d TO LESS THAN 5d, 5d TO LESS THAN 10d AND 10d OR MORE

Price Movement	Peaks		Troughs	
	Number	%	Number	%
Less than 2d	45	60.8	48	64.0
2d to less than 5d	21	28.4	19	25.3
5d to less than 10d	4	5.4	2	2.7
10d or more	4	5.4	6	8.0
TOTAL	74	100	75	100

Source: Candler (3), p. 21.

Finally Candler attempted to determine if there was any recognisable pattern in wool price fluctuations by searching for the best raw wool purchasing policy that a buyer could adopt with perfect knowledge. Subject to assumptions on the cost of storage and manufacturing requirements, it was found that the optimum policy of purchase and storage of wool was 11% cheaper than "feeding hand to mouth" (or not engaging in speculation). Assuming that the foresight and the financial strength needed to carry out this policy was not readily available³ then opportunities for profitable storage of wool were considered limited. Candler argued that this indicated it was difficult to find any systematic way of predicting future wool prices on the basis of past wool prices. The randomness of wool price movements at auction has only been defined negatively; that is, patterns in price movements have not been detected, and therefore any systematic pattern in price changes is not likely to be simple.

The second analysis by Candler (4) examined the relationship between the weekly average price of all New Zealand wools (at auction), and related futures, tops and yarn prices. The possibility of lagged relationships existing between

3. This "optimum policy" on three occasions during the 13 year period being studied involved purchasing two seasons' requirements of wool in a limited period of time. Therefore, although the policy was optimum in the sense that it minimised the cost of supplying the required wool, it was not the sort of policy that a buyer could reasonably follow.

these products was investigated. Little was said about causal relationships, although some extreme views on the relationships between the products were refuted.

Initially, the correlation between price of wool at auction, and the price of related futures, tops and yarn occurring at the same time were tabulated. Lagged relationships were then introduced. Table 2.3 records the correlation between the prices of these products at the same time, the maximum serial correlation between the prices of the products, and the lag (in weeks) which gave the maximum serial correlation.

TABLE 2.3 : CORRELATIONS AND MAXIMUM SERIAL CORRELATIONS AMONGST WOOL, FUTURES, TOPS AND YARN PRICES (1952/3 TO 1963/4)

Price of		Correlation with				
		Wool	Futures	Tops		
				64 B	56's	50's
Futures	Corr.	.702				
	Ser.	.706				
	Lag	1				
Tops 64 B	Corr.	.618	.987			
	Ser.	.628	.987			
	Lag	2	-1			
Tops 56's	Corr.	.660	.782	.745		
	Ser.	.796	.789	.745		
	Lag	-3	-2	0		
Tops 50's	Corr.	.806	.683	.608	.925	
	Ser.	.822	.687	.609	.930	
	Lag	-5	-1	-1	2	
Yarn 50's	Corr.	.638	.307	.219	.662	.804
	Ser.	.641	.310	.219	.704	.808
	Lag	-7	-1	0	-2	-1

Source: Candler (4), p. 22.

In interpreting Table 2.3 Candler noted that even where strong relationships exist between prices in different weeks, any arguments about causal connections between prices need to be formulated with extreme care.

In the review of findings, three views which have been expressed on wool marketing were reported as disproved. The first extreme view was that the auction reflects the demand by the wool trade extremely accurately. There is some evidence of consistent price relationships between wool types at auction and products at different points in the marketing chain, however, these relationships are not as strong as some have argued.

The second extreme view was that through the accelerator mechanism fluctuations in the demand for raw materials are increased, by a constant stocks to sales ratio, from retailers backward along the chain to auction. Conversely, it has also been argued that fluctuations in auction prices are passed down through the marketing chain to the manufacturers. Such theories of simple causation were not substantiated as there were not strong price relationships between the products.

The third extreme view was that New Zealand wools can be effectively hedged on existing futures markets. Because of the low maximum serial correlation (0.7) between spot and futures prices, there is doubt whether New Zealand wools are adequately covered.

In the final study to be reviewed in this section, Candler and Yap (7)⁴ evaluated the proportion of the variation in wool prices at auction which could be attributed to the supply of New Zealand wool, and the proportion which could be attributed to demand. They found that regardless of the price elasticity of demand more than 75% of variations in wool prices were due to changes in demand, and if elasticity was less than -1 (more elastic) then over 90% of variations were due to demand effects.

The model used assumed:

- (i) In any one year the supply of wool was completely inelastic,
- (ii) The form of the function for the demand for wool was:

4. The basic approach used in this study was derived from an earlier article by Powell (40).

$$q_i = k_i p_i^e$$

where: q_i is the seasonal production of wool in year i ,
 p_i is the deflated seasonal average price in year i ,
 k_i is the shift parameter, and
 e is the price elasticity of demand.

(iii) Between seasons there are changes in demand and supply and these together explain price variation.

Given knowledge of the values of q_i and p_i and by assuming a constant value for e , the value for k_i can be found, and thus the constant elasticity demand function is completely specified for year i . There are no grounds for assuming elasticity constant during periods of high and low prices, but equally there is little evidence to show how it would vary. The variance of the estimated prices which would have resulted from a constant supply of wool in every year (which increased in each year in accordance with the trend in supply) was calculated for each of a number of assumptions about the price elasticity of demand. This was then compared with the variance in observed prices, and the result gave the percentage variability in wool prices which could be attributed to changes in demand. The remainder of the total variability was due to variations in supply.

In the subsequent sections of this chapter empirical studies which have attempted to explain or summarise wool price movements are reviewed. These studies have dealt with monthly and quarterly data. A review of studies which attempt to explain the cause of shorter term price movements has not been undertaken in this chapter.

2.4 Empirical Estimates of the Price Elasticity of Demand

The price elasticity of demand measures the percentage rise (fall) in the quantity demanded of a particular commodity if the price of that commodity falls (rises) by one percent, other things being equal.

The relevance of empirical estimates of the price elasticity of demand is their importance in the analysis of price containment schemes at auction. To be useful in this context, however, the estimates of the price elasticity have to refer to demand at auction, and not to demand at some stage of manufacturing.

In this section three studies which estimate the price elasticity of demand are reviewed. The study by Horner is the first to be reviewed. In this study the price elasticity of demand was determined, using pre-war data, from the relationship between the manufacturers' demand for wool and the final consumers' demand for wool clothing, and the relationship between the price of raw wool and the price of wool clothing.

The study by the Bureau of Agricultural Economics estimated the price elasticity of demand at the carding stage, and derived the price elasticity at Australian auctions from a knowledge of the Australian share of world (marketed) supplies of wool.

In the third study to be reviewed, McKenzie tested the hypothesis that quarterly wool price at New Zealand auctions depends on the extent to which stock holders are prepared to hold or sell stocks, and that current supply and current mill consumption are independent of price. Price fluctuations, according to this model, are determined solely by traders' expectations of the future.

2.4.1 Study by Horner

The estimates of price elasticity of demand and income elasticity of demand, made by Horner (26), were for pre-war demand for raw wool and wool clothing in the United States and the United Kingdom. Annual times series data were used, although recourse to cross-sectional family budget data was necessary to calculate the final consumers' demand for wool clothing.

In Horner's study the price elasticity of raw wool was composite, being derived from estimates for final consumers' demand for wool clothing and

manufacturers' demand for raw wool, and a relationship between price of wool clothing and the price of raw wool. This method was selected since the use of either final consumers' demand or manufacturers' demand was considered inappropriate as it neglected important explanatory variables.

(i) Analysis of the demand for all clothing.

Since no data on annual wool clothing consumption was available the data used was for annual all clothing consumption. The function fitted was:

$$\text{Log } C = a + b \log Y + c \log P_c + d \log P_r \quad (1)$$

where

C is quantity of clothing purchased,

Y is real national income,

P_c is the clothing price index,

P_r is the index of retail prices for commodities other than clothing, and

a, b, c and d are parameters.

It was assumed a priori that the function would be linear in logs. The coefficients were therefore the required elasticities. The inclusion of time to explain any changes in taste was tried but it had little effect on the sum of squares explained and hence was omitted.

Using regression analysis the price and income elasticities of demand were estimated. Serial correlation (where the successive observations of each of the independent variables are correlated) was presumed to be present.

In order to interpret equation (1) in terms of demand for wool clothing use was made of cross-sectional family budget data. It was considered that although variations in expenditure on clothing between income groups and expenditure on clothing by a community with different incomes through time were not the same conceptually, they could be assumed to be of the same order. By taking account of the probable differential between wool and all clothing, the income elasticity of demand for wool clothing was evaluated as 1.1.

The variables in equation (1) P_c and C therefore became P_{wc} and WC respectively, giving:

$$\text{Log } WC = e + f \log Y + g \log P_{wc} + h \log P_r \quad (2)$$

where

P_{wc} is the price of wool clothing,

WC is quantity of wool clothing purchased, and

e , f , g , and h are parameters.

The value for the price elasticity of demand for wool clothing was calculated as -1.0 .

(ii) Analysis of manufacturers' demand for raw wool.

Two types of functions were specified. The first measured only the quantity variation in manufacturers' demand:

$$\text{Log } MW = m + n \log P_w \quad (3)$$

where

MW is the quantity of wool consumed per unit of total clothing output,

P_w is the price of raw wool, and

m and n are parameters.

It was not possible to include the price of substitutes as an explanatory variable as these were mainly recovered (or reused) wools, and their introduction would also introduce multicollinearity since the price of recovered wool is closely related to the price of raw wool. Costs such as labour and capital were ignored due to the lack of data, and because these variables could be presumed to be constant.

The dependent variable was manufacturers' consumption (not purchases) per unit of output. Hence speculative demand was eliminated. Horner argued that although changes in manufacturers' consumption would occur as a result of price expectations, the latter changes would affect consumption and output equally and hence not affect the value of MW .

The second function measured both the quantity and quality variation in the amount of wool purchased by manufacturers:

$$\text{Log MQ} = q + r \log P_w \quad (4)$$

where

MQ is the value of wool consumed / standard quality price of wool, per unit of clothing output.

Rather than measuring consumption by the weight of wool consumed as in the first function, by dividing this weight by a price index the manufacturers' use of more or less expensive grades of raw wool would be reflected. The price elasticity estimated from equation (4) would therefore indicate how the manufacturers vary the quality of wool consumed, as well as the substitution between wool and other fibres, in response to price changes.

Using the least squares method of analysis the price elasticity of demand of manufacturers for raw wool was estimated as -0.4 in the United States and the United Kingdom with the quality variation included, and -0.2 for the United States and -0.1 for the United Kingdom if the quality variation was excluded.

- (iii) Estimation of the relationship between the price of raw wool and the price of wool clothing.

The function specified was:

$$P_{wc} = s + t P_w$$

where

P_{wc} is price of wool clothing,

s is that part of cost of transformation independent of the price of wool,

t is the pyramiding ratio - the number of times a given change in wool prices is magnified by fixed manufacturers' margins in manufacturing and distribution, and

P_w is the price of wool.

From this:

$$t = \frac{\partial P_{wc}}{\partial P_w}$$

The corresponding elasticity, u , is:

$$u = t \frac{P_w}{P_{wc}} = \frac{t \cdot P_w}{s + t \cdot P_w} \quad (5)$$

Horner assumed $t = 1.0$ so that:

$$u = \frac{P_w}{s + P_w}$$

The value of u in the United States was 0.08 and 0.14 in the United Kingdom.

(iv) Combining⁵ parts (i), (ii) and (iii).

5. The link between equations (2) and (4) is that: $WC = y \cdot \text{output}$, since quantity of wool clothing purchased, WC , is directly proportional to manufacturers' output.

The modified form of equation (2) becomes:

$$\text{Log } (y \cdot \text{output}) = e + f \log Y + g \log P_{wc} + h \log P_r \quad (6)$$

Equation (4) can be rearranged to give:

$$\frac{\text{Log } (\text{Value of wool consumed/standard quality price of wool})}{\text{log } (\text{output})} = q + r \log P_w \quad (7)$$

Therefore, rearranging equation (7):

$$\text{Log } (\text{output}) = -q - r \log P_w + \text{log } (\text{quantity wool consumed by manufacturer}) \quad (8)$$

The elasticity, u , in equation (5) can be obtained from:

$$\text{Log } P_{wc} = u \log P_w. \quad (9)$$

Rearranging equation (9):

$$\text{Log } P_{wc} = \text{Log } P_w^u. \quad (10)$$

To obtain the elasticity (the % change in P_{wc} given by 1% change in P_w), first find $\frac{d P_{wc}}{d P_w}$ by differentiating equation (10) totally with respect to P_w ,

and then multiplying both sides by $\frac{P_w}{P_{wc}}$:

$$\frac{d P_{wc}}{d P_w} \cdot \frac{P_w}{P_{wc}} = u.$$

Substituting equation (9) in equation (6):

$$\text{Log } (y \cdot \text{output}) = e + f \log Y + gu \log P_w + h \log P_r \quad (11)$$

Combining equations (8) and (11):

$$\text{Log } (\text{quantity of wool consumed by manufacturer}) = q + e + f \log Y + (gu + r) \log P_w + h \log P_r - \log y \quad (12)$$

In this equation e , q and $\log y$ are constants. Since equation (12) is in double logarithm form, the price elasticity of demand is given by $gu + r$.

Manipulation of the above estimates results in:

- (a) The income elasticity of demand for wool clothing = $f = -1.1$ for both the United States and the United Kingdom.
- (b) The price elasticity of demand for raw wool = $gu + r$, was from -0.4 to -0.6 , and slightly higher in the United States than in the United Kingdom.

2.4.2 Study by the Bureau of Agricultural Economics

The study by the Bureau of Agricultural Economics (47) is an econometric analysis of the quarterly mill consumption in the United Kingdom for the period 1952 to 1964. The study was specifically aimed at measuring the price elasticity of demand for Australian wool. Two hypotheses of considerable interest were tested; that the United Kingdom demand for wool is more elastic in periods of high price than in periods of low price, and that the demand for raw wool in the United Kingdom has become more price elastic over the period 1952 to 1964.

The level of mill consumption, measured at the carding stage, was chosen for the analysis, rather than demand at auction:

"...because it is more convenient with respect to the availability of data, and because it is more appropriate to the measurement of manufacturers' response to price changes. Wool auction data are expected to include an important element of short term stock changes because of speculative trading. Data on mill consumption, on the other hand, should reflect a longer run response by manufacturers."⁶

This statement is inconsistent with the aim to determine the elasticity of demand for Australian wool (to be used, for instance, in simulation studies of reserve price schemes). If the effect of speculation is present in the formation of auction prices, then estimates of the price elasticity of demand for raw wool at auction must include it. Consideration of Australia's share of the world market is not sufficient. If speculation was present at auction, then one might expect that the percentage change in the quantity of wool demanded,

6. Bureau of Agricultural Economics (47), p. 3.

for a given percentage change in price, would be greater than if speculation was not present; that is, demand would be more elastic if speculation was present.

The simplest statistical models postulated were:

Income Models

$$\log CH_t = \log a_0 + a_1 \log P_{t-2} + a_2 \log Y_{t-1} + a_3 \log T_{t-1} + a_4 \log A_{t-2} + \log U_t \quad (13)$$

$$\log CM_t = \log b_0 + b_1 \log P_{t-2} + b_2 \log Y_{t-1} + b_3 \log T_{t-1} + b_4 \log A_{t-2} + \log U_t \quad (14)$$

Sales Models

$$\log CH_t = \log c_0 + c_1 \log P_{t-2} + c_2 \log SH_t + c_3 \log T_{t-1} + c_4 \log A_{t-2} + \log V_t \quad (15)$$

$$\log CM_t = \log d_0 + d_1 \log P_{t-2} + d_2 \log SM_t + d_3 \log T_{t-1} + d_4 \log A_{t-2} + \log V_t \quad (16)$$

where

CH is raw wool available for home consumption per head (lb),

CM is mill consumption of raw wool per head (lb),

P is weighted prices (d/lb) of raw wool (64's and 56's)

deflated by a retail price index for all items (January 1956 = 100),

Y is personal disposable income per head (£ stg), deflated by a retail price index for all items (January 1956 = 100),

SM is manufacturers' sales of wool products per head (lb),

SH is availability of wool products for home consumption per head (lb),

T is ratio of stocks of tops to quantity of tops drawn plus exports,

A is synthetic staple fibre available for home consumption per

head (lb),

U, V are error terms,

$a_i, b_i, c_i, d_i; i = 0, \dots, 4$ are parameters,

a_1, b_1, c_1 and d_1 are the price elasticities of demand in equations (13), (14), (15) and (16) respectively, and

t is the quarter.

The two dependent variables (CM and CH) were included since about 40% of manufacturers' sales of wool products are exported. Raw wool available for home consumption was defined as mill consumption of raw wool minus an estimate of net exports of wool products.

The explanatory variables included those variables which determined manufacturers' consumption of raw wool, and yet (i) were not themselves a function of the level of consumption of raw wool, and (ii) were quantifiable and (iii) did not display multicollinearity.⁷

The influence of population growth was taken into account by converting absolute quantities consumed into a per head basis. The quantity of synthetic fibre sold was included rather than the price of synthetics, it being argued that the quantity sold has more effect than price. This conclusion is confirmed by the work reviewed in this chapter on the availability of substitutes.

The difference between equations (13) and (14), and equations (15) and (16) is in the treatment of income. In equations (13) and (14) disposable income was included, and tastes and fashions were ignored. In equations (15) and (16) manufacturers' sales of wool products were specified, expressing the joint effect of income and consumer tastes. If manufacturers' sales of wool products are a function of manufacturers' demand for raw wool then a simultaneous equation approach might be more appropriate than the single equation model being reviewed.

Using least squares analysis the parameters in the four equations were

7. Multicollinearity occurs where two explanatory variables are highly correlated.

estimated. For equations (13) and (14), R^2 , the coefficient of multiple determination, was 0.41 and 0.42 indicating that a little over 40% of the variation in demand for raw wool was explained by the independent variables. With an R^2 of 0.4, the explanation achieved by the model is so small that it is doubtful if any attention should be given to it.

For equations (15) and (16) R^2 was .79 and .63 respectively, and in both equations the coefficient for the variable A_{t-2} was not significant and the Durbin-Watson statistic indicated the presence of some serial correlation. Estimates of the price elasticity of demand were -0.26 in equation (15) and -0.16 in equation (16). These are lower than estimates of -0.4 and -0.6 obtained in Horner's pre-war study.

Testing the first hypothesis, that United Kingdom demand for wool has been more elastic in periods of higher wool price than in periods of low prices, the method used was to partition periods of high wool prices, and periods of low prices and apply the models to each. The differences between the high and low estimates of price elasticity were not significant at the 5% level. The results are consistent with the null hypothesis, that the price elasticity is the same for high and low prices.

The second hypothesis tested was that the price elasticity had not become more elastic over the period under consideration. The results indicated that the estimates of the price elasticity for the second half of the period, 1952-64, were significantly more elastic than for the first half. On this basis the second null hypothesis should be rejected.

By assuming a constant elasticity of demand schedule, equations (13) through (16) assumed that price elasticity is constant over time. The study proceeded by allowing changes in the price elasticity of demand for raw wool to occur due to wool's smaller share of the total fibre consumption by manufacturers. It was noted that through the period being studied (1952-64) wool's share of total fibre consumption has declined from 98% to 80%; however, the

inclusion of this substitution of wool for synthetics did not significantly raise the elasticity of the demand for raw wool.

The estimates of price elasticity of demand recorded above were made for the world demand for raw wool. The price elasticity of demand for Australian wool was evaluated by taking into account Australia's share of the market. The equation to give the price elasticity of demand for Australian wool, e_A , was taken to be:

$$e_A = 1/f(e_W - e_S) + e_S \quad (17)$$

where

f is the Australian share of world apparel wool production, e_W is the price elasticity of world demand for raw wool, as given by the estimated elasticity of United Kingdom demand, and e_S is the price elasticity of supply of wool from suppliers other than Australia.

By taking a range of estimated values for e_W , e_A was calculated as:

$$\begin{aligned} e_A &= 1/0.37 ((-0.27 \text{ to } -0.4) - 0.05) + 0.05 \\ &= -0.82 \text{ to } -1.17. \end{aligned}$$

The Bureau of Agricultural Economics have evaluated the price elasticity of demand for Australian wool at the carding stage but, as noted earlier, if there exists a speculative element in demand at auction, and this is not present to the same extent at the carding stage, then the estimated price elasticity will not necessarily be equivalent to the price elasticity of demand at Australian auctions.

In order to be able to use single equation models it was argued that mill consumption is a function of the price of raw wool lagged by two quarters, but that the current price of wool is not a function of current mill consumption. The condition necessary to be able to use single equation models is not that current price is independent of current mill consumption, as was argued, but rather that lagged prices are independent of current mill consumption. It

is likely that lagged prices are influenced by current mill consumption, or, current prices are some function of expected future mill consumption. Therefore, a single equation model is likely to be inadequately specified, and a simultaneous equation approach may be more appropriate.

2.4.3 Study by McKenzie

As contrasted with the Bureau of Agricultural Economics' study, the distinguishing feature of McKenzie's study (28) is the concentration on the effect of stocks in determining the quarterly price of raw wool.

The hypothesis tested in this thesis was that in any period as short as three months the prices settles at the level that stock holders are prepared to hold or sell stocks, and that current supply and current mill consumption are independent of price. This model says that price fluctuations are caused by movements in speculative demand, which in turn are determined solely by traders' expectations of the future. That supply is inelastic is a common assumption, however it is desirable to give some of the reasons why mill consumption in a given quarter was assumed independent of price. The first reason was that the price of raw wool is only one of the costs of production which influence management decisions (though according to Fead (16) it is a substantial one) and that costs can be passed on by pricing on a "cost plus" basis. Further, it is costly to have a fluctuating rate of production. Finally, it was considered that current mill consumption is a function of current demand for wool textiles.

The models McKenzie constructed specified a supply function, a consumption function, a stock demand function and an equilibrium equation.

The stock demand function he specified took the form:

$$S_t^1 = f(C_{t+1}^*, \Delta^*PW_{t+1}) \quad (18)$$

where

S_t^1 = desired level of manufacturers' stocks at the end of

quarter t ,

C^*_{t+1} = expected rate of mill consumption in quarter $t+1$, and
 Δ^*PW_{t+1} = expected change in price between periods t and $t+1$ as
 assessed in period t .

Initially a linear function was assumed:

$$S_t^1 = a_0 + a_1 C^*_{t+1} + a_2 \Delta^*PW_{t+1} \quad (19)$$

where

a_0, a_1, a_2 are parameters.

The difficulty with this formulation was that the two independent variables were not directly observable. In order to enable statistical testing of the original hypothesis it was necessary to specify these two variables in terms of observable variables.

First, it was initially assumed that the expected level of mill consumption in the next quarter, C^*_{t+1} , was equal to the current rate of mill consumption. That is:

$$C^*_{t+1} = C_t \quad (20)$$

where

C_t is the actual rate of mill consumption in period t .

Secondly, the expected change in price, Δ^*PW_{t+1} , was specified in terms of a series of price expectation hypotheses which have been postulated by various research workers. Incorporating each of these hypotheses gave a number of models which were subsequently tested. Three of these models will be given in this review.

The data used were quarterly wool prices (simple averages of 64s and 46s on a clean basis in the United Kingdom), quarterly mill consumption (for nine countries), quarterly stocks, and quarterly supply of wool, for the period January 1952 to June 1964. Owing to the paucity of data on stocks, McKenzie estimated these himself. McKenzie recognised many of the deficiencies of his

data, but the series he constructed appear to be better than any other stock series currently available.

Model A: Taking equation (20), and specifying Δ^*PW_{t+1} using the Keynesian type price expectation hypothesis,

$$\Delta^*PW_{t+1} = f(PW_t) \quad (21)$$

where

PW_t is the actual price of wool in period t .

then by substitution in equation (19) the following relationship is obtained:

$$S_t^1 = a_0 + a_1 C_t + a_2 PW_t \quad (22)$$

The model is completed by the equation:

$$S_t^1 = S_t \equiv Q_t + S_{t-1} - C_t \quad (23)$$

where

S_t is the actual level of stocks at the end of quarter t , and

Q_t is the supply of wool in quarter t .

By equating S_t^1 to S_t equation (22) becomes:

$$S_t = a_0 + a_1 C_t + a_2 PW_t \quad (24)$$

the reduced form of which is:

$$PW_t = B_0 + B_1 C_t + B_2 S_t \quad (25)$$

where

$$B_0 = -a_0/a_2, B_1 = -a_1/a_2, B_2 = 1/a_2$$

This model had a low explanatory ability, for $R^2 = 0.39$, and hence it is very doubtful if anything can be concluded from the model, except that it is incompletely specified. It should also be noted that there is no a priori reason to fit (25) rather than (24), unless there are thought to be errors in the observations of stocks. If there are thought to be errors of measurement in stocks, then (24) is likely to be preferable to (25).

Model D: Equations (19) and (20) were taken again, and Δ^*PW_{t+1} was defined as:

$$\Delta^*PW_{t+1} = PW_{t+1}^* - PW_t \quad (26)$$

where

PW_{t+1}^* is the expected price in period t+1, formulated in period t.

Nerlove's adaptive expectations hypothesis was used to define PW_{t+1}^* :

$$PW_{t+1}^* = PW_t^* + \beta(PW_t - PW_t^*); \quad 0 \leq \beta \leq 1 \quad (27)$$

where

PW_t^* is the expected price in period t, formulated in period t-1, and β is a coefficient.

This hypothesis says that the forecast is changed by an amount proportional to the most recently observed forecast error.

By substitution,⁸ the reduced form was obtained:

$$\Delta PW_t = B_0 + B_1 C_t + B_2 C_{t-1} + B_3 S_t + B_4 S_{t-1} \quad (28)$$

where

$$B_0 = \frac{a_0 \cdot \beta}{a_2(1-\beta)}, \quad B_1 = \frac{a_1}{a_2(1-\beta)}, \quad B_2 = \frac{-a_1}{a_2}$$

$$B_3 = \frac{1}{-a_2(1-\beta)}, \quad B_4 = \frac{1}{a_2}$$

The explanatory ability of this model was also very low ($R^2 = 0.35$).

8. Substituting equations (20), (26) and (23) in equation (19):

$$S_t = a_0 + a_1 C_t + a_2(PW_{t+1}^* - PW_t) \quad (29)$$

Substituting equation (27), in equation (29):

$$S_t = a_0 + a_1 C_t + a_2(PW_t^* + \beta PW_t - \beta PW_t^* - PW_t)$$

Rearranging:

$$PW_t = \frac{a_0}{a_2(1-\beta)} + \frac{a_1 C_t}{a_2(1-\beta)} + \frac{a_2(1-\beta)PW_t^*}{a_2(1-\beta)} - \frac{S_t}{a_2(1-\beta)} \quad (30)$$

From (29):

$$S_{t-1} = a_0 + a_1 C_{t-1} + a_2(PW_t^* - PW_{t-1}) \quad (31)$$

Rearranging (31) in terms of PW_t^* and substituting in (30):

$$PW_t - PW_{t-1} = \Delta PW = \frac{a_0}{a_2(1-\beta)} + \frac{a_1 C_t}{a_2(1-\beta)} - \frac{a_1 C_{t-1}}{a_2} + \frac{S_t}{a_2(1-\beta)} - \frac{S_{t-1}}{a_2}$$

This model is over-identified in the sense that the number of parameters in the reduced form equations exceed the number of structural parameters. Therefore the parameters in equation (28) do not provide a unique estimate of the structural parameters of the model. Given over-identification ordinary least squares should not be applied to the reduced form equation. Other estimating procedures, such as two stage least squares, can be used to obtain determinate estimates of the structural parameters.

Another difficulty exists in the specification of the model. The hypothesis to be tested was that the quarterly price is a function of the demand for stocks, and that the mill consumption in that period is independent of price. In equation (23) it is indicated that the desired level of stocks in the current period is equal to the actual level of stocks in the current period, which is in turn a function of the current supply of wool, the stocks of wool last quarter and current mill consumption. In equation (18) desired stocks are specified as being a function of price. If stocks last quarter and current supply are taken as given then the only way the series of equations in the model can hold is for mill consumption to be dependent on price. This contradicts the original hypothesis.

In subsequent models McKenzie used alternative price expectations hypotheses, and respecified C_{t+1}^* for some models (so that expected mill consumption next quarter was not equal to the actual level this quarter). The criticisms of model D also apply to many of these models.

Model H: The best model, in terms of explanatory ability,¹⁰ was heuristic in its approach. Heuristic models are not deduced from structural relationships but rather include those variables which are considered significant. Such models are not inherently bad, but the specification of the model, or the results obtained from the model, may be ambiguous or inadequate.

9. This point has also been made by Yap (50).

10. Meaning that a large proportion of the total sum of squares have been explained by the inclusion of the independent variables - not that the model is correctly specified.

Model H, a heuristic model, yielded the following estimates:

$$\begin{aligned}
 PW_t = & -40.28 + 0.124 C_{t+1} + 0.165 C_t - 0.125 C_{t-1} & (32) \\
 & -0.035 S_t - 0.39 D_1 - 16.21 D_2 - 7.04 D_3 \\
 R^2 = & 0.89
 \end{aligned}$$

where

D_i is a seasonal shift variable for the i^{th} quarter.

All parameters were significant at the 1% level, except that for the D_1 which was significant at the 5% level. It argues, *inter alia*, that current mill consumption is independent of both current and lagged prices. It may be correct that current mill consumption is independent of the current price of raw wool however it is unlikely to be independent of lagged price.

The price elasticity of demand indicated by model H is -6 plus or minus -4, i.e. somewhere between -10 and -2.¹¹ The reason for the higher estimate of price elasticity than the two previous studies is due to the inclusion of an important speculative element. The quantity demanded, by including speculative demand, is much more responsive to price changes and is therefore more elastic. Given some substitutability between wool and synthetic fibres, demand could be even more elastic.

Comment could be made on the use of expectations hypotheses as a method of specifying the expected change in price, Δ^*PW_{t+1} . These hypotheses have been attempts to understand and estimate the generation of expectations by relating them to observable variables. They have also been simple autoregressive systems in which the expected value of price in the next period is a function of the weighted and/or lagged values of past prices. Mills (30) notes that empirical studies have shown that for many economic series only a limited

11. As stocks alone are responsive to current price, the short run price elasticity for demand for all raw wool was calculated from the stock coefficient in equation (32) (-0.035), and the average price of wool in each quarter, clean, delivered in the United Kingdom, and the average level of demand for raw wool in the United Kingdom. The price elasticity for New Zealand wool was obtained by multiplying the elasticity for all wool by the fraction that New Zealand supplies.

proportion of the variation in that variable can be explained by looking at past values of the variable. Mills therefore concludes that an expectation based exclusively on an autoregressive scheme is likely to yield a poor forecast of the next period's value. The inference from Mills' argument is not that traders and manufacturers of wool make near perfect forecasts, but rather that they are likely to take more variables into account than only historical movements in prices.¹²

In the context of McKenzie's study, it is likely that mill consumption is one of the variables that the wool trade would consider in forming expectations of future price movements.

McKenzie's analysis is based on the assumption that in the short run, demand at auction is dominated by speculative purchases. The Bureau of Agricultural Economics measured the responsiveness of mill consumption to changes in the price of raw wool, and obtained an estimate of price elasticity of demand for Australian wool in the vicinity of -1 , whereas McKenzie measured the responsiveness of auction purchases and obtained a price elasticity for New Zealand wool of -6 . McKenzie's estimate therefore provides some support for the hypothesis that speculation is an important factor in determining wool prices at auction.

The implications for the present study is that an evaluation of the merits of floor and ceiling price schemes need to take into account the possibility of some response by speculators. McKenzie's results suggest that, in general, speculative activity is stabilising since in equation (32) stocks vary inversely with price. McKenzie notes, however, that in times of "boom" speculators may "follow the market" and in times of "bust" speculators may adopt a "wait and see" attitude, and in both cases demand at auction would become very inelastic. The presence of a floor price when prices are low, and the presence of a ceiling price when prices are high may, therefore, generate a response in speculative activity which is not simply a movement along the linear or constant elasticity

12. Fairly extensive simulation studies by Candler, referred to in (3), failed to produce good buying guides at auction which relied solely on past price information.

demand schedule which is said to exist at more intermediate prices.

In the study by the Bureau of Agricultural Economics it was argued that manufacturers' consumption was a function of lagged prices, but that current prices were independent of current consumption. McKenzie, on the other hand, argued that current price is a function of current consumption, but that current mill consumption is independent of current price. Such divergences of opinion are in part due to the simplifying assumptions necessary in model construction and to the lack of readily available data to test the model with, but they are also due to a basic lack of knowledge of the operation of the wool market. The econometric model which provides a complete specification of the wool market is likely to be very complex, and lack of data is likely to impose severe restrictions on its application.

2.5 The Availability of Substitutes for Wool

In the last two decades synthetic (non-cellulosic) fibres have become available commercially, and have replaced wool in many of its traditional end uses.

In this section two approaches to analysing the degree of market penetration achieved by synthetics are discussed. The first approach investigates the relative technological competitiveness of alternative fibres, whilst the second estimates from empirical data the speed and likely extent of market penetration achieved by synthetics.

2.5.1 Technological Competitiveness of Fibres

Polasek (37) notes that man made fibres fall into two broad groups: cellulosic (mainly rayon) and non-cellulosic. In the latter group three main types can be distinguished, namely polyamides, polyesters and acrylics. Polyamides (for instance nylon) because of their properties of high tensile and abrasive strength are complementary to rather than competitive with wool and are used in blends with wool. Polyesters are produced under a variety of trade-

marks, the best known being Terylene and Dacron. Polyesters are often blended with wool as they add strength, crease retention and easy care properties to the blends. Acrylic fibres appear under trade names such as Orlon, Acrilon, Courtelle and Dralon, and because of their softness, lightness and bulkiness have competed with wool in the unblended form.

Lipson (27) provides a comparison of some of the physical properties for wool and synthetics. These are listed in Table 2.4. It should be noted, however, that given the large amount of research expenditure aimed at overcoming the defects of fibres breakthroughs in eliminating these defects are common. Further, different synthetic fibres have significantly different physical properties.

TABLE 2.4 : A COMPARISON OF PHYSICAL PROPERTIES
OF WOOL AND SYNTHETICS

PROPERTY	WOOL	SYNTHETICS
Strength	Fair	Excellent
Resistance to insect attack	Poor ⁽¹⁾	Excellent
Permanent creasing	Poor ⁽¹⁾	Good
Resistance to heat and flame	Excellent	Poor
Resistance to shrinkage	Poor	Excellent
Dyeing properties	Excellent	Poor
Mill processing performance	Good	Fair
Moisture absorption	Excellent	Poor

(1) Research has more or less overcome these disadvantages.

Source: Lipson (27), p. 546.

It is also possible to compare the "commercial" merits of wool and synthetics in terms of properties such as:

- (i) availability of supplies,
- (ii) classification of the technical properties of the fibres into clearly defined grades,
- (iii) guarantee of quality of fibre bought,
- (iv) availability of technical advice and advertising support, and

(v) price stability.

The importance of these properties depends on the manufacturers' attitudes. For instance, with respect to price stability, Weisser (45, p. 513) notes:

"To what extent wool price instability is the operative factor in any permanent switch from wool to synthetics or in the displacement of potential demand for wool is so far a matter for conjecture. Australian manufacturers operating integrated-mills have been most critical of price fluctuations associated with the free auction system, whereas Bradford topmakers, specialising in risk taking, are strongly in favour."

Gutman and Fead (23) note that synthetics have many commercial advantages over wool, in particular synthetics have greater price stability and a more positive promotional programme. It could be noted that in discussions on the stability of synthetic prices, reference is usually made to quoted prices rather than to actual negotiated prices (which are thought to be less stable).

In comparing the physical and technical merits of wool vis à vis synthetics, Boyer (1) has argued that for many purposes wool is a more satisfactory raw material for the manufacturer on physical grounds, but synthetics are used in large measure due to their considerable commercial advantages.

2.5.2 Studies of Market Penetration by Synthetics

A series of studies are now reviewed which attempt to describe the speed and the ultimate extent of the displacement of wool in a number of its traditional end uses by synthetic fibres. The technique used in these studies is first described, and then attention is turned to the contribution of each study.

The technique used, as described by Powell, Polasek and Burley (41), involves statistically fitting a logistic growth curve to past data on the consumption of wool and synthetics. The curve describes the rate of adoption of synthetics as a function of time, and indicates what the final extent of the displacement of wool is likely to be. If necessary, the effect of changes in the price of synthetics relative to the price of wool, in accelerating the rate of adoption of synthetics, can also be incorporated.

The logistic curve used in the studies reviewed in this section has the

form:

$$Y_t = K/(1 + e^{-(a + bt)}) \quad (33)$$

where

Y_t is the ratio (consumption of synthetic staples)/(consumption of raw virgin wool + synthetic staples),

K is the ceiling or upper limit that the curve becomes asymptotic to (the final extent of the penetration of synthetics),

a is the coefficient locating the logistic on the time scale,

b is the rate of adoption or speed at which the curve becomes asymptotic to K ,¹³

t is time, and

e is the base of the natural logarithms.

A graphical exposition of the information provided by the logistic growth curve is given in Figure 2.3.

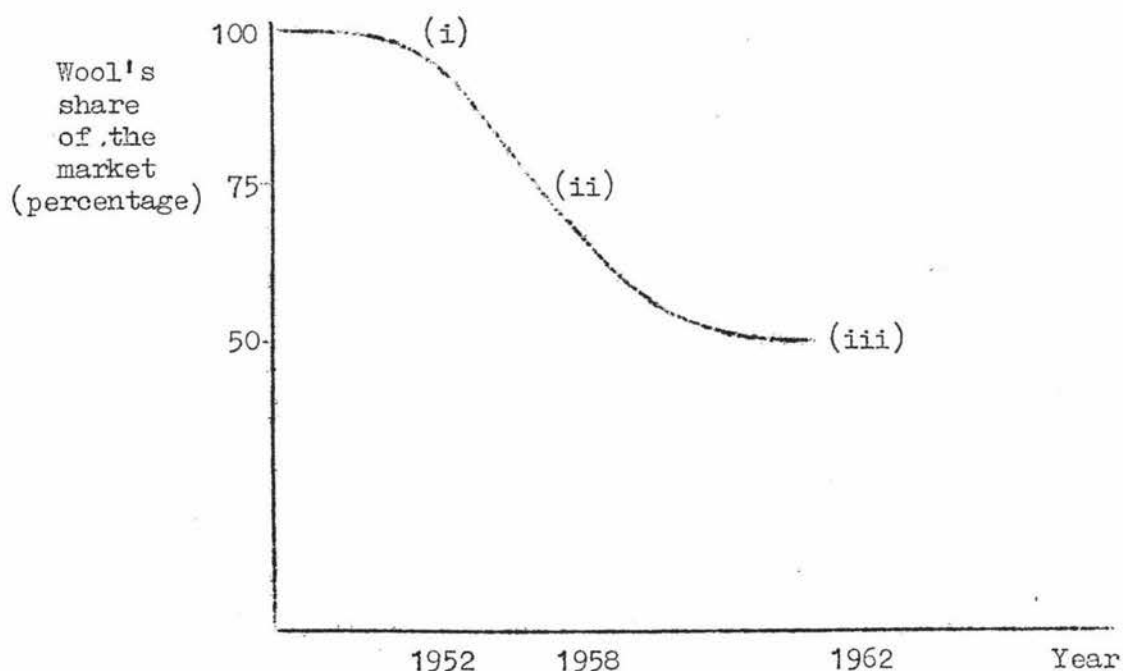


FIGURE 2.3 EXAMPLE OF LOGISTIC CURVE

Source: Polasek and Powell (38) p. 22.

13. Powell, Polasek and Burley (41) reformulated b in order to include the effect of the relative prices of wool and synthetics accelerating the rate of adaptation.

The upper limit of the penetration by synthetics in Figure 2.3 is 50%, and the process of market adjustment takes place over a period of ten years. Three phases in the adoption of synthetics can be distinguished: (i) the initial innovational impact, (ii) the gradual assimilation of synthetics, and (iii) a relatively stable market adjustment giving a long run equilibrium.

The logistic growth curve approach infers what happened rather than explains why it happened, since it describes the general trend of synthetic penetration and does not isolate the market forces at work except perhaps in the case of relative fibre prices. Further, it implicitly assumes a constant technology, and this reduces the usefulness of the method for predictive purposes. The method does, however, provide a convenient summary measure of market adjustment.

Turning now to an analysis of the results using this technique, Polasek and Powell (38) contended that two approaches to the analysis of the penetration of synthetics were practicable. The first approach focussed attention on inter-fibre substitution at the mill level. This assumes that a substantial amount of the changes in the proportion of fibre used is determined by the technology of the fibres, subject to acceleration by relative prices and promotion expenditure. Polasek and Powell noted that for the first approach, since synthetics were in the early stages of development, the changes in the proportion of fibre use was due to the manufacturers' initiative, rather than the consumers' choice.

The second approach suggested by Polasek and Powell utilised statistical information on the changing fibre composition of a series of end products. This approach would indicate those garments and other end products where substantial synthetic penetration had occurred.

Using the first approach (discussed above), Powell, Polasek and Burley (41) studied the substitution of synthetics for wool by manufacturers in the United States, using quarterly data for the period 1954 to 1962. The logistic

growth function, given in equation (33) explained 96% of the variance in the data used. In this analysis the rate of adoption of synthetics was only a function of time, and the relative price effect was ignored. The ceiling, K, was estimated to be a little over 50%. One might argue that as the price of wool relative to synthetics rose, the trend towards an increased use of synthetics would accelerate. The study by Powell, Polasek and Burley showed, however, that the inclusion of relative prices as an explanatory variable reduced the accuracy of fit. The conclusion that relative prices are of no interest in the adjustment process may be erroneous since relative prices, as an explanatory variable, were only lagged by three months and for a major decision like switching from wool to synthetics a longer lag might be justified.

The introduction of the price variable did however substantiate the suggestion of Ferguson and Polasek (17) that there was a structural change in the United States wool in 1958. Any set of estimates prior to mid 1958 understated the rate of growth of the consumption of synthetics after 1958.

The second approach applies the logistic growth curve to statistics on the changing fibre composition of a number of end products. Polasek and Powell (38), using the same technique as above, quantified the trend against wool for a wide range of end products. Items suitable for casual wear had a high or intermediate ceiling - some over 80%. For women's apparel the ceiling varied considerably. For non-apparel end uses, e.g. drapery, upholstery, blankets and carpets, there was a high to intermediate ceiling. Aggregate data was then used and, although there was some difficulty with the index number problem, the ceiling for the United States was 50% with or without carpet wools being included.

A further study using the logistic curve, by Polasek and Powell (39), indicated the logistic trends in a number of the main wool consuming countries, and indicated which countries could expect further displacement of wool.

In the light of more recent data Gruen et al. (22) have recalculated a

number of the above results. The recalculations indicated that the earlier projections under-estimated the ceiling in synthetics share of the market. Two main reasons were suggested; firstly there has been quality improvement in synthetics (that is technology has not remained constant), and secondly the change of relative prices has been markedly in favour of synthetics, and that this factor becomes more important close to the ceiling.

2.6 The Reference Cycle Approach

Fluctuations in the business activity in the textile industry can be considered in terms of cycles in a number of economic variables; namely, output, prices, stocks and orders. The reference cycle approach attempts to establish the interdependence of these variables by first documenting how these cycles are related, and then explaining why the variables are related.

Zarnowitz (52) has observed that some relationship between output, prices, stocks and orders exists since changes in demand for a commodity can be met by:

- (i) increases or decreases in output and/or price,
- (ii) depletion or replenishment of stocks, and/or
- (iii) accumulating or running down orders.

Phillips (35) has attempted to relate fluctuations in Japanese wool textile activity to wool price movements at Australian auctions.

"The questions that have been put to the data are several. Are fluctuations initiated by changes in general economic activity, consumer incomes, or retail sales of clothing or are they caused by changing expectations and stockholding at intermediate stages of the production process? Or, is there a combination of both factors operating? If so, what is the time sequence of transmission of fluctuations. Do these factors result in magnification of activity amplitude, if so from where does the stimulus originate and is it intensified or damped at any stage?"¹⁴

Phillips argues that stocks (of raw materials, goods in process and finished goods) are not merely held for speculative purposes, but rather serve a wide range of functions. The reasons for holding stocks under perfect

14. Phillips (35), p. 89.

knowledge situations were given as; economies of purchasing and leads in the ordering of raw materials, and to overcome seasonal variations in the demand for finished goods. In conditions of uncertainty additional reasons were; stocks of purchased raw materials may be needed as a hedge against price changes and against shortages or delays in supplies, and stocks of finished goods may be needed to smooth the production flow and to overcome unforeseen fluctuations in demand. The reasons listed for restricting stockholding were; cost of storage, physical deterioration and the risk of economic deterioration, and because stockholding tied up capital which could be used elsewhere.

To explain either the initiation or the continuance of cyclical activity in the Japanese wool textile industry three mechanisms were postulated.

The first mechanism hypothesised a constant stock to sales ratio. This implied the simplest form of the accelerator model, a technological or mechanical model of business behaviour where the net investment is a function of the rate of change in output.¹⁵ It also implies the relatively instantaneous transmission of demand from the retailer back along the marketing chain, and, further, an increase in the amplitude of fluctuations in demand from retail to auction.

The second mechanism which was postulated was a long term and a short term speculative model. In the long term model, cycles were initiated and curtailed by expectations resulting from movements in general economic activity. The cumulative increases or decreases in demand which moved along the marketing chain were produced by speculation. Whereas the accelerator mechanism is essentially based on past changes in consumer demand, the long term speculative model is based on expectations of future consumer demand.

The short term speculative model suggests that short term cycles were irrational, and were caused by waves of over optimism and over pessimism of expectations in responding to changes in consumer demand. Phillips argued that

15. A retardation in rate of increase in output will cause an absolute fall in net investment, thus cycles in net investment should lead cycles in output.

the expectations of speculators could become divorced from consumer demand.

The third mechanism which was postulated involved a combination of the first and second models discussed above.

The data that Phillips presents does display cyclical tendencies.¹⁶ In Figure 2.4, raw wool consumption, yarn production and fabric production have been graphed for the period 1951 to 1963. It can be seen that these activities move up and down at more or less the same time, rather than being lagged by time required for the physical flow of goods. This is a basic finding of the reference cycle approach; it is stocks and orders, rather than the actual flow of goods through sequential physical operations, which express the transmission of demand.

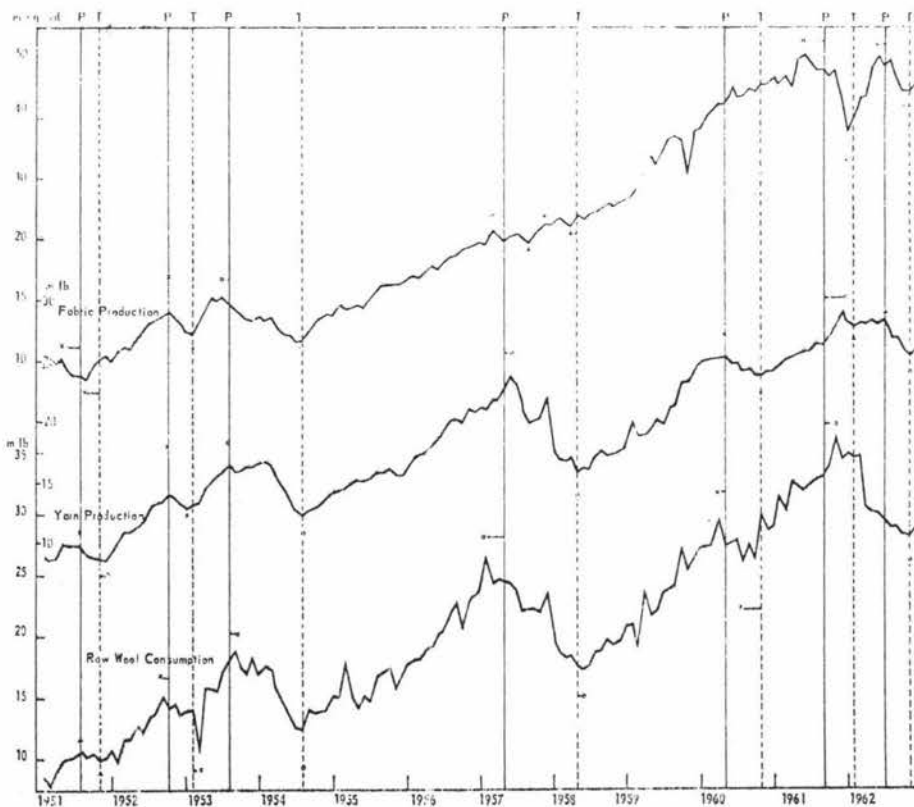


FIGURE 2.4 CYCLICAL ACTIVITY IN THE TOPMAKING, SPINNING AND WEAVING SECTIONS

Source: Phillips (35), pp. 117.

16. Techniques have been developed, to a large extent by the National Bureau of Economic Research, to provide a reference frame for defining cyclical movements.

Monthly deseasonalised data of stocks of yarn, tops and raw wool were also charted. The stocks of purchased materials increased during periods of cyclical expansion in production, and decreased during periods of cyclical contraction. Spinners' stocks of finished goods moved inversely to the reference frame indicating the inverse relationship between final (buffer) stocks and sales, while weavers' fabrics showed no conformity. Here the study of the movement of orders would probably explain more, since weavers tend to work to order rather than to stock. Stocks of tops, which are a hybrid of raw materials, goods in process and finished goods, also showed no relation to the cyclical trend.

The movement in the yarn price series shared all the movements of the output series. The raw wool price series also showed a considerable conformity to the trends in production. Both the yarn and the raw wool price series showed a fairly consistent lead over the output series.

Phillips' conclusion was that the three mechanisms were unsuccessful in explaining the initiation of the cyclical activity from consumers' purchases of wool textiles, and their transmission back along the marketing chain "due perhaps to the inadequacies of data or, more fundamentally, to the method of inquiry."¹⁷

The part played by inventories in transmitting and increasing the amplitude of movements in demand was apparent, however, in that stocks of purchased materials varied positively with the output series.

Further, the price series conformed to variations in demand as measured by inventory investment.

Perhaps the most important aspect of the study was the charting of monthly data, and indicating the relationships between the output, price and stock series and the relationships within each series between the various stages of production. Although considerable attention was paid to the importance of

17. Phillips (35), p: 143.

stocks, the models postulated for the initiation and transmission of cyclical behaviour were simple and were expressed in descriptive terms. The ability of the models in explaining the cyclical behaviour was only tested by a visual analysis of the charts.

2.7 Summary

In this chapter, literature on five different topics has been reviewed. The topics covered were: a description of the manufacturing processes; the extent of wool price fluctuations; estimates of the price elasticity of demand; the availability of substitutes for wool; and an application of the reference cycle approach to the wool marketing system.

A description of the complexity of the manufacturing processes involved in converting greasy wool into the final product indicates the difficulties involved in transferring information from the final consumer back to the growers. It also indicates that the marketing of wool is by no means completed once the wool has been sold by auction.

In documenting price fluctuations, three different types of fluctuations were distinguished; namely, fluctuations in price between wool types, fluctuations in the average price of all wool over time, and a comparison of fluctuations in the average price of raw wool with related futures, tops and yarn prices. Of particular importance in constructing a model of the operation of wool auctions is the observation that the prices of eight major wool types tend to move together. This provides some justification for considering the average price of all wool, thus avoiding the tedious process of considering the prices of a number of individual wool types.

Three studies which have estimated the price elasticity of demand have been reviewed. The estimated values of price elasticity ranged from -1 to -10. A number of short-comings were noted in the studies, and these indicate the difficulties involved in estimating the price elasticity of demand at auction. All three analyses assumed a constant elasticity of demand, but it is unlikely

that this assumption is correct.

Two approaches to considering the impact of the availability of synthetic substitutes for wool have been distinguished. The first approach involved a discussion of the physical and commercial merits of wool vis à vis synthetics. It is possible that although wool may be a more satisfactory raw material for manufacturers because of its physical properties, synthetics may be preferred because of substantial commercial advantages. The second approach makes use of logistic growth curves to summarise the speed and likely extent of market penetration by synthetic fibres.

The reference cycle approach attempts to summarise how, and explain why, cycles in output, prices, stocks and orders are related. The study by Phillips indicated that some cyclical activity was present, but because of data inadequacies and the methodological approach used it was not possible to distinguish clearly the relationships between the variables.

CHAPTER 3THE AUCTION SUB-SYSTEM AND ALTERNATIVE MARKETING POLICIES3.1 Introduction

This chapter describes some features of the operation of the auction sub-system in detail, and indicates the considerations which are of interest in an assessment of alternative price containment schemes. This chapter therefore "sets the stage" for the development of the wool marketing simulation model in Chapter 5.

Initially a brief description of the growers' supply of wool is provided. The chapter then proceeds to a description of the actual process of sale by auction, covering topics such as the preparation and display of wool, the classification of wool, and the activities of the New Zealand Wool Commission.

In the next section, the demand for wool at auction is discussed, by examining, firstly, some of the characteristics of demand for wool, and then the problems involved in formulating a realistic demand function for wool. The formulation of a demand function is a necessary prerequisite for the analysis of alternative Wool Commission floor and ceiling price policies, since we have to argue what would have happened with alternative floor/ceiling price policies. Finally the section contains a discussion of the possible effects of the Wool Commission's policy on demand.

Attention is then turned to a consideration of wool marketing policies, particularly floor/ceiling price policies, which can be superimposed on the wool auction and the objective of these policies. The section also includes a brief summary of the history of wool price stabilisation in New Zealand.

The next section is concerned with the problem of comparing the "success" of alternative Wool Commission floor and ceiling price policies. A number of summary measures which are likely to be of interest in describing the outcome of a Wool Commission policy are defined.

A limited number of simulations, testing the effect of alternative floor and ceiling price policies, have been carried out in the Australian context, and the chapter proceeds with a review of these studies.

The chapter concludes with a summary of the important ideas contained in the chapter which have relevance for the construction of a model of the auction sub-system.

3.2 Growers' Supply of Wool

3.2.1 Production of Wool

Wool is supplied by growers on a seasonal basis meaning that, without supply control, through each season the quantity of wool being sold varies, and considerable changes in the composition of the clip occurs. The variation in quantity sold through each season is illustrated in the partial listing of the data used in this study given in Appendix C. This data consists of weekly readings of average price and quantity of wool sold for the 1965/66 season. It can be seen that in a number of weeks during winter no wool is sold.¹ The composition of the clip varies through each season since different categories of wool are shorn through each season, and wool is usually sold at auction soon after it is shorn. This latter aspect is developed more fully in section 3.3.4.

The supply of wool is price inelastic both within a season, and between a limited number of seasons; that is, given a certain percentage change in the price of wool, the percentage change in the quantity supplied is very small. Supply is price inelastic in the short term because the amount of wool produced is largely a function of sheep numbers, and the amount of wool held by growers from one season to the next is a small and relatively constant amount. Over the longer term supply also tends to be price inelastic due to the presence of joint products of meat and wool.

Over a series of seasons there is a trend towards increased production.

1. This is in spite of the Wool Board-Wool Commission's attempt to extend auction sales over more of the season.

Changes in the supply of wool away from this trend owing to a change in price would take three or four seasons to eventuate.

3.2.2 Disposal of Wool

In New Zealand there is no control over the way in which a grower disposes of his clip;² he may sell privately, or sell by auction in London or New Zealand. The majority of New Zealand wool is sold by the last method. Reasons for only a limited amount of wool being sold by auction in London include the delay in the receipt of payment, suspicion that the average price tends to be lower in London, and the general convenience of local sales.

The figure that Fraser (19) gives for the extent of private sales and sales by auction overseas, principally London, is 11% of the New Zealand clip.

The actual process of the growers' supply of wool to New Zealand auctions begins with the sorting of wool into more or less homogeneous bins from which it is pressed into 320 to 350 lb. bales in the shearing shed. The bales are marked with the grower's brand, a description of the wool, and are numbered consecutively. Growers arrange for the transport of their wool from the shearing shed to the wool broker's store. In addition, growers may provide information to the broker on the required preparation of the wool, and whether a reserve is to be put on his wool when it is offered at auction. A reserve price is the minimum price which is acceptable to the grower, and if this price is not reached the wool will be retained by the grower.

3.3 A Description of Sale by Auction

This section provides information on: the classification of wool, the preparation and display of wool, the distribution of lot sizes sold at auction, the seasonal distribution of wool types sold at auction, the auction sale procedure, the activities of buyers, and the activities of the Wool Commission.

2. Other than the requirement that all foreign exchange earned must be repatriated through the banking system.

3.3.1 Classification of Wool

Although treated in most empirical work as a homogeneous commodity, wool is in fact extremely heterogeneous. At present the New Zealand Wool Commission has classified well over a thousand wool types, based on quality number, style, type and length of wool. A number of these criteria which are used for classifying wool are discussed by Fraser (19).

Quality number indicates how fine a thread can be spun from the wool; historically it referred to the number of (560 yard) hanks per pound of yarn. Fibre fineness is the most important determinant of quality number although crimp, handle and lustre are significant.

Style refers to such factors as unsoundness in the fleece (such as breaks and tenderness), coting, vegetable and mineral contamination, tippyness or hairyness, and stains.

Type depends on the breed of sheep, position of the wool on the sheep, and the time of shearing.

Length is self explanatory - it affects the tensile strength of the yarn which can be spun from the wool and hence dictates to a certain extent the process and garment in which the wool will be used.

Another factor in the appraisal of wool is yield. This refers to the percentage of clean wool in a sample of greasy wool. The remaining percentage is comprised of wool grease, swint from the sweat glands, and vegetable and mineral contaminants.

Greasy wool prices depend to a varying extent on all of these factors. At present the determination of the physical characteristics and hence the value of wool can be considered to be subjective, rather than objective, as the above characteristics of wool are determined by visual and tactile tests.

3.3.2 Preparation and Display of Wool

The handling and display of wool prior to sale by auction is carried out by wool brokers on behalf of growers. The preparation of wool for sale may be

partly or completely done by the grower, or left to the broker.

Preparation of wool by the broker, when instructed by the grower, can involve reclassing, binning and interlotting. Reclassing refers to one grower's wool being classified by the broker according to Wool Commission types. Binning involves the pooling of fleeces owned by a number of growers into one even line of bales of the same type. In recent seasons approximately 60% of wool offered at auction in New Zealand was binned or reclassified by brokers.

A lot is the unit amount of wool being sold by the auctioneer at one time at auction, and is comprised of a number of bales of the same wool type. Interlotting involves combining a number of small lots of the same wool type into one larger lot. Approximately 6% of New Zealand wool is handled in this manner.

At present in New Zealand the degree of preparation of wool prior to sale is left to the grower and/or the broker to decide, and standards of preparation are not enforceable.

Wool is displayed to prospective buyers in well lit sheds to which buyers have access, and a limited number of bales are opened for inspection. The wool buyer notes his assessment of the wool in which he is interested in a catalogue provided by the broker.

Regulations regarding the display of wool are jointly agreed to by wool brokers and wool buyers, and cover points such as the stacking of the bales and the proportion of bales to be opened. The wool broker makes no undertaking as to the quality of the wool being displayed, except that the bales which are opened for inspection are representative of each lot.

3.3.3 Distribution of Lot Sizes Sold at Auction

An analysis of the distribution of sizes of lots sold at New Zealand auctions has been carried out by Pierser and Beggs (36) in order to examine the effect of lot size on price. Their findings are recorded in Table 3.1 for the 1964/65 season. Pierser and Beggs reviewed their findings on the distribution

TABLE 3.1 : DISTRIBUTION OF SIZES OF LOTS SOLD AT AUCTION

Lot Size (bales)	No. of Lots	%	No. of Bales	%
1 - 6	64,360	48.8	287,747	21.8
7 - 10	31,618	23.9	260,368	19.9
11 - 15	16,166	12.3	204,714	15.8
16 - 20	7,313	5.5	129,705	9.8
21 - 25	4,949	3.8	14,805	8.7
26 and over	7,610	5.8	315,036	24.0
Total	132,016	100	1,312,375	100

Source: Pierse and Beggs (36), p. 1

of lot sizes by noting that almost half the time at an auction sale is devoted to selling one fifth of the clip (the 1 - 6 bale lot category) while, at the other extreme, one sixteenth of the time is spent selling one quarter of the clip. Further, they showed that small lots and some very large lots were sold at auction at a perceptible discount.

3.3.4 Seasonal Distribution of Wool Types Sold at Auction

Once the sheep have been shorn the wool is usually immediately sent to brokers. One reason for growers doing this is the fear that there is a downward trend in prices over the season. Because different wool types are shorn at different times of the season, the composition of wool types being sold at auction varies through the season.

During the winter months crutchings, oddments and some second shear are sold, although, as mentioned earlier, there are a number of weeks in which no wool is sold. In September, October and November hogget wool is sold. From November to March the main fleece comes onto the market. During February, March and April the bulk of lamb's wool is sold.

In evaluating fluctuations in the average price for all wool types over time, care needs to be taken that the movements in price due to the changing composition of wool being sold are taken into account.

3.3.5 Auction Sale Procedure

In New Zealand there are eight selling centres at which wool is sold, four in the North Island and four in the South Island. A roster of auction sales, detailing the date of the sale and the selling centre, is drawn up at the beginning of each season.

Sale by auction is a simple method of passing wool from the grower to the buyer. Each lot is sold to the highest bidder. The grower can, if he desires, place a reserve price on his wool, below which the wool cannot be sold, however the use of this practice is very limited. In order to enforce the floor price, the Wool Commission purchases wool which otherwise would have sold below the floor.³ The stocks of wool are subsequently resold through auction.

3.3.6 Activities of Buyers

Wool is displayed prior to the auction sale to allow the buyer to examine the lots which interest him and to enable him to note his own estimate of the wool type and yield of each lot. In the situation where the buyer is acting on behalf of a client the estimate of yield is used to calculate the greasy price limit from the clean price limit specified by the client. The greasy price limit then becomes the maximum price the buyer is prepared to pay, and this forms the basis of his bidding at auction. A more detailed discussion of the purchasing arrangements between buyer and client is given in the following section.

Where the buyer's assessment of the classification of the wool is considered incorrect by the client, the client is able to claim compensation.

After the sale, bales which were opened for the purposes of display are sewn up and countermarks requested by buyers are put on the bales. Space in ships is booked to ensure prompt shipment of wool overseas. Buyers pay for

3. The current form of supporting growers' income, the deficiency payment scheme, is outlined in section 3.5.2.

their purchases on "prompt date", that is eighteen days after the sale.

3.3.7 Activities of Wool Commission

The first duty of the Wool Commission, in conjunction with other interested bodies, is to set the average floor price at the beginning of each season, and a bareme of floor prices for each wool type. Factors which are taken into account in making these decisions are discussed in a later section.

The "day to day" activities of the Wool Commission in maintaining the floor price first involve an appraisal of all wool which is to be sold at auction, both in New Zealand and in London. The Wool Commission's valuers place a floor price on every lot which is to be sold at auction. At auction, if the bidding for a given lot does not rise above the floor price, the Wool Commission's buyers bid the floor price. If the commercial buyer wishes to purchase that lot, he must bid higher. Once wool has been passed to the Wool Commission, growers (or dealers who have bought wool direct from growers) may:

- (i) through their brokers, negotiate a higher price with buyers,
- (ii) accept the Wool Commission's floor price, or
- (iii) withdraw their wool, and subsequently re-offer it at auction
(and again receive protection).

The second possibility is the one most commonly used.

3.4 Demand for Wool at Auction

This section provides a brief analysis of the demand for wool at auction. Initially a study which summarises reasons for short term fluctuations in price at auction is reviewed. This is followed by a discussion of the purchasing arrangements that buyers adopt in supplying wool to manufacturers. Some comments are then made on the existance of both speculative and trading components in the demand at auction. The section continues with a discussion of the assumptions which need to be made in order to specify a function for the demand for wool. Finally, there is an analysis of some of the possible effects of floor

and ceiling price policies on the demand for wool.

3.4.1 A Model of Buyer Behavior at Auction

In section 2.3 studies which documented the extent of wool price fluctuations at auction were reviewed. One type of price fluctuations considered was variations in the price of one wool type on one day. Whan and Richardson (46) have constructed a model which attempts to account for the price variability of one wool type during one sale. They list three factors which would lead to variations in the price paid for identical lots during one sale. The first factor is that there are variations in the demand for wool caused by buyers withdrawing from, or entering the market, according to some buying strategy. An example is where buyers withdraw from bidding when they have filled the orders for wool they have received from manufacturers and other clients. The second factor leading to price variability is that price limits for one wool type differ between buyers. The price limit is the maximum price that each buyer is prepared to pay, and is determined by factors such as the "efficiency" of the buyer and the requirements of the manufacturer he is acting on behalf of. With effective market intelligence it is unlikely that price limits will vary over a wide range.

Thirdly, variations in price result from errors in the estimation of the value of wool which occur since the technical characteristics of wool are estimated on a subjective basis.

The auction serves the double purpose of transferring ownership of wool and determining the price at which it will be transferred. In the absence of perfect information (which would make the auction unnecessary) there are bound to be different opinions about the value of wool, and these differences result in price variations for successive lots of identical wool as buyers feel their way towards an "equilibrium" price level.

3.4.2 Purchasing Arrangements

Since an overseas manufacturer cannot obtain wool directly from New Zealand auctions, he must employ someone to buy wool on his behalf. Wool buyers therefore purchase wool at auction either to fill orders which have already been placed by manufacturers, or to hold in stock until sale can be negotiated at a later date.

The Report of the Wool Marketing Committee of Enquiry (48) (the Philp Report) listed four major methods by which buyers fill orders. These are:

(i) Commission Buying. Commission buying refers to wool purchased against orders for an agreed rate of commission. An order from a manufacturer specifies that a particular quantity of a particular wool type, at or below a given price is to be purchased. The commission buyer usually fills orders by entering the auction market, rather than from stocks, or from other buyers. The commission received is in the region of 2 to 3% of the cost of the wool.

(ii) Merchanting. The merchant, at the time he purchases wool, either within or outside auction, has no specific orders to fill and stocks of wool are held for sale at a later date. Wool is purchased for a variety of reasons; the current price at auction may be expected to rise, the price of poorly prepared wool may be raised by reclassing, or because sales at a later date are anticipated.

(iii) Firm Offer. The wool buyer and client agree on the price of a given quantity of a particular wool type to be delivered immediately, that is, within one month. The buyer fills the contract by either entering the auction market, or from his stocks.

(iv) Forward Sales. The wool buyer contracts to sell a particular quantity of a particular type of wool at a fixed price (usually below market price) for a delivery date which is more than one month in the future. The wool buyer may fill the order by entering the market some time before the delivery date, or from his stocks.

The forward sales' price is likely to be at or below the current auction price. If the agreed forward price was below the market,⁴ the manufacturer profits. If the agreed forward price was above the market at some point in time then the wool buyer may make a profit.⁵ The forward price is tied to the price of wool futures, and the cost of wool storage, insurance and interest on capital involved.

In the above discussion four methods of buying and selling wool have been listed, not four distinct categories of buyers. A buyer may employ a number of the buying methods.

3.4.3 The Speculative Component of Demand at Auction

An element of speculation exists at auction partly because of purchasing policies adopted by wool buyers, and also because of manufacturers' inventory policies and ordering strategies. Buyers, when adopting a merchanting role, may speculate at auction for two distinct reasons. The first reason is that they buy wool in anticipation of receiving orders. Most buyers who have operated in the auction market for some length of time have built up a clientele of manufacturers. From the historical pattern of the placement of orders by these manufacturers, the buyers can expect a similar pattern in the current season, and may enter the market early to fill these orders.

Secondly, buyers may engage in pure speculation, where orders have not been placed with buyers and are not anticipated, but purchases (or sales) are made because wool prices are expected to rise (or to fall). Buyers who engage in forward selling can also be considered a speculative element since they buy at an appropriate time before the forward contract is due.

A buyer may operate in both the spot (or the forward) market and the futures market, either to reduce the uncertainty of adverse price movements,

4. Actually "below the price at which wool could have been bought and held until needed." Thus "below the market" refers to prices over the entire period of the forward contract, and not at the time of delivery.

5. If he has the knowledge to buy wool at the most opportune point of time.

or to speculate further. The buyer may hedge his profit (made by buying and selling wool at different points in time) by selling futures when he buys wool on the spot market and buying futures when he sells wool. The buyer hopes that through this operation any rise or fall in prices on the spot market is matched by corresponding movements in the price of futures. To the extent that the spot price rises above the futures price ("backwardation"), or the futures price rises above the spot price ("contango") arbitraging between the two markets may prove to be profitable. In this case the buyer is not trying to make a profit through absolute price movements on one market, but rather in relative price movements between markets.

Speculation at auction may also exist because of manufacturers' inventory policies and ordering strategies. Some element of speculation exists if only because a time lag occurs between purchase at auction and arrival at factory, or purchase at auction and the placement of orders for the manufacturer's product. The manufacturer may attempt to reduce the uncertainty of adverse price movements at auction through placing himself in a "nil ownership position" by entering the futures market, or by undertaking forward buying.

3.4.4 Formulation of a Demand Function for Wool

For the purpose of empirical research into the operations of the wool auction under alternative floor and ceiling price policies it is necessary to decide on the form of the demand function for wool, and the appropriate value (or range of values) for the price elasticity of demand. The form of the demand function and the value of price elasticity of demand are of crucial importance in evaluating the merits of alternative Wool Commission floor and ceiling price policies; that is, they largely determine the effect of Wool Commission purchases and sales on variables such as weekly average price, variance in price, Wool Commission profits, and grower profits.

In econometric analyses which estimate the price elasticity of demand for wool, the usual assumption made regarding the form of the demand function

is that it is linear or has a constant elasticity along its length. In the absence of such assumptions very serious estimation problems would be encountered.

Although there are no empirical grounds for assuming that price elasticity of demand for wool is constant for periods of high and low prices, or that demand is linear with respect to price there is equally little evidence to show how elasticity would vary through time. A study by the Bureau of Agricultural Economics (47) tested the hypothesis that demand is more elastic in periods of high prices than in periods of low prices. The difference in the estimates of price elasticity between high and low prices was not statistically significant.

Duloy and Parish (15) have summarised three theoretical arguments concerning the relationship between price elasticity and the level of price. Firstly, the demand for wool is derived from the demand for woollen products, and, according to Marshallian derived demand theory, the derived demand for a factor of production used in fixed proportions with other factors will be more elastic the greater the fraction of total cost that goes to the factor in question. It follows that in periods of high prices, demand tends to be more elastic.

The second argument had been put forward by Grubel (20). During periods of high demand for a manufacturing firm's products the price of the factor input rises, but firms are usually reluctant to substitute other factors because factor substitution is typically accompanied by technical uncertainties and temporary reductions in output. Therefore, during a boom, demand is likely to be more inelastic.

The third argument was attributed to Powell and Campbell (42), and suggests that the elasticity for Australian wool would become more inelastic when the (hypothetical) Australian marketing authority sells wool at auction during periods of high price. This is because, for a given elasticity of demand in the world market, the demand facing a single country will be less elastic the

greater than country's share of the world market.

Estimates of the price elasticity of demand obtained from the econometric studies reviewed in the preceding chapter vary considerably. The value of price elasticity ranged from -1 to -10; that is, with a 1% change in price the quantity demanded changed, in the opposite direction, by 1 to 10%.

In the present thesis, both linear and constant elasticity demand schedules have been employed, and a range of values for price elasticity from -0.25 to -8.0 have been tested.

3.4.5 Effect of Wool Commission's Policies on Demand

When the Wool Commission is operating in the auction market, enforcing floor and ceiling price policies, changes are likely to occur in the demand for wool by the trade in each sale. Three reasons for changes in the quantity of wool demanded can be distinguished. Firstly, changes in the quantity demanded will result from changes in price, and the extent of these changes in demand can be calculated from the wool trade's demand function. These changes in the quantity demanded involve shifts along the wool trade's demand curve, and are independent of any reaction to the intervention in the wool auctions by the Wool Commission. In this case, overall demand is unchanged.

Secondly, changes in demand will result if, in the long term, the wool trade's demand curve shifts. A shift to the right, indicating an expansion in demand, may occur as a result of wool becoming a more acceptable raw material for manufacturers because of the price stabilisation achieved by the Wool Commission. The demand curve may shift to the left, indicating a contraction in demand, because of the wool trade's attitude to the "interference" by the Wool Commission.

The third reason for expecting some changes in demand is the immediate response by the wool trade to changed conditions at auction. In particular, speculative purchases and sales of raw wool may be made, which would not have been made in the absence of Wool Commission activity. Some of the factors

which might lead to these inter-temporal shifts in demand are now examined.

As the price at auction moves towards the floor (and as long as the floor is below a generally accepted long term equilibrium price the trade believes the floor will be held) then demand is likely to expand since the trade can expect that price will fall no further. This is evident from the number of times the Wool Commission has bidden on lots at auction, and the smaller number of lots the Wool Commission has actually bought. Gruen (21) provides figures for the South African Wool Commission's operations. The floor price may terminate a cumulative speculative price decline where the price of wool is below its real market value, but buyers do not enter the market as they expect further price declines. Speculators may also buy at the floor since they can be assured of making a profit when prices rise. Note, however, that if the "floor" is set above a price that the trade would accept as a long term equilibrium price, then there may be no speculative support for the floor, because the trade expects the floor to collapse before prices rise from it.

Increased demand at the floor is more likely to occur where only a small number of purchases are made by the Wool Commission than in the case where the Wool Commission is required to purchase a substantial proportion of the clip. In the latter case, the purpose of the floor, as seen by the buyer, is likely to change from being a stabilising influence, to holding wool prices above their true market value. If the Wool Commission is running out of funds, or if the season is drawing to a close then the credibility of the floor may be affected and in this case buyers may withdraw from the market and adopt a "wait and see" attitude. This withdrawal of speculative support would cause the authority to buy a greater proportion of the clip, and would increase the likelihood of the floor being lowered.

Similar arguments can be put forward as to why the demand for wool may be reduced at the ceiling price.

Another response by the wool trade to changed conditions at New Zealand

auctions may occur where the prices at New Zealand auctions become out of line with prices overseas. If wool is cheaper at New Zealand auctions than overseas then demand at New Zealand auctions is likely to increase. Conversely if wool is cheaper overseas, then demand at New Zealand auctions is likely to decrease. The level of Wool Commission stocks may also affect demand at New Zealand auctions.

The changes in demand due to changed conditions existing at auction is termed the "net speculative effect" of the Wool Commission activities. This net speculative demand refers to speculative purchases (and sales) net of the speculative purchases (and sales) which would have been made in the absence of Wool Commission activity. Over a period of years it would be expected that the sum of net speculative purchases and sales would tend to zero (since sales cannot exceed purchases by more than a small margin, and accumulation of large stocks would almost certainly be unprofitable). It would also be expected that the long run effect of speculation would be profitable to speculators (otherwise they would be unlikely to persist in their speculative role).

3.5 Alternative Wool Marketing Policies Within the Auction Sub-System

This section describes alternative wool marketing policies that can be superimposed on the wool auction, but retain the auction as the basic method for wool disposal.

Initially a brief résumé of the history of wool price stabilisation policies in New Zealand is given. The section proceeds by discussing wool price support and stabilisation policies. The first two policies to be considered are the deficiency payment scheme and the stabilised payout scheme. These two schemes adjust the receipts accruing to growers from the sale of wool, but do not alter the payments made by wool users. Both these policies basically operate outside the auction. Attention is then turned to floor and ceiling price policies. Floor and ceiling price policies do involve "interference" in the auction, to the extent that they alter the amount of wool sold on a

particular day.

3.5.1 The History of Wool Price Stabilisation in New Zealand

Between the early 1950's and the beginning of the 1967/68 season a floor price scheme was in operation in New Zealand. In this scheme, the Wool Commission bought any wool which otherwise would have sold below the floor price. The floor price scheme did not include an explicit ceiling price, and Wool Commission stocks were subsequently sold when (according to subjective judgement) the wool market had recovered sufficiently. The floor price was rigid within a season, but could vary between seasons. Although the floor price is spoken of in terms of an average price, in fact a bareme of floor prices for all wool types existed. Both the average floor price and the structure of the bareme could be changed between seasons.

The floor price scheme included greasy, scoured and slipe wool sold on grower's or owner's account at New Zealand auctions. New Zealand wool which was sold at London auctions was also covered by the scheme. The London floor price was the equivalent of the New Zealand floor price after allowing for shipping charges to London.

The initial funds of the Wool Commission (\$m 40 in 1952) consisted mainly of profits from the Joint Organisation, a post-war wool disposal organisation, and have been augmented since by interest payments from the investment of the funds, and from operations of the Wool Commission, until they reached \$70 million at the beginning of the 1966/67 season.

Over much of the period for which the floor price scheme was in operation a sufficiently conservative floor price was set, and very little wool was bought in by the Wool Commission. An exception occurred in the 1957/58 season when 45,000 bales were purchased by the Wool Commission. In the 1966/67 season, however, the floor price was raised by 1 pence (0.83c.) to 36 pence (30c.)/lb. (greasy) and in the same season a considerable drop in the demand for wool occurred. The Wool Commission was required to buy in 650,000 bales,

approximately one third of the season's clip. In the following season, although the floor price was reduced by 6 pence (5c.), purchases by the Wool Commission continued and a further 50,000 bales were bought. This led to the abandonment of the floor price scheme and the substitution of a deficiency payment scheme. The deficiency payment scheme is described in section 3.5.2 below.

In the 1968/69 season the Wool Commission resold wool from their stockpile of 700,000 bales, and by the end of 1968 about 100,000 bales were sold.

3.5.2 Deficiency Payment Scheme

In the previous section it was noted that a deficiency payout scheme was introduced by the New Zealand Wool Commission in 1967/68 season. The basic feature of this scheme is that the floor price facing growers is higher than that facing wool trade, the difference being made up by direct payment by the Wool Commission.

If the ruling auction price is above the growers' floor price then wool prices are neither stabilised nor supported for either the wool trade or growers. If the ruling auction price is between the growers' floor price and the buyers' floor price then the price paid to growers is supported, at the level of the growers' floor price, by making supplementary payments. The ruling auction price cannot fall below the trade's floor price as the Wool Commission purchases sufficient wool to hold this floor price. In the 1968/69 season the floor price facing the wool trade was 16.25c. per lb. (greasy), while the floor price on which supplementary payments to growers were based was 22.25c. per lb. greasy.

A complete deficiency payment scheme would not impose a floor price for the wool trade.

3.5.3 Stabilised Payout Scheme

The next wool price stabilisation scheme to be considered is the stabilised payout scheme. This scheme aims to reduce the fluctuations in wool prices

paid to growers through the use of a stabilisation fund, but makes no explicit attempt to reduce the variation in prices paid by wool users. Therefore, the stabilised payout scheme, together with the deficiency payment scheme (except when prices are very low), really operates outside the auction room.

In their final report, the New Zealand Wool Marketing Study Group (49, pp. iii) recommended, inter alia, "an appraisal and purchase system in which all wool would be bought by an authority and would be sold by the authority through existing channels." The prices paid to growers for a given wool type would be stabilised completely within each season and partially between seasons. Although the Group recognised that the effect of price fluctuations to wool users was detrimental, they reasoned that attempts to stabilise prices to growers and users would require substantially more resources than stabilising prices to growers alone.

The purpose of the stabilised payout scheme is to enable growers to carry out farm management programmes, in particular development plans, in a rational manner.

Factors which would need to be taken into account in varying the payout price between seasons include the size of the stabilisation fund, the conflict between degree of wool price stability (to growers) achieved and variations in the level of the stabilisation fund, and limitations on the maximum change in the average payout price between seasons.

3.5.4 Floor and Ceiling Price Policies

The essential features of floor and ceiling price policies is that they set a (floor) price at which the Wool Commission will buy wool (as long as it has funds), and a (ceiling) price at which the Commission will sell wool (as long as it has stocks of wool). In this section the objectives of floor and ceiling price policies are discussed, and a number of alternative (floor and ceiling price) policies are identified.

3.5.4.1 Objective of Floor/Ceiling Price Policies

The basic objective of floor and ceiling price schemes is to reduce the amplitude of wool price fluctuations, occurring at auction, by the direct intervention of the Wool Commission in the wool auction. The Wool Commission buys wool when the price is low, thus raising price, and sells wool when the price is high, thus lowering price. Wool price stabilisation (or reduction in the variance of auction prices) is therefore achieved by altering the amount of wool sold at auction on a particular day.

The objective of a floor/ceiling price policy must also include the profitability of price stabilisation. Profits (or loss) from the operation of a floor and ceiling price policy accrue both to the Wool Commission and to growers. The profit (or loss) to the Wool Commission in administering floor and ceiling price policies is the difference between the floor and the ceiling price multiplied by the quantity of wool bought in, minus the costs of operating the scheme (such as storage, handling, insurance). Interest receipts from the investment of Wool Commission funds not currently being used to maintain the floor price (i.e. excluding capital tied up in stocks) can also be considered in an evaluation of Wool Commission profit. If interest receipts are included, then the order (or time pattern) of periods of high or low prices and hence the pattern of purchases and sales of wool will affect the level of Wool Commission profits.

Two possible definitions of Wool Commission profit (or loss) are of interest. The first definition is that a policy is profitable when the Wool Commission shows a positive return ($> 0\%$) on its capital. The second definition is that the policy is profitable if the Wool Commission earns more than the ruling rate of interest; that is, there is an opportunity cost involved in tying capital up in stocks of wool.

The profits (or losses) accruing to growers from the operation of a Wool Commission policy have been termed by economists as hidden gains and

losses, and are quite distinct from the profits accruing to the Wool Commission. When the Wool Commission buys wool at the floor, all wool being sold benefits. Conversely, when the Wool Commission sells wool at the ceiling the price of all wool is depressed. The profit to growers is the revenue gained at the floor by the price for all wool being raised, minus the revenue lost at the ceiling by the price for all wool being lowered.

In assessing growers' profit interest receipts on revenue gained, and interest payments on revenue lost can be included or ignored. If it is included then the order, or time pattern of periods of high and low prices becomes important. The inclusion of interest and the compounding of hidden gains and losses yields an estimate of the effect of alternative floor/ceiling over the particular sequence of high and low prices which occurred in the period studied. Omission of interest charges corresponds to the assumption that the order of high and low demand periods is essentially random.

A more analytical treatment of the conditions under which Wool Commission profits, and hidden gains and losses to growers are generated by price stabilisation is now presented. Wool Commission profits and growers' hidden gains and losses will first be considered together, and then separately.

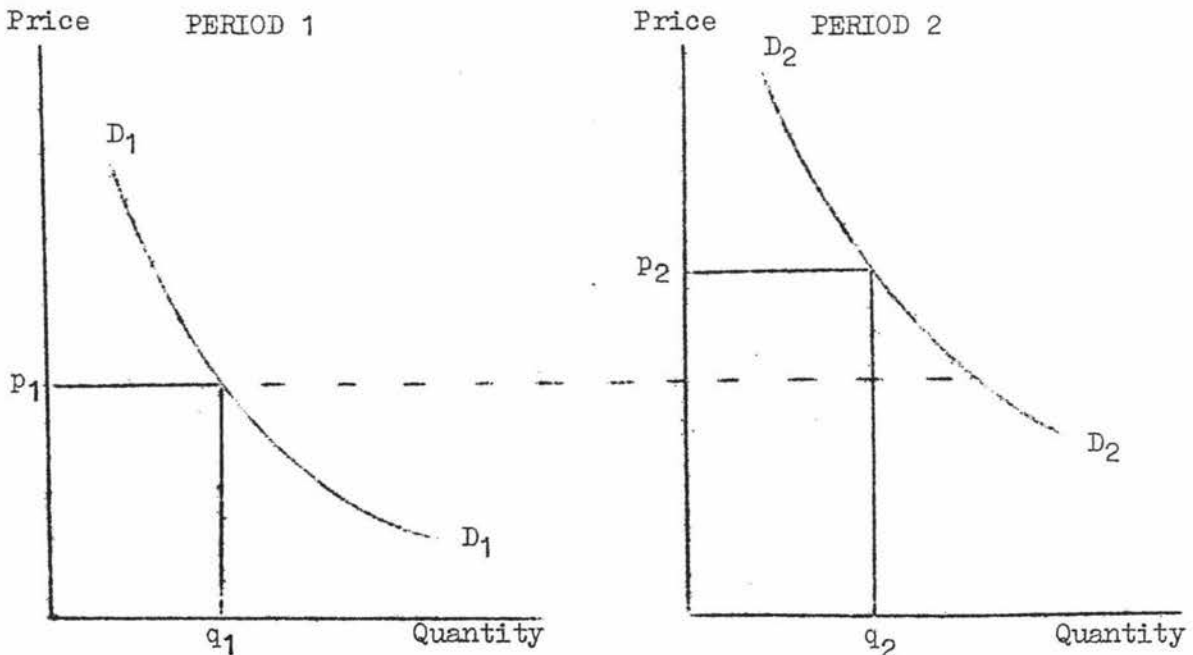


FIGURE 3.1 CONDITIONS FOR PROFITABILITY OF PRICE STABILISATION

Referring to Figure 3.1 the price elasticity of demand is defined as:

$$e_i = \frac{dq_i}{q_i} / \frac{dp_i}{p_i} = \frac{p_i}{q_i} \frac{dq_i}{dp_i} ; i = 1, 2$$

where

e_i is the price elasticity of demand in period i ,

dq_i is the quantity bought in period 1 or sold in period 2 by the price stabilising authority (in this case the Wool Commission),

dp_i is the effect of dq_i on price,

p_i is the price at which the wool is bought and sold, and

q_i is the quantity of wool sold in each period.

The total revenue in each period, R_i , and the difference in total revenue between the two periods, r , can be defined as:

$$R_i = p_i q_i$$

$$r = R_2 - R_1$$

The differential effect on total commercial revenue due to the Wool Commission's purchase, and sale can be obtained by differentiating r with respect to q :

$$dr = - (q_1 \frac{dp_1}{dq_1} + p_1) dq + (q_2 \frac{dp_2}{dq_2} + p_2) dq$$

where

dr is the differential effect on total revenue due to a purchase of dq in period 1, and the sale of an equal quantity in period 2 (ignoring costs of the Wool Commission).

$$\begin{aligned} dr &= - p_1 \left(\frac{q_1}{p_1} \frac{dp_1}{dq_1} + 1 \right) dq + p_2 \left(\frac{q_2}{p_2} \frac{dp_2}{dq_2} + 1 \right) dq \\ &= - p_1 \left(1 + \frac{1}{e_1} \right) dq + p_2 \left(1 + \frac{1}{e_2} \right) dq \end{aligned} \quad (1)$$

In equation (1) the terms $p_1 \left(1 + \frac{1}{e_1} \right)$ and $p_2 \left(1 + \frac{1}{e_2} \right)$ are the marginal revenue curves for period 1 and period 2.

$$dr = (p_2 + p_2/e_2 - p_1 - p_1/e_1) dq$$

The conditions under which the Wool Commission and growers together make a profit ($dr > 0$) can now be determined from equation (2):

$$dr > 0, \text{ if } p_2(1 + 1/e_2) > p_1(1 + 1/e_1)$$

(i) $dr > 0, \text{ if } e_2 > -1 \quad \text{and} \quad p_2 < p_1 \frac{(e_2 + 1)}{(e_1 + 1)}$

(ii) $dr > 0, \text{ if } e_2 = -1 \quad \text{and} \quad e_1 > -1$

(iii) $dr > 0, \text{ if } e_2 < -1 \quad \text{and} \quad p_2 > p_1 \frac{(e_2 + 1)}{(e_1 + 1)}$

Notice that if $e_2 < -1$ (elastic) there may be an increase in revenue, even though $e_1 < e_2$, i.e. where demand is more elastic at the time of purchase than at the time of sale.

Rearranging (2):

$$dr = (p_2/e_2 - p_1/e_1) dq + (p_2 - p_1) dq \quad (3)$$

Including the negative signs of e_1 and e_2 , equation (3) becomes:

$$dr = (dp_1 q_1 - dp_2 q_2) + (p_2 - p_1) dq$$

The condition for growers alone to make a profit is that the rise in price times the quantity sold in period 1, $(dp_1 q_1)$, is greater than the fall in price times the quantity sold in period 2 $(dp_2 q_2)$.

The condition for the Wool Commission alone (i.e. without redistribution of grower profit) to make a profit is that the price in the sale period is higher than in the purchase period, $p_2 > p_1$, (ignoring the cost of Wool Commission activities).

The above considerations focus attention on the two primary aims of any floor and ceiling price policy. The first is to reduce wool price fluctuations so as to limit fluctuations in growers' incomes, and to make wool a more acceptable raw material for manufacturers. The second aim is that the Wool Commission should at least remain self supporting and the growers should not make a loss, and if possible the Wool Commission and growers should together make a profit.

Considerable difference of opinion can exist as to the relative importance of the potentially conflicting aims of price stabilisation, and maximisation of Wool Commission and grower profit. At one extreme the Wool Commission might be instructed to only stabilise prices to the extent consistent with profit maximisation, while at the other extreme they may be told to stabilise prices, even at the expense of making losses on the operation of the Wool Commission.

The "rational" objective would be an "efficient" combination of the reduction in the variance of auction prices, and the maximisation of the sum of Wool Commission profit and hidden gains/losses to growers. Here efficient means that it would be impossible to reduce variance in auction prices without also lowering the sum of Wool Commission profit and hidden gains/losses to growers. This objective might also be subject to the possibility of transferring gains from the Wool Commission to the growers, or vice versa.

3.5.4.2 Alternative Floor and Ceiling Price Policies

The operation of a floor and ceiling price policy requires that the Wool Commission:

- (i) sets an average floor price below which the price of wool is not allowed to fall - subject to the availability of funds to buy in wool.
- (ii) sets an average ceiling price above which the price of wool is not allowed to rise - subject to the availability of stocks of wool, and
- (iii) determines a bareme of floor prices and ceiling prices for each wool type.

Given that the Wool Commission holds the floor and the ceiling, if possible, the important question becomes whether the floor and the ceiling are to be rigid or flexible, within or between seasons. There are a variety of ways of setting the floor and ceiling prices and a number of these policies are now discussed.

The first approach to setting the floor and ceiling prices, and that

which has actually been employed by the Wool Commission, involves stating an explicit floor price and assuming an implicit ceiling price. An implicit ceiling price exists where the Wool Commission has no stated policy objective on the resale of stocks of wool it has accumulated other than "when the market can take it". The advantage of such a scheme is that the Wool Commission can sell stocks in small amounts at a time it considers appropriate, rather than incurring substantial storage costs by waiting until price has risen to a ceiling price. The disadvantage of the implicit ceiling is that the presence of Wool Commission stocks and the absence of a stated policy on their resale may undermine the confidence of the trade during a period of market recovery.

Attention is now turned to a number of explicit floor and ceiling price policies. The first policy involves holding floor and ceiling prices constant for the entire period under consideration. In practice, this policy is likely to be unsatisfactory since there is a possibility of large stocks being accumulated, and hence a conservative floor price will probably be set.

Flexible floor and ceiling policies may also be employed by the Wool Commission, enabling them to follow trends in demand. The floor and ceiling prices may vary on a seasonal, quarterly, monthly or weekly basis. In order to set the floor and ceiling prices it would be preferable to make use of information on expected future prices, but in the absence of such information use can be made of past trends in prices. Information on past trends in prices in relation to the floor price is summarised by changes in the level of Wool Commission stocks, and possibly by unsupported overseas market prices.

The relevant variables to include in the decision rule for varying the floor and ceiling prices between time periods include: the level of Wool Commission stocks (which are highly and inversely correlated with Wool Commission funds), the maximum possible movements in the floor or ceiling from one time period to the next, and a measure of how much the floor and ceiling should shift, either as a function of the level of Wool Commission stocks, or on a

percentage basis, or both.

Another possible Wool Commission policy is the "sliding" floor and ceiling price policy. The aim of this type of scheme is to ameliorate the tendency for prices to fluctuate excessively by the Wool Commission purchasing a progressively larger proportion of the wool clip as the price fell towards the floor price, and selling proportionately more wool as price rose to the ceiling. For example, 2 per cent of the clip is purchased by the Wool Commission at 4 cents above the floor, and an extra 2 per cent is bought for each one cent drop in the auction price towards the floor.

3.6 Summary Measures

In the preceding sections, reference has been made to a number of variables which are of interest in evaluating the success of alternative Wool Commission floor and ceiling price policies. This section defines some statistics, termed summary measures, which can be used to help summarise the performance of the auction under a given floor and ceiling price policy. The impact of Wool Commission buying on auction prices is multi-dimensional, so that no single measure can tell us whether one Wool Commission policy would have been preferable to another. In this study ten summary measures were calculated, but additional statistics which were obviously useful could easily be defined.

The summary measures calculated in this thesis are designed to help answer the following questions:⁶

- (i) Did the Wool Commission's policy raise wool prices at auction?
- (ii) Did the policy reduce the variance of auction prices?
- (iii) Did the Wool Commission have sufficient funds to maintain its policy?
- (iv) Did the Wool Commission make a profit?
- (v) Did growers make a profit (hidden gain)?

6. In this thesis the bench-mark against which the characteristics are measured is what actually happened during the historical period being considered.

- (vi) Did the Wool Commission profit and growers profit exceed Wool Commission losses and grower losses?
- (vii) Did the net speculators make a long term profit?
- (viii) Did the floor and ceiling price policy increase or reduce the variance in foreign exchange earnings from wool?

The individual measures are now discussed in detail.

(i) Average Price: Average price can be considered a summary measure since it is of interest to know whether an alternative Wool Commission floor and ceiling price policy would have raised or lowered prices. If the Wool Commission's policy had allowed the market to be cleared, and the average price was higher, then, other things being equal, this presumably would have been a better policy.

The qualification "other things being equal" is important since the effect of the Wool Commission policy may have a conflicting effect on the other summary measures. Some summary measures may indicate that the policy would have been an improvement, while other summary measures may show that the policy would have been detrimental.

(ii) Variance in Price: Variance in price provides a measure of price stability. If an alternative Wool Commission policy would have reduced price variability then, other things being equal, this is an improved policy.

Some "trade off" between average price and price variability probably exists. Growers may be prepared to accept a lower average price if wool prices were stabilised. That is, some growers would presumably be willing to sacrifice at least some income on average in order to obtain a steadier income.

It should be noted that a reduction in the variance of wool prices will not necessarily reduce the variability of grower's incomes. No estimate of the variability of grower's income was calculated.

(iii) Minimum Wool Commission Funds: The minimum level of Wool Commission funds during the period for which a floor and ceiling price policy was in force

is of interest since it indicates whether the floor price could have been maintained using the Wool Commission's own funds. With the backing of Government funds, policies which would have required more than the Wool Commission funds to hold the floor price could be made feasible. Policies which could have been supported by the Wool Commission's funds, without recourse to borrowing were, however, thought to be more desirable. Further, other things being equal, most people would probably argue the higher the minimum level of Wool Commission funds, the better.

(iv) Wool Commission Profit: The level of Wool Commission profits is important since it is considered politically desirable that the Wool Commission's policy show some return on capital. That is, other things being equal, policies which would have raised price by running down the Wool Commission's capital are considered to be less desirable than policies which increased the Wool Commission's capital. Thus, a deficiency payment scheme might have been very effective in raising average price and lowering price variability, but if this was at the expense of exhausting the Wool Commission's capital it would be doubtful if many people would consider it to be a "good" policy.

Two methods of defining a profit for the Wool Commission are possible. The first is that the Wool Commission's policy earns more than zero per cent on the initial level of its funds. The second is that the Wool Commission's policy earns more than the ruling rate of interest on the initial level of funds. In this thesis the absolute annuity value of profits⁷ and profitability at the ruling rate of interest are given.

(v) Grower Profit: The existence of profits to growers, as distinct from trading profits accruing to the Wool Commission has been noted in the preceding section. This summary measure is of interest per se, but given the possibility of the Wool Commission distributing any profit it makes, it is more useful to consider grower profit and the Wool Commission's profit together.

7. i.e. without deducting "interest" as a cost.

In assessing growers' profit interest payments on receipts can be included or ignored. If the order, or time pattern, of high and low prices is considered as being random it would be more consistent to ignore interest payments in determining grower profit since it would be a matter of pure chance whether profits tended to precede losses, or vice versa. Conversely, if we want to make statements about how alternative policies would have behaved in the particular historical period studied, then it would be logical to include interest earnings and costs.

(vi) Wool Commission and Grower Profit: If the Wool Commission and growers together make a loss then unless price stabilisation was extreme, and the loss small, few people would consider the particular policy to be desirable.

(vii) Net Speculative Profits: It has been postulated in section 3.4.5 that the Wool Commission's policy may bring about some net effect on the demand for wool, such as increased purchases at the floor price and reduced purchases at the ceiling. If net speculative activity does take place, it can be regarded as implausible or unlikely that the net speculators will continue to operate at a loss for long periods, and hence it is of interest to know whether net speculative activity generated a profit.

(viii) Variance in Foreign Exchange Earnings: The final measure suggested refers to whether the activities of the Wool Commission tend to stabilise (i.e. reduce the variance of) or destabilise (i.e. increase the variance of) national foreign exchange earnings. Whilst this is not of prime interest to wool growers it is thought desirable from a national point of view, other things being equal, that the Wool Commission's policy should reduce the variability in the foreign exchange earnings from wool. The measure of the effects of Wool Commission purchases on the variance of foreign exchange earnings only includes the direct effect of average wool price and Wool Commission stocks held off the market. It does not include multiplier effects due to higher and lower wool growers' income. The exact definition of simulated foreign exchange

earnings in a given week is the quantity of wool bought by the trade multiplied by the simulated price.

In the preceding discussion, a number of summary measures have been isolated. The summary measures have not been ranked in order of importance. A weighting system, where the summary measures are weighted according to their importance, has not been devised and hence the success of an alternative Wool Commission policy cannot be reduced to a single number. In comparing different Wool Commission policies, therefore, cognizance must be taken of the values of all the summary measures. If, for instance, the values of all the summary measures were better for Wool Commission policy A than for Wool Commission policy B, then one may infer that policy A would have been an improvement over policy B. If, however, a comparison of the values of the summary measures for policy A and policy B gave conflicting results, (that is for some summary measures policy A would have been an improvement and for others it would have been detrimental relative to policy B), then it is not possible to say whether or not policy A is better than policy B.

3.7 A Review of Simulation Studies of the Wool Auction

A limited number of simulation studies of the wool auction have been carried out in Australia. The relevance of such simulation studies to a discussion of the feasibility of floor and ceiling price schemes is that they generate information on the requirements, and degree of effectiveness of a variety of floor and ceiling price schemes for a variety of demand conditions, and this is information which would otherwise be difficult or impossible to obtain.

3.7.1 Study by Duloy and Parish: The aim of the study by Duloy and Parish (15, pp. 17) was:

"... to investigate how sensitive the results of the floor price scheme are to the values of three parameters - the reserve price, the elasticity of demand, and the selling margin (i.e. the difference between the reserve price and

the price at which the authority sold its acquired stocks of wool).")

The model which was constructed consisted of a completely inelastic supply of Australian wool, a marketing authority which purchased sufficient to maintain the floor and sold sufficient to maintain a ceiling price at the floor price plus selling margin - subject to stocks being available, a wool trade demand function, and lastly an auction identity; with a constant elasticity trade demand function:

$$q_i = a_i p_i^e \quad (4)$$

where

q_i is the quantity sold in the i^{th} month,

a_i is the shift parameter, a constant calculated for the i^{th} month,

p_i is the average price of wool sold in the i^{th} month,

e is the assumed price elasticity of demand - taken as being constant for the entire period under analysis.⁸

Duloy and Parish assumed that the demand function for Australian wool would not change as a result of the introduction of the floor price scheme, however, they gave three reasons why a change might occur.

"First, if the authority's activities lead to a substantial reduction in the variability of wool prices, wool's competitive position vis à vis synthetics may be enhanced. ... Second, and for a similar reason, the speculative demand for wool may change. It is not possible to specify the affects of any such change, and we have not been able to take it into account. Third, the operations of the authority in one period are likely to affect, in various ways, the demand for wool in subsequent periods."⁹

8. The Duloy-Parish model corresponds exactly to the model used in this thesis, except that in this thesis:

- (i) weekly rather than monthly data are used,
- (ii) "net speculative demand" is allowed to be generated by the activities of the Wool Commission,
- (iii) shifts of the trade demand function are allowed for, and
- (iv) some accounting details of the costs of Wool Commission activities are incorporated.

9. Duloy and Parish (15), page 19.

In the operation of the model, the authors followed the simulation procedure of testing the effect of various combinations of the three parameters (floor price, selling margin and the price elasticity of demand). Monthly data was used for the period 1951/52 to 1963/64. To increase the realism of the model, the costs of the marketing authority incurred in operating the scheme were deducted. A selling margin of 6 pence/pound was taken to be sufficient to cover all costs.

The results were given in terms of:

a) The capital backing required by the marketing authority.

This indicated the largest amount which would have been needed in any one month to finance the continued operation of the scheme.^{10,11}

(i) As the price elasticity of demand became more elastic then, for a given floor price, the capital backing required rose proportionally.

(ii) As the selling margin is increased to 6d the capital backing required rose at an increasing rate, but above 6d it rose in proportion to changes in the selling margin.

b) The variability of growers' income.¹²

This was calculated by expressing the variance in the annual wool cheque with and without the operations of a floor price scheme as a ratio.

(i) The results only varied slightly with different assumptions of the price elasticity of demand.

(ii) Greatest reductions in variation are possible from higher floor prices and, generally, higher selling prices.

Duloy and Parish pointed out that two comments followed from their results. Firstly, if £80 million were required to reduce the variance in

10. More would have been required to retain the trade's confidence in the ability of the authority to maintain the floor.

11. This summary measure corresponds to the "minimum" Wool Commission Funds reported in this thesis, except that in this thesis we assume that the Wool Commission started with a fund of \$60 million.

12. No corresponding summary measure is offered in this thesis.

income by 20% then the investment may not be warranted. Secondly for an individual grower a substantial proportion of income variation was due to quantity and quality variations rather than changes in price, and hence on an individual basis the reduction in variance in income was likely to be a lot less than 20%.

c) The variability of receipts from commercial sales of wool.¹³

The effect of the marketing authority's purchases on the variance in foreign exchange earnings from wool depended on the elasticity of demand. If

TABLE 3.2 : THE HIGHEST SUSTAINABLE RESERVE PRICE WITH CAPITAL BACKING OF £80 MILLION:
Selling Margin of 6d. per pound

Elasticity of Demand	Highest Reserve Price	Percentage Change in the Variances of Receipts from	
		Wool Cheque	Commercial Sales
	pence per pound	per cent	per cent
-0.25	60	-43	-37
-0.50	55	-35	-22
-0.75	55	-35	-12
-1.00	53	-27	0
-1.25	53	-27	+10
-1.50	52	-18	+12
-1.75	52	-17	+18
-2.00	52	-18	+24
-2.25	51	-7	+14
-2.50	51	-7	+17
-2.75	51	-7	+20
-3.00	51	-7	+24

Source: Duloy and Parish (15), page 27.

this is less than -1.0 (i.e. elastic) then variance in foreign exchange earnings is increased, since at the floor to raise price by 1% the authority has to buy more than 1% giving a reduction in revenue paid by wool users. At the ceiling the reverse holds; to lower the price by 1%, the authority has to sell more than 1% and the revenue paid by wool users increases. Where the price elasticity is greater than -1.0 (inelastic) the converse holds, and variance in

13. This corresponds to the variance in foreign exchange earnings, reported in this thesis.

foreign exchange earnings is reduced.

A summary of the main findings of the study by Duloy and Parish is given in Table 3.2.

3.7.2 Study by Powell and Campbell: The study by Powell and Campbell (42) was designed to study some of the questions raised by proposals for a wool price stabilisation scheme. Whereas the study by Duloy and Parish (15) specified a constant elasticity of demand curve and assumed that the price elasticity of demand was constant through time (for periods of high and low prices), Powell and Campbell investigated the effect of elasticity changing between periods of high and low prices. More specifically, they tested the effect of different price elasticity assumptions at the time of purchase of wool by the marketing authority, and at the time of sale.¹⁴

In evaluating the profitability (or otherwise) of a buffer stock scheme Powell and Campbell distinguished between hidden gains and losses¹⁵ which were a function of the price elasticity of demand at the floor and the ceiling, and trading profits¹⁶ which were a function of the stocks of wool purchased and the difference between the floor and ceiling price less operating costs. They argued that the magnitude of hidden gains and losses bears no relation to the marketing authority's performance as a speculator. Rather, the condition for hidden gains/losses to occur is the relationship between the price elasticity at the time of purchase of wool and at the time of sale.

-
14. Thus Powell and Campbell's model differs fundamentally from the model in the present thesis. The Duloy-Parish model can be seen as a special case of:
- (i) The model used in this thesis - where there is no shifts of demand function, and no net speculative demand, or
 - (ii) The Powell-Campbell model - where the elasticity of demand is the same in buying and selling periods.
15. This corresponds to the hidden gains and losses to growers recorded in this thesis, except that in this thesis interest receipts (or payments) on the hidden gains/losses are included.
16. Trading profits are equivalent to Wool Commission profits reported in the present study, where profitability is defined as the operations of the Wool Commission earning more than the ruling rate of interest.

The calculations that were carried out were:

- (i) A two year transaction cycle with 5%, and 10% of the clip being acquired by the authority and then resold.
- (ii) A six year cycle for transactions - again 5% and 10% of the clip being acquired.

The principle assumptions made were:

- (i) The existence of the marketing authority did not affect the demand for Australian wool.
- (ii) The marketing authority sold wool 7d above the bought price in order to cover costs (including handling, storing and insuring costs, and interest on working capital).
- (iii) The short term supply of wool by growers was completely inelastic.
- (iv) Initially an assumption was that there would be zero trading profits - the minimal requirement for the success of the scheme.

Again constant elasticity of demand curves were assumed, although the price elasticity at the floor was different to that at the ceiling.

The conclusion Powell and Campbell reached was that even small differences between the price elasticity at the floor and at the ceiling led to significant hidden gains and losses. They argued that since the marketing authority has little information on changes in the price elasticity through time, then the result of the authority's operations were a matter of chance.

Parish (34) points out that Powell and Campbell argued that lack of knowledge of the magnitude and sign of the hidden gains or losses was a reason for rejecting the floor price scheme. Parish suggested that the non-adoption of the scheme was subject to a similar set of hidden gains and losses. If the signs on Powell and Campbell's tables (indicating the magnitude of gains and losses for various elasticity assumptions) were reversed then the tables would show equally well the hidden gains and losses accruing to the growers for not

operating a reserve price scheme, and hence could be used equally well as an argument for the adoption of a reserve price scheme.

3.7.3 Study by Duloy and Nevile: Duloy and Nevile (14) investigated the effect of a floor price scheme on macroeconomic variables. In particular, they examined the deflationary or inflationary effects of decreases or increases in grower income on the gross national income, and the effect of varying levels of imports (due to changes in growers' income) on the balance of trade.

The approach used was first to construct an econometric model of the Australian economy which demonstrated the effect of changes in wool exports and farm incomes on the gross national income and the balance of trade.¹⁷

The simulated effects of the operation of a reserve price scheme were obtained from a study by Duloy (13) which investigated the effect of changes in floor price, selling margin and price elasticity of demand on variance in growers' income, and variance in foreign exchange earnings from wool.

The simulated effects of the operation of the reserve price scheme were then entered into the econometric model and results were obtained for the period 1957/58 to 1963/64. The changes in the balance of trade were not marked, except for policies where the reserve price was very high, and here the capital backing required made this an unlikely policy. The stabilising effect on the national income, by increasing growers' income during periods of low prices (and vice versa), was also very limited.

3.8 Summary

This chapter has discussed a number of features of the auction sub-system which would be important in the construction of a simulation model of the operation of auction under alternative Wool Commission floor and ceiling price policies. These features are now summarised.

17. This is a much more sophisticated model of the effect of a floor price on foreign exchange earnings than is provided in this thesis.

The growers' supply of wool can be assumed completely inelastic since the production of wool is largely a function of sheep numbers, and the volume of stocks held by growers from one season to the next appears to be a small and relatively constant proportion.

The demand for wool, as expressed at auction, is the result of a number of complex forces, but has been summarised by most research workers by postulating linear or constant elasticity of demand functions. Such functions are obviously unrealistic, but because of a lack of information a more realistic function cannot be specified.

When the Wool Commission implements a particular floor and ceiling price policy, changes in demand are likely to occur in response to the changed conditions at auction. Three possible reasons for changes in demand have been distinguished. The first is shifts along the demand curves which are a result of changes in price, and are independent of any reaction to the Wool Commission's policy. The second reason is that the entire demand curve could shift to the right or to the left due to Wool Commission activity. The third reason for changes in demand is an immediate response by the trade to particular conditions at auction. It was suggested that factors such as the proximity of the floor or the ceiling, the level of Wool Commission stocks, or the difference in average price between New Zealand and overseas auctions would cause some changes in demand for speculative stocks.

In summary, three effects of Wool Commission activity have been distinguished:

- (i) shifts along the demand function,
- (ii) shifts of the demand function, and
- (iii) inter-temporal transfers of demand due to net speculative activity.

A number of alternative floor and ceiling price policies which the Wool Commission could impose on auction were discussed. In particular, the

objectives and the profitability of Wool Commission policies together with alternative means of setting the floor and the ceiling prices have been considered.

Summary measures which would summarise the performance of the auction under different Wool Commission policies were selected. These provide sufficient information for the "success" of different Wool Commission policies to be compared.

Finally, the findings of three previous simulation studies of the wool auction sub-system were reviewed.

CHAPTER 4

THE USE OF SIMULATION IN RESEARCH

4.1 Introduction

This chapter discusses simulation as a research technique. The discussion is introduced by a brief review of the systems analysis approach to problem solution.

4.2 The Philosophy and Scope of Systems Analysis

The "systems approach" can be viewed as a general method of analysis as it provides a conceptual framework for the study of phenomena. It arose from the requirement of research workers to analyse and assist in the management of complex systems, and involves the recognition that the interactions of the components or parts of a system are important, and hence the system must be viewed as a whole. This is contrary to the trend in traditional research towards increased specialisation.

One definition of a system is given by McMillan and Gonzales (29, pp. 1): "A system is a set of objects together with relationships between the objects and their attributes."

The systems approach is comprised of a number of systems orientated specialisations. McMillan and Gonzales distinguish systems analysis and systems design. Systems analysis involves the observation and collation of relevant information on the system's behaviour, the formulation of hypotheses which provide possible explanations of the system's behaviour, and the application of research techniques which enable the researcher to test the hypotheses and thereby obtain insights into the behaviour of the system. Systems design, on the other hand, involves the synthesis of the components or elements of a system into a connected whole. There are usually a number of ways of recombining the elements of a system, and it is the aim of the researcher to optimise the system's structure or design according to some criteria of effectiveness.

The type of change suggested usually rests on the information provided by systems analysis.

Writers differ on their emphasis on systems analysis and systems design. Some writers, such as Young (51), see systems analysis as breaking the system down into smaller and smaller sub-systems until one is able to state exactly what happens at every part of a process and what effect that part will have on the overall system. Others, such as Dorfman (12), see systems analysis as related to, and incorporating information theory. It deduces from the structure of the information flow between parts of an organisation or system, and the decision rules employed by the parts of the system, how the system will respond to changes in its environment or conditions. Chorafas (9) goes further to say that systems analysis is an attempt to define the most feasible, suitable and acceptable means for accomplishing a given purpose. This statement appears to involve not only systems analysis, but also systems design.

Systems analysis as described by Chorafas has much in common with operations research or management science; they are both normative approaches, concerned with determining the optimum solution of a problem, or at least improving the organisation of an operation. These approaches involve a synthesis of systems analysis and design.

Systems analysis (without design, i.e. as defined by Young or Dorfman) is a positive study in that it attempts to explain how and why an organisation makes decisions, and to study the implications of the organisation's behavior. Systems analysis tends to give quantitative as opposed to qualitative answers: typically it involves mathematical model building and empirical analysis. Defining the boundaries of the particular system under consideration focusses attention on another important aspect of systems analysis, that of deciding what is relevant to a particular study.

The above discussion implies a number of features of systems analysis. Systems analysis suggests a pattern for research: firstly define the problem,

secondly analyse the behaviour of the system, thirdly suggest solutions and finally fit the chosen solution into the real life system so as to give an improvement. Given the necessity of quantitative analysis and the complexity of most real life decision problems the use of computers is usually essential. Further because the systems approach ignores traditional disciplinary boundaries, the use of an interdisciplinary team is frequently required.

4.3 The Method of Systems Analysis

Systems analysis provides an approach to solving problems, and frequently involves using techniques which build models in order to produce operationally useful information on the behaviour of the system. Systems analysis begins with identifying the problem and collecting relevant information on the system's behaviour. The next step is the formulation of empirically testable hypotheses which are possible explanations of the system's behaviour, the construction of mathematical models, and the testing of the hypotheses. The models developed are an abstract or a simplified version of the appropriate sections of the real life system. Models which are constructed may be deduced from logical or observable premises. The models may also be heuristic in approach, where the relationships specified are based on the researcher's intuition. The heuristic approach is not inherently bad, but may be incomplete or ambiguous in content and result.

Van Court Hare (44) distinguishes between inside and outside tests of systems analysis models. With outside tests the model is viewed as a "black box" and the relationship between the output and input variables is found by measuring the model's response for a wide range of input conditions. The use of outside tests are relevant where the complete detail of the relationship between input and output variables is not needed, or cannot be determined, and response tests provide sufficient information. With inside tests, on the other hand, the structure of the model is examined for consistency and effectiveness.

4.4 Simulation

In its general usage "to simulate" means to provide a model or replica of some process or object. The model then displays some of the characteristics of the original process or object. The use of simulation in research follows a somewhat similar but more refined pattern. In this discussion only numerical simulation models will be dealt with; that is, models which express a real life system in terms of a series of mathematical equations. Further, only deterministic or non-stochastic models will be considered.

The technique of simulation takes no set form and has been used in a wide variety of contexts, however, in the ensuing discussion some of the more important features of simulation will be outlined. These features will be presented under three headings; simulation as a descriptive technique, where simulation is appropriate, and the flexibility of simulation.

4.4.1 Simulation: A Descriptive Technique

Simulation involves the construction of a model, including those variables the researcher considers significant. Parameters can be associated with variables whose influence on the system is to be tested. A parameter is a number whose magnitude is assigned by the researcher, and indicates the relative importance of the variable associated with it in the model. Parameters are defined as numbers which are fixed for any one "run" of the simulation, but can be varied between runs. A run of the simulation involves assigning values to the parameters in the model and recording the performance of the model for actual or synthetic data. Inference in terms of the real life system being simulated can be made from one or a series of runs (or parameter combinations) and takes the general form: "If these were the conditions ruling ..., and if the model is correct ..., then this would have been the outcome ..."

From a methodological point of view simulation is a descriptive, as opposed to an analytical, technique. Orcutt (32) notes that simulation is a

general approach to the study and use of models and is an alternative to conventional analytical mathematical techniques. The latter techniques have the object of determining deductively, and with generality, the way in which the model relates the output variables to the initial conditions. The construction of a simulation model may include some deductive reasoning, however, the results of a simulation run involving a particular parameter combination are unique, and to examine the effects of another parameter combination requires another run. The model relates output variables to the initial conditions numerically; that is, by assigning a series of levels to the parameters and seeing what happens to the output variables. In this sense simulation is descriptive; the model is run, not solved.

Being a descriptive technique, for an individual run simulation is non-optimising as the result merely reflects the size of the parameters and the relationships which have been specified. With analytic techniques it is possible to incorporate and maximise certain objective functions. Where optimisation is appropriate, this can be achieved by a series of runs of a simulation to provide a form of sequential experimentation. In this context it may be more correct to say that a more promising, as opposed to an optimum, solution has been found.

4.4.2 Where Simulation is Appropriate

Simulation may be used where analytical procedures are not available or are too costly. Simulation is more flexible than an analytical approach since it does not require restrictive assumptions in order to allow the model to be constructed. Indeed, a powerful feature of simulation is that a number of functional forms can be employed, and modifications to the model are relatively easy. It is important to remember, however, that the conclusions from a simulation study are still implied by the assumptions of the model.¹

1. The same comment can, of course, be made about analytical models.

Simulation may also allow the research worker to by-pass some of the problems of econometric analysis. Econometric analyses are hampered by problems such as autocorrelation, multicollinearity, identification and missing data, which make statistical inference difficult. Simulation does not provide an alternative method of estimating the parameters in an economic relationship, but may permit us to draw conclusions for any reasonable values of a particular parameter.²

Many research techniques are not applicable to studying the influence of an alternative policy of an organisation to the one being currently used since information on the alternative policy is not available. Simulation is useful under these circumstances since it does not require information on how an alternative policy would work, rather it can generate quantitative information on how that policy would work. In this respect, simulation may be safer and quicker than experiments in situ.

4.4.3 Flexibility of Simulation

In general, simulation allows for the construction of a model where neither data nor the complexity of the system being simulated places any restriction on the detail or generality of the relationships which can be specified and tested.

An important feature of simulation is the flexibility allowed in the construction of the model. Much analytical economic theory, in particular that which is tested empirically, is based on linear or linear transform relationships. In the construction of the simulation model - again provided the aim is to make "if ... then ..." statements - it is possible to incorporate stochastic, non linear, integer and recursive relationships.

2. Whereas an econometric approach would attempt to estimate the value of the price elasticity of demand, a simulation study may be able to show that particular conclusions can be drawn regardless of the value assigned to elasticity. Simulation may in some cases allow us to "by-pass" problems of estimation of structural coefficients.

An example of the use of stochastic relationships is given by Orcutt et al. (33) where a model is constructed to show, amongst other things, the composition through time of a small population in the U.S.A. from probabilities of birth, marriage and death etc.

The relationships postulated can be dynamic. For example, Holland (25) reviews his simulation study of a developing economy where special reference is made to the balance of payments problem. The aim of this study was to establish an economically and technically feasible development investment plan. The significance of the study is that simulation allows the dynamic interaction of a number of aspects of a developing economy which are usually studied in isolation, such as balance of payments, consumers' behaviour and investment decisions. The model is dynamic in the sense that the relationships between variables are traced through time, and may change during that period.

A special type of dynamic model is the recursive model in which the relationships between the variables do not change over time, and knowledge of the variables at one time period permits the calculation of the variables in the next time period. An example of this is given by Naylor et al. (31) where the behaviour of the textile industry is simulated on the basis of the behavioural relationships given by a recursive econometric model.

A further feature of simulation is that if historical data is unavailable then provided the statistical distribution of the data can be specified, synthetic data can be generated and used.

4.5 The Method of Simulation

Once the problem to be studied has been isolated, an objective has (or significant summary measures have) been identified, and (numerical) simulation has been chosen as the research technique, the basic procedure involves the following:

- (a) the construction of the model,
- (b) the operation (or running) of the model, and

(c) drawing conclusions from the model.

4.5.1 Construction of the Model

Construction of the model involves expressing the original system in terms of a series of mathematical equations such that the model exhibits the features of the original system that the researcher considers significant for his purpose. Even though the simulation model is only an approximation of the real life system, the construction of this simulation model forces the researcher to consider all relevant aspects of the system being modelled, including aspects which otherwise might have been overlooked. It is evident that the simpler the model the less realistic it is likely to be but also the easier it is to construct and understand. There is, therefore, a conflict between the ease of manipulation and the realism of the model.

A simulation study is carried out for the purpose of generating information which is of interest to the researcher. A large amount of information is generated by each simulation run, but only a small proportion of this information is useful (for the purpose of the study) and is worth recording. More specifically, the construction of a simulation model involves, inter alia, the choice of summary measures which will summarise the performance of the model.

Attention is now turned to the method by which a simulation model is constructed. The elements of a simulation model have been classified by Orcutt (32) as variables, components and relations. In addition, summary measures are also considered to be an element of a model.

The variables used in a simulation model have been classified by Candler and Cartwright (5) as; exogenous variables, endogenous variables, structural parameters, and policy parameters (or, using their terminology, decision variables). Exogenous variables are determined outside the model (or system being simulated) while endogenous variables are determined within the model. Policy parameters are within the control of the policy maker, while the

structural parameters are not subject to control by the policy maker.

A component can be defined as an entity which exerts some causitive effect on the system being simulated. Each component is made up of some or all of the types of variables and parameters listed above. Which variables are included in the component is largely at the discretion of the researcher. A series of components sum up the forces dictating the behaviour of the system.

Two broad types of relations exist in a simulation model; namely, identities and operating characteristics. An identity is an accounting or tautological statement and enables the components to be related together. An operating characteristic indicates the relationship between the variables and parameters making up the component.

Included in the construction of a simulation model are summary measures which describe the outcome or performance of the model. Usually, a large number of endogenous variables are incorporated in the model, however, only a limited number of these are of interest. Often the performance of the model is summarised adequately by recording the average, variance, maximum or minimum values of the important endogenous variables. It may, or may not be possible to rank the summary measures in order of importance, and/or to weight them to give an objective function.

4.5.2 Operation of the Model

Following the construction of the model (usually in the form of a computer program), it is then "run" for different combinations of parameter values. A "run" involves obtaining results from the model for a particular set of parameter values. The parameter values are constant within a given run, but can vary between runs.³

3. An alternative approach to selecting parameter values is through the use of stochastic variables, where there is a distribution for each stochastic variable. By selecting a start number from a pseudo random number generator a set of values, one from each of the distribution, is specified, and this set is inserted in the simulation model. In this case a "run" is one drawing or sample from a set of possible stochastic variables, and is therefore distinct from the meaning of "run" used in this thesis (where stochastic variables are not used) where run refers to the outcome(s) from one set of parameter values.

Because the model is constructed so as to incorporate all relevant features of the original system, then for each run the full effects of the variables, associated parameters and specified relationships are seen. That is, for a given set of parameters, the model is completely specified and the run evaluates, in quantitative terms, the consequences of that set of parameters on the entire system, in terms of the summary measures.

In a non-stochastic simulation study the result of an individual simulation run is unique, and is completely dependent on the parameter values chosen. A single run, therefore, gives little or no insights into how the summary measures would be influenced by a change in any one of the parameters. This can only be determined by a series of separate runs. Since the researcher does not know the actual magnitude of the structural parameters or the most appropriate value of the policy parameters, the operation of the model involves running the model for a number of different parameter assumptions.

The method of choosing parameter values to use in the model varies considerably, and is primarily a function of the purpose of the study. In Monte Carlo studies where stochastic relationships are involved in parameter selection, the parameter values are derived from the appropriate probability distribution.

Candler and Cartwright (5) note that where a simulation model contains important structural parameters (which are not within the control of the policy maker) the researcher is not interested in finding the optimum levels of the parameters, but rather he is interested in estimating what values of summary measures are associated with particular levels of the parameters. If the study is orientated in this manner, the combinations of parameter values will be chosen because of the specific requirements of a particular method of estimating the relationships between parameters and summary measures.

In general, however, the choice of parameter values is completely within the hands of the researcher, and he can test such levels as he considers

appropriate.

4.5.3 Drawing Conclusions from the Model

The third phase of a simulation study is concerned with reaching conclusions about the real life system being considered from the numerical results obtained. For an individual simulation run the form of inference is:

If the model is realistic, and
if these are the appropriate parameter values,⁴
then this is how the system would have behaved

Given that the appropriate values of the parameters in the simulation model are not known a priori, a number of runs are required to show performance of the model for a series of likely values for the parameters. The direction of inference for a series of simulation runs is similar to that for an individual run.

Drawing inferences from a series of simulation runs (or from a single run) has two conceptual parts. It is necessary to distinguish between firstly, drawing conclusions about the numerical results obtained, within the context of the model, and secondly, relating the conclusions reached within the context of the model to the real world.

4.5.3.1 Deriving Conclusions Within the Context of the Model

In this thesis three aspects of drawing conclusions, within the context of the model, are of interest:

- (i) the need for an orderly approach to selecting a series of parameter combinations,
- (ii) the difficulty of evaluating the implicit function which expresses the summary measures as a function of the parameters, and

4. Since the policy parameters are within the control of the policy maker, they may take any one of a range of (reasonable) values. The structural parameters, however, must be assigned their actual value (which may be a function of the values of the policy parameters).

- (iii) the difficulty in evaluating the "success" of alternative parameter sets, even though a number of summary measures are available.

The performance function technique provides a means of estimating from a series of simulation runs the functional relationship, termed a performance function, between a limited number of parameters being varied and a given summary measure. The performance function, which approximates the implicit function between summary measures and parameters, can be estimated for any summary measure which is of interest. Using the performance function technique the performance surface, for all reasonable values of the parameters, can be generated and subsequently explored, providing information which would be difficult or impossible to obtain directly from the simulation runs. To define the parameter combinations necessary to estimate the performance function, use is made of the central composite design.⁵ As the number of parameters to be varied are increased, the number of simulation runs necessary to estimate the corresponding performance functions increases at an approximately exponential rate, hence there is an upper limit (say six to eight parameters) that it is reasonable to vary at the one time using this technique.

To determine the "success" of a parameter combination it is necessary to look at all the summary measures. If, for a given parameter combination, all the summary measures are improved then that parameter combination would have been an improvement. If the direction results of the summary measures are mixed then, because the summary measures have not been weighted according to importance, it is not possible to say whether or not the parameter combination is an improvement. In this case useful information can, of course, be derived as to which parameters exert a significant influence on the performance of the model, and individual policy makers can decide whether, on balance, they prefer the set of summary measures to any other combination which was obtained.

5. More detailed comments are given on experimental designs in Chapter 7.

4.5.3.2 Relating Conclusions from the Model to the Real World

The basic premise of a simulation study is that it is meaningful to base inferences about the behavior of a real world system on the observed performance of a simulation model. Obviously this requires that the model is a reasonably realistic approximation of the real world system.

The evaluation of the realism of the model is termed verification. Conway (10), among others, considers that verification remains a problem because the information required to verify the model is not available. Frequently, it is this lack of information which leads researchers to use simulation. Conway argues, for example, that the researcher does not know how an alternative policy affects the real world system under consideration, for if he did there would be little point in using simulation. He concludes that because the alternative policy has not been in operation, the realism of the model must be evaluated largely by a priori reasoning.

A feature of numerical simulation is that the construction of a mathematical model of a real world system involves some departure from reality. In relating the conclusions obtained within the context of the model to the real world the operational question, therefore, is not "does the model provide a perfect answer", but rather "does the model provide useful information". Results from a simulation study can be considered useful information if the results reduce the degree of uncertainty facing the decision maker.

The ability to relate conclusions obtained from the model to the real world depends to a large extent on how "clear cut" are the conclusions which have been obtained from the model. Simulation allows "if ..., then ..." statements to be made. If the "if" assumptions do not affect the "then" statement, then the conclusions for the real world may be quite strong. If, on the other hand, the "if" assumptions do have a significant effect on the "then" statement, then at the very least the researcher is given considerable insights into the likely critical parameters.

4.6 Summary

Systems analysis is not a specific research technique, but rather is an approach to problem analysis. It involves making observations of a system's behaviour, formulating and testing hypotheses about the system's behaviour and the inference of behaviour in altered circumstances. Simulation is one research technique which can be used to test hypotheses about the behaviour of a system. Simulation allows the analysis of complex, dynamic relationships which, in many instances, cannot be investigated using analytical methods, and, therefore, in these circumstances provides information which otherwise could not be obtained.

The method of simulation involves the construction, and operation of a model, and drawing conclusions from the results obtained from the model. In the construction of the model there is considerable flexibility in the relationship which can be specified, and in the overall complexity of the model. The operation of the model involves running the model for all reasonable values of the parameters included in the model. Conceptually, drawing conclusions from the model consists of two parts; firstly, reaching conclusions, within the context of the model, about the results obtained from the operation of the model, and, secondly, relating these conclusions to the real world system which is being simulated. In this thesis, conclusions can be drawn, within the context of the model, directly from the results of the simulation runs, but additional information can be obtained by estimating and investigating the functional relationship between parameters being varied and summary measures, and by using directional results to determine which parameter combinations would have been an improvement over the historical performance of the auction system. To relate these conclusions to the real world requires an evaluation of the realism of the model, and this can only be attempted by a priori reasoning, and, in part, is the responsibility of each person wishing to use the results of the present study.

CHAPTER 5

THE SIMULATION MODEL

5.1 Introduction

The aim of this chapter is to describe the simulation model in detail.

The model is comprised of three main parts. The first is the quantitative balance which is designed to account for all wool sold at auction by calculating the amount taken by the wool trade and net speculators, and hence the residual amount bought or sold by the Wool Commission. This part also calculates the simulated price at which the market would have been cleared.

The model is then extended to include the financial implications of the quantitative balance.

The third part involves the inclusion of summary measures which indicate the performance of the model for different parameter combinations. In Chapter 3 a number of summary measures were discussed. In the third part of the model these summary measures are defined in terms of the variables used in the model.

Initially, in this chapter, the data used in the calculations is described. Following this the quantitative balance is presented. Because of the complexity of this part of the model, the quantitative balance is first discussed in general terms, and then set out in detail. Financial implications and summary measures are subsequently defined.

The reader who wishes a more technical description of the model is referred to the flow diagrams for the computer programmes, given in Appendix A.

5.2 Data Used

The data used for the computer calculations were weekly measurements of average price and quantity sold at the New Zealand greasy wool auctions. Because the time basis for the aggregation of data was weekly, the figures may include one or part of two or more sales. In some weeks no wool was sold.

The data, drawn from Wool Commission records, was for the 14 seasons from 1952/53 to 1965/66 inclusive.

The quantity measurement was merely the total number of bales (assumed to be 325 lbs. in weight) sold, expressed in thousands of bales.

The weekly average price was derived from the averages of adjusted, estimated, greasy prices for selected wool types. The prices were adjusted so that prices from sales at all auction centres were comparable on a clean c.i.f. (cost, insurance and freight) basis in the U.K..

The selected Wool Commission types were:

86, 100, 107, 114, 128, E695, 739¹

The price for each wool type was that price which it would have sold for (not should have sold for) rather than the actual sales price. Providing the estimates of prices don't get too much out of line with actual prices, this method is advantageous. It avoids bias in the average price during the season due to changes in the composition of wool types sold. In any case this data is the best available price series, and constitutes official Wool Commission statistics.

Given the aggregated nature of the data, it is evident that this study excludes from consideration the situation where the price of one particular wool type (other than one of the seven above) falls; that is, where a "hole" appears in the market.

The present study refers to the prices of all individual wool types in terms of an average price. The justification of this approach can be argued on two grounds. Firstly, in a study reviewed in section 2.3, Candler (3) showed that the weekly prices of the major wool types, used to derive the average price series, showed a considerable tendency to move together.

Secondly, to run the model for a large number of wool types would avoid the aggregation problem but, apart from being tedious and time consuming, this

1. For a description of these types see Candler (3), pp. 2.

approach would pose other difficulties. In particular, it would be necessary to specify the demand for individual wool types and their cross elasticity. To the author's knowledge no demand estimates with this degree of detail have been made for any commodity.

5.3 The Quantitative Balance

The quantitative balance is designed to account for all wool sold at auction. In addition, the price at which the market is cleared is also calculated. This is the most important part of the model; it details how the demand for, and supply of wool at auction is broken down into various components. Further, it indicates what variables are included in each component, the relationship between the variables in each component, i.e. the operating characteristic, and the identity relationship between the components.

The components of supply and demand in this model are:

- (a) the grower supply function,
- (b) the normal trade demand function,
- (c) the net speculative demand/supply function, and
- (d) the Wool Commission demand/supply function.

The identity is:

- (e) the auction identity.

The above permit the calculation of:

- (f) the simulated price.

5.3.1 Grower Supply Function

This takes the form of the identity:

$$Q_3 \equiv Q_1 \quad (1)$$

where

Q_1 is the observed sales in ,000 bales at auction in a given week, and

Q_3 is the quantity in ,000 bales supplied on to the market

in a given week.

The nature of this function indicates that the supply from growers in any week is assumed completely inelastic. From this it follows that in a given week the grower's supply of wool to auction will not alter as a result of the Wool Commission's activities, or altered auction prices.

5.3.2 Normal Trade Demand Function

Both the normal trade demand function and the net speculative demand/supply function refer to the demand for wool by all sections of the wool trade. The division between the two is not on the basis of whether wool is bought for manufacturing, or for speculative purposes,² but rather the division is between that demand which is unaffected by the Wool Commission's activities, and the net demand (positive or negative) which is "created" by the Wool Commission's activity. Both functions include demand for wool for speculative purposes. The "Normal Trade Demand" includes only the speculative demand which would have occurred in the absence of Wool Commission activity.

The basis of the normal trade demand function is the equation:

$$Q_1 = B_3 P_1^{A_1} \quad (2)$$

where

Q_1 is the observed quantity of wool supplied by growers, and demanded by the trade, in a given week where there is no interference by the Wool Commission,

B_3 is termed the shift parameter and is constant for each week,

A_1 is the price elasticity of demand - a parameter,³ and

-
2. In practice it is extremely difficult, if not impossible, to distinguish speculative from manufacturer's purchases since speculation is carried out both by the "pure speculator" and by manufacturers who increase stocks to maintain the desired level of production. Further, the motive for holding stock can vary through time.
 3. A parameter could be more formally defined as a number which may vary from one run to another, but which is constant for any one run. It determines the relative importance of the variable associated with it in the model.

P_1 is the "equilibrium"⁴ or observed average price⁵ in a given week, when simulated price P_2 differs from the observed P_1 , P_1 is taken as an index of "world price" for wool.

Re-arranging equation (2):

$$B_3 = Q_1 P_1^{-A_1} \quad (3)$$

Q_1 and P_1 are known from the available data, a value for A_1 is assumed and hence the value of B_3 can be calculated as in (3). Given the assumed value A_1 , and calculated value B_3 , the normal trade demand function is completely specified, enabling the derivation of the constant elasticity demand curve for each week. For a change in the average price in a particular week, the quantity demanded by the normal trade demand can be evaluated by:

$$Q_2 = A_2 B_3 P_2^{A_1} \quad (4)$$

or

$$Q_2 = A_2 (Q_1 P_1^{-A_1}) P_2^{A_1}$$

where

Q_2 is the quantity demanded by the normal trade demand in a given week, and

P_2 is the simulated price (defined later), and

A_2 is a "shift" effect on normal trade demand due to the Wool Commission's activities, it is a parameter.

From (3) and (4) we can see that if $A_2 = 1.0$, and if $P_2 = P_1$ then

$$Q_2 = Q_1.$$

The normal trade demand measures that demand for wool by the wool trade which is not affected directly by the Wool Commission's activities. This

4. "Equilibrium" price in the sense that in the absence of any activity by the Wool Commission, this is the price which would have ruled; it is the price which was actually observed. In a few cases the Wool Commission's floor bids did actually influence this price, but this effect is ignored.
5. Average price will be referred to in future as "price."

demand is strictly a function of price, but allowance is made, through the parameter A_2 for some expansion (or contraction) of demand due to the general stabilising effect of the Wool Commission on wool price variability. If A_2 is less than 1 there is a reduction in the normal trade demand. If A_2 is greater than 1 there is an expansion in demand.

The accuracy of this approach in explaining the nature of the normal trade demand for wool is dependent to a very large extent on the appropriateness of the value of the price elasticity of demand and the form of the demand function. On this subject there is very little information. Therefore, two computer programmes were written, one with a constant elasticity demand schedule, the other with a linear demand schedule and each was run for a range of elasticity values.

It is also probable that the elasticity varies through time, but again due to lack of information, the elasticity has been assumed constant for each run. If the actual variations in elasticity through time could be specified, then this could easily be included in the model.

5.3.3 Net Speculative Demand/Supply Function

This function measures the net demand by the wool trade as a result of the Wool Commission's activities. As such, in a particular week, it may be positive, indicating a demand for wool, or negative, indicating a supply of wool.

The assumptions regarding the form of this function provide one of the most difficult aspects of the model since it was necessary in the construction of the model to state how the trade would react to a particular Wool Commission floor and ceiling price policy. The formulation of this function was considered desirable, firstly, because some reaction to a Wool Commission policy was considered probable, and secondly, because the design and operation of a simulation model provide a means of generating information as to the effect of different levels of net speculative activity.

If the elimination of the effect of the net speculative demand/supply equation is desired, then this can be achieved by equating the parameters associated with this function to zero.

The net speculative demand/supply function takes the form:

$$B_4 = f(Q_6, Q_7, P_1, P_2, A_6) \quad (5)$$

where

B_4 is the desired net speculative demand or supply⁶ in a given week,

Q_6 is the level of Wool Commission stocks of wool,

Q_7 is the level of Net Speculative stocks of wool,

$(P_2 - P_1)$ is the spread between the simulated price P_2 (in the N.Z. auction rooms) and the (world) "equilibrium" price P_1 , and

A_6 is a parameter indicating the change in net speculative demand for wool when the simulated price is at the floor or ceiling price.

The algebraic expression of this functional form is such that B_4 decreases as Q_6 , Q_7 and $(P_2 - P_1)$ increase. When the simulated price is at the floor, most people would want to assume A_6 has a positive effect on B_4 and when at the ceiling the effect of A_6 is likely to be negative. In the model, A_6 has zero effect between the floor and ceiling.

A further equation specifying the net speculative demand/supply function is:

$$Q_4 = f(B_4, -Q_7) \quad (6)$$

where

Q_4 is the amount the net speculators actually buy or sell,

B_4 is the amount that net speculators would like to buy or sell, and

Q_7 is the availability of speculative wool stocks which can

6. The net speculative demand or supply is termed, in future, net speculative demand. It is assumed that supply is a negative demand.

be sold.

This equation indicates that net speculators are only allowed to sell wool which has previously been bought in.

5.3.4 Wool Commission Demand/Supply Function

The Wool Commission's demand/supply function can be stated as:

$$Q_5 = f(P_3, P_4, Q_6) \quad (7)$$

where

Q_5 is the Wool Commission's demand for, or supply of wool in a given week,

P_3 is the floor price,

P_4 is the ceiling price, and

Q_6 is the level of Wool Commission stocks.

Once the assumptions of the level of the floor and ceiling prices have been made for a given week then the Wool Commission simply buys or sells the difference between what the trade wants and what the growers supply. For purchases at the floor it is assumed that the Wool Commission has infinite financial backing, but at the ceiling the sales by the Wool Commission are subject to stocks of wool being available. Hence the Wool Commission always maintains the floor, but can only enforce the ceiling so long as it has sufficient stocks.

Given that the Wool Commission holds the floor, and the ceiling if possible, the important aspect of the Wool Commission demand/supply function then becomes the nature of the floor and ceiling price policy; whether the floor and ceiling prices are to be rigid or flexible and, if flexible, decision rules which govern how they are set. The model is sufficiently flexible to incorporate a number of alternative policies.

5.3.5 The Auction Identity

The action identity is given as:

$$Q_3 = Q_2 + Q_4 + Q_5 \quad (8)$$

This equation relates the wool bought or sold by the normal trade demand (Q_2), the net speculative demand (Q_4) and the Wool Commission (Q_5) to the quantity supplied (Q_3). As such it ensures that all the wool supplied is accounted for.

5.3.6 Calculation of Simulated Price

The simulated price, P_2 , calculated each week, is found initially by solving for P_2 in the normal trade demand equation and the net speculative demand/supply equation. This is the price which would have prevailed at auction given a positive Wool Commission policy, but first without including the Wool Commission's direct interference in that week. The second step is then to determine the simulated price given the restraints of the Wool Commission's floor and ceiling price policy, and the effect on the net speculator's demand for wool of A_6 - a parameter indicating the change in net speculative demand for wool when the simulated price is at the floor or ceiling.

5.4 Algebra of the Quantitative Balance

In this section the discussion of the quantitative balance is extended by showing more precisely how the components of supply and demand are formulated, and then how they are related. This includes the derivation of the simulated price. Further, the algebra of the normal trade demand function will be analysed for both the linear demand model and the constant elasticity of demand model.

In Appendix A the flow diagrams for the quantitative balance of the two models are given.

5.4.1 Grower Supply Equation

The grower supply equation takes the form:

$$Q_3 = Q_1 \quad (9)$$

where

Q_1 is the observed sales in a particular week, and

Q_3 is the supply of wool on to the market in that week.

Equation (9) indicates that the grower supply is completely inelastic.

5.4.2 Net Speculative Demand/Supply Equation

The net speculative demand for wool, if the Wool Commission is present but does not enter the market, is given as:

$$B_4 = -Q_1(A_3 Q_6 + A_4 (P_2 - P_1) + A_5 Q_7) \quad (10)$$

where

B_4 is the desired net speculative demand in a given week,

A_3, A_4, A_5 are parameters⁷ and have a linear effect on the variables they are associated with,

Q_6 is the opening⁸ level of Wool Commission stocks,

P_2 is the simulated New Zealand auction price,

P_1 is the observed "world equilibrium" price, and

Q_7 is the opening net speculative stocks.

If the Wool Commission does enter the market to make purchases or sales and the simulated price is at the floor or at the ceiling, then equation (10) is altered by $(+Q_1 A_6)$ or $(-Q_1 A_6)$ respectively. The parameter A_6 represents the change in net speculative activity when the simulated price of wool is at the floor or ceiling.

Equation (10) by including A_6 becomes:

$$B_4 = \pm(Q_1 A_6) - Q_1(A_3 Q_6 + A_4(P_2 - P_1) + A_5 Q_7)$$

When B_4 is positive this indicates a desired demand for wool, when negative it indicates a desired supply of wool.

The term $-Q_1(A_3 Q_6)$ indicates that the effect of rising Wool Commission stocks is to reduce the net speculative demand for wool.

7. See footnote 3 for definition of "parameter."

8. "Opening" - at the start of the week.

The term $-Q_1 A_4 (P_2 - P_1)$ represents the effect of the spread between the simulated price and the observed price. If P_2 is greater than P_1 then this term is negative owing to the wool trade being able to purchase wool cheaper elsewhere in the world. If P_2 is less than P_1 this term is positive showing the tendency towards a positive net speculative demand for wool, since wool is cheaper in the New Zealand auction room than overseas.

The term $-Q_1 (A_5 Q_7)$ measures the reduction in the net speculative demand for further stocks of wool due to the magnitude of present speculative stocks.

If the simulated price is at the floor or ceiling price, the term $\pm Q_1 A_6$ is included in the calculation of B_4 . At the floor it is likely to be positive⁹ indicating an increased net speculative activity since, providing the wool trade is confident in the Wool Commission's holding the floor price, net speculators can be assured prices will not fall further. For the manufacturer this could signal the end of a cumulative price decline. This phenomenon occurs when the price is falling and, although the price is below what the manufacturer is prepared to pay for a particular type of wool, he would not enter the market in view of the possibility of a further price decline. Hence the presence of the floor price would in this case initiate buying operations again. The speculator would respond similarly since he could be confident that price would not fall further and therefore could be sure of not making an immediate loss. At the ceiling the term $Q_1 A_6$ is likely to be negative indicating for similar reasons that there would be a reduction in net speculative demand.

5.4.2.1 Interactions Between Net Speculative Demand and Simulated Price

It is of some interest to examine the ways in which net speculative demand can affect the simulated price of wool, P_2 , and vice versa. This examination will provide a good review of the structure of the model. These interactions between simulated price and net speculative demand are now given.

9. And will be positive provided $A_6 > 0$.

5.4.2.2 Simulated Price Between Floor and Ceiling

First we consider the situation where the simulated price P_2 lies between the floor and ceiling price. Three situations are investigated. These are; zero Wool Commission and net speculative stocks, zero net speculative and positive Wool Commission stocks, and positive net speculative and Wool Commission stocks.

(a) Zero Wool Commission and Net Speculative stocks, and:

- (i) No effect on trade demand due to Wool Commission activities (i.e. $A_2 = 1$).

In this case $P_2 = P_1$ and $Q_4 = 0$ and $Q_2 = Q_1 = Q_3$ (i.e. simulated price and trade purchases correspond exactly to observed price and trade purchases).

- (ii) Positive effect on trade demand due to Wool Commission activities (i.e. $A_2 > 1$).

In this case the simulated price will tend to exceed observed price (i.e. $P_2 > P_1$) and net speculative demand might tend to be negative (since $-Q_1 A_4 (P_2 - P_1) < 0$), but with zero stocks effective net speculative demand would be zero ($B_4 < Q_4 = 0$).

- (iii) Negative effect on trade demand due to Wool Commission activities (i.e. $A_2 < 1$).

In this case, the simulated price will tend to fall short of observed price (i.e. $P_2 < P_1$) and net speculative demand may be positive (will be positive if $A_4 > 0$, since $-Q_1 A_4 (P_2 - P_1) > 0$).¹⁰

If the existence of the Wool Commission's floor and ceiling tends to depress trade demand ($A_2 < 1$), but simulated prices below observed prices ($P_2 < P_1$) tends to increase speculative demand, there is a "conflict" between these two tendencies and simulated price should fall below observed price -

10. Note: With appropriate (or, perhaps more accurately, inappropriate) values of the coefficients A_4 and A_5 , the model could produce an unstable "see-saw" effect where in one period with zero speculative stock, $Q_7 = 0$, simulated price would be below observed price ($P_2 < P_1$), and hence net speculative demand would be positive. In the next period speculators would have large stocks $Q_7 > 0$, and if these depressed speculative demand sufficiently, the speculators could sell their stocks, forcing simulated price down. This is an undesirable feature of the model, and may need to be modified.

but may not fall as far below as would occur if there were zero net speculative demand.

(b) Zero Net Speculative Stocks

The relationships here correspond to (a) (i), (ii) and (iii) above, except that the existence of Wool Commission stocks, Q_6 , will tend to depress net speculative demand, Q_4 (if $A_3 > 0$). Since we don't expect net speculative purchases for $A_2 \geq 1$ (and there can't be sales so long as net speculative stocks are zero), the only effect of Wool Commission stocks is likely to be to reduce the net speculative purchases which may be made if the existence of the Wool Commission tends to depress trade demand (i.e. $A_2 < 1$).

(c) Positive Net Speculative Stocks

The existence of net speculative stocks, Q_7 , will tend to reduce net speculative demand (if $A_5 > 0$). At the same time these stocks mean that net speculative sales can be made. The larger the values of A_2 , A_3 and A_5 , the larger will these sales tend to be. To the extent that net speculative sales lower simulated price below observed price ($P_2 < P_1$), there will be an offsetting tendency for net speculative demand to rise.

In any case, the size of net speculative stocks sets an upper limit to the amount that speculators can sell in any one period, thus

$$Q_4 = \max(-Q_7, B_4 \mid P_3 < P_2 < P_4) \quad (11)$$

where

B_4 is as defined in (10).

5.4.2.3 Simulated Price Above Ceiling, No Wool Commission Stocks

This implies that Wool Commission stocks, Q_6 , have been exhausted since, it is assumed that the Commission will always sell any available wool in an attempt to hold the ceiling.

With zero Wool Commission stocks, the analysis of the interrelationship of net speculative demand and price follows the same lines as for simulated

price between the floor and ceiling. The level of net speculative demand is therefore:

$$Q_4 = \max(-Q_7, B_4 \mid P_2 > P_4, Q_6 = 0)$$

Net speculators cannot sell more wool than they have in stock.

5.4.2.4 Simulated Price at Floor

It is assumed that the Wool Commission has infinite financial resources, so that the floor price can always be maintained. This implies that trade demand, Q_2 , is:

$$Q_2 = A_2 B_3 P_3^{A_1}$$

and the initial estimate of net speculative demand, B_4 , is:

$$B_4 = -Q_1(-A_6 + A_3Q_6 + A_4(P_3 - P_1) + A_5Q_7).$$

If this initial estimate is negative (which is unlikely, since it involves the speculators selling at the floor) then:

$$Q_4 = \max(-Q_7, B_4 \mid B_4 < 0, P_2 = P_3)$$

The desired net speculative supply, B_4 , is limited by the availability of stocks, Q_7 .

If the initial estimate of net speculative demand, B_4 , is positive, then it is necessary to check the availability of wool to meet this demand. If there is sufficient wool to meet normal trade and the initial estimate of speculative demand, then speculative demand is equal to the initial estimate, that is:

$$Q_4 = (B_4 \mid Q_3 \geq B_4 + Q_2)$$

If there is insufficient wool available (Q_3), to supply the initial estimate and normal trade demand, then net speculative demand takes all available wool in excess of normal trade demand;¹¹

11. Hence $Q_4 < -Q_1(-A_6 + A_3Q_6 + A_4(P_3 - P_1) + A_5Q_7)$

But $Q_4 \geq -Q_1(A_3Q_6 + A_4(P_3 - P_1) + A_5Q_7)$

since if the latter inequality is violated normal trade and speculative demand are together sufficient to hold simulated price above the floor, without any action by the Wool Commission.

$$Q_4 = (Q_3 - Q_2 \mid Q_3 < B_4 + Q_2)$$

Wool Commission purchases are the residual amount not taken by trade and speculative demand:

$$Q_5 = Q_3 - Q_2 - Q_4.$$

It is interesting to note that this model allows for weeks in which the Wool Commission holds the floor, without making any purchases.

5.4.2.5 Simulated Price at Ceiling

It is assumed that the Wool Commission can only sell wool it has previously bought, but that, subject to this restriction, it will always try to maintain the ceiling. That is, the model calls on the Wool Commission to sell any available wool to maintain the ceiling price this week, even if it is very likely that price will go sky-high next week.

So long as wool price is at the ceiling, normal trade demand, Q_2 , is:

$$Q_2 = A_2 B_3 P_4^{A_1}$$

and the initial estimate of net speculative demand, B_4 , is:

$$B_4 = -Q_1(A_6 + A_3 Q_6 + A_4(P_4 - P_1) + A_5 Q_7).$$

If this initial estimate is negative then it is necessary to check if sufficient stocks of wool are available to the speculators. The speculative sales become:

$$Q_4 = \max(-Q_7, B_4).$$

If the initial estimate is positive (which is unlikely, since it involves the speculators buying at the ceiling), then we have to check on the availability of Wool Commission stocks to maintain the ceiling. If the Wool Commission has adequate stocks, (i.e. $Q_3 + Q_6 \geq Q_2 + B_4$), then:

$$Q_4 = (B_4 \mid P_2 = P_4 ; Q_6 \geq Q_2 + B_4 - Q_3).$$

If the Wool Commission's stocks together with growers' supply are less

than normal trade demand and the initial estimate of speculative demand, but not less than

$$Q_2 - Q_3 - Q_1(A_3 Q_6 + A_4(P_4 - P_1) + A_5 Q_7).$$

then the speculative demand is:

$$Q_4 = (Q_6 - Q_2 \mid Q_6 \geq -Q_1(A_3 Q_6 + A_4(P_4 - P_1) + A_5 Q_7)).$$

Wool Commission sales are simply

$$Q_2 - Q_4 - Q_3$$

If Wool Commission stocks are less than the difference between wool offered for sale, Q_3 , and the initial estimate of speculative demand, B_4 , then the model will result in zero Wool Commission stocks at the end of the period.

5.4.2.6 Simulated Price Above Ceiling, Some Wool Commission Stocks

In this case the Wool Commission has some stocks, but not enough to enforce the ceiling price in the week being studied. All Wool Commission stocks will be released on to the market, but simulated price, P_2 , is still above the ceiling, P_4 .

Net speculative demand, Q_4 , is

$$Q_4 = \max(-Q_7, B_4)$$

where

$$B_4 = -Q_1(A_3 Q_6 + A_4(P_2 - P_1) + A_5 Q_7).$$

The simulated price, P_2 , is selected such that:

$$Q_2 + Q_4 = Q_3 + Q_6$$

5.4.3 Net Speculative Inventory Equation

The net speculative inventory equation assumes that the closing inventory of wool for the week is equal to the opening inventory plus purchases (or less sales).

$$Q_{7t+1} = Q_{4t} + Q_{7t} ; Q_{4t} \geq -Q_{7t} \quad (12)$$

where

Q_{4t} is the net speculative purchases (if positive) or sales (if negative) in week t , and

Q_{7t} is the net speculators' stocks of wool at the beginning of week t .

5.4.4 Wool Commission Demand/Supply Equation

The Wool Commission demand/supply function takes the form of the following equations. For (simulated) prices at the floor:

$$Q_5 = Q_3 - Q_2 - Q_4 \quad \text{if } P_2 = P_3 \quad (13)$$

where

Q_5 is the Wool Commission's demand in a given week.

Equation 13 indicates that the Wool Commission purchases sufficient wool to maintain the weekly floor price, P_3 . Thus the amount the Wool Commission purchases, Q_5 , is calculated by subtracting normal trade demand, Q_2 , and the net speculative demand, Q_4 , at the floor price, from the grower's supply, Q_3 .

For prices away from the floor and ceiling:

$$Q_5 = 0 \quad \text{if } P_3 < P_2 < P_4 \quad (14)$$

or if $Q_6 = 0, P_2 \geq P_4$

where

Q_6 is the level of Wool Commission stocks.

That is, the Wool Commission makes no purchases or sales if the simulated price is between the weekly floor and ceiling prices, or if the simulated price is at or above the ceiling and the Wool Commission has no stocks.

For prices at the ceiling, or above the ceiling, when the Wool Commission has some stocks of wool:

$$Q_5 = \max(Q_3 - Q_2 - Q_4, -Q_6) \quad \text{if } P_2 \geq P_4 \quad (15)$$

The Wool Commission either sells sufficient stocks to hold the ceiling, or if the Wool Commission's stocks are not sufficiently large then all of the Wool Commission's stocks are placed on the market to hold the simulated price as low as possible.

The level of Wool Commission funds is assumed not to be a limiting factor. If the level of funds becomes negative this indicates that the Wool Commission is using borrowed funds - presumably from the Government.

5.4.4.1 Alternative Floor and Ceiling Price Policies

Given that the Wool Commission buys and sells sufficient to maintain the floor and ceiling price policy (subject to sufficient stocks being available), the important aspect of the Wool Commission demand/supply function becomes the manner in which the weekly and seasonal floor and ceiling prices are set.

5.4.4.2 Rigid Floor and Ceiling Price Policies

The simplest Wool Commission policy studied was where the floor and ceiling prices were constant throughout the fourteen seasons for which data is available.

Here

$$P_3 = A_{12}$$

$$P_4 = A_{13}$$

where

A_{12} is the initial floor price, and

A_{13} is the initial ceiling price.

A more complex determination of flexible floor and ceiling prices involves weekly and annual calculations of their values. The weekly values can be determined either on a percentage basis, or from the level of Wool Commission stocks. The calculations of annual floor and ceiling prices

incorporate both.

5.4.4.3 Flexible Weekly Floor and Ceiling Price Policies

For the calculation of flexible weekly floor and ceiling prices based on the level of Wool Commission stocks, the new floor and ceiling prices are given by:

$$P_{3t+1} = \max (P_{3t}(1 - A_{14}), P_5 - A_{16} Q_{6t}) \quad (16)$$

$$P_{4t+1} = \min (P_{4t}(1 + A_{15}), P_6 - A_{17} Q_{6t}) \quad (17)$$

where

A_{15} is the percentage rise in the ceiling price allowed from one week to the next,

A_{16} is the linear effect of the Wool Commission's stocks on the floor,

A_{17} is the linear effect of the Wool Commission's stocks on the ceiling,

P_{3t} is the weekly simulated floor price in the t^{th} week,

P_5 is the seasonal simulated floor price,

P_{4t} is the weekly simulated ceiling price in the t^{th} week,

P_6 is the seasonal simulated ceiling price,

A_{14} is the percentage drop in floor price allowed from one week to the next, and

Q_{6t} is the Wool Commission stocks at the end of week t .

In the calculation of the floor price for the following week P_{3t+1} is first equated to $P_{3t}(1 - A_{14})$. This figure is then tested to see if it is greater or smaller than the reduction in the seasonal price due to the level of Wool Commission stocks i.e. $(P_5 - A_{16} Q_{6t})$. If less, then

$$P_{3t+1} = (P_5 - A_{16} Q_{6t})$$

If greater, then P_{3t+1} is left as initially determined.

The ceiling price is calculated similarly. If $P_{4t}(1 + A_{15})$ is less than $P_6 - (A_{17} Q_{6t})$, the drop in the seasonal ceiling due to the level of Wool Commission stocks, then $P_{4t+1} = P_4(1 + A_{15})$. If greater, then $P_{4t+1} = P_6 - (A_{17} Q_{6t})$.

For the determination of the flexible weekly floor and ceiling prices on a percentage basis, the new floor, P_{3t+1} , and ceiling, P_{4t+1} , are given by:

$$P_{3t+1} = \min (P_{3t}(1 - A_{14}), P_5(1 - A_{14})) \quad (18)$$

$$P_{4t+1} = \max (P_{4t}(1 + A_{15}), P_6(1 + A_{15})) \quad (19)$$

Initially the weekly floor price is compared to the seasonal floor price. If P_3 is less than P_5 then:

$$P_{3t+1} = P_5(1 - A_{14}),$$

If greater, then:

$$P_{3t+1} = P_{3t}(1 - A_{14}).$$

The rises in the ceiling price are determined in a similar manner.

5.4.4.4 Flexible Seasonal Floor and Ceiling Price Policies

In the evaluation of the seasonal floor and ceiling prices, the calculations incorporate both the percentage, and the level of Wool Commission stocks effects. Initially, P_7 is calculated from:

$$P_7 = (1 + A_{22}) P_5 + (A_{20} Q_6) \quad (20)$$

where

A_{20} is the linear effect of Wool Commission stocks on the annual floor price, and

A_{22} is the annual increment of the floor price if there are no stocks.

This equation therefore measures the maximum change in the floor price. If this exceeds the maximum allowable increase in seasonal floor, then the new seasonal "target" floor price, P_{5s+1} , is given by:

$$P_{5s+1} = P_{5s}(1 + A_{18}) < P_7$$

where

A_{18} is maximum percentage change in the floor between seasons, and

P_{5s} is the target floor price for the s^{th} season.

If it could result in a bigger drop than the maximum permissible change in the seasonal floor, then

$$P_{5s+1} = P_{5s}(1 - A_{18}) \geq P_7$$

Thus

$$P_{5s}(1 + A_{18}) \geq P_{5s+1} \geq P_{5s}(1 - A_{18}) \quad (21)$$

If either relationship holds as an equality, the equality is used to define P_{5s+1} . If (21) holds as a strict inequality, then P_{5s+1} is defined as equal to P_7 in (20).

The ceiling is determined, using the same procedure, from:

$$P_9 = (1 + A_{23}) P_6 + (A_{21} Q_6)$$

where

A_{21} is the linear effect of Wool Commission stocks on the annual ceiling, and

A_{23} is the annual increment of ceiling price if zero stocks.

This equation therefore measures the maximum change in the seasonal ceiling price. If this exceeds the maximum allowable rise in the seasonal ceiling price, then the new seasonal "target" ceiling price is

$$P_{6s+1} = P_{6s}(1 + A_{19}) < P_9$$

where

A_{19} is the maximum allowable percentage change in the ceiling between seasons, and

P_{6s} is the target ceiling price in the s^{th} season.

If the fall in the seasonal ceiling exceeds the maximum allowable fall

then

$$P_{6s+1} = P_{6s}(1 - A_{19}) > P_9$$

Otherwise

$$P_{6s+1} = P_9$$

Thus

$$P_{6s}(1 + A_{19}) \geq P_{6s+1} \geq P_{6s}(1 - A_{18}) \quad (22)$$

The model thus provides for both some response of seasonal floor to Wool Commission stocks, and some movement of the floor within a season. This completes the discussion on the rigid and flexible floor and ceiling price policies which have been incorporated in the model.

5.4.5 Wool Commission Inventory Equation

The Wool Commission inventory equation ensures that the closing wool inventory (at the end of the week) is equal to the opening inventory plus purchases (or sales):

$$Q_{6t+1} = Q_{5t} + Q_{6t}; \quad Q_{5t} \geq -Q_{6t} \quad (23)$$

where

Q_{5t} is the Wool Commission's purchases (if positive) or sales (if negative) in week t , and Q_{6t} is the Wool Commission's stock of wool at the beginning of week t .

5.4.6 Normal Trade Demand Equation

This function measures the demand for wool which is a function of price only, and is independent of the Wool Commission's activity (apart from the Wool Commission's effect on price). Since little information is available on what form this function should take two forms were chosen. These were a linear demand function and constant elasticity demand function.

Models were developed to incorporate each of these functions. The models which incorporated the constant elasticity of demand function were termed WMSM*5 (Wool Marketing Simulation Model 5) and WMSM*7. The models

which incorporated the linear demand function were termed WMSM*4 and WMSM*6. The difference between the two models for each demand function is given below in the discussion of summary measures.

5.4.6.1 Constant Elasticity of Demand Model

In an earlier discussion (Section 5.3.2) the normal trade demand equation was given in equation (4) as:

$$Q_2 = A_2 (B_3 P_2^{A_1}) \quad (24)$$

where

A_1 is the price elasticity of demand - a parameter,

A_2 is the shift in the normal trade demand due to the stabilisation of prices achieved by the Wool Commission, and is also a parameter,

B_3 is shift parameter specifying the demand curve in a given week ($= Q_1/P_1^{A_1}$), and

P_2 is the simulated price in a given week.

If the "stabilising" effects of the Wool Commission's activities is taken to expand demand for wool from mills and final consumers, then A_2 should be greater than 1. If the "interference" of the Wool Commission's stabilising activities is taken to depress the normal trade demand for wool from mills and consumers, then A_2 should be taken as less than 1.

Equation (24) is used directly in WMSM*5 and WMSM*7.

5.4.6.2 Linear Demand Model

The constant elasticity demand equation with no Wool Commission interference is:

$$Q_1 = A_2 B_3 P_1^{A_1} \quad (25)$$

where

Q_1 is the observed quantity sold in a given week,

P_1 is the observed price in a given week, and

$A_2 = 1$, by assumption.

The first step in deriving the linear demand schedule is to determine the slope at the point with the coordinates (P_1, Q_1) . This is calculated by taking the first derivative of equation (25) with respect to P_1 , on the assumption that $A_2 = 1$, i.e. $\frac{\partial Q_1}{\partial P_1}$.

This gives:

$$\frac{\partial Q_1}{\partial P_1} = B_2 = A_1 B_3 P_1^{A_1 - 1} \quad (26)$$

where

B_2 indicates the slope of the normal trade demand equation in the i^{th} week.

On the assumption of a linear demand schedule, the slope at the point (P_2, Q_2) is the same as at the point (P_1, Q_1) .

Therefore:

$$\frac{\partial Q_1}{\partial P_1} = \frac{\partial Q_2}{\partial P_2} = B_2$$

The form of the linear demand equation without the Wool Commission having any effect on the wool market is:

$$Q_1 = B_1 + B_2 P_1 \quad (27)$$

where B_2 can be found as discussed above.

Rearranging, (27) B_1 - the intercept on the Q axis - can be found:

$$B_1 = Q_1 - B_2 P_1 \quad (28)$$

Therefore the quantity that the trade takes at the simulated price, by including the effect of the Wool Commission's activities, can be calculated as:

$$Q_2 = A_2 (B_1 + B_2 P_2) \quad (29)$$

5.4.7 Calculation of Simulated Price

5.4.7.1 Constant Elasticity of Demand Model

The auction identity is:

$$Q_3 = Q_2 + Q_4 + Q_5$$

where

$$Q_5 = 0 \text{ if } P_2 > P_3, \text{ and if } Q_6 = 0.$$

In the first instance assume $Q_5 = 0$. In this case:

$$Q_3 = Q_2 + Q_4 \quad (30)$$

where

$$Q_2 = A_2 (B_3 P_2^{A_1})$$

$$Q_4 = \max (B_4, -Q_7)$$

(i) If $Q_4 = B_4$, then:

$$Q_4 = -Q_1 (A_3 Q_6 + A_4 (P_2 - P_1) + A_5 Q_7)$$

and from (30)

$$Q_3 = A_2 (B_3 P_2^{A_1}) - Q_1 (A_3 Q_6 + A_4 (P_2 - P_1) + A_5 Q_7) \quad (31)$$

Equation (31) cannot be solved for P_2 easily since it is in the form of a polynomial. This would take too long to solve using normal analytical methods hence an iterative procedure was employed.

The iterative procedure used in this situation was "Newton's Method".

Rewriting equation (31):

$$f(P_2) = A_2 B_3 P_2^{A_1} - Q_1 A_4 P_2 - Q_3 - Q_1 (A_3 Q_6 - A_4 P_1 + A_5 Q_7) \quad (32)$$

The aim of this method is to determine where the curve AB, in Figure 5.1 which graphs $f(P_2)$ as a function of P_2 , cuts the P_2 axis, or the value of P_2 for which $f(P_2) = 0$; i.e. the appropriate root of $f(P_2)$. The first approximation in the iterative procedure is P_1 , the observed price. The slope of the curve AB where $P_2 = P_1$ is determined, then extrapolated to the P_2 axis,

and the value of P_2 at D becomes the second approximation. In mathematical terms this is given by:

$$D = P_1 - (f(P_2)/f^1(P_2)) \quad (33)$$

where

$f^1(P_2)$ is the first partial derivative of $f(P_2)$ with respect to P_2 .

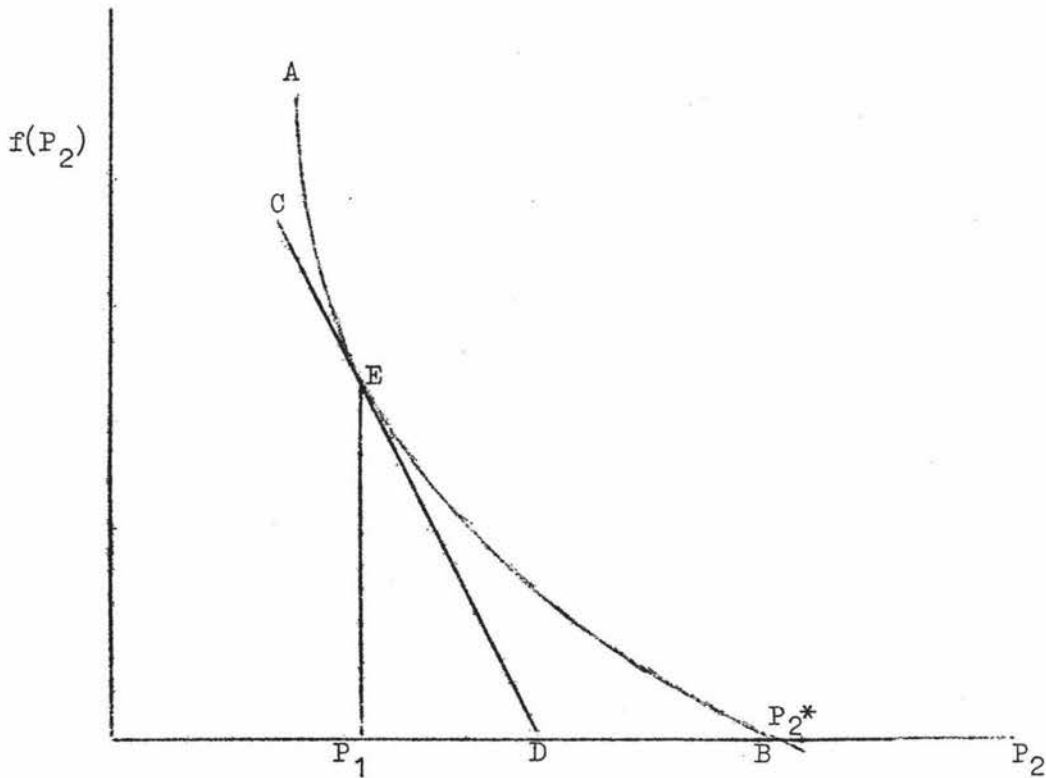


FIGURE 5.1 ITERATIVE CALCULATION OF SIMULATED PRICE

(The only restriction on the use of this method is that the curve AB must increase or decrease monotonically from the first approximation to the appropriate root of $f(P_2)$; i.e. P_2^*). This process of successive numerical approximation is continued until the point P_2^* is reached. The simulation programme is written to iterate the value of P_2 until it comes within 0.001 cent of the correct root of the simulated price, P_2 , in the polynomial in equation (33).

(ii) If $Q_4 = -Q_7$, then

$$Q_3 = Q_2 - Q_7, \quad (34)$$

$$\begin{aligned} \therefore Q_3 &= A_2(B_3 P_2^{A_1}) - Q_7, \\ \therefore P_2 &= \left(\frac{Q_3 + Q_7}{A_2 B_3} \right)^{\frac{1}{A_1}}, \end{aligned} \quad (35)$$

and P_2 can be calculated directly.

5.4.7.2 Linear Demand Model

For the linear demand model the auction identity takes the form:

$$Q_3 = Q_2 + Q_4 + Q_5$$

Again assume $Q_5 = 0$, and hence that

$$Q_3 = Q_2 + Q_4$$

where

$$Q_2 = A_2(B_1 + B_2 P_2)$$

$$Q_4 = \max(B_4, -Q_7)$$

(i) If $Q_4 = B_4$, then

$$Q_4 = -Q_1(A_3 Q_6 + A_4(P_2 - P_1) + A_5 Q_7)$$

$$Q_3 = Q_2 + Q_4$$

$$\therefore Q_3 = A_2(B_1 + B_2 P_2) - Q_1(A_3 Q_6 + A_4(P_2 - P_1) + A_5 Q_7)$$

$$P_2 = \frac{Q_3 - A_2 B_1 + Q_1(A_3 Q_6 - A_4 P_1 + A_5 Q_7)}{A_2 B_2 - Q_1 A_4} \quad (36)$$

(ii) If $Q_4 = -Q_7$, then

$$Q_3 = Q_2 - Q_7$$

$$Q_3 = A_2(B_1 + B_2 P_2) - Q_7$$

$$P_2 = \frac{Q_3 + Q_7 - A_2 B_1}{A_2 B_2} \quad (37)$$

In both the constant elasticity model and the linear demand model where the initial value of P_2 is less than the floor price or greater than the ceiling price, then the Wool Commission will maintain the floor price and

attempt to maintain the ceiling price (subject to stocks of wool being available). For the calculations of the simulated price, P_2 , under these conditions, the reader is referred to section 5.4.2 and to the flow diagrams in Appendix A.

5.5 Calculation of Financial Implications

In this part of the model, weekly changes in the financial position of the Wool Commission, the net speculators, and growers are calculated. The cumulative effects of these changes are also recorded.

- (a) The change (in \$ millions) in the Wool Commission's total cash balance in a given week is calculated as:

Interest for the week on opening¹² total cash balance
 plus value of sales,
 less value of purchases,
 less storage cost on opening inventory, and
 less insurance cost on opening inventory.

The weekly interest rate is given by:

$$B_5 = (1 + A_{11})^{\frac{1}{52}} - 1 \quad (38)$$

where

A_{11} is the annual interest rate - a parameter, and

B_5 is the weekly interest rate.

The interest on the opening cash balance is calculated by $(B_5 R_2)$ where R_2 is the opening cash balance. There is no restriction on R_2 being positive. If R_2 is negative, then the term $(B_5 R_2)$ is negative indicating payment of interest rather than receipt of interest.

The cash effect of Wool Commission purchases and sales of stocks, Q_5 , were calculated as $(- .00325 P_2 Q_5)$.

If the Wool Commission purchases wool then Q_5 ¹³ is positive and the

12. Opening = at the start of the week.

13. All quantities in this model are in ,000 of 325 lb. bales.

The insurance cost for wool was therefore 22.5 cents/\$100/year.

The value of wool held by the Wool Commission is given by

$$325,000 \cdot Q_6 \cdot P_2 \text{ cents/},000 \text{ bales.}$$

The insurance cost on a weekly basis is

$$\frac{22.5}{52} \quad 32.5 \quad Q_6 \quad P_2 \text{ cents/},000 \text{ bales/week}$$

$$\text{or} \quad 14.0625 \quad Q_6 \quad P_2 \text{ cents/},000 \text{ bales/week}$$

$$\text{or} \quad 0.000000140625 \quad Q_6 \quad P_2 \text{ \$/},000 \text{ bales/week.}$$

(b) Similar calculations were made to evaluate the change in the net speculative cash balance using the same insurance and storage costs as for the Wool Commission.

(c) The hidden gains and losses accruing to growers in a given week due to the Wool Commission's activities were measured by

$$R_5 = Q_3 (P_2 - P_1) 0.00325$$

where

R_5 is the hidden gains and losses to growers in \$ millions in a given week, and

Q_3 is the total wool sold by growers in that week.

The cumulative effects of changes in the Wool Commission cash balance, the net speculative cash balance, and hidden gains and losses to growers are also recorded. For the hidden gains and losses to growers this was done by summing and by compounding.

By summing

$$R_{6t+1} = R_{5t} + R_{6t} \quad (39)$$

where

R_{5t} is the hidden gains (or losses) to growers in week t , and

R_{6t} is the total sum of hidden gains and losses to growers at the beginning of the t^{th} week.

By compounding

$$R_{7t+1} = R_{7t}(1 + B_5) + R_{5t} \quad (40)$$

where

R_{7t} is the compounded value of hidden gains and losses at the beginning of week t , and

B_5 is the weekly interest rate.

The final value of this variable obtained by summation assumes that the sequence gains and losses could have occurred with equal probability in any order. The final compounded value gives the profit or loss to growers for the exact order in which weekly gains and losses happened to occur.

5.6 Inclusion of Summary Measures

The purpose of summary measures is to indicate the performance of the model (or more specifically the computer programmes) for different parameter combinations, over the period for which data was available. This is in line with the overall aim of the study which is to provide simulation programmes which will describe and summarise the performance of the New Zealand wool market under a variety of parameter assumptions (in particular, Wool Commission floor and ceiling price policies).

The results from the quantitative balance and financial calculations can only answer a limited number of questions which one could pose of the effect of a particular parameter combination. The mean and variance and/or maximum and minimum values of some of the variables generated within the model may also be of interest, and hence can be considered as potentially useful summary measures.

5.6.1 Available Summary Measures

The simulation programmes WMSM*4 (linear demand) and WMSM*5 (constant elasticity of demand) include a large number of summary measures. The output from the operation of these programmes, where the results for all of the

summary measures are recorded, is unsatisfactory since an embarrassingly large amount of information is provided. For this reason a limited number of summary measures were chosen, and WMSM*4 was re-written to incorporate only these summary measures in order to save computer time, giving a new programme WMSM*6. Similarly, WMSM*7 was derived from WMSM*5.

The available summary measures provided in WMSM*4 and 5 were:

- (i) Weekly calculations,
- (ii) Maximum and minimum values, both seasonally and overall together with the date for: Wool Commission's cash balance and cash and asset balance; net speculative cash balance, and cash and asset balance; compounded, and total hidden gains and losses to growers,
- (iii) The maximum value both seasonally and overall together with the date for: simulated price; Wool Commission stocks of wool; net speculative stocks of wool,
- (iv) The seasonal and overall value for the variance of: simulated price; Wool Commission funds, funds and assets; total, and compounded hidden gains and losses to growers; net speculative funds and assets,
- (v) The seasonal and overall average of: weighted simulated price; Wool Commission funds, funds and assets; net speculative cash and asset balance; total, and compounded hidden gains and losses to growers,
- (vi) Final week calculations of: Wool Commission's stocks, funds; net speculative cash and asset balance; total, and compounded value of hidden gains and losses to growers,
- (vii) Overall variance of seasonal foreign exchange earnings (taken as a ratio of the variance of seasonal foreign exchange earnings without a Wool Commission policy operating), the average seasonal foreign exchange earnings (again in terms of a ratio), the maximum addition to and reduction in foreign exchange earnings in any one year, and
- (viii) The seasonal and overall categories of the level of weekly Wool

Commission and net speculative stocks.

The overall averages were found by summing a particular statistic for each week of the entire period and dividing by the number of weeks in that period. The average price, however, was weighted and calculated only for the weeks in which wool was sold. Therefore:

$$X_3 = \frac{\sum_{j=1}^N (P_2 (Q_2 + Q_4))}{N (Q_2 + Q_4)} \quad (41)$$

where

P_2 is the simulated price,

Q_2 is normal trade demand,

Q_4 is net speculative demand, and the summation is over the weeks in which wool was sold,

X_3 is the overall average price, and

N is the number of weeks in which wool was sold.

In general terms the variances were determined by:

$$\text{Var } X = \frac{\sum_{j=1}^N (X_j - (\sum_{j=1}^N X_j / N))^2}{N-1} \quad (42)$$

where

X is the weekly observations of the appropriate summary measure,

N is the number of observations.

The calculation of the variance of price was restricted to those weeks in which wool was sold.

In evaluating the summary measures of foreign exchange earnings it was assumed that the Wool Commission stocks would remain in New Zealand and that the net speculative and normal trade demand stocks would be exported. Since this variability is calculated as a ratio, it is sufficient that a constant proportion of normal trade and net speculative demand be exported. The sales of net speculative stocks affects the simulated price, not by passing physically through the New Zealand auction system, but rather by these stocks reducing

demand at auction. The normal trade demand acquires its wool either from the New Zealand auctions, or from the release overseas of net speculative stocks previously acquired through the auctions.

5.6.2 Summary Measures Reported

If all the available summary measures mentioned above were recorded then, even excluding the weekly calculations, over 560 seasonal and 40 overall summary measures would be listed for each run of the simulation model. Apart from being difficult to handle, many of the summary measures which could be recorded do not provide useful information for the purpose of this study. They may, however, be quite relevant for a study with a different objective. In section 3.6 a number of summary measures were isolated which are thought to adequately summarise the performance of the wool market under alternative Wool Commission floor and ceiling price policies.

The summary measures which were isolated were:

- (i) Did the Wool Commission's policy raise wool prices at auction?
- (ii) Did the policy reduce the variance of wool prices?
- (iii) Did the Wool Commission have sufficient funds to maintain its policy?
- (iv) Did the Wool Commission make a profit?
- (v) Did growers make a profit?
- (vi) Did the Wool Commission's profit and grower's profit exceed Wool Commission losses and grower losses?
- (vii) Did the net speculators make a long term profit?
- (viii) Did the floor and ceiling price policy increase or reduce the variance in foreign exchange earnings from wool?

Most of these measures are self-explanatory, but it should be noted that ending stocks provide a problem in the evaluation of Wool Commission profit. This summary measure is obtained by subtracting the initial level of Wool Commission funds from the overall average level of these funds. Final

stocks are given zero value since with an inelastic demand their value is less than that measured at market price, and it is not appropriate to use "market price" if this price is being supported by holding wool off the market.

Grower and Wool Commission profit is calculated both by compounding and summation to allow for the two interpretations of Wool Commission profits (as in section 3.6). With the summary measures listed in this section it is possible to measure the success, or otherwise, of Wool Commission floor and ceiling price policies.

CHAPTER 6

REALISM OF THE MODEL

6.1 Introduction

In Chapter 4 the form of inference from a single simulation run was stated to be:

"Given the model ..., if these are the appropriate parameter values ..., then the result from the simulation run is what the result in the real world would have been ..."

It can be argued that the model developed in the preceding chapter is oversimplified, and is not a realistic description of the complex forces which dictate the formation of wool prices at auction.

This chapter gives detailed consideration to the realism of the model. At the outset it should be understood that it is not argued that the model will provide a perfect answer, but rather the model is a sufficiently realistic approximation of the operation of the wool auctions in New Zealand under alternative Wool Commission floor and ceiling price policies that it provides useful inferences as to the likely impact of alternative policies on the wool auctions.

The approach followed in this chapter is to comment on the realism of each of the four functions in the quantitative balance. These four functions are:

- the Supply Function,
- the Normal Trade Demand Function,
- the Wool Commission Demand/Supply Function, and
- the Net Speculative Demand/Supply Function.

The chapter not only provides a criticism of the assumptions made in the model, but also discusses other assumptions which could be postulated, and how they would be incorporated in the model. The validity of the net speculative demand/supply function, in particular, is examined closely, and several

reformulations of this function are suggested.

6.2 Supply Function

The present specification of the grower's supply function is given by the identity:

$$Q_3 = Q_1 \quad (1)$$

where

Q_1 is the observed sales, in ,000 bales, at auction in a given week, and

Q_3 is the quantity, in ,000 bales, supplied onto the market in a given week.

This function assumes that the supply of wool is completely inelastic; that is, in a given week the grower's supply of wool at auction will not alter as a result of the Wool Commission's activities, or altered auction prices.

In the short run the present specification of the supply function is adequate since it is unlikely that the supply of wool will alter within a season in response to changed conditions at auction. Given that the production of wool is largely a function of sheep numbers, and that there is little storage of wool by growers from one season to the next, then the supply of wool is unlikely to be changed by changes in the conditions at auction. In the longer run, however, changes away from the observed trend in the supply of wool may occur as a result of price support or price stabilisation.

If the Wool Commission supports the average price paid to the New Zealand growers above average New Zealand auction price, then in time the simulated supply of wool may increase at a faster rate than the trend. Decreased price variability could also affect production (positively or negatively).

The case where stabilised and/or increased average price leads to an increase in growers' supply could be treated as follows:¹

1. The situation where prices paid to growers are supported above New Zealand auction prices can be treated similarly.

$$Q_3 = A_{26} Q_1 \quad (2)$$

where

A_{26} is a parameter indicating the change in wool supplied by growers in a given week.

If $A_{26} = 1$, there is no change in the supply of wool. If A_{26} is greater than 1 there is an increase in the supply of wool, if less than 1 there is a fall in supply.²

Alternatively, the difference between actual and simulated supply could be expressed as:

$$Q_{3S} = Q_{1S} + A_{27} P_{s-r}$$

where

P_{s-r} is the average price for season s-r, and

A_{27} is a parameter indicating the effect of the average price in season s-r on the quantity supplied in season 3S.

In the situation where stabilised prices lead to increased production, the average price of wool is likely to fall. This suggests that to growers there is some "trade off" between average price and variability of price.

In the situation where stabilised prices lead to increased production and increased consumption the effect on average price depends on how strong the two reactions are.

6.3 Normal Trade Demand Function

The normal trade demand function refers to that demand for wool (for both manufacturing and speculative purposes) which is a simple function of price, and is unaffected by the Wool Commission's activities. Allowance is made, however, for long term expansions or contractions in the normal trade demand owing to the intervention of the Wool Commission in the wool auctions. The net speculative demand/supply equation refers to the demand for wool which

2. In the long run supply is likely to be more price elastic with rising prices than with falling prices.

is the net effect of the Wool Commission changing the conditions existing in the auction market.

Two normal trade demand equations have been specified in the model, one with a linear demand schedule the other with a constant elasticity of demand. The two equations are:

a) Linear normal trade demand equation

$$Q_2 = A_2 (B_1 + B_2 P_2) \quad (3)$$

where

Q_2 is the quantity demanded by the normal trade demand in a given week,

B_1 is the intercept on the Q axis,

B_2 is the slope of the normal trade demand schedule,

P_2 is the simulated price, and

A_2 refers to the expansion or contraction in normal trade demand due to the Wool Commission's activities.

b) Constant elasticity normal trade demand equation

$$Q_2 = A_2 (B_3 P_2^{A_1}) \quad (4)$$

where

B_3 is the shift parameter for the week.

Difficulties inherent in specifying the normal trade demand function have been discussed in section 3.4.4. The conclusion reached in that section was that neither a linear nor a constant elasticity demand function was likely to be entirely accurate since the price elasticity of demand is likely to change significantly through periods of high and low prices, and even within periods of high or low prices. Because of the lack of empirical information on this subject, however, a more realistic normal trade demand function cannot be specified. In order to construct an operational simulation model of the wool market, some assumption must be made as to the elasticity of demand.

By including both normal trade demand equations, and running each for a range of values of price elasticity, a range of results can be obtained. Further, by including the parameter A_2 it is possible to test the effect (in terms of the essential summary measures) of the "interference" of the Wool Commission in the New Zealand wool market causing a long term contraction in demand ($A_2 < 1.0$), or, of making wool a more attractive raw material, through the stabilisation of price achieved by the Wool Commission, causing a long term expansion in demand ($A_2 > 1.0$).

It may be mentioned now, that within the context of the model used in this thesis there can be no doubt that A_2 , the expansion/contraction effect of the Wool Commission's activities, is the key parameter.

6.4 Wool Commission Demand/Supply Function

The present specification of the Wool Commission demand/supply function can be summarised as follows:

- (i) the Wool Commission holds the floor price, by borrowing from the Government if necessary,
- (ii) the Wool Commission does not interfere in the wool market if the simulated price is between the floor and the ceiling, or is above the ceiling and the Wool Commission has no stocks, and
- (iii) the Wool Commission sells sufficient wool to hold the ceiling, subject to stocks being available. If insufficient stocks are available then the Wool Commission places all its stocks on the market, and holds the price as low as possible.

Given these decision rules, the important aspect of the Wool Commission demand/supply function becomes the manner in which the weekly and seasonal floor and ceiling prices are set. A number of rigid or flexible floor and ceiling price policies have been incorporated in the model. With the appropriate choice of parameter values, the floor and ceiling prices can be constant for the entire period under consideration. The floor and ceiling prices can be

varied weekly on a percentage basis or according to the level of Wool Commission stocks. Between seasons, the floor (or the ceiling) can be varied according to: the increase in the floor (or in the ceiling) if there are zero Wool Commission stocks, the lowering of the floor (or ceiling) due to the high level of Wool Commission stocks, and the maximum allowable increase or decrease in the floor price (or ceiling price) between consecutive seasons.

In considering the realism of the Wool Commission demand/supply function the only real question is whether there is sufficient flexibility in the policies which can be employed to alter the floor and ceiling prices. It is possible that the floor and ceiling prices could be varied, not only on a weekly or seasonal basis, but also on a monthly or quarterly basis.

A sliding floor and ceiling price policy could be included in the model. In the case of the floor, the Wool Commission would purchase a progressively higher proportion of the clip as simulated price fell towards the floor. For instance, the Wool Commission would purchase 2% of the wool being sold in a given week if the simulated price was 4 cents above the floor, and an extra 2% for every one cent fall in the simulated price. There would be two effects on the demand for wool. Firstly, since the quantity of wool being sold is reduced the simulated price will rise due to the normal trade demand function being negatively sloped. Secondly, net speculative activity may increase, through the parameter A_6 being positive.

While the operation of the simulation model generates considerable information on how a flexible floor and ceiling price policy will affect prices at auction, it may be argued that the variance in price, as a summary measure, does not adequately describe how the simulated price series differs from the observed price series. The documentation of wool price fluctuations given in section 2.3 indicates that the observed fluctuations in price are made up of cycles of varying lengths of time. The total variability in wool prices may, for instance, be classified in terms of short term, medium term and long term

movements in prices. A question the policy maker may ask is: "Which cycles does a flexible floor and ceiling price policy dampen or eliminate?" Should such a question be posed then the overall variance in price will not provide the desired information, and it may be necessary to resort to a sophisticated technique such as spectral analysis (18).

From the viewpoint of the present model, the representation of alternative floor/ceiling price policies is the least of the problems. Given any fully specified (actual) Wool Commission purchase/sale strategy, relatively minor modifications of the model would allow the policy to be modelled exactly, at least to the extent that it operated on average price. Support policies which concentrated on the relative worth of individual types could not, of course, be represented in the present model.

6.5 Net Speculative Demand/Supply Function

The purpose of the net speculative demand/supply function is to reflect the net effect of the Wool Commission's activities on the speculative demand for wool. The function includes those variables which indicate how the demand by the wool trade will respond to changed conditions in the New Zealand auctions due to the presence of the Wool Commission. Since the function is concerned exclusively with speculative demand it deals with short term changes in demand, and in the long term leaves overall demand unchanged; what the speculator buys, he must eventually sell.

The present specification of the net speculative demand/supply function is as follows:

$$B_4 = -Q_1 (+A_6 + A_3 Q_6 + A_4 (P_2 - P_1) + A_5 Q_7) \quad (5)$$

$$Q_4 = \max (-Q_7, B_4) \quad (6)$$

where

B_4 is the desired net speculative demand in a given week,

P_2 is the simulated New Zealand auction price,

P_1 is the observed "world equilibrium" price,

A_3, A_4, A_5 are parameters, and have a linear effect on the variables they are associated with,

A_6 indicates the change in net speculative activity when the simulated price is at the floor or ceiling,

Q_1 is the observed quantity sold in a given week,

Q_4 is the actual net speculative demand in a given week,

Q_6 is the opening level of Wool Commission stocks, and

Q_7 is the opening net speculative stocks.

The desired net speculative demand tends to become negative if the Wool Commission holds stocks, if the simulated price at New Zealand auctions exceeds the (observed) world price, if net speculative stocks exist, or if the simulated price is at the ceiling. The desired net speculative demand tends to become positive if the (observed) world price exceeds the simulated price at New Zealand auctions, or if the simulated price is at the floor. Actual net speculative purchases are unrestricted, but sales are subject to net speculative stocks being available.

The validity of the present specification of the net speculative function is open to question. The present formulation of this function has been justified largely on the basis of a priori reasoning, and it is quite possible that further variables could be included, or that a more complex relationship between the present variables could be postulated. Although some difficulty existed in deciding on the form of this function, its inclusion was considered desirable, firstly, because some reaction to the Wool Commission's policy was considered likely, and, secondly, because the construction and operation of a simulation model of the wool auction provide a means of generating information on the effect of different levels of net speculative activity. The effect of the net speculative function on the model can, of course, be eliminated by equating A_3, A_4, A_5 and A_6 to zero.

The inclusion of a Net Speculative Demand Function was amply justified in the present study by the finding that within the context of the present model the results obtained are not sensitive to the selection of the parameter values in (5). As stated earlier the dominant parameter in the model is A_2 , and any case for altered Wool Commission policies over the period studied would need to rest on its effect in expanding the manufacturer's demand for wool.

In the ensuing discussion a number of alterations to the present specification of the net speculative function are suggested. One undesirable feature of this function has already been noted (in Chapter 5, footnote 10). If $A_2 < 1$, with certain values of the parameters A_4 and A_5 , the model could produce an unstable "see-saw" effect. In one week with zero net speculative stocks ($Q_7 = 0$) the simulated price would be below the observed price ($P_2 < P_1$), and hence net speculative demand would be positive thus raising the simulated price. In the next period net speculators would have large stocks, and, if these depressed net speculative demand sufficiently, the net speculators could sell their stocks, forcing the simulated price down. If this "see-saw" effect did occur over a wide enough range of values of A_4 and A_5 , then some modification to the model would be necessary. The problem could be overcome by limiting the extent to which net speculators could raise price under these conditions.

When the simulated price is in the vicinity of the floor or the ceiling the net speculative function may be inadequately formulated. At the floor, for instance, with the present specification net speculative demand increases abruptly once the simulated price reaches the floor. Net speculative demand may increase more gradually as the simulated price falls towards the floor. This effect can be introduced by increasing the effect of A_6 in a stepwise fashion as the simulated price approaches the floor. More specifically, when the simulated price is 3 cents above the floor equation (5) could be rewritten

as:

$$B_4 = -Q_1 \left(-\frac{1}{4}A_6 + \dots \right) \quad \text{if } P_2 = P_3 + 3$$

Further:

$$B_4 = -Q_1 \left(-\frac{1}{2}A_6 + \dots \right) \quad \text{if } P_2 = P_3 + 2$$

and,

$$B_4 = -Q_1 \left(-\frac{3}{4}A_6 + \dots \right) \quad \text{if } P_2 = P_3 + 1.$$

The above alteration would probably increase the realism of the model but, except in the case where A_6 takes unreasonably large values, the alteration is likely to have a negligible effect on the overall results.

One could include the level of Wool Commission funds to explain some net speculative activity, however, since Wool Commission funds are highly and inversely correlated with Wool Commission stocks, the inclusion of Wool Commission funds would appear not to be an improvement.

By far the weakest aspect of the net speculative demand function is that it makes no provision for a "reversal of confidence" which may occur at the floor and ceiling. So long as the trade believes that the floor or ceiling will hold, net speculative demand is likely to reinforce the activities of the Wool Commission; but at some ill-defined point, the trade may cease to believe the floor or ceiling will hold, in which case they may rush to abandon or build stocks in a thoroughly destabilising manner which could well over-power the Wool Commission. This would not be in response to any organised conspiracy, but due to a general consensus in the trade as to likely future price movements.

Excluding the Wool Commission funds does ignore the possible change in net speculative activity when Wool Commission funds begin to run out. In this situation speculators may not enter the market as they expect the floor price to be lowered. These considerations suggest that net speculative activity could be viewed as a function of the extent of the Wool Commission's market operations. At the floor price, for instance, net speculative activity would

depend on Wool Commission purchases. If the Wool Commission purchased only a small amount of wool net speculative demand would be positive, whereas if the Wool Commission purchased a large proportion of the clip net speculative demand would become negative. Similarly, where Wool Commission sales at the ceiling were small net speculative demand would be negative, whereas if the Wool Commission sold large quantities of wool net speculative demand would be positive. This latter reaction would be particularly marked if Wool Commission stocks were running out. Between the floor and the ceiling Wool Commission activity is zero, and hence net speculative activity would also be zero. This alteration to the present specification of the net speculative function may increase the realism of the model, but again is unlikely to have a significant effect on the overall results.

With these comments on the realism of the model, attention is now turned to an analysis of the results obtained from the model.

CHAPTER 7

ANALYSIS OF SIMULATION RUNS

7.1 Introduction

Chapter 7 is comprised of two distinct parts. The first part provides an aid in interpreting the numerical results obtained from simulation runs.¹ The second part records the empirical results obtained, and summarises the conclusions that can be reached within the context of the model.

The performance function technique provides a means of estimating, from the results of a series of simulation runs, the functional relationship between the parameters being varied, and any specified summary measure. Given the estimated functional relationship, or performance function, the performance surface can be explored, providing information which otherwise would be difficult to obtain.

Given our estimates of the summary measures we can consider directional results for each summary measure. The directional results indicate whether, for a particular parameter combination, each summary measure was improved or made worse, relative to their actual value for the historical period 1952/53 through 1965/66. The "success" or otherwise of different parameter combinations can then be assessed.

7.2 The Performance Function Technique

In this section there is a discussion of: the aim of the performance function technique, the method of deriving performance functions, and the interpretation of the performance surface. The discussion follows that presented elsewhere by Candler and Cartwright (5).

1. The difficulties which arise in deriving conclusions from the present simulation study, together with the rationale for the method of inference used, have been discussed in section 4.5.3.1.

7.2.1 Aim of the Performance Function Technique

The aim of the performance function technique is to estimate, using regression analysis, the functional relationship between the parameters being varied and a particular summary measure. In the wool marketing simulation models an implicit functional relationship exists between the parameters being varied and the summary measures. This relationship can be written for any individual summary measure as:

$$P = f(X_1, X_2, \dots, X_n) \quad (1)$$

where

P is the performance (or outcome) of the summary measure,
 f refers to the implicit, or true, functional relationship, and
 (X_1, X_2, \dots, X_n) are the parameters being varied.

When the implicit, or true functional relationship, f , is unknown and cannot be determined analytically, the aim of the performance function technique is to approximate, within an appropriate region, the implicit or true functional relationship, f , by another functional relationship, g , which is estimated such that:

$$P = g(X_1, X_2, \dots, X_n) \quad (2)$$

The choice of the function, g , is at the discretion of the researcher. If there is no a priori information to suggest a particular functional form, then a symmetric polynomial function can be used.

The purpose of estimating the functional relationship between the parameters being varied and the summary measure, given in equation (2), is that it provides a complete summary of the shape of the performance surface (within the region being explored). An analysis of the performance function, g , can therefore generate information which would otherwise be difficult or impossible to obtain.

7.2.2 Derivation of the Performance Function

The method of estimating a performance function is now outlined in terms of a series of steps. These steps are:

- (a) Decide on a limited number of the parameters in the simulation model to vary, and hold the other parameters constant.

The numerical values of the parameters held constant are important. For example, setting $A_3 = A_4 = A_5 = A_6 = 0$ eliminates the net speculative demand/supply function from the calculations.

The reason for varying only a limited number of parameters is that the computational burden, in terms of the number of simulation runs required to estimate the performance function, rises exponentially as the number of parameters being varied increases.

- (b) Determine the range of values that each of the parameters being varied will take.

The range of values taken depends on the precision which is required or the biases which are acceptable in the performance surface. In general, however, the researcher is concerned with the derivation of the performance surface for all reasonable values of the parameters being varied.

- (c) Decide on a function which will provide an approximation of the true performance function.

The present study used a second order symmetric polynomial. The form of the polynomial where three parameters were varied was, for example:

$$\begin{aligned}
 P = & b_0 + b_1 X_1 + b_2 X_2 + b_3 X_3 + b_{11} X_1^2 + b_{22} X_2^2 \\
 & + b_{33} X_3^2 + b_{12} X_1 X_2 + b_{13} X_1 X_3 + b_{23} X_2 X_3 \quad (3)
 \end{aligned}$$

where

P = performance of summary measure,

X_1, X_2, X_3 are the parameters being varied, and

b_0, \dots, b_{23} are the regression coefficients which are to be

estimated.

In general, the higher the order of the polynomial fitted the better is the approximation to the true or implicit function, but also the greater the number of runs (or parameter combinations) that are required.

The choice of the general polynomial is pertinent to the situation where the researcher has little idea of the true functional relationship. A priori knowledge, where available, may suggest that another type of function would provide a better approximation of the true functional relationship.

- (d) Determine the experimental points, using experimental design theory, which would provide sufficient information to estimate the performance function.

A number of experimental designs have been developed for the purpose of efficiently (in terms of the number of experimental points required) estimating the performance function. These experimental designs which have the purpose of determining (approximately) the shape of the performance surface can be contrasted with experimental designs which have been developed for the purpose of investigating how output responds to a limited number of discrete changes in the inputs, and determining the interactions between inputs. The latter experimental designs are required for experiments where an analysis of variance is to be carried out, and here replication is needed, not to increase the accuracy of the analysis of variance but to increase the statistical significance.

Several of the experimental designs used to estimate performance surfaces are discussed in some detail by Heady and Dillon (24), and have been conveniently summarised by Dillon (11), and by Cartwright (8). The experimental design used in the present study to define the experimental points (or parameter combinations) was the central composite design, and in the ensuing discussion only this design will be described.

The central composite design involves taking five different levels for

each parameter - sufficient to estimate linear, quadratic and interaction effects. Where two parameter are being varied this can be expressed in the coded form as:

		0, a	
	-1, 1		1, 1
-a, 0		0, 0	a, 0
	-1, -1		1, -1
		0, -a	

(The five levels for each parameter are: -a, -1, 0, 1, a)

The choice of "a" in the above design depends on the biases which are acceptable, or the precision which is required. The choice of "a" can be made so that the design is orthogonal; that is, there is zero covariance between the regression coefficients being estimated. For the cases where 2, 3, 4 and 5 parameters are being varied, the partial requirement for orthogonality is that "a" takes the coded value 1, 1.215, 1.414 and 1.547 respectively. To complete the requirements for orthogonality it is necessary to fit a symmetric (second order) polynomial.

An example of a central composite design, both in the coded form and in natural units, can be seen in Table 7.1

In section 4.5.3.1 it was noted that there was some difficulty in deciding on what parameter combinations to insert into the simulation model. In the present study, for instance, there are over 20 parameters which can be varied. Even if the performance functions are not estimated, the use of the central composite design is helpful as it provides an orderly and methodical approach to choosing a series of parameter combinations.

(e) Run the simulation model for these parameter combinations.

An example of the results obtained, in terms of the ten summary measures, is shown in Table 7.1

- (f) Using least squares regression analysis, estimate the regression coefficients for the polynomial being fitted (e.g. b_0, \dots, b_{23} in equation (3)).

It is possible to assess the accuracy of the estimated performance function (in approximating the true functional relationship) from the level of R^2 , the coefficient of multiple determination, and from a "plot back."

The interpretation of R^2 is as follows. The least squares regression analysis fits the function specified to the data so as to minimise the sum of squares of the differences between the observed and estimated performance of a given summary measure. The value of R^2 is the ratio of the sum of squares explained by the regression over the total sum of squares. An R^2 of +1 indicates a perfect fit, while $R^2 = 0$ indicates there is a complete lack of fit and no explanation of the relationship between parameters and summary measures has been achieved. An R^2 of less than 1 is not caused by statistical errors in the function being approximated, but is due to "lack of fit", or the true (but unknown) form of the performance function being other than a second order polynomial.

The "plot back" calculates the difference between the estimated and the actual performance (as obtained from a simulation run) of the performance function. The estimated performance of a summary measure for a given parameter combination can be calculated from the performance function, while the actual value is obtained from the simulation model. The plot back provides useful information as it indicates whether there is an aberration or lack of fit in some section of the performance surface.

If the degree of fit, in terms of R^2 and the plot back, is not sufficiently good then, if desirable, it is possible to choose a higher order function, or fit the function over several smaller ranges of the parameters.

7.2.3 Analysis of the Performance Surface

The estimated performance function can be analysed to show:

(a) Performance Points.

It is possible to calculate the performance of a summary measure for any parameter combination (within the experimental region) from a knowledge of the function fitted, and the regression coefficients which were estimated.² This method is a less tedious means of generating information on the performance of different parameter combinations than inserting the parameter values into the simulation model.

(b) Sensitivity Analysis.

It is also possible to derive information on the slope of the performance surface at any point within the experimental region.

More specifically one can calculate how much, and in what direction the performance of a summary measure would change with a unit increase in a particular parameter.³

This is useful information as it enables one to see more fully what

2. If three parameters (X_1, X_2, X_3) are to be varied, the range over which each is to vary chosen, and the function to be fitted is specified as:

$$P = b_0 + b_1 X_1 + b_2 X_2 + b_3 X_3 + b_{11} X_1^2 + b_{22} X_2^2 + b_{33} X_3^2 + b_{12} X_1 X_2 + b_{13} X_1 X_3 + b_{23} X_2 X_3, \quad (4)$$

and regression coefficients $b_0 \dots, b_{23}$ have been estimated, then to estimate the performance point, P , for the parameter combination (X_1^*, X_2^*, X_3^*) we have:

$$\hat{P} = b_0 + b_1 X_1^* + b_2 X_2^* + b_3 X_3^* + b_{11} (X_1^*)^2 + b_{22} (X_2^*)^2 + b_{33} (X_3^*)^2 + b_{12} X_1^* X_2^* + b_{13} X_1^* X_3^* + b_{23} X_2^* X_3^*$$

where \hat{P} is the estimated value of P .

3. Given the function specified in footnote 2, the sensitivity of a summary measure to a change in a given parameter is evaluated by calculating the first partial derivatives of the function with respect to the parameters. The effect of a unit increase in X_1 on P is estimated by calculating the first derivative with respect to X_1 i.e. $\frac{\partial P}{\partial X_1}$.

$$\frac{\partial P}{\partial X_1} = b_1 + 2b_{11} X_1 + b_{12} X_2^* + b_{13} X_3^* \quad (5)$$

The effect of a unit change in X_2^* and X_3^* on P can be found similarly.

effect each of the parameters being varied has on a given summary measure. Without the (at least implicit) calculation the performance function, this information could not be obtained. Examples of sensitivity analysis can be seen in Table 7.7.

(c) Break Even Points.

The aim of this method is to find points on the performance surface, or parameter combinations, where there is zero performance. Such points are determined, in the three parameter case, by holding two of the parameters constant, and deriving the value of the third parameter which would give zero performance for the summary measure of interest.⁴

(d) Determination of maximum, minimum and saddle points.

The performance function can be analysed further by determining what combinations of values of the parameters being varied give maximum, minimum and saddle points⁵ (stationary points) on the performance surface (if they

4. Given the function specified in footnote 2, if X_2^* and X_3^* are held constant, and if $P = 0$ (zero performance) then this equation can be rearranged and expressed as:

$$0 = (2b_{11})(X_1)^2 + (b_1 + b_{12} X_2^* + b_{13} X_3^*) X_1 + (b_0 + b_2 X_2^* + b_{22}(X_2^*)^2 + b_{33}(X_3^*)^2 + b_{23} X_2^* X_3^*) \quad (6)$$

This equation takes the form of a quadratic and can be solved for X_1 accordingly. The general form of a quadratic is:

$$0 = ax^2 + bx + c$$

The roots x_1, x_2 of the quadratic are:

$$x_1, x_2 = \frac{1}{2a} (-b \pm \sqrt{b^2 - 4ac})$$

If $b^2 < 4ac$, there are no real roots indicating that no value of X_1 will satisfy (6) above.

5. Saddle points occur where maximum and minimum points coincide.

exist).⁶

Where some of the parameters being varied are structural parameters (the actual values of which are not within the control of the researcher) the researcher is not faced with an optimisation problem. Determining the stationary point may, however, provide interesting information.

In all four methods of interpreting the performance surface, inference from the performance function is only valid within the range of parameter values taken for the simulation runs. Extrapolation of the performance surface outside these values can lead to erroneous conclusions.

By the use of the performance function technique we can infer the value of any summary measure within the relevant range of parameter values.

7.3 Indices of Success

In trying to evaluate the results of the simulation runs we can ask a number of questions, such as:

- (a) Did the policy stabilise and/or raise price?
- (b) Did the Wool Commission have sufficient funds to maintain its policy?
- (c) Did the net speculators make a long term profit?
- (d) Did growers make a profit?
- (e) Did the Wool Commission make a profit?

6. Given the function specified in footnote 2, the procedure for determining a stationary point is to set the first order partial derivatives to zero. That is:

$$\frac{\partial P}{\partial X_1} = b_1 + 2b_{11} X_1 + b_{12} X_2 + b_{13} X_3 = 0 \quad (7)$$

$$\frac{\partial P}{\partial X_2} = \dots\dots\dots = 0 \quad (8)$$

$$\frac{\partial P}{\partial X_3} = \dots\dots\dots = 0 \quad (9)$$

This gives three simultaneous equations in three unknowns and provided the equations are independent can therefore be solved for values of X_1 , X_2 , X_3 .

- (f) Did Wool Commission profit and grower profit exceed Wool Commission losses and grower losses?
- (g) Was the variance in foreign exchange earnings from wool increased or decreased?

Such queries were raised in section 3.6 in order to suggest important summary measures and were defined in terms of the variables in the model in section 5.6.2.

The summary measures have not been ranked in order of importance, and it is necessary to examine the performance of the summary measures individually.

To simplify the comparison of the performance of different parameter combinations with what actually happened at auction in the period 1952/53 through 1965/66 the directional results rather than the numerical results of the simulation runs have been recorded. For a given parameter combination, the directional results involve placing a tick beside summary measures which improved, and placing a cross beside summary measures which became worse. An example of this is shown in Table 7.15. Employing the central composite design to define parameter combinations provides an orderly approach to selecting a series of parameter combinations.

Once the directional results of a series of simulation runs are recorded it is possible to see which parameter combinations result in an answer "Yes" (or tick) to the questions (a) to (g) above.

If every set of parameters gave a "yes" to every question it could be concluded that almost any floor/ceiling price scheme would have been an improvement over the present auction procedure. The aim would then be to find the policy which gave the biggest series of "yes" answers.

If every set of parameters gave an answer "no" to at least one of the questions posed above, it could be concluded that the marketing system would best be left alone.

If definite trends in the results could be established, corresponding inferences may be made. If very mixed results were obtained, it might not be

possible to isolate any important factors in the operation of the auction market.

7.4 Numerical Results

In this section the numerical results obtained from a series of simulations are presented. In addition, a limited number of the results which were obtained from the analysis of the estimated performance functions are recorded.

7.4.1 Analyses Performed and Information Recorded

To test the performance of the model for different parameter combinations, four sets of analyses were performed. For each set of analyses a limited number of parameters were varied and the rest were held constant. The parameter combinations were defined by a central composite design, and were run for both the linear and the constant elasticity of demand simulation models. More specifically, the four sets of analyses to be reported are:

- (i) fixed floor and ceiling prices, no net speculative activity (parameters A_1 , A_2 , A_{12} and A_{13} varied),
- (ii) fixed floor and ceiling prices, net speculative activity (parameters A_1 , A_3 , A_4 , A_5 and A_6 varied),
- (iii) variable weekly floor and ceiling prices, no net speculative activity (parameters A_1 , A_{14} and A_{15} varied), and
- (iv) variable weekly and seasonal floor price, no net speculative activity (parameters A_1 , A_{16} , A_{18} , A_{20} and A_{22} varied).

For the first set of analyses, four analyses were made:

- a) linear normal trade demand, elasticity of demand varied from -7.101 to -0.1408,
- b) linear normal trade demand, elasticity of demand varied from -2.056 to -0.4864,
- c) constant elasticity normal trade demand, elasticity of demand varied from -7.101 to -0.1408, and

- d) constant elasticity normal trade demand, elasticity of demand varied from -2.056 to -0.4864.

The narrower range of elasticities in runs, b) and d), enable more information to be provided on elasticities close to -1, whilst the wider range, a) and c), allow the testing of more extreme cases.

For each of the last three sets of analyses two analyses were made:

- a) linear normal trade demand, and
b) constant elasticity normal trade demand.

In each of the above analyses, the parameter combinations were defined by a central composite design.

For all four sets of analyses the following information is recorded:

(i) The actual value of each of the eleven nominated summary measures at each of the parameter combinations constituting the central composite design.

(ii) The equation of the derived performance functions. The performance function was estimated both for elasticity in its natural units (i.e. A_1), and coded as $\alpha_1 = \log(-A_1)$. Both performance functions are given.

In addition, for the first set of analyses further information is recorded:

(iii) The derivation of actual from predicted values of two summary measures for the four performance functions, at the parameter combinations of the experimental design, and

(iv) A sensitivity analysis of the same two summary measures to changes in two of the variable parameters, for each of the four performance functions.

The chapter continues by examining the results from each set of analyses in turn.

7.4.2 Fixed Floor and Ceiling Prices - No Net Speculative Activity

The analysis of the fixed floor and ceiling prices with no net speculative activity is discussed below.

7.4.2.1 Parameters Varied

The parameters varied were:

- A_1 , the price elasticity of demand,
- A_{12} , the initial floor price,
- A_{13} , the initial ceiling price, and
- A_2 , the shift in the normal trade demand schedule due to the Wool Commission's activities.

As mentioned earlier, for this set of analyses, two ranges of elasticity were taken, requiring two central composite designs. The actual values taken by the parameters being varied are recorded in Tables 7.1 and 7.2.

7.4.2.2 Parameters Held Constant

The parameters held constant were:

- $A_3 = A_4 = A_5 = A_6 = 0$, thus there was zero net speculative demand or supply throughout each run,
- $A_9 = 0$, indicating fixed floor and ceiling prices in each run (and equal to A_{12} and A_{13}),
- $A_{10} = 60\$m$, the initial level of Wool Commission funds,
- $A_{11} = 0.05$, the annual rate of interest expressed as a decimal,
- A_{14}, \dots, A_{23} , because $A_9 = 0$ the values of these parameters are not relevant, and
- $A_{25} = 86.11645$, the weekly average Wool Commission funds where there is no Wool Commission interference in the wool market.

7.4.2.3 Estimation and Analysis of Performance Function

Although, as mentioned earlier, two central composite designs were taken, the runs from the two designs were combined to calculate each performance function. The two functions which were fitted to the results of the simulation runs were:

- (i) Using the actual values of the price elasticity of demand (A_1)

$$\begin{aligned}
P = & b_0 + b_1 A_1 + b_2 A_{12} + b_3 A_{13} + b_4 A_2 \\
& + b_{11}(A_1)^2 + b_{22}(A_{12})^2 + b_{33}(A_{13})^2 + b_{44}(A_2)^2 \\
& + b_{12} A_1 A_{12} + b_{13} A_1 A_{13} + b_{14} A_1 A_2 \\
& + b_{23} A_{12} A_{13} + b_{24} A_{12} A_2 + b_{34} A_{13} A_2
\end{aligned} \tag{10}$$

(ii) Using the logarithm (to base 10) of the negative value of the price elasticity of demand, i.e. $\alpha_1 = \text{Log}(-A_1)$

$$\begin{aligned}
P = & b_0 + b_1 \alpha_1 + b_2 A_{12} + b_3 A_{13} + b_4 A_2 \\
& + b_{11}(\alpha_1)^2 + b_{22}(A_{12})^2 + b_{33}(A_{13})^2 + b_{44}(A_2)^2 \\
& + b_{12} \alpha_1 A_{12} + b_{13} \alpha_1 A_{13} + b_{14} \alpha_1 A_2 \\
& + b_{23} A_{12} A_{13} + b_{24} A_{12} A_2 + b_{34} A_{13} A_2
\end{aligned} \tag{11}$$

where

P is the performance of the summary measure being considered, and b_0, \dots, b_{34} are the regression coefficients.⁷

The regression coefficients b_0 through b_{34} which were obtained by fitting the performance functions to the results of the simulation runs are recorded in Tables 7.5 and 7.6. Table 7.5 records the regression coefficients obtained by fitting the two functions (10) and (11) to the results of the simulation runs given in Tables 7.1 and 7.2 (where the linear normal trade demand simulation model was used). The regression coefficients listed in the first column of Table 7.5 correspond with those found in equations (10) and (11), and have been estimated for each of the eight summary measures. In Tables 7.5 and 7.6 the coefficients of multiple determination, R^2 , are also recorded.

From the regression coefficients listed in Tables 7.5 and 7.6, the parameter combinations listed in Tables 7.1 and 7.2, and using equations (10)

7. The regression calculations were performed by using an I.B.M. Library Program.

TABLE 7.1 NUMERICAL RESULTS OF SIMULATION RUNS
 FIXED FLOOR AND CEILING PRICES, NO NET SPECULATIVE ACTIVITY
 LINEAR DEMAND - COMPOSITE DESIGN A

Run No.	Coded Design				Actual Parameter Levels				Average Price (cents)	Variance in Price	Min. W.C. Funds (\$M)	Max. W.C. Stocks (,000 bales)	Final Stocks (,000 bales)	Average Net. Spec. Funds (\$M)	Av. W.C. Profit (\$M)	Av. Comp. Grower Profit (\$M)	Av. Sum W.C. & Grower Profit (\$M)	W.C.	Ratio of Variance of Foreign Exchange
	A1	A12	A13	A2	A1	A12	A13	A2											
1	1	1	1	1	-4	30	40	1.01	37.467	4.882	51.380	373.755	12.596	0	11.442	4.754	16.196	-9.920	1.123
2	1	1	1	-1	-4	30	40	0.99	37.280	4.815	50.145	392.362	13.537	0	10.638	-8.861	9.752	-16.364	1.123
3	1	1	-1	1	-4	30	34	0.01	37.370	5.288	50.968	319.320	0	0	14.107	1.709	25.817	-0.300	1.045
4	1	1	-1	-1	-4	30	34	0.99	37.184	5.242	49.703	331.805	0	0	23.893	-4.119	19.774	-6.342	1.043
5	1	-1	1	1	-4	26	40	1.01	37.367	5.496	60.056	46.264	0	0	24.629	3.079	27.709	1.592	1.016
6	1	-1	1	-1	-4	26	40	0.99	37.181	5.461	60.056	47.706	0	0	24.506	-2.713	21.793	-4.324	1.011
7	1	-1	-1	1	-4	26	34	1.01	37.355	5.538	60.056	46.264	0	0	26.471	2.641	29.112	2.996	1.004
8	1	-1	-1	-1	-4	26	34	0.99	37.167	5.506	60.056	47.252	0	0	26.417	-3.193	23.224	-2.892	0.999
9	-1	1	1	1	-0.2505	30	40	1.01	38.652	5.375	60.049	12.777	0.134	0	25.637	46.783	72.420	46.304	1.023
10	-1	1	1	-1	-0.2505	30	40	0.99	35.653	4.275	60.021	38.491	8.757	0	24.412	-42.619	-18.207	-44.323	0.922
11	-1	1	-1	1	-0.2505	30	34	1.01	38.680	5.621	60.049	12.777	0	0	26.068	45.167	71.234	45.118	1.036
12	-1	1	-1	-1	-0.2505	30	34	0.99	35.611	4.707	60.021	36.601	0.040	0	25.209	-45.997	-20.788	-46.905	0.933
13	-1	-1	1	-1	-0.2505	26	40	1.01	38.713	5.756	60.056	1.995	0	0	26.139	45.839	71.979	45.862	1.039
14	-1	-1	1	-1	-0.2505	26	40	0.99	35.720	5.173	60.056	5.028	0	0	25.954	-46.568	-20.613	-46.730	0.953
15	-1	-1	-1	1	-0.2505	26	34	1.01	38.714	5.771	60.056	1.995	0	0	26.134	45.828	71.963	45.846	1.039
16	-1	-1	-1	-1	-0.2505	26	34	0.99	35.730	5.255	60.056	4.450	0	0	26.133	-47.280	-21.146	-47.262	0.958
17	0	0	0	0	-1.0	28	37	1.0	37.235	5.407	60.035	30.832	0	0	25.984	-0.342	25.642	-0.475	1.000
18	a	0	0	0	-7.101	28	37	1.0	37.361	5.407	59.455	218.941	0	0	25.176	-0.342	24.833	-1.283	1.036
19	-a	0	0	0	-0.1408	28	37	1.0	37.218	5.407	60.056	4.341	0	0	26.097	-0.342	25.755	-0.3609	0.997
20	0	a	0	0	-1.0	30.828	37	1.0	37.138	4.788	59.658	111.363	0.269	0	21.617	1.785	23.402	-2.714	0.991
21	0	-a	0	0	-1.0	25.172	37	1.0	37.245	5.536	60.056	8.254	0	0	26.195	-0.162	26.032	-0.084	1.000
22	0	0	a	0	-1.0	28	41.242	1.0	37.224	5.261	60.035	35.392	0	0	24.876	0.635	25.511	-0.606	0.998
23	0	0	-a	0	-1.0	28	32.758	1.0	37.232	5.459	60.035	30.832	0	0	26.102	-0.552	25.550	-0.566	1.000
24	0	0	0	a	-1.0	28	37	1.01414	37.757	5.512	60.050	25.835	0	0	26.201	15.748	41.949	15.833	1.014
25	0	0	0	-a	-1.0	28	37	0.98586	36.961	5.250	60.016	37.216	0	0	25.338	-16.559	8.779	-17.338	0.984
A*					-1.0	0	100	1.0	37.247	5.590	60.056	0	0	0	26.116	0	26.116	0	1.0

* In run A there was no Wool Commission interference in the auction system.
 The initial level of the Wool Commission fund was \$60M.

TABLE 7.2 NUMERICAL RESULTS OF SIMULATION RUNS
 FIXED FLOOR AND CEILING PRICES, NO NET SPECULATIVE ACTIVITY
 LINEAR DEMAND - COMPOSITE DESIGN B

Run No.	Coded Design				Actual Parameter Levels				Average Price (cents)	Variance in Price	Min.W.C. Funds (\$M)	Max.W.C. Stocks (,000 bales)	Final Stocks (,000 bales)	Av.Net Spec.Funds & Assets (\$M)	Av.W.C. Profit (\$M)	Av.Comp. Grower Profit (\$M)	Av.Sum W.C.& Grower Profit (\$M)	Av.Comp. W.C.& Grower Profit (\$M)	Ratio of Variance of Foreign Exchange
	A1	A12	A13	A2	A1	A12	A13	A2											
1	1	1	1	1	-1.665	30	40	1.01	37.447	4.939	59.573	148.368	4.892	0	20.284	8.685	28.968	2.852	1.023
2	1	1	1	-1	-1.665	30	40	0.99	36.996	4.762	59.495	170.958	5.985	0	19.368	-4.882	14.486	-11.630	1.013
3	1	1	-1	1	-1.665	30	34	1.01	37.440	5.321	59.573	127.582	0	0	25.341	5.754	31.095	4.978	1.012
4	1	1	-1	-1	-1.665	30	34	0.99	36.989	5.210	59.496	143.658	0	0	25.116	-8.241	16.874	-9.242	1.001
5	1	-1	1	1	-1.665	26	40	1.01	37.471	5.521	60.056	18.695	0	0	25.539	7.100	32.639	6.523	1.001
6	1	-1	1	-1	-1.665	26	40	0.99	37.023	5.436	60.056	20.957	0	0	25.405	-6.819	18.586	-7.530	0.997
7	1	-1	-1	1	-1.665	26	34	1.01	37.470	5.560	60.056	18.695	0	0	26.271	6.691	32.962	6.845	1.006
8	1	-1	-1	-1	-1.665	26	34	0.99	37.021	5.483	60.056	20.230	0	0	26.239	-7.321	18.917	-7.199	0.994
9	-1	1	1	1	-0.6006	30	40	1.01	37.787	5.094	59.981	45.886	1.409	0	24.230	20.619	44.939	18.823	1.001
10	-1	1	1	-1	-0.6006	30	40	0.99	36.511	4.587	59.930	70.425	2.547	0	23.337	-17.011	6.326	-19.790	0.960
11	-1	1	-1	1	-0.6006	30	34	1.01	37.814	5.423	59.981	40.424	0	0	25.897	18.125	44.022	17.906	1.013
12	-1	1	-1	-1	-0.6006	30	34	0.99	36.523	5.111	59.930	58.212	0	0	25.474	-20.429	5.045	-21.072	0.979
13	-1	-1	1	1	-0.6006	26	40	1.01	37.846	5.588	60.056	6.129	0	0	26.003	19.220	45.224	19.107	1.014
14	-1	-1	1	-1	-0.6006	26	40	0.99	36.608	5.352	60.056	9.023	0	0	25.812	-19.281	6.530	-19.586	0.980
15	-1	-1	-1	1	-0.6006	26	34	1.01	37.856	5.630	60.056	6.129	0	0	26.167	18.985	45.153	19.037	1.016
16	-1	-1	-1	-1	-0.6006	26	34	0.99	36.612	5.414	60.056	8.329	0	0	26.160	-19.855	6.305	-19.812	0.983
17	0	0	0	0	-1.0	28	37	1.0	37.235	5.407	60.035	30.832	0	0	25.984	-0.342	25.642	-0.475	1.000
18	a	0	0	0	-2.056	28	37	1.0	37.257	5.407	59.953	63.391	0	0	25.844	-0.342	25.502	-0.615	1.005
19	-a	0	0	0	-0.4864	28	37	1.0	37.225	5.407	60.056	14.997	0	0	26.052	-0.342	25.710	-0.407	0.998
20	0	a	0	0	-1.0	30.828	37	1.0	37.138	4.788	59.658	111.363	0.269	0	21.617	1.785	23.402	-2.714	0.992
21	0	-a	0	0	-1.0	25.172	37	1.0	37.245	5.536	60.056	8.253	0	0	26.195	-0.163	26.032	-0.084	1.000
22	0	0	a	0	-1.0	28	41.242	1.0	37.224	5.361	60.035	35.392	0	0	24.876	0.635	25.511	-0.606	0.998
23	0	0	-a	0	-1.0	28	32.758	1.0	37.232	5.459	60.035	30.832	0	0	26.102	-0.552	25.550	-0.566	1.000
24	0	0	0	a	-1.0	28	37	1.01414	37.736	5.511	60.050	25.835	0	0	26.201	15.748	41.949	15.833	1.014
25	0	0	0	-a	-1.0	28	37	0.98586	36.691	5.230	60.016	37.216	0	0	25.338	-16.559	8.779	-17.338	0.984
A					-1.0	0	100	1.0	37.247	5.590	60.056	0	0	0	26.116	0	26.116	0	1.0

TABLE 7.3 NUMERICAL RESULTS OF SIMULATION RUNS
 FIXED FLOOR AND CEILING PRICES, NO NET SPECULATIVE ACTIVITY
 CONSTANT ELASTICITY OF DEMAND - COMPOSITE DESIGN A

Run No.	Coded Design				Actual Parameter Levels				Average Price (cents)	Variance Price	Min.W.C. Fund (\$M)	Max.W.C. Stock (,000 bales)	Final Stocks (,000 bales)	Av.Net Spec. Funds & Assets	Av.W.C. Profit (\$M)	Av.Comp. Grower Profit (\$M)	Av.Sum W.C. & Grower Profit (\$M)	Av.Comp.W.C. & Grower Profit (\$M)	Ratio of Variance of Seasonal Fgn.Exchange
	A1	A12	A13	A2	A1	A12	A13	A2											
1	1	1	1	1	-4	30	40	1.01	37.555	5.067	58.95	268.60	10.824	0	15.974	6.552	22.526	-3.590	1.096
2	1	1	1	-1	-4	30	40	0.99	37.386	5.005	58.88	289.29	11.800	0	15.263	0.968	16.231	-9.886	1.099
3	1	1	-1	1	-4	30	34	1.01	37.446	5.277	58.95	227.46	0	0	25.112	4.634	29.746	3.630	1.028
4	1	1	-1	-1	-4	30	34	0.99	37.267	5.227	58.83	241.76	0	0	24.998	-1.063	23.935	-2.181	1.027
5	1	-1	1	1	-4	26	40	1.01	37.370	5.516	60.05	34.15	0	0	25.061	3.251	28.312	2.196	1.013
6	1	-1	1	-1	-4	26	40	0.99	37.186	5.480	60.05	35.63	0	0	24.937	-2.532	22.405	-3.711	1.008
7	1	-1	-1	1	-4	26	34	1.01	37.358	5.538	60.05	34.15	0	0	26.421	2.955	29.376	3.260	1.002
8	1	-1	-1	-1	-4	26	34	0.99	37.174	5.505	60.05	35.38	0	0	26.447	-2.865	23.581	-2.535	0.998
9	-1	1	1	1	-0.2505	30	40	1.01	38.719	5.448	60.05	11.00	0	0	25.721	48.264	73.986	47.869	1.028
10	-1	1	1	-1	-0.2505	30	40	0.99	35.690	4.290	60.02	36.44	0	0	24.683	-41.421	-16.738	-42.855	0.923
11	-1	1	-1	1	-0.2505	30	34	1.01	38.737	5.625	60.05	11.00	0	0	26.079	46.926	73.005	46.888	1.038
12	-1	1	-1	-1	-0.2505	30	34	0.99	35.724	4.808	60.02	28.81	0.026	0	25.391	-44.023	-18.633	-44.749	0.944
13	-1	-1	1	1	-0.2505	26	40	1.01	38.752	5.762	60.05	1.77	0	0	26.137	47.040	73.177	47.061	1.040
14	-1	-1	1	-1	-0.2505	26	40	0.99	35.766	5.189	60.05	4.79	0	0	25.964	-45.320	-19.356	-45.473	0.955
15	-1	-1	-1	1	-0.2505	26	34	1.01	38.753	5.776	60.05	1.77	0	0	26.133	47.051	73.184	47.067	1.041
16	-1	-1	-1	-1	-0.2505	26	34	0.99	35.773	5.262	60.05	4.22	0	0	26.134	-45.952	-19.817	-45.934	0.959
17	0	0	0	0	-1.0	28	37	1.0	37.247	5.410	60.03	26.83	0	0	26.190	-0.130	26.060	-0.057	1.000
18	a	0	0	0	-7.101	28	37	1.0	37.352	5.414	59.59	134.79	.00	0	26.683	0.681	27.364	1.248	1.020
19	-a	0	0	0	-0.1408	28	37	1.0	37.226	5.409	60.05	4.00	0	0	26.116	-0.225	25.891	-0.225	0.997
20	0	a	0	0	-1.0	30.828	37	1.0	37.247	4.879	59.72	95.66	0	0	22.535	3.168	25.702	-0.414	1.000
21	0	-a	0	0	-1.0	25.172	37	1.0	37.247	5.536	60.05	7.51	0	0	26.188	-0.085	26.103	-0.013	1.000
22	0	0	a	0	-1.0	28	41.242	1.0	37.247	5.321	60.03	31.04	0	0	25.047	0.926	25.973	-0.143	1.000
23	0	0	-a	0	-1.0	28	32.758	1.0	37.247	5.453	60.03	26.83	0	0	26.122	-0.045	26.077	-0.039	1.000
24	0	0	0	a	-1.0	28	37	1.01414	37.774	5.515	60.05	21.77	0	0	26.195	16.333	42.528	16.411	1.014
25	0	0	0	-a	-1.0	28	37	0.98586	36.720	5.275	60.02	33.25	0	0	25.582	-16.035	9.547	-16.569	0.986
A*					-1.0	0	100	1.0	37.247	5.590	60.056	0	0	0	26.116	0	26.116	0	1.0

* In Run A there was no Wool Commission interference in the auction system. The initial level of Wool Commission funds was 60\$M.

TABLE 7.4
 NUMERICAL RESULTS OF SIMULATION RUNS
 FIXED FLOOR AND CEILING PRICES, NO NET SPECULATIVE ACTIVITY
 CONSTANT ELASTICITY OF DEMAND - COMPOSITE DESIGN B

Run No.	Coded Design				Actual Parameter Levels				Average Price (cents)	Variance of Price	Min. W.C. Fund (\$M)	Max. W.C. Stocks (,000 bales)	Final Stocks (,000 bales)	Av. Net Spec. Funds and Assets (\$M)	Av. W.C. Profit (\$M)	Av. Comp. Grower Profit (\$M)	Av. Sum & Grower Profit (\$M)	Av. Comp. W.C. & Grower Profit (\$M)	Ratio of Variance of seasonal Fgm. Exchange
	A1	A12	A13	A2	A1	A12	A13	A2											
1	1	1	1	1	-1.665	30.0	40.0	1.01	37.259	5.061	59.65	121.85	4.481	0	21.458	9.803	31.261	5.145	1.026
2	1	1	1	-1	-1.665	30.0	40.0	0.99	37.090	4.902	59.58	144.96	5.582	0	20.560	-3.641	16.919	-9.197	1.018
3	1	1	-1	1	-1.665	30.0	34.0	1.01	37.497	5.314	59.65	104.3	0	0	25.599	7.576	33.176	7.059	1.011
4	1	1	-1	-1	-1.665	30.0	34.0	0.99	37.054	5.196	59.58	120.83	0	0	25.412	-6.248	19.164	-6.952	1.000
5	1	-1	1	1	-1.665	26.0	40.0	1.01	37.478	5.532	60.05	15.74	0	0	25.649	7.243	32.892	6.776	1.008
6	1	-1	1	-1	-1.665	26.0	40.0	0.99	37.032	5.448	60.05	18.02	0	0	25.510	-6.654	18.856	-7.260	0.997
7	1	-1	-1	1	-1.665	26.0	34.0	1.01	37.475	5.561	60.05	15.74	0	0	26.256	6.914	33.170	7.054	1.006
8	1	-1	-1	-1	-1.665	26.0	34.0	0.99	37.028	5.482	60.05	17.33	0	0	26.257	-7.059	19.198	-6.918	0.994
9	-1	1	1	1	-0.6006	30.0	40.0	1.01	37.845	5.154	59.99	39.75	1.318	0	24.595	21.476	46.071	19.955	1.006
10	-1	1	1	-1	-0.6006	30.0	40.0	0.99	36.595	4.690	59.95	64.41	2.456	0	23.618	-15.916	7.702	-18.414	0.967
11	-1	1	-1	1	-0.6006	30.0	34.0	1.01	37.855	5.417	59.99	35.03	0	0	25.999	19.378	45.338	19.221	1.014
12	-1	1	-1	-1	-0.6006	30.0	34.0	0.99	36.608	5.103	59.94	52.92	0	0	25.739	-19.172	6.567	-19.549	0.979
13	-1	-1	1	1	-0.6006	26.0	40.0	0.99	37.866	5.607	60.05	5.49	0	0	25.986	19.602	45.589	19.472	1.015
14	-1	-1	1	-1	-0.6006	26.0	40.0	0.99	36.623	5.369	60.05	8.36	0	0	25.835	-18.937	6.898	-19.219	0.981
15	-1	-1	-1	1	-0.6006	26.0	34.0	1.01	37.867	5.630	60.05	5.45	0	0	26.162	19.334	45.497	19.380	1.017
16	-1	-1	-1	-1	-0.6006	26.0	34.0	0.99	36.625	5.414	60.05	7.67	0	0	26.161	-19.439	6.722	-19.395	0.983
17	0	0	0	0	-1.0	28.0	37.0	1.0	37.247	5.410	60.03	26.83	0	0	26.190	-0.130	26.060	-0.057	1.000
18	0	0	0	0	-2.056	28.0	37.0	1.0	37.271	5.410	59.96	51.54	0	0	26.277	0.049	26.326	0.210	1.004
19	0	0	0	0	-0.4864	28.0	37.0	1.0	37.235	5.409	60.05	13.50	0	0	26.132	-0.189	25.943	-0.173	0.998
20	0	0	0	0	-1.0	30.888	37.0	1.0	37.247	4.879	59.72	95.66	0	0	22.535	3.168	25.702	-0.414	1.000
21	0	0	0	0	-1.0	25.172	37.0	1.0	37.247	5.536	60.05	7.51	0	0	26.188	-0.085	26.103	-0.013	1.000
22	0	0	0	0	-1.0	28.0	41.242	1.0	37.247	5.312	60.03	31.04	0	0	25.047	0.926	25.974	-0.143	1.000
23	0	0	0	0	-1.0	28.0	32.758	1.0	37.247	5.453	60.03	26.83	0	0	26.122	-0.045	26.077	-0.039	1.000
24	0	0	0	0	-1.0	28.0	37.0	1.01414	37.774	5.515	60.05	21.79	0	0	26.195	16.333	45.528	16.411	1.014
25	0	0	0	0	-1.0	28.0	37.0	0.98586	36.721	5.275	60.02	33.25	0	0	25.582	-16.035	9.547	-16.569	0.986
A					-1.0	0	100	1.0	37.247	5.590	60.056	0	0	0	26.116	0	26.116	0	1.0

TABLE 7.5 ESTIMATED REGRESSION COEFFICIENTS
FIXED MOOR AND GRASSING PRICES, IN THE SEASONAL ACTIVITY
ANIMAL DEMAND

(i) Using A1

Regr. Coef.	Average Price	Variance in Price	Minimum Wool Commission Funds	Final Stocks	Av. Net. Spec. Funds and Assets	Average Wool Commission Profit	Av. Compoundd Greaser Profit	Av. Sum of V.C. and Greaser Profit	Av. Comp. V.C. and Greaser Profit	Ratio of Variance in seasonal foreign Exchange
b ₀	311.09704	-90.21397	896.32290	N.A.	N.A.	809.12210	-8725.7608	-1057.0326	-1049.8416	2.02129
b ₁	-26.14990	-6.64138	-6.90661			-58.69887	-819.08140	-823.70516	-823.72847	-0.60190
b ₂	-1.63717	0.62223	0.26740			34.19680	-19.97075	-21.90160	-22.26410	-0.16719
b ₃	-0.35382	0.27471	0.13182			2.72520	-60.28100	-18.96220	-19.24580	-0.03073
b ₄	-985.09000	143.54080	-1685.0760			-8665.53	17177.260	910.12000	475.19000	1.10964
b ₁₁	-0.00109	-0.00011	0.17684			0.24470	0.13529	0.22016	0.21974	-0.00171
b ₂₂	-0.01332	-0.02694	-0.14035			-0.33831	0.75845	-0.07155	-0.07498	0.00002
b ₃₃	0.00132	0.00431	-0.01367			-0.04303	0.17004	0.01061	0.0179	0.00011
b ₄₄	301.35900	-72.53890	709.77700			1417.44000	-7468.0900	468.76000	468.74000	-1.06398
b ₁₂	-0.00931	-0.00298	0.66419			0.64845	0.03467	0.51519	0.51536	-0.00646
b ₁₃	-0.00290	0.08176	-0.00944			0.20679	-0.03170	0.29738	0.29748	-0.00253
b ₁₄	26.48239	6.69446	-9.45118			35.26611	819.9185	800.27208	800.28740	0.85382
b ₂₃	-0.00190	-0.01341	0.00092			-0.13898	0.16806	-0.04790	-0.04674	0.00060
b ₂₄	2.42996	1.26055	8.03513			-10.10188	-28.8602	27.41490	28.3423	0.13666
b ₃₄	0.30968	-0.24909	0.84391			4.30860	43.20300	19.77840	20.0271	0.00320
R ²	0.795	0.853	0.845			0.886	0.794	0.781	0.781	0.853

(ii) Using LOB (-41)

b ₀	369.22018	-86.82438	940.06930	N.A.	N.A.	948.99690	-6894.9286	-644.71006	-636.98963	2.04399
b ₁	113.28929	29.53499	22.69215			177.04664	3472.7449	3955.8192	3955.8248	2.90931
b ₂	-0.93621	0.89049	1.67383			37.54336	3.68098	11.92710	11.19990	-0.14885
b ₃	0.11428	0.41404	-0.42741			2.82790	-46.03700	-0.94800	-1.2265	-0.01726
b ₄	-688.04400	134.08020	-1778.9840			-2990.7900	13517.010	-679.14000	-714.79000	0.99944
b ₁₁	0.09947	-0.01678	-4.09080			-3.28734	0.97478	-2.18329	-2.18905	0.04161
b ₂₂	-0.02185	-0.02820	-0.17003			-0.39261	0.46367	-0.29068	-0.29405	0.00006
b ₃₃	0.00069	0.00406	-0.01747			-0.09090	0.14666	-0.03245	-0.03226	0.00017
b ₄₄	347.21100	-68.15120	798.11100			1946.2300	-9970.3900	1044.7000	1044.7900	-1.2546
b ₁₂	0.02695	0.00918	-1.76368			-1.91611	-0.19541	-1.64568	-1.6457	0.01904
b ₁₃	0.00736	-0.00400	0.02996			-0.64848	0.04814	-0.90908	-0.90909	0.00719
b ₁₄	-114.22638	-29.62153	22.84649			-102.94988	-3469.0309	-3479.0419	-3479.0444	-3.66381
b ₂₃	-0.002805	-0.01372	0.00141			-0.13933	0.13997	-0.08498	-0.08433	0.00096
b ₂₄	2.29441	1.07939	7.27326			-11.3956	-34.6154	4.63330	3.96400	0.12790
b ₃₄	-0.08608	-0.3634	1.68397			4.49790	31.31100	5.54800	5.798300	-0.01001
R ²	0.950	0.936	0.703			0.821	0.941	0.933	0.932	0.852

N.A. = Not Applicable

TABLE 7.6 ESTIMATED REGRESSION COEFFICIENTS
FIXED FLOOR AND CEILING PRICES, NO NET SPECULATIVE ACTIVITY
CONSTANT ELASTICITY OF DEMAND

(i) Using A1

Regr. Coeff.	Average Price	Variance in Price	Min. Wool Commission* Funds	Final Stocks	Av. Net Spec. Funds & Assets	Av. Wool Commission Profit	Av. Comp. Grower Profit	Av. Sum of W.C. & Grower Profit	Av. Comp. W.C. and Grower Profit	Ratio of Variance of Seasonal Foreign Exchange.
b ₀	-122.32016	-65.72325	37.59516	N.A.	N.A.	-880.55431	180.91290	-893.18407	-669.04913	2.14528
b ₁	-25.69113	-6.30151	-1.48236			-16.20441	-798.53184	-817.33800	-814.7911	-0.64465
b ₂	-0.22482	0.02176	1.011985			23.2775	-54.57670	-27.21190	-32.2547	-0.13724
b ₃	-0.37429	0.02322	0.67392			5.62180	-27.61700	-20.56110	-22.4745	-0.03822
b ₄	244.02540	120.93940	18.33070			939.55000	-751.84000	392.93000	118.82000	0.29419
b ₁₁	-0.00126	-0.00152	0.01655			0.19117	0.03195	0.21157	0.22261	-0.00167
b ₂₂	0.00859	-0.02121	-0.02237			-0.19874	0.25899	0.03109	0.05945	0.00030
b ₃₃	0.00242	0.00334	0.00105			0.01359	0.00114	0.00432	0.01469	0.00003
b ₄₄	-71.93390	-67.56410	-11.93959			-308.76800	871.28000	512.47000	572.47000	-0.34358
b ₁₂	-0.01282	-0.00564	0.07681			0.30419	-0.06887	0.23502	0.23554	-0.00482
b ₁₃	-0.00391	-0.00267	-0.00052			0.22999	-0.00252	-0.22719	0.22761	-0.00223
b ₁₄	26.16209	6.54076	-0.43108			0.67723	800.64018	803.89001	801.35855	0.84407
b ₂₃	0.00199	-0.00952	0.00041			-0.14087	0.10940	-0.03065	-0.03071	0.00059
b ₂₄	-0.34259	1.40605	1.23739			-7.25930	36.4004	26.82430	30.28170	0.09590
b ₃₄	0.13624	-0.03290	-0.76385			-2.67430	24.66200	21.30100	22.4483	0.01712
R ²	0.770	0.865	1.001			0.890	0.778	0.784	0.779	0.831

(ii) Using LOO (-A1)

b ₀	-110.57875	-62.65565	39.07643	N.A.	N.A.	-914.50280	571.05634	-527.86880	-312.46611	2.47878
b ₁	112.47378	28.17244	4.73994			61.40824	3463.9469	3525.4874	3525.3475	2.99037
b ₂	0.81541	0.26875	0.04931			25.63370	-22.66260	6.93930	2.00390	-0.11747
b ₃	0.18303	0.17798	0.76049			6.40810	-10.28800	-2.45390	-4.36110	-0.02641
b ₄	209.35690	112.40300	13.55607			936.87000	-1866.8500	-735.10000	-999.09000	-0.39179
b ₁₁	0.08877	0.00157	-0.42798			-0.81126	1.12773	0.05016	0.31643	0.02491
b ₂₂	0.00377	-0.02223	-0.02398			-0.22535	0.10526	-0.13036	-0.12379	0.00036
b ₃₃	0.00148	0.00318	0.000245			0.00225	-0.03085	-0.03841	-0.02860	0.00009
b ₄₄	-56.04270	-63.78990	-7.92619			-285.79400	1390.0000	1057.3700	1114.1800	-0.21484
b ₁₂	0.03875	0.01792	-0.23067			-0.97907	0.18740	-0.79174	-0.79160	0.014661
b ₁₃	0.01128	0.01071	0.00166			-0.69717	-0.00735	-0.70437	-0.70434	0.00670
b ₁₄	-113.89179	-29.03389	1.24188			-9.94250	3468.8254	-3478.8949	-3478.7596	-3.61858
b ₂₃	0.00076	-0.00983	0.00045			-0.14035	0.07170	-0.06801	-0.06789	0.00053
b ₂₄	-1.04828	1.23578	1.18118			-8.43560	14.60040	3.87730	7.30800	0.07911
b ₃₄	-0.31376	-0.14319	-0.79114			-2.98180	10.76100	7.06280	8.24030	0.00532
R ²	0.927	0.931	0.944			0.834	0.932	0.935	0.933	0.867

* In the estimation of the regression coefficients for this summary measure, the matrix gave evidence of singularity - (where the determinant of the matrix tends towards zero), hence the subsequent information derived from these regression coefficients cannot be relied upon.

TABLE 7.7 ANALYSIS OF PERFORMANCE FUNCTION - LINEAR DEMAND
USING FUNCTION WITH A1 + WITH A2 (= A01-A1)

Run No.	Average Price (cents)		Av. Price A1	Av. Comp. W.C. & Grower Profit (\$)		Comp. W.C. & G. A2	Av. Price (cents)		Av. Price A1	Av. Comp. W.C. & Grower Profit (\$)		Comp. W.C. & G. A2
	Predicted	Deviation		Predicted	Deviation		Predicted	Deviation				
1A	37.299	0.168	0.244	-12.104	3.184	-127	37.223	0.244	-0.897	-13.002	2.966	-300
2A	37.362	-0.082	-0.318	-9.361	-7.003	-146	37.387	-0.107	1.428	-6.981	-9.899	-341
3A	37.365	0.005	0.294	-7.244	6.944	-185	37.215	0.195	-1.113	-7.909	7.609	-396
4A	37.396	-0.172	-0.301	-2.086	-4.243	-266	37.384	-0.200	1.383	-0.892	-5.548	-376
5A	37.169	-0.198	0.248	-5.031	6.636	-241	37.198	0.289	-0.964	-5.975	7.244	-322
6A	37.247	-0.246	-0.281	-0.081	-4.290	-239	37.482	-0.301	1.320	1.110	-5.537	-364
7A	37.080	0.275	0.266	-1.280	4.287	-361	37.078	0.277	-1.088	-2.785	5.695	-357
8A	37.375	-0.212	-0.264	6.133	-9.014	-380	37.413	-0.246	1.276	4.776	-7.753	-398
1B	37.786	-0.339	0.206	12.827	-9.999	1740	37.963	-0.116	-0.932	4.273	-1.539	1024
2B	36.612	0.384	-0.323	-21.804	10.189	1782	36.898	0.238	1.952	-15.792	4.044	982
3B	37.783	-0.343	0.283	13.532	-8.340	1620	37.588	-0.148	-0.976	7.200	-2.321	989
4B	36.647	0.342	-0.306	-18.696	9.467	1602	36.872	0.117	1.308	-12.170	2.829	947
5B	37.743	-0.272	0.243	15.087	-8.930	1627	37.519	-0.048	-1.080	9.014	-2.994	1001
6B	36.764	0.341	-0.286	-17.277	9.760	1608	36.994	0.029	1.244	-10.606	2.973	960
7B	37.695	-0.225	0.261	14.670	-7.813	1507	37.477	-0.007	-1.084	9.917	-3.158	967
8B	36.753	-0.268	-0.269	-15.290	8.103	1488	36.941	0.080	1.200	-9.008	1.722	925
9B	38.004	-0.227	0.204	24.986	-6.148	2992	37.995	-0.208	-1.020	23.974	-4.868	2564
10B	36.267	0.244	-0.326	-26.681	6.806	2973	36.278	0.233	1.264	-27.304	7.396	2523
11B	38.020	-0.206	0.221	23.791	-5.892	2472	38.040	-0.226	-1.064	24.096	-6.288	2530
12B	36.319	0.204	-0.308	-23.472	4.414	2453	36.312	0.211	1.220	-26.087	4.915	2488
13B	38.001	-0.195	0.241	25.052	-5.932	2479	38.000	-0.194	-1.128	25.400	-6.396	2542
14B	36.458	0.190	-0.288	24.348	4.775	2460	36.463	0.145	1.196	-25.033	5.344	2500
15B	37.971	-0.115	0.298	22.735	-3.687	2399	37.977	-0.121	-1.172	23.898	-4.947	2507
16B	36.465	0.147	-0.271	-24.261	4.461	2340	36.429	0.183	1.112	-25.839	5.941	2465
9A	38.075	0.977	0.203	29.094	17.224	2872	38.997	0.295	-1.096	39.444	6.742	3886
10A	36.153	-0.300	-0.327	-28.176	-16.131	2854	35.813	-0.160	1.188	-37.860	-6.381	3844
11A	38.097	0.983	0.202	27.275	17.896	2792	38.498	0.222	-1.140	37.903	7.115	3831
12A	36.211	-0.600	-0.309	-27.993	-19.299	2794	35.863	-0.232	1.144	-38.705	-8.299	3809
13A	38.085	0.628	0.246	28.438	17.436	2799	38.443	0.270	-1.204	38.770	6.989	3863
14A	36.375	-0.695	-0.289	-26.564	-20.151	2740	36.038	-0.318	1.080	-38.039	-8.745	3822
15A	38.061	0.653	0.297	23.497	20.380	2699	38.436	0.278	-1.248	35.205	10.594	3829
16A	36.371	-0.641	-0.272	-27.103	-20.147	2680	36.021	-0.291	1.036	-40.998	-6.391	3787
17ABB	37.213	0.022	-0.033	-1.023	0.963	2146	37.248	-0.013	0.090	-0.220	-0.336	1745
18A	37.373	-0.012	-0.019	-2.341	1.071	-2735	37.397	-0.036	0.299	-4.176	2.792	-1216
18B	37.246	0.011	-0.031	-2.424	1.822	1301	37.286	-0.029	0.132	-1.307	0.590	636
19B	37.195	0.090	-0.034	-0.168	-0.888	2997	37.230	-0.009	0.027	0.438	-0.947	2834
19A	37.183	0.099	-0.035	0.474	-0.821	3834	37.244	-0.086	-0.079	0.969	-1.032	4707
20ABB	37.066	0.072	-0.099	-2.698	-0.041	2227	37.047	0.091	0.166	-4.015	1.190	1763
21ABB	37.146	0.101	-0.006	-0.992	-0.519	2066	37.100	0.145	0.014	-0.488	0.312	1729
22ABB	37.233	-0.009	-0.045	-0.945	0.352	2231	37.264	-0.040	0.121	-1.390	0.830	1769
23ABB	37.240	-0.008	-0.021	-0.719	0.165	2062	37.298	-0.026	0.099	-0.091	0.604	1720
24ABB	38.270	-0.513	0.341	29.426	-13.980	2160	38.114	-0.351	-1.525	24.664	-8.932	1774
25ABB	36.276	0.425	-0.407	-31.290	13.965	2133	36.321	0.170	1.703	-24.686	7.247	1715

* This column refers to the appropriate parameter combination in Composite Design A or B.

**Deviation = Actual - Predicted

TABLE 7.8 ANALYSIS OF PERFORMANCE FUNCTION - CONSTANT ELASTICITY OF DEMAND
USING FUNCTION WITH A1 : WITH A1 (- LOG(-A1))

Run No.	Average Price (Cents)		Av. Price $\Delta A1$	Av. Comp. W.C. & Grower Profit (\$M)		Comp. W.C. & G. $\Delta A2$	Average Price (cents)		Av. Price $\Delta A1$	Av. Comp. W.C. & G. Profit (\$M)		Comp. W.C. & G. $\Delta A2$
	Predicted	Deviation**		Predicted	Deviation		Predicted	Deviation		Predicted	Deviation	
1A	37.377	0.178	0.201	-6.526	2.920	-123	37.265	0.290	-0.836	-7.643	4.076	-294
2A	37.564	-0.178	-0.312	-3.820	-6.081	-146	37.570	-0.184	1.441	-1.317	-9.552	-338
3A	37.354	0.092	0.259	-3.324	6.864	-190	37.250	0.196	-0.541	-3.962	7.592	-364
4A	37.474	-0.207	-0.289	2.151	-4.346	-281	37.489	-0.222	1.374	3.366	-5.533	-388
5A	37.213	0.157	0.253	-4.480	6.661	-244	37.178	0.192	-0.991	-4.685	6.897	-323
6A	37.372	-0.186	-0.277	0.648	-4.374	-267	37.401	-0.215	1.286	2.226	-5.920	-367
7A	37.154	0.204	0.276	-1.938	5.187	-379	37.153	0.205	-1.059	-2.621	5.893	-372
8A	37.330	-0.266	-0.247	5.883	-8.430	-402	37.338	-0.164	1.219	5.279	-7.801	-417
1B	37.841	-0.312	0.196	15.634	-10.508	1747	37.596	-0.067	-0.904	7.533	-2.371	1030
2B	36.806	0.284	-0.327	-19.083	9.869	1724	37.035	0.055	1.374	-12.624	3.445	985
3B	37.790	-0.293	0.219	15.724	-8.678	1612	37.578	-0.081	-0.971	9.617	-2.545	980
4B	36.771	0.283	-0.304	-16.300	9.334	1589	36.978	0.076	1.306	-9.551	2.612	936
5B	37.797	-0.319	0.247	15.480	-8.719	1626	37.569	-0.091	-1.058	9.285	-2.493	1000
6B	36.734	0.298	-0.276	-16.814	9.534	1603	36.924	0.108	1.219	-10.287	3.043	956
7B	37.793	-0.318	0.270	14.833	-7.796	1491	37.569	-1.094	-1.126	9.741	-2.674	951
8B	36.747	0.281	-0.253	-14.768	7.838	1468	36.887	0.140	1.151	-8.843	1.937	906
9B	38.048	-0.203	0.193	26.541	-6.603	2600	38.013	-0.168	-0.982	25.303	-5.331	2570
10B	36.456	0.139	-0.330	-25.235	6.805	2577	36.444	0.151	1.295	-25.664	7.267	2526
11B	38.022	-0.167	0.216	25.177	-5.970	2465	38.026	-0.171	-1.050	25.516	-6.282	2521
12B	36.446	0.162	-0.307	-23.904	4.343	2442	36.418	0.190	1.227	-24.462	4.927	2476
13B	38.058	-0.192	0.244	25.385	-5.928	2479	38.055	-0.189	-1.137	25.653	-6.166	2541
14B	36.439	0.184	-0.279	-23.969	-4.735	2456	36.401	0.222	1.400	-24.729	5.526	2476
15B	38.079	-0.212	0.268	23.284	-3.916	2344	38.086	-0.219	-1.205	24.237	-4.845	2491
16B	36.476	0.149	-0.255	-23.379	3.969	2321	36.394	0.231	1.073	-25.157	5.774	2447
9A	38.116	+0.603	0.192	30.239	17.619	2880	38.399	0.320	-1.050	40.642	7.244	3891
10A	36.340	-0.650	-0.331	-27.149	-15.723	2857	35.964	-0.274	1.228	-36.748	-6.090	3847
11A	38.097	0.640	0.216	28.397	18.477	2746	38.437	0.300	-1.117	39.250	7.652	3842
12A	36.338	-0.614	-0.307	-26.297	-18.466	2723	35.965	-0.241	1.160	-37.152	-7.583	3797
13A	38.144	0.608	0.243	28.759	18.293	2759	38.500	0.252	-1.205	39.790	7.287	3862
14A	36.341	-0.575	-0.280	-26.213	-19.275	2736	35.981	-0.215	1.073	-37.016	-8.441	3818
15A	38.173	0.580	0.267	26.172	20.881	2625	38.556	0.197	-1.272	36.768	10.331	3813
16A	36.387	-0.614	-0.256	-26.098	-19.848	2602	35.999	-0.222	1.005	-39.049	-6.873	3768
17A & B	37.217	0.030	-0.030	-0.430	0.358	2140	37.221	0.026	0.084	0.349	-0.391	1738
18A	37.354	-0.002	-0.015	0.907	0.327	-2748	37.357	-0.005	0.235	-0.822	2.085	-1222
18B	37.247	0.024	-0.027	-1.384	1.580	1298	37.256	0.015	0.140	-0.135	0.360	649
19B	37.201	0.034	-0.031	0.214	-0.401	2552	37.203	0.032	0.029	0.894	1.053	2827
19A	37.170	0.036	-0.032	0.713	-0.953	2829	37.214	0.012	-0.067	1.978	-2.189	4700
20A & B	37.285	-0.038	-0.066	0.001	-0.431	2226	37.269	-0.022	0.194	-1.015	0.617	1759
21A & B	37.285	-0.038	0.006	0.089	-0.116	2055	37.233	0.024	-0.025	-0.267	0.268	1718
22A & B	37.263	-0.016	-0.047	-0.279	0.119	2236	37.256	-0.009	0.132	-0.752	0.626	1773
23A & B	37.257	-0.010	-0.013	-0.052	0.011	2045	37.239	0.008	0.036	0.470	-0.446	1703
24A & B	38.184	-0.410	0.339	29.956	-13.356	2157	38.006	-0.224	-1.526	25.160	-8.732	1770
25A & B	36.220	0.500	-0.400	-30.588	14.004	2124	36.414	0.306	1.695	-24.015	7.460	1707

** Deviation = Actual - Predicted.

and (11), the predicted values of the summary measures can be calculated. By subtraction, the deviation between the actual and predicted value of a summary measure can be determined. This analysis is termed the "plot back", and provides information on the extent to which the regression function fits the observed points, and indicates if there is a lack of fit in some section of the performance surface. The plot back has been performed for two summary measures, namely average price and average compounded Wool Commission and grower profit, and the results are reported in Tables 7.7 and 7.8. Interpreting Table 7.7, for the linear demand case, in the first column the run numbers are listed, and refer to the runs in composite design A or composite design B (listed in Tables 7.1 and 7.2). On the left of Table 7.7 the plot back is determined using the performance function with price elasticity in its natural units, while on the right elasticity is coded as $\text{Log}(-A_1)$. In the first row second column of Table 7.7 the predicted value of the average price (for the parameter combination given by Run 1 of Composite Design A in Table 7.1) is 37.299, while the actual value given in Table 7.1 is 37.467. The deviation in the first row, third column is $(37.467 - 37.299)$ which equals +0.168. The other plot backs documented in Tables 7.7 and 7.8 can be interpreted similarly.

Tables 7.7 and 7.8 also contain the results of sensitivity analyses. The sensitivity analysis provides information on the slope of the performance surface at any point within the experimental region. More specifically it is possible to calculate how much, and in what direction the performance of the summary measure would change with a unit (positive) increase in a particular parameter. The results of the sensitivity analyses presented in Table 7.7 can be interpreted as follows. The first row and fourth column records the change in the average price for a unit increase in the price elasticity of demand, for the point on the performance surface defined by run 1A. That is, by reducing the price elasticity of demand from -4 to -3, the average price

rose by 0.211 cents.

7.4.2.4 Conclusions from Simulation Runs

From an inspection of the results from simulation runs in Tables 7.1 to 7.4 a number of conclusions, within the context of the model, are apparent. Except where it is specifically mentioned the results apply for both the linear and the constant elasticity of demand models.

(i) If there was no expansion or contraction in the normal trade demand (i.e. $A_2 = 1.0$), then for the range of values of the parameters, i.e. price elasticity, floor price, and ceiling price which were chosen it is not possible to find conditions which would have shifted the average price by even .5%. If, however, a 1% expansion (or contraction) in normal trade demand is assumed, then the average price was increased (decreased) by 0.6 to 4%. The more elastic was the price elasticity, the smaller the change in the average price.

In run 20 in Table 7.1 it will be noted that the average price of wool has been lowered, but the average compounded value of grower profit has been raised. The reason for grower profits being positive is due to these profits being compounded. In this case, the order of purchases and sales by the Wool Commission was important.

(ii) All parameter combinations, except for a limited number of cases where there was an expansion in normal trade demand, achieved some reduction in the price variance. The maximum reduction in the variance in price for all parameter assumptions is in the vicinity of 20%, and this is achieved where there is a high floor and a high ceiling price. Variance in price is reduced more by a high floor and high ceiling than by a high floor and low ceiling, because in the latter case the Wool Commission stocks run out more quickly, and subsequently the Wool Commission is not able to prevent "runaway" high prices. In general, however, regardless of the value of the price elasticity of demand, the reduction in price variability was less than 10%. Varying price elasticity from -7.0 to -0.25 reduced price variability by less than 1%.

(iii) For all parameter assumptions made, over the historical period being considered, all policies were highly viable in terms of the minimum level of Wool Commission funds. It can be seen, nevertheless, that in terms of the maximum level of Wool Commission stocks there was, for some parameter combinations, considerable interference at auction by the Wool Commission. The maximum amount of Wool Commission activity occurred with a high floor price and an elastic demand.

(iv) Except for the combination of a high floor price and an elastic demand, average Wool Commission profits are insensitive to the parameter assumptions which were made. The Wool Commission would therefore earn 5% (the ruling rate of interest) on the money invested. In the exception cited above, Wool Commission funds are tied up in stocks of wool for a period of time and the price at which the stocks were sold did not adequately cover storage costs.

(v) Where $A_2 = 1.0$, no matter what assumptions are made regarding the price elasticity of demand, the floor or the ceiling price, average compounded Wool Commission and grower profits were seldom positive and seldom more than $\pm \$1$ million. If, however, demand expanded (or contracted) by 1% then average compounded Wool Commission and grower profit increased (or decreased) by up to \$47 million. In general, the more elastic the demand for wool the smaller the increase or decrease in profits.

(vi) If demand is elastic the variance in foreign exchange earnings from wool is increased. Conversely, if demand is inelastic variance is decreased. In the first case (elastic demand) when the Wool Commission maintains the floor, the percentage increase in price is less than the percentage fall in quantity demanded by the wool trade, and hence foreign exchange earnings are reduced. Similarly, with elastic demand, foreign exchange earnings are increased at the ceiling. Variance in foreign exchange earnings are, therefore, increased by the Wool Commission's purchases and sales.

In this set of analyses, the expansions or contractions in the normal

trade demand dominated the effect of price elasticity on variance in foreign exchange earnings, but in later sets of analyses the effect of price elasticity becomes more evident.

(vii) The linear normal trade demand simulation model generates more conservative results, in a number of respects, than the constant elasticity simulation model. The reason for this is as follows. In the linear demand model the price elasticity varies along the demand schedule. At higher prices, demand is more elastic, and at lower prices less elastic than for the constant elasticity model. When the observed auction price is below the floor price, more wool has to be bought with a linear demand function in order to maintain the floor price than in the case of the constant elasticity model. Similarly if the observed price is above the ceiling, less wool is required to be sold to hold the ceiling with a linear demand model than with a constant elasticity model. Because in the linear demand model the Wool Commission purchases more wool in order to maintain the floor and sells less wool to hold the ceiling, it can therefore hold the ceiling price for a longer period of time than in the constant elasticity model.

More specifically, in terms of the summary measures, compared with the constant elasticity model, the linear model gave: (a) a lower average price, (b) a lower variance in price, (c) a lower minimum Wool Commission fund, (d) higher maximum Wool Commission stocks, (e) a lower average Wool Commission profit, (f) a lower average compounded grower profit, (g) a lower average compounded Wool Commission and grower profit, and (h) a greater variation in the ratio of variances of seasonal foreign exchange earnings from wool.

7.4.2.5 Conclusions from Analysis of Performance Functions

It is evident from the values of the coefficient of multiple determination, R^2 , for each summary measure listed in Tables 7.5 and 7.6, and from an inspection of the deviations given in the plot backs, that the performance functions do not fit the observed points particularly well. Indeed, for runs

9A through 16A the differences between actual and estimated values of the summary measures are particularly large. Should a "better fit" be required, then this can be obtained by fitting a higher order polynomial or by fitting the present second order polynomial for a reduced range of values for all or some of the parameters being varied.

Little weight can be put on the numerical values obtained in the sensitivity analyses. A comparison of the effect of changes in elasticity on average price with the effect of an expansion in demand on compounded Wool Commission and grower profits does, however, indicate that the model is much more sensitive to shifts in the demand curve than changes in the slope of the demand curve.

7.4.3 Fixed Floor and Ceiling Prices - Net Speculative Activity

The results from the simulation run in which net speculative activity occurred with a fixed floor and ceiling are now discussed.

7.4.3.1 Parameters Varied

The parameters varied were:

- A₁, the price elasticity of demand,
- A₃, the linear effect of the Wool Commission's stocks on net speculative demand/supply for wool,
- A₄, the linear effect of the spread between the simulated, and the world price on the net speculative demand/supply for wool,
- A₅, linear effect of net speculative stocks on net speculative demand/supply for wool, and
- A₆, a shift parameter indicating a change in net speculative demand/supply for wool, when the simulated price is either at the floor or the ceiling.

The parameter combinations defined by the central composite design are reported in Table 7.9.

7.4.3.2 Parameters Held Constant

The parameters held constant were:

$A_2 = 1.0$, there was no shift in the normal trade demand curve,

$A_9 = 0$, this indicates that the floor and ceiling price were fixed (equal to A_{12} and A_{13}),

$A_{10} = \$m60$, the initial level of Wool Commission funds,

$A_{11} = 0.05$, the annual rate of interest expressed as a decimal,

$A_{12} = 28$ cents, the initial floor price,

$A_{13} = 37$ cents, the initial ceiling price,

A_{14}, \dots, A_{23} , because $A_9 = 0$ the value of these parameters is not relevant, and

$A_{25} = 86.11645$, the weekly average Wool Commission funds where there is no Wool Commission interference in the market.

7.4.3.3 Equations of Performance Functions

The equations which would be fitted to the results of the simulation runs for this parameter set are as follows:

(i) Using the actual values of the price elasticity of demand

$$\begin{aligned}
 P = & b_0 + b_1 A_1 + b_2 A_3 + b_3 A_4 + b_4 A_5 + b_5 A_6 \\
 & + b_{11}(A_1)^2 + b_{22}(A_3)^2 + b_{33}(A_4)^2 + b_{44}(A_5)^2 + b_{55}(A_6)^2 \\
 & + b_{12} A_1 A_3 + b_{13} A_1 A_4 + b_{14} A_1 A_5 + b_{15} A_1 A_6 \\
 & + b_{23} A_3 A_4 + b_{24} A_3 A_5 + b_{25} A_3 A_6 + b_{34} A_4 A_5 \\
 & + b_{35} A_4 A_6 + b_{45} A_5 A_6
 \end{aligned} \tag{12}$$

(ii) Using the logarithm (to base 10) of the absolute value of the price elasticity of demand; i.e. $\alpha_1 = \text{LOG}(-A_1)$

$$\begin{aligned}
 P = & b_0 + b_1 \alpha_1 + b_2 A_3 + b_3 A_4 + b_4 A_5 + b_5 A_6 \\
 & + b_{11}(\alpha_1)^2 + b_{22}(A_3)^2 + b_{33}(A_4)^2 + b_{44}(A_5)^2 + b_{55}(A_6)^2
 \end{aligned}$$

TABLE 7.9 NUMERICAL RESULTS OF SIMULATION RUNS
FIXED FLOOR AND CEILING PRICES, BUT SPECULATIVE ACTIVITY - LINEAR DEMAND

Run No.	Coded Design					Actual Parameter Levels				Average Price (cents)	Variance in Price (\$)	Min. Fund (\$)	W.C. Stocks (,000 bales)	Max. W.C. Stocks (,000 bales)	Final W.C. Stocks (,000 bales)	Av. Net Profit (\$)	Av. W.C. Profit (\$)	Av. Comp. Grower Profit (\$)	Av. Sum I.C. & Grower Profit (\$)	Av. Comp. I.C. & Grower Profit (\$)	Ratio of seasonal var. in Foreign Exchange
	A1	A2	A3	A4	A5	A3	A4	A5	A6												
1	1	1	1	1	1	-4	0.1	0.2	0.1	0.1	37.297	5.407	59.792	123.33	0	0	25.587	-0.342	25.245	-0.872	1.015
2	1	1	1	1	-1	-4	0.1	0.2	0.1	-0.1	37.297	5.407	59.792	123.33	0	0	25.587	-0.342	25.245	-0.872	1.015
3	1	1	1	-1	1	-4	0.1	0.2	0.02	0.1	37.297	5.407	59.792	123.33	0	0	25.587	-0.342	25.245	-0.872	1.015
4	1	1	1	-1	-1	-4	0.1	0.2	0.02	-0.1	37.297	5.407	59.792	123.33	0	0	25.587	-0.342	25.245	-0.872	1.015
5	1	1	-1	1	1	-4	0.1	0.05	0.1	0.1	37.297	5.407	59.806	123.33	0	0	25.581	-0.340	25.241	-0.876	1.015
6	1	1	-1	1	-1	-4	0.1	0.05	0.1	-0.1	37.297	5.407	59.792	123.33	0	0	25.587	-0.342	25.245	-0.872	1.015
7	1	1	-1	-1	1	-4	0.1	0.05	0.02	0.1	37.297	5.407	59.806	123.33	0	0	25.581	-0.340	25.241	-0.876	1.015
8	1	1	-1	-1	-1	-4	0.1	0.05	0.02	-0.1	37.297	5.407	59.792	123.33	0	0	25.587	-0.342	25.245	-0.872	1.015
9	1	-1	1	1	1	-4	0	0.2	0.1	0.1	37.298	5.420	59.792	123.33	0	-0.280	26.552	-0.543	26.009	-0.108	1.015
10	1	-1	1	1	-1	-4	0	0.2	0.1	-0.1	37.300	5.444	59.792	123.33	0	-0.843	26.687	-0.542	26.145	0.028	1.015
11	1	-1	1	-1	1	-4	0	0.2	0.02	0.1	37.300	5.413	59.792	123.33	0	-0.137	26.545	-0.507	26.038	-0.078	1.015
12	1	-1	1	-1	-1	-4	0	0.2	0.02	-0.1	37.300	5.415	59.792	123.33	0	-0.172	26.634	-0.509	26.125	0.008	1.015
13	1	-1	-1	1	1	-4	0	0.05	0.1	0.1	37.295	5.413	59.816	118.941	0	0.029	25.730	-0.373	25.357	-0.759	1.014
14	1	-1	-1	1	-1	-4	0	0.05	0.1	-0.1	37.298	5.418	59.792	123.33	0	-0.226	26.550	-0.541	26.010	-0.107	1.015
15	1	-1	-1	-1	1	-4	0	0.05	0.02	0.1	37.295	5.414	59.817	116.133	0	0.047	25.810	-0.393	25.417	-0.699	1.014
16	1	-1	-1	-1	-1	-4	0	0.05	0.02	-0.1	37.298	5.413	59.792	123.33	0	-0.092	26.511	-0.523	25.988	-0.120	1.015
17	-1	1	1	1	1	-0.2505	0.1	0.2	0.1	0.1	37.222	5.415	60.056	7.723	0	-0.020	26.146	-0.448	25.698	-0.419	0.997
18	-1	1	1	1	-1	-0.2505	0.1	0.2	0.1	-0.1	37.222	5.415	60.056	7.723	0	-0.015	26.144	-0.444	25.700	-0.417	0.997
19	-1	1	1	-1	1	-0.2505	0.1	0.2	0.02	0.1	37.224	5.407	60.056	7.732	0	-0.055	26.117	-0.035	26.082	-0.034	0.996
20	-1	1	1	-1	-1	-0.2505	0.1	0.2	0.02	-0.1	37.224	5.408	60.056	7.732	0	-0.099	26.111	0.032	26.143	0.027	0.996
21	-1	1	-1	1	1	-0.2505	0.1	0.05	0.1	0.1	37.220	5.410	60.056	7.723	0	0.007	26.071	-0.315	25.756	-0.360	0.997
22	-1	1	-1	1	-1	-0.2505	0.1	0.05	0.1	-0.1	37.220	5.411	60.056	7.723	0	-0.002	26.086	-0.339	25.747	-0.370	0.997
23	-1	1	-1	-1	1	-0.2505	0.1	0.05	0.02	0.1	37.220	5.408	60.056	7.723	0	0.009	26.072	-0.319	25.752	-0.364	0.997
24	-1	1	-1	-1	-1	-0.2505	0.1	0.05	0.02	-0.1	37.220	5.409	60.056	7.723	0	-0.002	26.086	-0.333	25.752	-0.364	0.997
25	-1	-1	1	1	1	-0.2505	0	0.2	0.1	0.1	37.224	5.424	60.056	7.723	0	-0.052	26.181	-0.438	25.743	-0.375	0.997
26	-1	-1	1	1	-1	-0.2505	0	0.2	0.1	-0.1	37.224	5.434	60.056	7.723	0	-0.094	26.192	-0.429	25.764	-0.353	0.998
27	-1	-1	1	-1	1	-0.2505	0	0.2	0.02	0.2	37.227	5.408	60.056	7.733	0	-0.104	26.147	0.238	26.385	0.269	0.996
28	-1	-1	1	-1	-1	-0.2505	0	0.2	0.02	-0.1	37.227	5.410	60.056	7.733	0	-0.102	26.163	0.191	26.354	0.238	0.996
29	-1	-1	-1	1	1	-0.2505	0	0.05	0.1	0.1	37.222	5.426	60.056	7.061	0	-0.006	26.131	-0.494	25.637	-0.479	0.998
30	-1	-1	-1	1	-1	-0.2505	0	0.05	0.1	-0.1	37.226	5.432	60.056	7.723	0	-0.149	26.253	-0.511	25.743	-0.374	0.998
31	-1	-1	-1	-1	1	-0.2505	0	0.05	0.02	0.1	37.222	5.422	60.056	7.061	0	-0.003	26.128	-0.409	25.719	-0.398	0.997
32	-1	-1	-1	-1	-1	-0.2505	0	0.05	0.02	-0.1	37.225	5.429	60.056	7.723	0	-0.040	26.179	-0.397	25.782	-0.335	0.997
33	0	0	0	0	0	-1	0.05	0.125	0.06	0	37.235	5.406	60.035	30.832	0	-0.003	25.991	-0.336	25.654	-0.462	1.000
34	0	0	0	0	0	-8.541	0.05	0.125	0.06	0	37.391	5.407	58.161	263.940	0	0	24.986	-0.342	24.644	-1.473	1.048
35	0	0	0	0	0	-0.117	0.05	0.125	0.06	0	37.220	5.416	60.056	3.607	0	-0.021	26.133	-0.233	25.900	-0.216	0.996
36	0	0	0	0	0	-1	0.12735	0.125	0.06	0	37.235	5.406	60.035	30.832	0	0.002	25.986	-0.342	25.644	-0.472	1.000
37	0	0	0	0	0	-1	-0.02735	0.125	0.06	0	37.229	5.411	66.035	29.960	0	0.192	26.298	0.381	25.677	-0.499	0.998
38	0	0	0	0	0	-1	0.05	0.242	0.06	0	37.236	5.412	60.035	30.832	0	-0.024	26.139	-0.452	25.687	-0.429	1.000
39	0	0	0	0	0	-1	0.05	0.008	0.06	0	37.235	5.407	60.035	30.832	0	0	25.984	-0.342	25.642	-0.462	1.000
40	0	0	0	0	0	-1	0.05	0.125	0.16188	0	37.236	5.409	60.035	30.832	0	-0.005	25.991	-0.336	25.654	-0.462	1.000
41	0	0	0	0	0	-1	0.05	0.125	0.0	0	37.240	5.409	60.035	31.485	0	-0.099	25.962	-0.185	25.777	-0.339	1.000
42	0	0	0	0	0	-1	0.05	0.125	0.06	0.1547	37.235	5.407	60.035	30.832	0	0.008	25.973	-0.336	25.644	-0.473	1.000
43	0	0	0	0	0	-1	0.05	0.125	0.06	-0.1547	37.236	5.411	60.035	30.832	0	-0.009	25.997	-0.339	25.658	-0.458	1.000
A						-1	0	0	0	0	37.247	5.390	60.056	0	0	0	26.116	0	26.116	0	1.0

TABLE 7.10 NUMERICAL RESULTS OF SIMULATION RUNS
FIXED FLOOR AND CEILING PRICES, NET SPECULATIVE ACTIVITY - CONSTANT ELASTICITY

Run No.	Coded Design					Actual Parameter Levels					Average Price (cents)	Variance Price	Min. W.C. Fund (\$M)	Max. W.C. Stocks (baloo)	Final Stocks (,000 baloo)	Av. Net Spec. Funds (\$M)	Av. W.C. Profit (\$M)	Av. Comp. Grover Profit (\$M)	Av. Sum W.C. & Grover Profit (\$M)	Av. Comp. W.C. & Grover Profit (\$M)	Variance in Seasonal Fgn. Ex.
	A1	A3	A4	A5	A6	A1	A3	A4	A5	A6											
1	1	1	1	1	1	-4	0.1	0.2	0.1	0.1	37.307	5.412	59.844	89.333	0	0.001	26.449	0.319	26.768	0.651	1.010
2	1	1	1	1	-1	-4	0.1	0.2	0.1	-0.1	37.307	5.412	59.844	89.333	0	0.001	26.449	0.319	26.768	0.651	1.010
3	1	1	1	-1	1	-4	0.1	0.2	0.02	0.1	37.307	5.412	59.844	89.333	0	0.001	26.449	0.319	26.768	0.651	1.010
4	1	1	1	-1	-1	-4	0.1	0.2	0.02	-0.1	37.307	5.412	59.844	89.333	0	0.001	26.449	0.319	26.769	0.651	1.010
5	1	1	-1	1	1	-4	0.1	0.05	0.1	0.1	37.307	5.413	59.899	89.333	0	0	26.443	0.320	26.762	0.646	1.010
6	1	1	-1	1	-1	-4	0.1	0.05	0.1	-0.1	37.307	5.412	59.844	89.333	0	0	26.449	0.319	26.768	0.651	1.010
7	1	1	-1	-1	1	-4	0.1	0.05	0.01	0.1	37.307	5.413	59.899	89.333	0	0	26.443	0.320	26.763	0.646	1.010
8	1	1	-1	-1	-1	-4	0.1	0.05	0.02	-0.1	37.307	5.412	59.844	89.333	0	0	26.449	0.319	26.768	0.651	1.010
9	1	-1	1	1	1	-4	0	0.2	0.1	0.1	37.310	5.420	59.844	89.333	0	-0.176	26.549	0.412	26.961	0.845	1.010
10	1	-1	1	1	-1	-4	0	0.2	0.1	-0.1	37.314	5.428	59.844	89.333	0	-0.455	26.596	0.536	27.093	0.976	1.010
11	1	-1	1	-1	1	-4	0	0.2	0.02	0.1	37.309	5.415	59.844	89.333	0	-0.041	26.738	0.346	27.084	0.968	1.010
12	1	-1	1	-1	-1	-4	0	0.2	0.02	-0.1	37.307	5.416	59.844	89.333	0	-0.076	26.570	0.323	26.892	0.777	1.010
13	1	-1	-1	1	1	-4	0	0.05	0.1	0.1	37.304	5.417	59.860	89.333	0	0.032	26.379	0.328	26.707	0.591	1.010
14	1	-1	-1	1	-1	-4	0	0.05	0.1	-0.1	37.308	5.418	59.844	89.333	0	-0.132	26.544	0.331	26.876	0.759	1.010
15	1	-1	-1	-1	1	-4	0	0.05	0.02	0.1	37.310	5.419	59.862	82.071	0	0.057	26.414	0.533	26.948	0.831	1.008
16	1	-1	-1	-1	-1	-4	0	0.05	0.02	-0.1	37.306	5.415	59.844	89.333	0	-0.043	26.521	0.299	26.820	0.704	1.010
17	-1	1	1	1	1	-0.2505	0.1	0.2	0.1	0.1	37.230	5.415	60.056	7.069	0	-0.015	26.147	-0.212	25.935	-0.181	0.997
18	-1	1	1	1	-1	-0.2505	0.1	0.2	0.1	-0.1	37.230	5.415	60.056	7.069	0	-0.015	26.147	-0.212	25.935	-0.181	0.997
19	-1	1	1	-1	1	-0.2505	0.1	0.2	0.02	0.1	37.231	5.409	60.056	7.079	0	-0.055	26.119	0.186	26.305	0.188	0.997
20	-1	1	1	-1	-1	-0.2505	0.1	0.2	0.02	-0.1	37.232	5.413	60.056	7.079	0	-0.057	26.121	0.161	26.282	0.165	0.997
21	-1	1	-1	1	1	-0.2505	0.1	0.05	0.1	0.1	37.229	5.413	60.056	7.069	0	0.007	26.107	-0.189	25.918	-0.198	0.997
22	-1	1	-1	1	-1	-0.2505	0.1	0.05	0.1	-0.1	37.229	5.412	60.056	7.069	0	-0.003	26.136	-0.264	25.872	-0.245	0.997
23	-1	1	-1	-1	1	-0.2505	0.1	0.05	0.02	0.1	37.229	5.411	60.056	7.069	0	0.009	26.107	-0.194	25.913	-0.203	0.997
24	-1	1	-1	-1	-1	-0.2505	0.1	0.05	0.02	-0.1	37.230	5.412	60.056	7.069	0	-0.007	26.135	-0.232	25.903	-0.214	0.997
25	-1	-1	1	1	1	-0.2505	0	0.2	0.1	0.1	37.232	5.423	60.056	7.069	0	-0.047	26.177	-0.194	25.984	-0.133	0.997
26	-1	-1	1	1	-1	-0.2505	0	0.2	0.1	-0.1	37.233	5.433	60.056	7.069	0	-0.049	26.188	-0.202	25.987	-0.130	0.998
27	-1	-1	1	-1	1	-0.2505	0	0.2	0.02	0.1	37.233	5.409	60.056	7.079	0	-0.096	26.147	0.379	26.525	0.409	0.996
28	-1	-1	1	-1	-1	-0.2505	0	0.2	0.02	-0.1	37.233	5.413	60.056	7.079	0	-0.093	26.162	0.332	26.494	0.377	0.996
29	-1	-1	-1	1	1	-0.2505	0	0.05	0.1	0.1	37.231	5.427	60.056	6.414	0	-0.001	26.127	-0.224	25.903	-0.213	0.998
30	-1	-1	-1	1	-1	-0.2505	0	0.05	0.1	-0.1	37.239	5.462	60.056	7.069	0	-0.119	26.202	-0.101	26.101	-0.015	0.998
31	-1	-1	-1	-1	1	-0.2505	0	0.05	0.02	0.1	37.246	5.422	60.056	6.414	0	0.008	26.285	0.120	26.405	0.289	0.998
32	-1	-1	-1	-1	-1	-0.2505	0	0.05	0.02	-0.1	37.232	5.429	60.056	7.069	0	-0.039	26.178	-0.181	25.998	-0.119	0.998
33	0	0	0	0	0	-1	0.05	0.125	0.06	0	37.247	5.411	60.040	26.831	0	-0.007	26.197	-0.129	26.068	-0.049	1.000
34	0	0	0	0	0	-8.541	0.05	0.125	0.06	0	37.369	5.415	59.497	151.563	0	0.003	26.820	0.792	27.612	1.495	1.024
35	0	0	0	0	0	-0.117	0.05	0.125	0.06	0	37.227	5.418	60.056	3.332	0	-0.020	26.134	-0.058	26.075	-0.041	0.996
36	0	0	0	0	0	-1	0.12735	0.125	0.06	0	37.247	5.410	60.040	26.831	0	0	26.190	-0.130	26.060	-0.056	1.000
37	0	0	0	0	0	-1	-0.02735	0.125	0.06	0	37.251	5.406	60.040	26.831	0	-0.185	26.269	0.085	26.355	0.238	0.999
38	0	0	0	0	0	-1	0.05	0.242	0.06	0	37.248	5.413	60.040	26.831	0	-0.027	26.216	-0.123	26.093	-0.023	1.000
39	0	0	0	0	0	-1	0.05	0.008	0.06	0	37.247	5.410	60.040	26.831	1.8	0	26.190	-0.130	26.060	-0.060	1.000
40	0	0	0	0	0	-1	0.05	0.125	0.1618	0	37.247	5.411	60.040	26.831	0	-0.006	26.196	-0.130	26.066	-0.050	1.000
41	0	0	0	0	0	-1	0.05	0.125	0.0	0	37.251	5.411	60.040	27.444	0	-0.081	26.190	0.017	26.190	0.074	1.000
42	0	0	0	0	0	-1	0.05	0.125	0.06	0.1347	37.248	5.411	60.040	26.831	0	0.007	26.177	-0.122	26.054	-0.060	1.000
43	0	0	0	0	0	-1	0.05	0.125	0.06	-0.1347	37.247	5.411	60.040	26.831	0	-0.008	26.198	-0.128	26.070	-0.046	1.000
4						-1	0	0	0	0	37.247	5.390	60.056	0	0	0	26.116	0	26.116	0	1.0

$$\begin{aligned}
& + b_{12} \alpha_1 A_3 + b_{13} \alpha_1 A_4 + b_{14} \alpha_1 A_5 + b_{15} \alpha_1 A_6 \\
& + b_{23} A_3 A_4 + b_{24} A_3 A_5 + b_{25} A_3 A_6 + b_{34} A_4 A_5 \\
& + b_{35} A_4 A_6 + b_{45} A_5 A_6.
\end{aligned} \tag{13}$$

7.4.3.4 Conclusions from the Simulation Runs

The numerical results obtained from the simulation runs (where net speculative activity is present) are recorded in Table 7.9 for the linear demand model, and in Table 7.10 for the constant elasticity model. The overriding impression gained from an examination of the numerical results is that the different parameter assumptions for the price elasticity of demand and net speculative activity had very little effect on performance of the model. Three comments can, however, be made:

(i) In many cases the average net speculative funds and assets were negative, indicating that net speculators would have made a long term loss. This is an implausible result, and therefore these parameter combinations are unlikely to occur in the wool market.

(ii) Alternative specifications of the net speculative demand/supply function could be suggested, and their introduction may affect the outcome of the simulation runs.

(iii) The numerical value of average compounded Wool Commission and grower profits for most runs is slightly negative, indicating that the corresponding parameter combinations are undesirable.

7.4.4 Variable Weekly Floor and Ceiling Prices - No Net Speculative Activity

The results from the simulation run with variable weekly floor and ceiling prices, but no net speculative activity, are now discussed.

7.4.4.1 Parameters Varied

The parameters varied were:

A_1 , price elasticity of demand,

A_{14} , percentage drop in the weekly floor price allowed, and

A_{15} , percentage rise in the weekly ceiling price allowed.

The parameter combinations taken are listed in Table 7.11.

7.4.4.2 Parameters Held Constant

The parameters held constant were:

$A_2 = 1.0$, A_2 indicates the shift in the normal trade demand schedule due to the Wool Commission's activities,

$A_3 = A_4 = A_5 = A_6 = 0$, this means zero net speculative demand/supply throughout each simulation run,

$A_9 = 1$, there is a flexible floor price, the weekly floor being varied on a percentage basis,

$A_{10} = \$m60$, the initial level of Wool Commission funds,

$A_{11} = 0.05$, the annual rate of interest expressed as a decimal,

$A_{12} = 28$ cents, the initial weekly floor price,

$A_{13} = 37$ cents, the initial weekly ceiling price,

$A_{16}, \dots, A_{23} = 0$, so that the movement in the floor and ceiling prices was determined completely by A_{14} and A_{15} , and

$A_{25} = 86.11645$, the weekly average Wool Commission funds where there is no Wool Commission interference in the wool market.

7.4.4.3 Equations of Performance Functions

The two functions which were fitted to the results of the simulation runs (in Tables 7.11 and 7.12) were:

(i) Using the actual values of the price elasticity of demand:

$$\begin{aligned}
 P = & b_0 + b_1 A_1 + b_2 A_{14} + b_3 A_{15} \\
 & + b_{11}(A_1)^2 + b_{22}(A_{14})^2 + b_{33}(A_{15})^2 \\
 & + b_{12} A_1 A_{14} + b_{13} A_1 A_{15} + b_{23} A_{14} A_{15}
 \end{aligned}$$

TABLE 7.11 NUMERICAL RESULTS OF SIMULATION RUNS
 VARIABLE WEEKLY FLOOR AND CEILING PRICES, NO NET SPECULATIVE ACTIVITY - LINEAR DEMAND

Run No.	Coded Design			Actual Parameter Level			Average Price (cents)	Variance in Price	Min.W.C. Funds (\$M)	Max.W.C. Stocks (,000 bales)	Final Stocks (,000 bales)	Av.Net Spec. Funds and Assets (\$M)	Av.W.C. Profits (\$M)	Av.Comp. Grower Profit (\$M)	Av.Sum W.C. & Grower Profit' (\$M)	Av.Comp.W.C. & Grower Profit (\$M)	Ratio in Seasonal Foreign Exchange	Variance
	A1	A14	A15	A1	A14	A15												
1	1	1	1	-4	0.01	.01	37.279	5.426	59.854	72.795	0	0	23.821	0.232	24.053	-2.063	1.021	
2	1	1	-1	-4	0.01	0.0	37.275	5.468	59.854	64.236	0	0	26.498	-0.381	26.117	0.001	1.001	
3	1	-1	1	-4	.00	.01	37.305	5.305	59.792	137.310	0	0	21.267	0.606	21.873	-4.243	1.039	
4	1	-1	-1	-4	.00	0.0	37.297	5.406	59.792	123.330	0	0	25.586	-0.342	25.244	-0.872	1.015	
5	-1	1	1	-0.2505	0.01	.01	37.225	5.426	60.056	4.559	0	0	25.973	0.232	26.205	0.088	0.994	
6	-1	1	1	-0.2505	0.01	0.0	37.231	5.468	60.056	4.022	0	0	26.140	-0.381	25.759	-0.357	0.998	
7	-1	-1	1	-0.2505	.00	.01	37.204	5.305	60.056	8.599	0	0	25.813	0.606	26.419	0.302	0.989	
8	-1	-1	-1	-0.2505	.00	0.0	37.220	5.407	60.056	7.723	0	0	26.083	-0.342	25.741	-0.375	0.997	
9	0	0	0	-1	0.005	0.005	37.235	5.423	60.041	16.784	0	0	25.642	0.118	25.760	-0.356	0.999	
10	a	0	0	-5.39	0.005	0.005	37.299	5.423	59.729	90.469	0	0	23.558	0.118	23.677	-2.440	1.030	
11	-a	0	0	-0.1855	0.005	0.005	37.223	5.423	60.056	3.113	0	0	26.028	0.118	26.147	0.030	0.994	
12	0	a	0	-1	0.011075	0.005	37.236	5.440	60.049	15.922	0	0	25.681	0.110	25.791	-0.325	0.999	
13	0	-a	0	-1	-0.001075	0.005	37.225	5.321	60.034	31.802	0	0	25.012	0.505	25.517	-0.599	0.998	
14	0	0	a	-1	0.005	0.011075	37.235	5.404	60.042	19.787	0	0	25.504	0.244	25.748	-0.368	0.999	
15	0	0	-a	-1	0.005	-0.001075	37.239	5.459	60.042	16.784	0	0	26.210	-0.403	25.807	-0.309	1.000	
A*				-1.0	0	0	37.247	5.590	60.056	0	0	0	26.116	0	26.116	0	1.0	

* Run A indicates the results with no Wool Commission interference at the auction. The level of Wool Commission funds was \$60M.

TABLE 7.12 NUMERICAL RESULTS OF SIMULATION RUNS
 VARIABLE WEEKLY FLOOR AND CEILING PRICES, NO NET SPECULATIVE ACTIVITY - CONSTANT ELASTICITY

RUN NO.	Coded Design			Actual Parameter Level			Average Price (cents)	Variance in Price	Min.W.C. Funds (\$M)	Max.W.C. Stocks (,000 bales)	Final Stocks (,000 bales)	Av.Net Spec. Funds and Assets (\$M)	Av W.C. Profits (\$M)	Av.Comp. Grower Profit (\$M)	Av.Sum W.C. & Grower Profit (\$M)	Av.Comp.W.C. & Grower Profit (\$M)	Ratio Variance in Seasonal Foreign Exchange
	A1	A14	A15	A1	A14	A15											
1	1	1	1	-4	0.01	0.01	37.287	5.459	59.88	47.39	0	0	24.764	0.552	25.316	-0.800	1.014
2	1	1	-1	-4	0.01	0	37.280	5.471	59.88	40.97	0	0	26.446	0.157	26.604	0.487	1.005
3	1	-1	1	-4	0	0.01	37.326	5.373	59.84	99.87	0	0	22.701	1.193	23.894	-2.222	1.031
4	1	-1	-1	-4	0	0	37.307	5.412	59.84	89.33	0	0	26.449	0.318	26.768	0.651	1.010
5	-1	1	1	-0.2505	0.01	0.01	37.234	5.433	60.05	4.06	0	0	25.993	0.337	26.330	0.213	0.995
6	-1	1	-1	-0.2505	0.01	0	37.237	5.468	60.05	3.56	0	0	26.140	-0.208	25.932	-0.185	0.998
7	-1	-1	1	-0.2505	0	0.01	37.221	5.325	60.05	7.88	0	0	25.843	0.799	26.642	0.526	0.991
8	-1	-1	-1	-0.2505	0	0	37.229	5.409	60.05	7.06	0	0	26.119	-0.213	25.905	-0.211	0.997
9	0	0	0	-1	0.005	0.005	37.247	5.440	60.04	13.81	0	0	25.769	0.287	26.057	-0.059	1.000
10	a	0	0	-5.39	0.005	0.005	37.302	5.453	59.79	50.93	0	0	25.345	0.469	25.815	-0.302	1.016
11	a	0	0	-0.1855	0.005	0.005	37.233	5.433	60.05	2.76	0	0	26.043	0.227	26.270	0.154	0.995
12	0	a	0	-1	0.011075	0.005	37.247	5.459	60.05	13.19	0	0	25.798	0.263	26.061	-0.055	1.000
13	0	a	0	-1	-0.001075	0.005	37.247	5.360	60.03	27.25	0	0	25.117	0.809	25.986	-0.130	1.000
14	0	0	a	-1	0.005	0.011075	37.247	5.424	60.04	16.54	0	0	25.627	0.419	26.046	-0.070	1.000
15	0.	0	a	-1	0.005	-0.001075	37.247	5.459	60.04	13.81	0	0	26.208	-0.119	26.089	-0.027	1.000
A*				-1	0	0	37.247	5.590	60.056	0	0	0	26.116	0	26.116	0	1.0

*Run A indicates the results with no Wool Commission interference at the auction. The level of Wool Commission funds was \$60M.

- (ii) Using the logarithm (to base 10) of the absolute value of the price elasticity of demand, i.e. $\alpha_1 = \text{LOG}(-A_1)$:

$$\begin{aligned}
 P = & b_0 + b_1 \alpha_1 + b_2 A_{14} + b_3 A_{15} \\
 & + b_{11} (\alpha_1)^2 + b_{22} (A_{14})^2 + b_{33} (A_{15})^2 \\
 & + b_{12} \alpha_1 A_{14} + b_{13} \alpha_1 A_{15} + b_{23} A_{14} A_{15}
 \end{aligned}$$

7.4.4.4 Conclusions from Simulation Runs

The numerical results are recorded in Table 7.11 for the linear demand simulation model, and in Table 7.12 for the constant elasticity model.

From an inspection of the numerical results of the simulation runs it can be seen that the different parameter assumptions have had very little effect on the performance of the model. In particular, varying the floor and ceiling prices on a simply determined percentage basis have very little effect on the variance in price, or average compounded Wool Commission and grower profit. It can be inferred from the numerical results that (given the model) a simply determined flexible floor/ceiling price policy would not have been a significant improvement over the actual policy pursued in the historical period 1952/53 through 1965/66.

7.4.5 Variable Weekly and Seasonal Floor Price - No Net Speculative Activity

The results from the simulation with variable weekly and seasonal floor price, but no net speculative activity, are now discussed.

7.4.5.1 Parameters Varied

The parameters being varied were:

A_1 , price elasticity of demand,

A_{16} , linear effect of the Wool Commission's stocks on the weekly floor price,

A_{18} , maximum allowable percentage change in the floor price between

seasons,

A_{20} , linear effect of the Wool Commission stocks on the seasonal floor price, and

A_{22} , seasonal increment in the floor price if zero Wool Commission stocks.

7.4.5.2 Parameters Held Constant

The parameters held constant were:

$A_2 = 1.0$, no shift in the normal trade demand schedule due to the Wool Commission's activities,

$A_3 = A_4 = A_5 = A_6$, no net speculative activity,

$A_9 = -1$, there is a flexible floor price, the weekly floor being dependent on Wool Commission stocks,

$A_{10} = \$m60$, the initial level of Wool Commission funds,

$A_{11} = 0.05$, the annual rate of interest expressed as a decimal,

$A_{12} = 29$ cents, the initial weekly floor price,

$A_{13} = 38$ cents, the initial ceiling price,

$A_{14}, A_{15}, A_{17}, A_{19}, A_{21}, A_{23} = 0$, these parameters are associated with the flexible floor and ceiling prices, and

$A_{25} = 86.11645$, the weekly average Wool Commission funds, where there is no Wool Commission interference in the wool market.

7.4.5.3 Equations of Performance Functions

The two functions which were fitted to the results of the simulation runs were:

(i) Using the actual values of the price elasticity of demand:

$$\begin{aligned}
 P = & b_0 + b_1 A_1 + b_2 A_{16} + b_3 A_{18} + b_4 A_{20} + b_5 A_{22} \\
 & + b_{11} (A_1)^2 + b_{22} (A_{16})^2 + b_{33} (A_{18})^2 + b_{44} (A_{20})^2 \\
 & + b_{55} (A_{22})^2 + b_{12} A_1 A_{16} + b_{13} A_1 A_{18}
 \end{aligned}$$

$$\begin{aligned}
& + b_{14} A_1 A_{20} + b_{15} A_1 A_{22} + b_{23} A_{16} A_{18} \\
& + b_{24} A_{16} A_{20} + b_{25} A_{16} A_{22} + b_{34} A_{18} A_{20} \\
& + b_{35} A_{18} A_{22} + b_{45} A_{20} A_{22}
\end{aligned}$$

(ii) Using the logarithm (to base 10) of the absolute value of the price elasticity of demand, i.e. $\alpha_1 = \text{LOG}(-A_1)$:

$$\begin{aligned}
P = & b_0 + b_1 \alpha_1 + b_2 A_{16} + b_3 A_{18} + b_4 A_{20} + b_5 A_{22} \\
& + b_{11} (\alpha_1)^2 + b_{22} (A_{16})^2 + b_{33} (A_{18})^2 + b_{44} (A_{20})^2 \\
& + b_{55} (A_{22})^2 + b_{12} \alpha_1 A_{16} + b_{13} \alpha_1 A_{18} \\
& + b_{14} \alpha_1 A_{20} + b_{15} \alpha_1 A_{22} + b_{23} A_{16} A_{18} \\
& + b_{24} A_{16} A_{20} + b_{25} A_{16} A_{22} + b_{34} A_{18} A_{20} \\
& + b_{35} A_{18} A_{22} + b_{45} A_{20} A_{22}.
\end{aligned}$$

7.4.5.4 Conclusions from Simulation Runs

This set of analyses tests the outcome of a series of flexible floor price policies. The numerical results from the simulation runs are recorded in Table 7.13 for the linear demand model, and in Table 7.14 for the constant elasticity of demand model.

Given the model and the parameter combinations taken, the effect of variations in price elasticity on average price dominated the effect of changes in the policy parameters. Changes in average price were, however, less than 1%. Significant reductions in price variability were achieved by some policy parameter combinations, particularly where the seasonal increment in the floor price (assuming there are zero Wool Commission stocks), A_{22} , was 0.01. In some cases variance in price was reduced by 15 to 20%. For a number of parameter combinations, particularly where demand is elastic, the Wool Commission made substantial purchases of wool. This affected the average Wool Commission profit, and therefore the level of average compounded Wool Commission

TABLE 7.13 NUMERICAL RESULTS OF SIMULATION RUNS
 VARIANCE VIBRID, AND SEASONAL FLOOR PRICES, TO THE SPECULATIVE ACTIVITY - LINEAR DEMAND

Run No.	Coded Design				Actual Parameter Levels				Average Price (cents)	Variance Price	Min. F.C. Fund (\$M)	Max. F.C. Stock (,000 bales)	Final Stock (,000 bales)	Av. Net Funds & Assets (\$M)	Av. F.C. Profit (\$M)	Av. Comp. Grover Profit (\$M)	A.V. Sum F.C. & Grover	Av. Comp. F.C. & Grover	Ratio of Variance of Seasonal Fgn. Ex.		
	A1	A16	A18	A20	A22	A1	A16	A18												A20	A22
1	1	1	1	1	1	-4	0.006	0.12	-0.02	0.01	37.310	5.292	59.273	196.761	0	0	19.706	0.718	20.425	-5.692	1.046
2	1	1	1	1	-1	-4	0.006	0.12	-0.02	0	37.301	5.385	59.273	130.820	0	0	23.290	0.190	23.439	-2.677	1.026
3	1	1	1	-1	1	-4	0.006	0.12	-0.005	0.01	37.312	5.170	57.954	252.326	0	0	16.949	1.032	17.982	-8.134	1.064
4	1	1	1	-1	-1	-4	0.006	0.12	-0.005	0	37.302	5.340	59.273	151.523	0	0	22.180	0.307	22.487	-3.629	1.032
5	1	1	-1	1	1	-4	0.006	0.04	-0.02	0.01	37.304	5.252	59.273	223.438	0	0	18.336	0.860	19.196	-6.920	1.052
6	1	1	-1	1	-1	-4	0.006	0.04	-0.02	0	37.301	5.376	59.273	135.791	0	0	23.004	0.215	23.219	-2.898	1.027
7	1	1	-1	-1	1	-4	0.006	0.04	-0.005	0.01	37.311	5.170	57.955	252.326	0	0	26.949	1.032	17.982	-8.314	1.032
8	1	1	-1	-1	-1	-4	0.006	0.04	-0.005	0	37.302	5.340	59.273	151.523	0	0	22.180	0.307	22.487	-3.629	1.032
9	1	-1	1	1	1	-4	0.002	0.12	-0.02	0.01	37.306	5.271	59.264	212.705	0	0	18.788	0.820	19.607	-6.309	1.050
10	1	-1	1	1	-1	-4	0.002	0.12	-0.02	0	37.301	5.372	59.264	139.116	0	0	22.828	0.241	23.070	-3.047	1.028
11	1	-1	1	-1	1	-4	0.002	0.12	-0.005	0.01	37.320	5.092	52.329	306.231	0	0	14.399	1.380	15.779	-10.338	1.083
12	1	-1	1	-1	-1	-4	0.002	0.12	-0.005	0	37.305	5.306	59.264	171.298	0	0	21.255	0.432	21.687	-4.429	1.038
13	1	-1	1	1	1	-4	0.002	0.04	-0.02	0.01	37.311	5.154	56.630	265.197	0	0	16.381	1.124	17.445	-8.671	1.067
14	1	-1	-1	1	-1	-4	0.002	0.04	-0.02	0	37.299	5.360	59.264	148.020	0	0	22.376	0.290	22.667	-3.450	1.030
15	1	-1	-1	-1	1	-4	0.002	0.04	-0.005	0.01	37.321	5.092	52.328	306.231	0	0	14.397	1.380	15.777	-10.340	1.083
16	1	-1	-1	-1	-1	-4	0.002	0.04	-0.005	0	37.305	5.306	59.264	171.298	0	0	21.255	0.432	21.688	-4.429	1.038
17	-1	1	1	1	1	-0.2505	0.006	0.12	-0.02	0.01	37.120	4.860	60.048	25.022	0.576	0	25.065	2.036	27.099	0.982	0.968
18	-1	1	1	1	-1	-0.2505	0.006	0.12	-0.02	0	37.187	5.236	60.048	12.437	0	0	25.725	0.586	26.312	0.195	0.986
19	-1	1	1	-1	1	-0.2505	0.006	0.12	-0.005	0.01	37.128	4.696	60.048	29.863	4.413	0	24.929	2.302	27.231	1.114	0.964
20	-1	1	1	-1	-1	-0.2505	0.006	0.12	-0.005	0	37.183	5.207	60.048	12.684	0	0	25.709	0.606	26.315	0.199	0.985
21	-1	1	-1	1	1	-0.2505	0.006	0.04	-0.02	0.01	37.120	4.860	60.048	25.022	0.576	0	25.065	2.036	27.099	0.982	0.968
22	-1	1	-1	1	-1	-0.2505	0.006	0.04	-0.02	0	37.187	5.236	60.048	12.437	0	0	25.725	0.586	26.311	0.195	0.986
23	-1	1	-1	-1	1	-0.2505	0.006	0.04	-0.005	0.01	37.128	4.696	60.048	29.863	4.413	0	24.929	2.302	27.231	1.114	0.964
24	-1	1	-1	-1	-1	-0.2505	0.006	0.04	-0.005	0	37.183	5.207	60.048	12.684	0	0	25.709	0.606	26.315	0.199	0.985
25	-1	-1	1	1	1	-0.2505	0.002	0.12	-0.02	0.01	37.117	4.846	60.048	25.656	0.546	0	25.035	2.095	27.130	1.014	0.967
26	-1	-1	1	1	-1	-0.2505	0.002	0.12	-0.02	0	37.186	5.234	60.048	12.585	0	0	25.717	0.601	26.318	0.202	0.986
27	-1	-1	1	-1	1	-0.2505	0.002	0.12	-0.005	0.01	37.123	4.679	60.048	30.811	4.382	0	24.892	2.373	27.264	1.148	0.963
28	-1	-1	1	-1	-1	-0.2505	0.002	0.12	-0.005	0	37.182	5.200	60.048	12.834	0	0	25.703	0.621	26.323	0.207	0.985
29	-1	-1	-1	1	1	-0.2505	0.002	0.04	-0.02	0.01	37.117	4.846	60.048	25.656	0.546	0	25.035	2.095	27.130	1.014	0.967
30	-1	-1	-1	-1	-1	-0.2505	0.002	0.04	-0.02	0	37.186	5.234	60.048	12.585	0	0	25.717	0.601	26.318	0.202	0.986
31	-1	-1	-1	-1	1	-0.2505	0.002	0.04	-0.005	0.01	37.123	4.679	60.048	30.811	4.382	0	24.892	2.373	27.264	1.148	0.963
32	-1	-1	-1	-1	-1	-0.2505	0.002	0.04	-0.005	0	37.182	5.200	60.048	12.834	0	0	25.702	0.621	26.323	0.207	0.985
33	0	0	0	0	0	-1	0.004	0.08	-0.013	0.005	37.200	5.139	59.954	64.118	0	0	23.832	1.001	24.834	-1.283	0.996
34	0	0	0	0	0	-8.514	0.004	0.08	-0.013	0.005	37.406	5.372	51.829	318.127	0	0	17.733	0.368	18.101	-2.015	1.087
35	0	0	0	0	0	-0.117	0.004	0.08	-0.013	0.005	37.141	5.000	60.052	8.849	0.296	0	25.776	1.263	27.039	0.923	0.972
36	0	0	0	0	0	-1	0.007094	0.08	-0.013	0.005	37.203	5.159	59.954	61.602	0	0	23.955	0.938	24.894	-1.222	0.996
37	0	0	0	0	0	-1	0.000906	0.08	-0.013	0.005	37.196	5.124	59.954	66.927	0	0	23.690	1.073	24.762	-1.354	0.996
38	0	0	0	0	0	-1	0.004	0.14188	-0.013	0.005	37.199	5.139	59.954	64.118	0	0	23.832	1.001	24.834	-1.283	0.996
39	0	0	0	0	0	-1	0.004	0.02812	-0.013	0.005	37.199	5.139	59.954	64.118	0	0	23.832	1.001	24.834	-1.283	0.996
40	0	0	0	0	0	-1	0.004	0.08	-0.02585	0.005	37.206	5.205	59.954	59.883	0	0	24.052	0.903	24.955	-1.161	0.997
41	0	0	0	0	0	-1	0.004	0.08	-0.00217	0.005	37.192	5.041	59.954	69.249	2.145	0	23.492	1.132	24.624	-1.493	0.995
42	0	0	0	0	0	-1	0.004	0.08	-0.013	0.012735	37.163	4.990	59.954	101.157	0	0	21.855	2.114	23.969	-2.147	0.994
43	0	0	0	0	0	-1	0.004	0.08	-0.013	0.002735	37.227	5.327	59.954	37.945	0	0	25.145	0.287	25.432	-0.684	0.999
A											37.247	5.590	60.05	0	0	0	26.116	0	26.116	0	1.0

TABLE 7.14 NUMERICAL RESULTS OF SIMULATION RUNS
 VARIABLE PRICES AND SEASONAL PROFIT FROM 10 PER SIMULATIVE ACTIVITY - CONSTANT ELASTICITY

Run No.	Coded Design					Actual Variable Level				Average Price (cents)	Var- ance Price	Min.F.C. Fund (\$M)	Max.F.C. Stocks (,000 bales)	Final Stocks (,000 bales)	Av.Net Spec. Funds \$	Av.F.C. Profit (\$M)	Av.Comp. Grower Profit (\$M)	Av. Sum F.C. & Grower	Av.Comp. F.C. & Grower	Ratio of Var- iance of Seasonal Figs. (K).	
	A1	A16	A18	A20	A22	A1	A16	A18	A20												A22
1	1	1	1	1	1	-4	0.006	0.12	-0.02	0.01	37.343	5.341	59.428	196.041	0	0	21.743	1.728	23.471	-2.645	1.034
2	1	1	1	1	-1	-4	0.006	0.12	-0.02	0.01	37.314	5.411	59.428	102.108	0	0	24.670	0.729	25.399	-0.717	1.017
3	1	1	1	-1	1	-4	0.006	0.12	-0.005	0.01	37.379	5.249	59.428	200.710	0	0	19.594	2.506	22.100	-4.016	1.053
4	1	1	1	-1	-1	-4	0.006	0.12	-0.005	0.01	37.327	5.373	59.484	117.190	0	0	23.866	1.031	24.897	-1.219	1.023
5	1	1	-1	1	1	-4	0.006	0.04	-0.02	0.01	37.355	5.312	59.428	169.762	0	0	81.140	1.937	23.079	-3.038	1.039
6	1	1	-1	1	-1	-4	0.006	0.04	-0.02	0.01	37.315	5.410	59.428	102.684	0	0	24.637	0.744	25.382	-0.735	1.017
7	1	1	-1	-1	1	-4	0.006	0.04	-0.005	0.01	37.379	5.249	59.428	200.710	0	0	19.594	2.506	22.100	-4.016	1.053
8	1	1	-1	-1	-1	-4	0.006	0.04	-0.005	0.01	37.327	5.373	59.428	117.190	0	0	23.866	1.031	24.897	-1.219	1.023
9	-1	1	1	1	1	-4	0.002	0.12	-0.02	0.01	37.354	5.315	59.423	171.096	0	0	21.053	1.970	23.023	-3.094	1.039
10	-1	1	1	1	-1	-4	0.002	0.12	-0.02	0.01	37.317	5.403	59.423	107.607	0	0	24.395	0.830	25.225	-0.932	1.019
11	-1	1	1	-1	1	-4	0.002	0.12	-0.005	0.01	37.399	5.200	59.220	237.893	0	0	17.827	3.115	20.942	-5.174	1.066
12	-1	1	1	-1	-1	-4	0.002	0.12	-0.005	0.01	37.336	5.348	59.423	130.179	0	0	23.307	1.216	24.523	-1.593	1.028
13	-1	1	-1	1	1	-4	0.002	0.04	-0.02	0.01	37.370	5.280	59.423	195.216	0	0	19.918	2.369	22.288	-3.829	1.048
14	-1	1	-1	1	-1	-4	0.002	0.04	-0.02	0.01	37.319	5.399	59.423	110.620	0	0	24.260	0.877	25.137	-0.979	1.019
15	-1	1	-1	-1	1	-4	0.002	0.04	-0.005	0.01	37.399	5.200	59.220	237.893	0	0	17.827	3.115	20.942	-5.174	1.066
16	-1	1	-1	-1	-1	-4	0.002	0.04	-0.005	0.01	37.336	5.348	59.423	130.179	0	0	23.307	1.216	24.523	-1.593	1.028
17	-1	1	1	1	1	-0.2505	0.006	0.12	-0.02	0.01	37.183	4.931	60.048	23.033	0.665	0	25.171	2.765	27.935	1.819	0.974
18	-1	1	1	1	-1	-0.2505	0.006	0.12	-0.02	0.01	37.213	5.254	60.048	11.429	0	0	25.779	0.906	26.684	0.568	0.989
19	-1	1	1	-1	1	-0.2505	0.006	0.12	-0.005	0.01	37.206	4.789	60.048	27.296	4.505	0	25.051	3.138	28.190	2.073	0.972
20	-1	1	1	-1	-1	-0.2505	0.006	0.12	-0.005	0.01	37.210	5.234	60.048	11.640	0	0	25.766	0.940	26.706	0.590	0.983
21	-1	1	-1	1	1	-0.2505	0.006	0.04	-0.02	0.01	37.183	4.931	60.048	23.033	0.665	0	25.171	2.765	27.935	1.815	0.974
22	-1	1	-1	1	-1	-0.2505	0.006	0.04	-0.02	0.01	37.213	5.254	60.048	11.429	0	0	25.779	0.906	26.684	0.568	0.989
23	-1	1	-1	-1	1	-0.2505	0.006	0.04	-0.005	0.01	37.206	4.789	60.048	27.296	4.505	0	25.051	3.138	28.190	2.073	0.972
24	-1	1	-1	-1	-1	-0.2505	0.006	0.04	-0.005	0.01	37.210	5.234	60.048	11.640	0	0	25.766	0.940	26.706	0.590	0.983
25	-1	1	1	1	1	-0.2505	0.002	0.12	-0.02	0.01	37.182	4.923	60.048	23.584	0.633	0	25.147	2.839	27.986	1.869	0.974
26	-1	1	1	1	-1	-0.2505	0.002	0.12	-0.02	0.01	37.212	5.250	60.048	11.554	0	0	25.773	0.922	26.696	0.579	0.989
27	-1	1	1	-1	1	-0.2505	0.002	0.12	-0.005	0.01	37.203	4.758	60.048	28.090	4.486	0	25.026	3.216	28.242	2.126	0.971
28	-1	1	1	-1	-1	-0.2505	0.002	0.12	-0.005	0.01	37.210	5.230	60.048	11.766	0	0	25.760	0.958	26.718	0.602	0.988
29	-1	1	-1	1	1	-0.2505	0.002	0.04	-0.02	0.01	37.182	4.923	60.048	23.584	0.633	0	25.147	2.839	27.986	1.869	0.974
30	-1	1	-1	1	-1	-0.2505	0.002	0.04	-0.02	0.01	37.212	5.250	60.048	11.554	0	0	25.773	0.922	26.696	0.579	0.989
31	-1	1	-1	-1	1	-0.2505	0.002	0.04	-0.005	0.01	37.203	4.758	60.048	28.090	4.486	0	25.026	3.216	28.242	2.126	0.971
32	-1	1	-1	-1	-1	-0.2505	0.002	0.04	-0.005	0.01	37.210	5.230	60.048	11.766	0	0	25.760	0.958	26.718	0.602	0.988
33	0	0	0	0	0	-1	0.004	0.08	-0.013	0.005	37.247	5.206	59.967	56.541	0	0	24.221	1.647	25.869	-0.247	1.000
34	0	0	0	0	0	-8.514	0.004	0.08	-0.013	0.005	37.400	5.399	58.765	208.504	0	0	23.560	1.338	24.899	-1.218	1.047
35	0	0	0	0	0	-0.117	0.004	0.08	-0.013	0.005	37.185	5.050	60.053	3.089	0.290	0	25.814	1.763	27.576	1.460	0.977
36	0	0	0	0	0	-1	.007096	0.08	-0.013	0.005	37.247	5.216	59.967	56.541	0	0	24.319	1.558	25.878	-0.237	1.000
37	0	0	0	0	0	-1	.00906	0.08	-0.013	0.005	37.247	5.197	59.967	58.285	0	0	24.106	1.752	25.858	-0.258	1.000
38	0	0	0	0	0	-1	0.004	.14188	-0.013	0.005	37.247	5.206	59.967	56.541	0	0	24.221	1.647	25.869	-0.247	1.000
39	0	0	0	0	0	-1	0.004	.02812	-0.013	0.005	37.247	5.206	59.967	56.541	0	0	24.221	1.647	25.869	-0.247	1.000
40	0	0	0	0	0	-1	0.004	0.08	-0.0283	0.005	37.247	5.245	59.967	53.131	0	0	24.405	1.482	25.887	-0.229	1.000
41	0	0	0	0	0	-1	0.004	0.08	-0.0217	0.005	37.252	5.106	59.967	60.731	0	0	23.919	1.923	25.842	-0.274	1.000
42	0	0	0	0	0	-1	0.004	0.08	-0.013	.012735	37.247	5.031	59.967	89.340	0	0	22.496	3.212	25.708	-0.408	1.000
43	0	0	0	0	0	-1	0.004	0.08	-0.013	.002735	37.247	5.350	59.967	33.363	0	0	25.369	0.615	25.985	-0.132	1.000
A											37.247	5.590	60.05	0	0	0	26.116	0	26.116	0	1.000

and grower profits.

It will be noted that for runs 1 through 32 there is a tendency for either the average price of wool to be raised or compounded grower profits to be positive. At first sight this seems to be the "wrong way around" because we would expect the profits to growers to be higher, the higher the average price. Inspection of Tables 7.13 and 7.14 show that the changes in average price and compounded grower profits are quite small. This small "contradiction" arises due to the comparison of average wool price with compounded profits.

7.5 Directional Results

In section 7.4.1, four sets of analyses were outlined. This section analyses the results of the simulation runs from each set of analyses using information on the direction of change of the summary measures.

7.5.1 Fixed Floor and Ceiling Prices - No Net Speculative Activity

The first series of simulation runs corresponded to a constant floor and ceiling price over the full 14 years, and no net speculative demand. The level at which the floor and ceiling were set was varied over a range, but the floor and ceiling were not allowed to vary from season to season, or week to week. The results of these simulations are summarised in Table 7.15.

The first column of Table 7.15 gives a run number, and it can be seen that 43 separate parameter combinations were examined. The next four columns give the values of the parameters for the particular run. The remaining sets of columns give, first, results of assuming a linear demand function, and then on the right, the results of assuming a constant elasticity demand function. Reading across the first row (from column 5 on), it can be seen that:

- (1) If a linear demand function is assumed, then the first set of parameters would have:
 - (a) raised (strictly, "not lowered") average price,
 - (b) decreased (strictly, "not increased") price variance,

- (c) left the Wool Commission enough funds to operate without borrowing from Government,
 - (d) left the net speculators with a profit (strictly, they would not have made a loss),
 - (e) left the Wool Commission with a profit (though possibly less than 1% on available funds),
 - (f) given the growers a hidden profit (strictly, not a hidden loss),
 - (g) resulted in a lower return to Wool Commission and growers, than the actual Wool Commission policy for the period, and
 - (h) increased the variability of export income from wool, and
- (ii) If a constant elasticity demand function is assumed, then (still reading across the first row of Table 1) the first set of parameters would have:
- (a) increased average price,
 - (b) reduced price variability,
 - (c) left the Wool Commission with adequate funds to operate without borrowing,
 - (d) left net speculators with no loss,
 - (e) returned the Wool Commission a profit,
 - (f) reduced the combined income of Wool Commission and growers as compared to the policy actually followed, and
 - (g) increased the variability of export income.

The numerical results from these simulations are given in Tables 7.1 to 7.4

Examination of the directional information in Table 7.15 shows that (within the confines of the 14 years examined and the model used) in order to get a "better" performance of the wool market, than was actually obtained, it is necessary to assume:

TABLE 7.15 DIRECTIONAL INDICATION OF SOME OUTCOMES - LINEAR DEMAND | CONSTANT ELASTICITY
 FLOOR AND CEILING PRICES, AND IN ELASTICITY INDICES

Run No.	Parameter Levels				Linear Normal Trade Demand							Constant Elasticity Normal Trade Demand							Star		
	Elast-icity	Floor Cents)	Ceiling Cents)	% Change in Trade Demand	Price	Vari-ance	Mini-mum Funds	Net Spec. Profit	Wool Comm. Profit	Grower Profit	Comp. Wool Comm. & Grower Profit	Export Vari-ance	Price	Vari-ance	Mini-mum Funds	Net Spec. Profit	Wool Comm. Profit	Grower Profit		Comp. Wool Comm. & Grower Profit	Export Vari-ance
1	-4	30	40	+1	✓	✓	✓	✓	✓	✓	x	x	✓	✓	✓	✓	✓	✓	x	x	
2	-4	30	40	-1	✓	✓	✓	✓	✓	✓	x	x	✓	✓	✓	✓	✓	✓	x	x	
3	-4	30	34	+1	✓	✓	✓	✓	✓	✓	x	x	✓	✓	✓	✓	✓	✓	x	x	**
4	-4	30	34	-1	x	✓	✓	✓	✓	✓	x	x	✓	✓	✓	✓	✓	✓	x	x	
5**	-4	26	40	+1	✓	✓	✓	✓	✓	✓	✓	x	✓	✓	✓	✓	✓	✓	✓	x	**
6	-4	26	40	-1	x	✓	✓	✓	✓	✓	x	x	x	✓	✓	✓	✓	✓	x	x	
7**	-4	26	34	+1	✓	✓	✓	✓	✓	✓	✓	x	✓	✓	✓	✓	✓	✓	✓	x	**
8	-4	26	34	-1	x	✓	✓	✓	✓	✓	x	x	✓	✓	✓	✓	✓	✓	x	x	
9	-1.665	30	40	+1	✓	✓	✓	✓	✓	✓	✓	x	✓	✓	✓	✓	✓	✓	✓	x	**
10	-1.665	30	40	-1	x	✓	✓	✓	✓	✓	x	x	x	✓	✓	✓	✓	✓	x	x	
11**	-1.665	30	34	+1	✓	✓	✓	✓	✓	✓	✓	x	✓	✓	✓	✓	✓	✓	✓	x	**
12	-1.665	30	34	-1	x	✓	✓	✓	✓	✓	x	x	x	✓	✓	✓	✓	✓	x	x	
13**	-1.665	26	40	+1	✓	✓	✓	✓	✓	✓	✓	x	✓	✓	✓	✓	✓	✓	✓	x	**
14	-1.665	26	40	-1	x	✓	✓	✓	✓	✓	x	x	x	✓	✓	✓	✓	✓	x	x	
15**	-1.665	26	34	+1	✓	✓	✓	✓	✓	✓	✓	x	✓	✓	✓	✓	✓	✓	✓	x	**
16	-1.665	26	34	-1	x	✓	✓	✓	✓	✓	x	x	x	✓	✓	✓	✓	✓	x	x	
17**	-6006	30	40	+1	✓	✓	✓	✓	✓	✓	✓	x	✓	✓	✓	✓	✓	✓	✓	x	**
18	-6006	30	40	-1	x	✓	✓	✓	✓	✓	x	x	✓	✓	✓	✓	✓	✓	x	x	
19**	-6006	30	34	+1	✓	✓	✓	✓	✓	✓	✓	x	✓	✓	✓	✓	✓	✓	✓	x	**
20	-6006	30	34	-1	x	✓	✓	✓	✓	✓	x	x	x	✓	✓	✓	✓	✓	x	x	
21**	-6006	26	40	+1	✓	✓	✓	✓	✓	✓	✓	x	✓	✓	✓	✓	✓	✓	✓	x	**
22	-6006	26	40	-1	x	✓	✓	✓	✓	✓	x	x	x	✓	✓	✓	✓	✓	x	x	
23*	-6006	26	34	+1	✓	x	✓	✓	✓	✓	✓	x	✓	✓	✓	✓	✓	✓	✓	x	*
24	-6006	26	34	-1	x	✓	✓	✓	✓	✓	x	x	✓	✓	✓	✓	✓	✓	x	x	
25**	-2905	30	40	+1	✓	✓	✓	✓	✓	✓	✓	x	✓	✓	✓	✓	✓	✓	✓	x	**
26	-2905	30	40	-1	x	✓	✓	✓	✓	✓	x	x	x	✓	✓	✓	✓	✓	x	x	
27*	-2905	30	34	+1	✓	x	✓	✓	✓	✓	✓	x	✓	✓	✓	✓	✓	✓	✓	x	*
28	-2905	30	34	-1	x	✓	✓	✓	✓	✓	x	x	✓	✓	✓	✓	✓	✓	x	x	
29*	-2905	26	40	+1	✓	x	✓	✓	✓	✓	✓	x	✓	✓	✓	✓	✓	✓	✓	x	*
30	-2905	26	40	-1	x	✓	✓	✓	✓	✓	x	x	✓	✓	✓	✓	✓	✓	x	x	
31*	-2905	26	34	+1	✓	x	✓	✓	✓	✓	✓	x	✓	✓	✓	✓	✓	✓	✓	x	*
32	-2905	26	34	-1	x	✓	✓	✓	✓	✓	x	x	✓	✓	✓	✓	✓	✓	x	x	
33	-1	28	37	0	x	✓	✓	✓	✓	✓	x	x	✓	✓	✓	✓	✓	✓	x	x	
34	-7.101	28	37	0	✓	✓	✓	✓	✓	✓	x	x	✓	✓	✓	✓	✓	✓	✓	x	**
35	-2.056	28	37	0	✓	✓	✓	✓	✓	✓	x	x	✓	✓	✓	✓	✓	✓	x	x	
36	-4.864	28	37	0	x	✓	✓	✓	✓	✓	x	x	x	✓	✓	✓	✓	✓	✓	x	
37	-1402	28	37	0	x	✓	✓	✓	✓	✓	x	x	x	✓	✓	✓	✓	✓	x	x	
38	-1	30.828	37	0	x	✓	✓	✓	✓	✓	x	x	✓	✓	✓	✓	✓	✓	✓	x	
39	-1	25.172	37	0	x	✓	✓	✓	✓	✓	x	x	✓	✓	✓	✓	✓	✓	x	x	
40	-1	28	41.242	0	x	✓	✓	✓	✓	✓	✓	x	✓	✓	✓	✓	✓	✓	✓	x	
41	-1	28	32.758	0	x	✓	✓	✓	✓	✓	x	x	✓	✓	✓	✓	✓	✓	x	x	
42**	-1	28	37	1.414	✓	✓	✓	✓	✓	✓	✓	x	✓	✓	✓	✓	✓	✓	✓	x	**
43	-1	28	37	-1.414	x	✓	✓	✓	✓	✓	x	x	✓	✓	✓	✓	✓	✓	x	x	

* Export Income and Price Variances Increased

** Only Export Income Variance Increased

- (i) that the floor and ceiling price should have been allowed to vary over the period, and/or
- (ii) that net speculative activity induced by the Wool Commission's activities would have been beneficial, and/or
- (iii) that net trade demand would have been increased by the Wool Commission's activities, and/or
- (iv) a highly elastic demand, say, less than -6.

If (within the context of the model) it is not possible to assume one of the above then the performance of the marketing system under different Wool Commission policies to the one actually employed would have been detrimental to growers.

To emphasise the above conclusion a double star (on the left for linear demand and right for constant elasticity demand) has been placed on rows where all changes except export income variability were improved, and a single star has been placed on rows where all changes were beneficial except export income and price variability. A brief examination of Table 7.15 shows that all but one of the starred rows assumes that normal trade demand was increased by the Wool Commission's policy. The exception is run 34, where with no effect on trade demand, and an elasticity of -7.101 all changes except the variability of export income are beneficial.

7.5.2 Fixed Floor and Ceiling Prices - Net Speculative Activity

The second series of simulation runs (or set of parameters being tested) allowed for net speculative activity as a result of the Wool Commission's floor and ceiling price policy. The results of these simulation runs are summarised in Table 7.16.

The parameters determining the net speculative behaviour were:

A_3 = The linear effect of the Wool Commission's stocks on the net speculative demand/supply for wool.

A_4 = The linear effect of the spread between the simulated New Zealand auction price and the equilibrium world price on the net speculative demand/supply of wool.

A_5 = The linear effect of net speculative stocks on the net speculative demand/supply for wool.

A_6 = A shift parameter indicating the change in the net speculative demand/supply for wool, when the simulated price is either at the floor or the ceiling price.

The various values taken by these parameters, and by the price elasticity of demand are seen in Table 7.16. The interpretation of individual runs in this table is similar to that given for Table 7.15.

What is not immediately apparent from this table is that none of the parameter combinations (including the price elasticity of demand) significantly affected the numerical results of the summary measures. (The numerical results are given in Tables 7.9 and 7.10). Regardless of the level of the numerical results, however, it is evident that a number of parameter combinations are implausible since the net speculators make a loss. Further, there were only a limited number of parameter combinations which gave positive compounded Wool Commission and grower profit.

Considering the stars used in Table 7.16; in the case of the linear demand function no stars are used since no parameter combinations give a profit both to speculators, and to growers and Wool Commission. For the constant elasticity of demand function there are a limited number of parameter combinations for which only the variance in seasonal export income was increased. These are distinguished by a single star.

The inference is that, in general, given the model, in particular the present specification of the net speculative demand/supply equation, and the parameter values taken, the net speculative activity induced by the Wool Commission's presence in the wool market would not have been beneficial. The

author accepts, however, that alternative speculative functions could be postulated.

Therefore, in order to get a significantly better performance of the wool market it is necessary to assume either:

- (i) that the floor and ceiling price were allowed to be flexible and/or
- (ii) that the normal trade demand was increased by the Wool Commission's activities, and/or
- (iii) that the constant elasticity demand function applies, and elasticity of demand is less than -4 (i.e. demand for wool is very responsive to wool price changes).

7.5.3 Variable Weekly Floor and Ceiling Prices - No Net Speculative Activity

In this series of simulation runs (or parameter combinations) the floor and ceiling prices were allowed to vary from week to week on a simply determined percentage basis.

These results, in directional terms, are given in Table 7.17. (The numerical results are given in Tables 7.11 and 7.12). Again the interpretation of the individual runs in each table is similar to that given for Table 7.15.

An examination of the results in Table 7.17 shows that none of the parameter combinations (both for linear and constant elasticity demand) gave positive answers to all the summary measures. The system of stars indicates those parameter combinations which came closest to this. One star indicates those runs where only the export income variance is increased. Two stars indicates where only average price is decreased.

The inference then is that given the model, and the parameter assumptions, a simply determined flexible floor and ceiling price policy based on a percentage weekly change would not have been an improvement on the present

TABLE 7.17 DIRECTIONAL INDICATION OF MODEL OUTCOMES - LINEAR DEMAND : CONSTANT ELASTICITY
 VARIABLE WEEKLY FLOOR AND CEILING PRICES, NO NET SPECULATIVE ACTIVITY

Run No.	Parameter Values			Linear Normal Trade Demand							Constant Elasticity Normal Trade Demand							Star	
	Elasticity	% Drop in weekly floor allowed	% Rise in weekly ceiling allowed	Price Variance	Mini-Funds	Net Spec- Profit	Wool Comm- Profit	Grow- er Profit	Compound- ed Wool Commission & Grower Profit	Export Price Variance	Price Variance	Mini-Funds	Net Spec- Profit	Wool Comm- Profit	Grower Profit	Compound- ed Wool Comm. & Grower Profit	Export Variance		
1	-4	+1%	+1%	✓	✓	✓	✓	✓	✓	x	x	✓	✓	✓	✓	✓	x	x	
2	-4	+1	0	✓	✓	✓	✓	✓	x	✓	x	✓	✓	✓	✓	✓	✓	x	•
3	-4	0	+1	✓	✓	✓	✓	✓	✓	x	x	✓	✓	✓	✓	✓	x	x	
4	-4	0	0	✓	✓	✓	✓	✓	x	x	x	✓	✓	✓	✓	✓	✓	x	•
5**	-0.2505	+1	+1	x	✓	✓	✓	✓	✓	✓	✓	x	✓	✓	✓	✓	✓	✓	**
6	-0.2505	+1	0	x	✓	✓	✓	✓	x	x	✓	x	✓	✓	✓	✓	x	x	✓
7**	-0.2505	0	+1	x	✓	✓	✓	✓	✓	✓	✓	x	✓	✓	✓	✓	✓	✓	**
8	-0.2505	0	0	x	✓	✓	✓	✓	x	x	✓	x	✓	✓	✓	✓	x	x	✓
9	-1	+0.5	+0.5	x	✓	✓	✓	✓	✓	x	✓	✓	✓	✓	✓	✓	x	✓	
10	-5.39	+0.5	+0.5	✓	✓	✓	✓	✓	✓	x	x	✓	✓	✓	✓	✓	x	x	
11**	-0.1855	+0.5	+0.5	x	✓	✓	✓	✓	✓	✓	✓	x	✓	✓	✓	✓	✓	✓	**
12	-1	+1.1075	+0.5	x	✓	✓	✓	✓	✓	x	✓	✓	✓	✓	✓	✓	x	✓	
13	-1	-0.1075	+0.5	x	✓	✓	✓	✓	✓	x	✓	✓	✓	✓	✓	✓	x	✓	
14	-1	+0.5	+1.1075	x	✓	✓	✓	✓	✓	x	✓	✓	✓	✓	✓	✓	x	✓	
15	-1	+0.5	-0.1075	x	✓	✓	✓	✓	x	x	✓	✓	✓	✓	✓	✓	x	x	✓

* Only export income variance increased

** Only average price decreased

marketing system.

Therefore, in order to justify a change in the marketing system it is necessary to assume:

- (i) that the floor and ceiling prices are flexible, but determined in a more complex manner, and/or
- (ii) that the normal trade demand is increased by the Wool Commission's activities, and/or
- (iii) that demand is highly elastic and follows a constant elasticity demand curve.

7.5.4 Variable Weekly and Seasonal Floor Prices - No Net Speculative Activity

In this series of simulations the floor price is varied in a relatively complex manner. It is varied weekly according to the level of Wool Commission stocks (the relevant parameter here is A_{16}). It is varied between seasons according to:

- (i) the increase in the floor if there are zero Wool Commission stocks (A_{22}),
- (ii) the lowering of the floor due to the Wool Commission stocks (A_{20}), and
- (iii) the maximum allowable increase or decrease in the floor price between consecutive seasons (A_{18}).

The directional results are given in Table 7.18, and again the interpretation of an individual run is similar to that given for Table 7.15.

No parameter combination, either for linear demand or constant elasticity of demand, gave positive results for all summary measures. Only where the price elasticity of demand was inelastic (greater than -1) was the compounded Wool Commission and grower profit improved. A single star is placed by each of these runs - where only average price is decreased.

From an examination of the numerical results in Tables 7.13 and 7.14 it is apparent that the compounded Wool Commission and grower gains (or

TABLE 7.18 DIMENSIONAL INDICATION OF WHEAT QUANTITY - LINEAR DEMAND & CONSTANT ELASTICITY
 (1970-71 TO 1980-81) (1970-71 = 100)

Run No.	Elasticity	PARAMETER LEVELS					LINEAR NORMAL TRADE DEMAND										CONSTANT ELASTICITY NORMAL TRADE DEMAND									
		Wool Commission (weekly)	Rate of Wool Increase	Wool Commission Stock (1000000)	Seasonal Change in Wool	Price	Variance	Millions Pounds	Net Speculative Profit	Wool Commission Profit	Grower Profit	Compounder Profit	Commission & Broker Profit	Export Variance	Price	Variance	Millions Pounds	Net Speculative Profit	Wool Commission Profit	Grower Profit	Compounder Profit	Commission & Broker Profit	Export Variance	Star		
1	1/4	0.006	0.12	-0.02	0.01	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
2	1/4	0.006	0.12	-0.02	0	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
3	1/4	0.006	0.12	-0.005	0.01	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
4	1/4	0.006	0.12	-0.005	0	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
5	1/4	0.006	0.04	-0.02	0.01	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
6	1/4	0.006	0.04	-0.02	0	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
7	1/4	0.006	0.04	-0.005	0.01	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
8	1/4	0.006	0.04	-0.005	0	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
9	1/4	0.002	0.12	-0.02	0.01	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
10	1/4	0.002	0.12	-0.02	0	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
11	1/4	0.002	0.12	-0.005	0.01	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
12	1/4	0.002	0.12	-0.005	0	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
13	1/4	0.002	0.04	-0.02	0.01	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
14	1/4	0.002	0.04	-0.02	0	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
15	1/4	0.002	0.04	-0.005	0.01	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
16	1/4	0.002	0.04	-0.005	0	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
17*	-0.2505	0.006	0.12	-0.02	0.01	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
18*	-0.2505	0.006	0.12	-0.02	0	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
19*	-0.2505	0.006	0.12	-0.005	0.01	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
20*	-0.2505	0.006	0.12	-0.005	0	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
21*	-0.2505	0.006	0.04	-0.02	0.01	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
22*	-0.2505	0.006	0.04	-0.02	0	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
23*	-0.2505	0.006	0.04	-0.005	0.01	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
24*	-0.2505	0.006	0.04	-0.005	0	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
25*	-0.2505	0.002	0.12	-0.02	0.01	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
26*	-0.2505	0.002	0.12	-0.02	0	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
27*	-0.2505	0.002	0.12	-0.005	0.01	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
28*	-0.2505	0.002	0.12	-0.005	0	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
29*	-0.2505	0.002	0.04	-0.02	0.01	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
30*	-0.2505	0.002	0.04	-0.02	0	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
31*	-0.2505	0.002	0.04	-0.005	0.01	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
32*	-0.2505	0.002	0.04	-0.005	0	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
33	-1	0.004	0.08	-0.013	0.005	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
34	-8.514	0.004	0.08	-0.013	0.005	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
35*	-0.117	0.004	0.08	-0.013	0.005	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
36	-1	0.00709	0.08	-0.013	0.005	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
37	-1	0.0009	0.08	-0.013	0.005	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
38	-1	0.004	0.1419	-0.013	0.005	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
39	-1	0.004	0.0281	-0.013	0.005	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
40	-1	0.004	0.08	-0.0238	0.005	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
41	-1	0.004	0.08	-0.0217	0.005	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
42	-1	0.004	0.08	-0.013	0.01273	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
43	-1	0.004	0.08	-0.013	0.00273	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		

* Only average price decreased

losses) for the various parameter combinations were only slight.

Therefore, in order to obtain a significant improvement in the Wool Market, in the context of this model, it is necessary to assume an increase in normal trade demand due to the Wool Commission's activities, or that price is highly elastic and follows a constant elasticity demand curve.

7.6 Summary

The two simulation models (linear demand and constant elasticity of demand) allow the effect of different Wool Commission floor and ceiling price policies to be evaluated in terms of the summary measures. In particular, the outcome of Wool Commission policies, where:

- (i) floor and ceiling prices were rigid for the entire period,
- (ii) floor and ceiling prices were flexible on a weekly basis, and
- (iii) the floor price was flexible on a seasonal basis,

were tested for wool trade demand conditions where:

- (i) demand was independent of the Wool Commission's activities and only a function of price,
- (ii) shifts in the normal trade demand curve occurred, and
- (iii) some net speculative activity was assumed.

The results of the simulation runs have been tabulated, and discussed.

Additional information has been provided by using two methods of inference. A broad view of the performance of any proposed scheme was obtained, through an inspection of the outcome of all summary measures. Performance functions were calculated to permit inferences to be made about the performance of the model over quite wide ranges of the parameters being varied. The analysis of performance functions therefore allows much more general conclusions to be drawn than could have been derived directly from the simulation results. This technique has only been used to a limited extent because, apart from shifts in the normal trade demand curve ($A_2 \neq 1.0$), the performance of the model was not particularly sensitive to the parameter combinations which

were tested,

A fairly careful examination of the simulation runs allowed the fairly strong conclusion:

In order to obtain a significant improvement in the wool market, in the context of the present model, it is necessary to assume an increase in normal trade demand due to the Wool Commission's activities, or that price is highly elastic and follows a constant elasticity of demand curve.

CHAPTER 8

CONCLUSIONS

8.1 Introduction

This chapter summarises the conclusions which can be drawn from the present study. Three topics are covered. Initially there is a brief résumé of the conclusions, given the model, which have been drawn from an analysis of empirical results. This is followed by a discussion of the usefulness of the conclusions obtained from the model, in relation to the realism of the model. Finally, conclusions which are relevant for policy makers within the New Zealand Wool Board and Wool Commission are distinguished.

8.2 Conclusions Within the Context of the Model

The empirical results from the "Simple Wool Marketing Simulation Model" lead to one over-riding conclusion. Within the context of the model, the evaluation of the success (or otherwise) of any modification to current wool marketing practices depends on the assumption with respect to only one parameter - the effect of this modification on shifts in the normal trade demand curve.

That the model would only be sensitive to shifts in the normal trade demand curve was not a foregone conclusion, since it would not have been surprising to find that a more aggressive, or possibly more flexible floor/ceiling price policy by the Wool Commission would have shifted wool from periods of low demand to periods of high demand. This would have increased average price, price stability, and grower and Wool Commission profits without any net increase in the demand for wool. If, however, the Wool Commission's function is considered to be price stabilisation without any direct demand expansion responsibilities, then the results show that it would have been difficult to find a markedly better floor price policy than that which was actually followed over the 14 seasons being studied. At the same time the study suggests that

quite a wide range of alternative floor price policies could have been followed without giving markedly inferior results.

8.3 Implications of the Realism of the Model

One possible line of criticism of the conclusions reached in the present study is that the underlying simulation model is not realistic. Some may argue that the model is just too simple and abstract to describe the very sensitive and complex considerations which dictate actual price formation in the wool market, and hence little confidence can be placed in the results which have been obtained from the model. Anyone who has studied the wool market cannot but be sympathetic to this type of argument. A number of considerations regarding the usefulness of the results obtained from the model can, however, be offered by way of rebuttal:

(i) The Wool Board and Wool Commission are continually called upon to make decisions on the basis of imperfect information. The operational question, therefore, is not "Does this study provide a perfect answer?", but rather "Does this study serve to reduce the degree of uncertainty in the decision making environment of the Wool Board and Wool Commission?".

(ii) As the present model incorporates much of the theoretical and empirical knowledge available on the likely effects of the Wool Commission's stabilisation policies on the wool auctions, it can be argued that the model is an approximation of the operation of the wool market under such conditions; it may possibly be a poor approximation, but it is certainly an approximation. The operation of the model should, therefore, be able to at least distinguish the critical parameters in the model.

(iii) Simulation as a research technique does provide a useful approach for generating information on the outcome of alternative Wool Commission policies. Should the model be considered too unrealistic to place much significance on the results, then the construction of the model will, at the very least, highlight what information on the system being simulated is lacking -

where there is scope for further research into the operation of the auction system. This is in itself useful information.

One aspect of the model where information is lacking is in the specification of the normal trade demand function. All econometric studies, for instance, agree with the present model in postulating either a linear demand function or constant elasticity - both of which are most unlikely to be correct. It is not known whether elasticity increases or decreases during periods of high prices.

The critic who can provide some empirical evidence on deficiencies in any aspect of the present model is welcomed as a constructive critic. Other criticisms may be valid, but they don't allow a more realistic model to be constructed.

8.4 Conclusions for the Policy Maker

One extremely pertinent observation can be made regarding the usefulness of the conclusions obtained from the model. This observation is that the model is no longer relevant; the model has been overtaken by events! The experience at the New Zealand wool auctions during the seasons 1966/67 and 1967/68 could only have been simulated by assuming a very substantial drop in the level of normal trade demand. The major conclusion obtained from the model was that for the historical period being considered a 1% rise or fall in normal trade demand dominated any other assumptions which were made with respect to the demand for wool and/or the Wool Commission's floor and ceiling price policy. In the last two seasons it would have been necessary to postulate a 30 to 40% drop in normal trade demand, and this clearly lies outside the range of experience of the data used in the model. Regardless of whether the drop in demand originated from factors outside auction or was directly due to the Wool Commission's floor price policy, the 1966/67 and 1967/68 experience highlights the fact that shifts in demand can dominate any Wool Commission policy.

Given this important caveat the over-riding conclusion for policy

makers remains; that the model is extremely sensitive to shifts in the normal trade demand curve, and, consequently, all arguments about interference with the wool marketing mechanism ought to be justified in terms of concrete evidence about their likely effect on the demand for wool.

The present study drives home the distinction between alternative plans for marketing wool, and improved marketing plans. In the present study a number of alternative marketing plans were examined, none of which proved to be a noticeable improvement over the actual Wool Commission floor policy.

For anyone to believe that they have an improved method of marketing wool, it now needs to be shown that either:

(i) Marketing costs would be reduced, or

(ii) Commercial manufacturing demand for wool would be increased

where an improved method is defined as yielding a higher average price to growers and/or a lower variance in price.

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APPENDIX AFLOW DIAGRAMS FOR THE COMPUTER SIMULATION
PROGRAMMES, WMSM*4, 5, 6 and 7

In this appendix the flow diagrams for WMSM*4 and 6 are given in full. The only difference between these models incorporating a linear normal trade demand function, and WMSM*5 and 7, which incorporate a constant elasticity normal trade demand function, is in the quantitative balance. Hence for WMSM*5 and 7 only the quantitative balance is given.

The relevance of the flow diagrams is that they detail exactly what calculations the computer performs.

Following the flow diagrams there are notes explaining some of the assumptions and calculations which were made.

FLOW DIAGRAM - WMSM*4 - LINEARISED SIMULATION MODEL.

C LINEARISED SIMULATION MODEL * WMSM*4
 C VERSION * 8
 C AFIT FORTRAN
 C SS1 ON FOR WEEKLY PRINT OUT
 C SS2 ON FOR DIAGNOSTIC PRINT
 C SS3 ON FOR ANNUAL PRINT OUT
 DIMENSION E(21), Y(18), AMY(18), W(20)
 DIMENSION C(4), D(4), X(18), V(2), U(2), Z(8)

READ, N2, A2, A3, A4, A5, A6, A7,
 A8, A9, A10, A11, A12, A13, A14, A15,
 A16, A17, A18, A19, A20, A21,
 A22, A23, A25,
 C(1), C(2), C(3), C(4),
 D(1), D(2), D(3), D(4)

TYPE LSM * WMSM*4 RUN N2

READ A1 TYPE A1

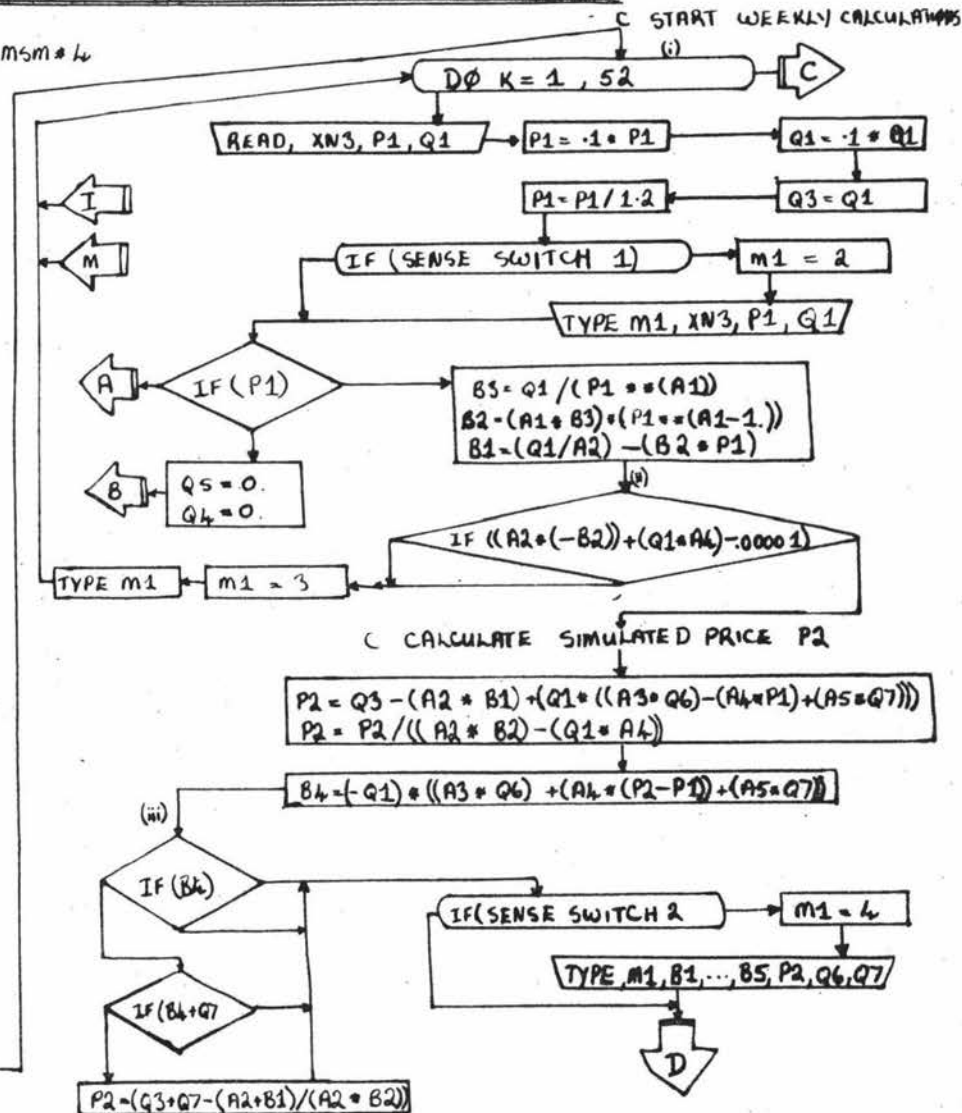
m1 = 1

TYPE, m1, A2, A3, ..., A23, A25

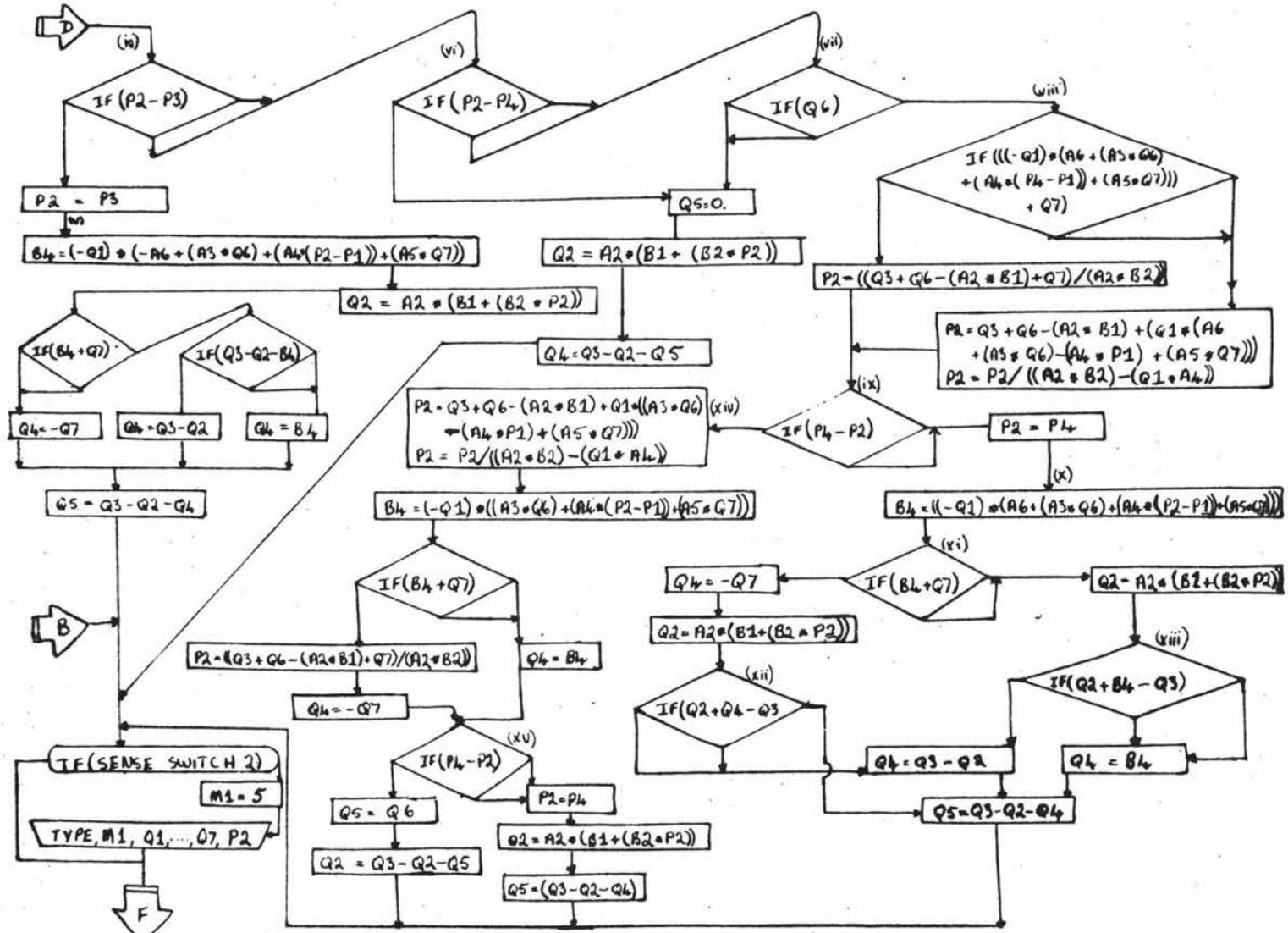
INITIAL ; X16=0.; Q6=Q7=0.; R4=R6=R7=0;
 U(1)=0, V(1)=0, I=1,2; Y(1)=0, AMY(1)=0, X(1)=0,
 I=1,8; W(1)=0, I=1,20; Z(1)=0, I=1,8;
 Z1=0; G1=Q2=Q3=0; X1=0, I=1,4;
 P3=A12; P4=A13; P5=A12; P6=A13;
 A2=A10, Y(1)=999999, I=13, ..., 18; SMQ7=0

ROOT = 1./52.

B5 = ((1. + A11) ** (ROOT)) - 1.



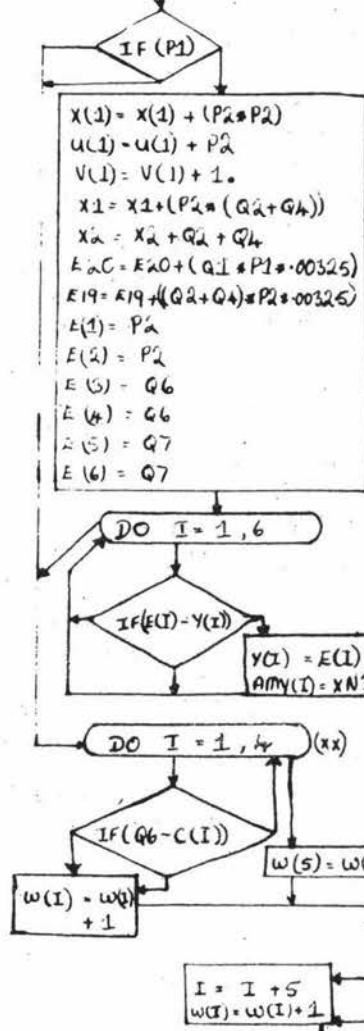
WMSM 4 + 6 - QUANTITATIVE BALANCE



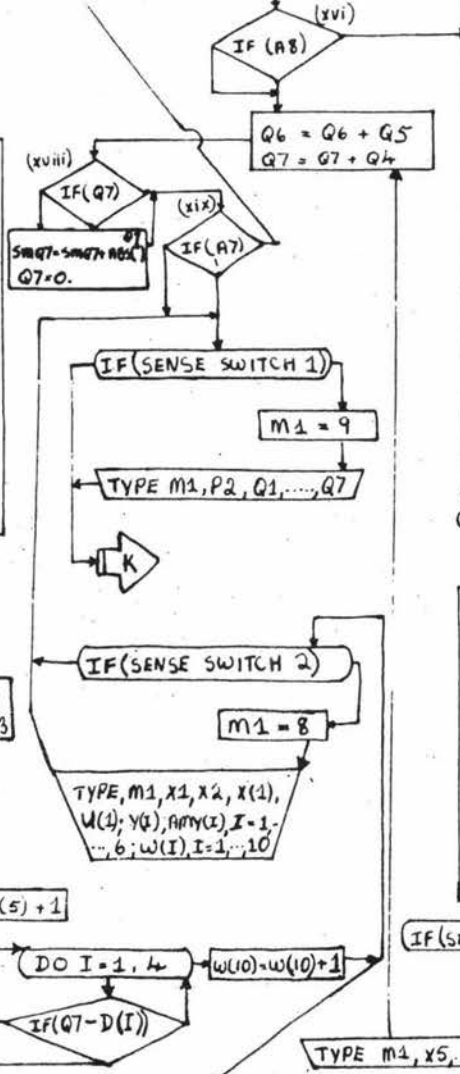
C COMPLETION OF QUANTITATIVE BALANCE

WMSM # 4

C START QUANTITATIVE SUMMARY MEASURES

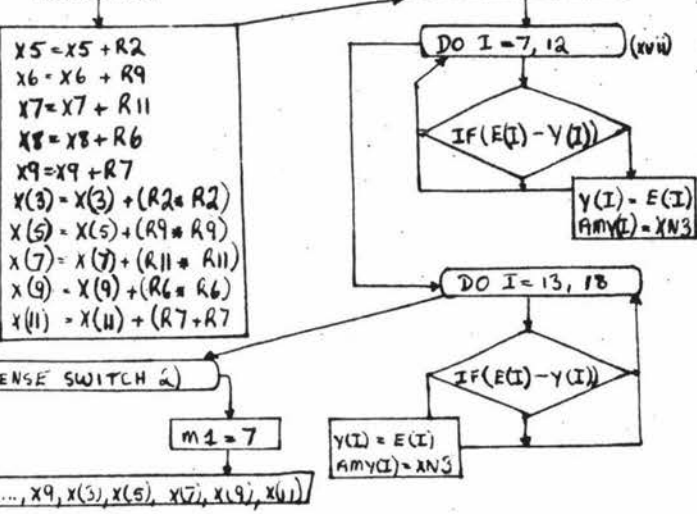


↓
C CALCULATE FINANCIAL IMPLICATIONS



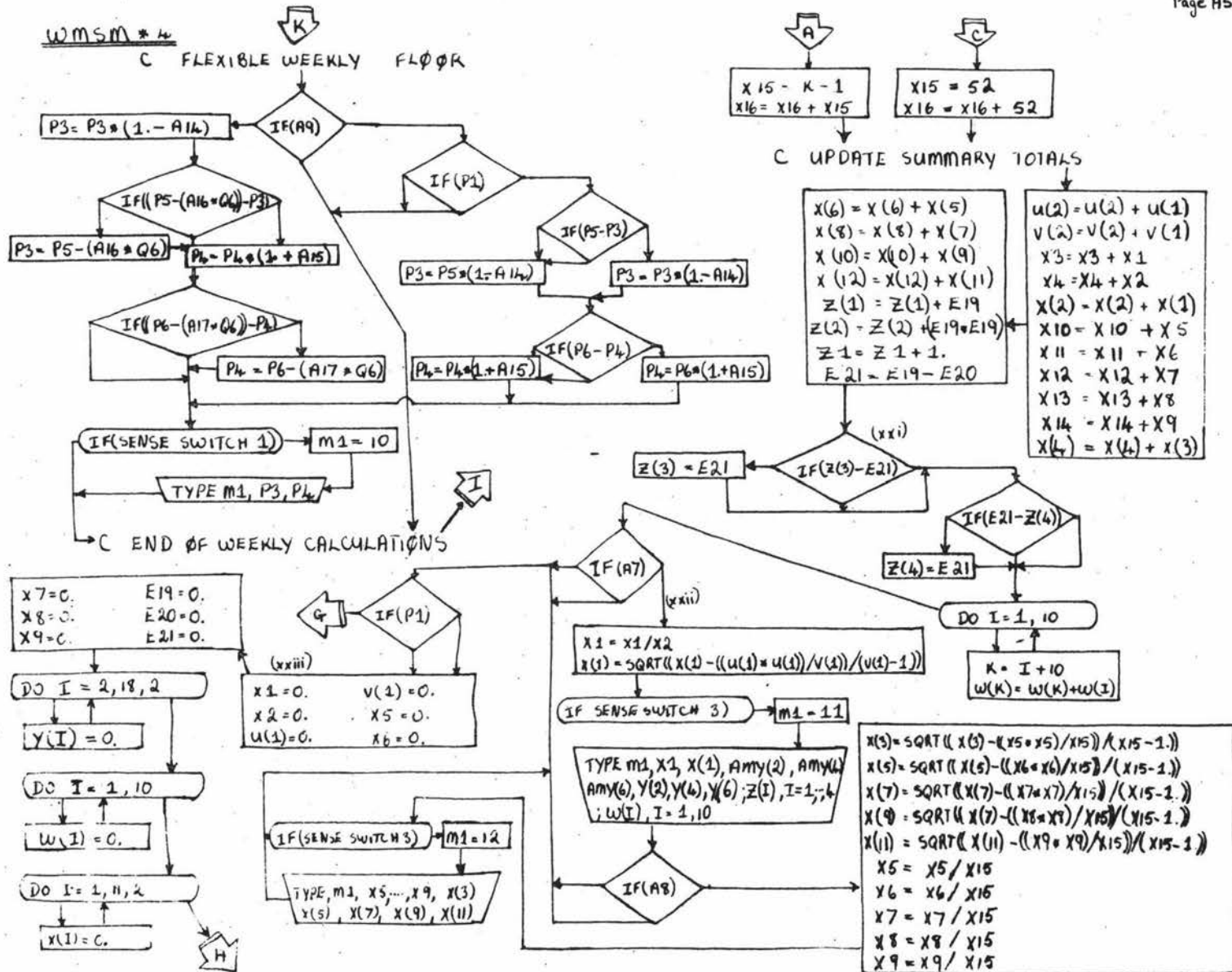
$$\begin{aligned} R1 &= (R2 * B5) - ((Q5 * P2) * 0.00325) \\ R1 &= R1 - (Q6 * (-0.00003696 + (P2 * 0.00000014 * 0.625))) \\ R2 &= R2 + R1 \\ R3 &= (R4 * B5) - ((Q4 * P2) * 0.00325) \\ R3 &= R3 - (Q7 * (-0.00003696 + (P2 * 0.00000014 * 0.625))) \\ R4 &= R4 + R3 \\ R5 &= ((Q1 * (P2 - F1)) * 0.00325) \\ R6 &= R6 + R5 \\ R7 &= (R7 * (1 + B5)) + R5 \\ R8 &= ((P2 * (Q5 + Q6)) * 0.00325) \\ R9 &= R8 + R2 \\ R10 &= (P2 * (Q4 + Q7)) * 0.00325 \\ R11 &= R10 + R4 \end{aligned}$$

C START FINANCIAL SUMMARY MEASURES

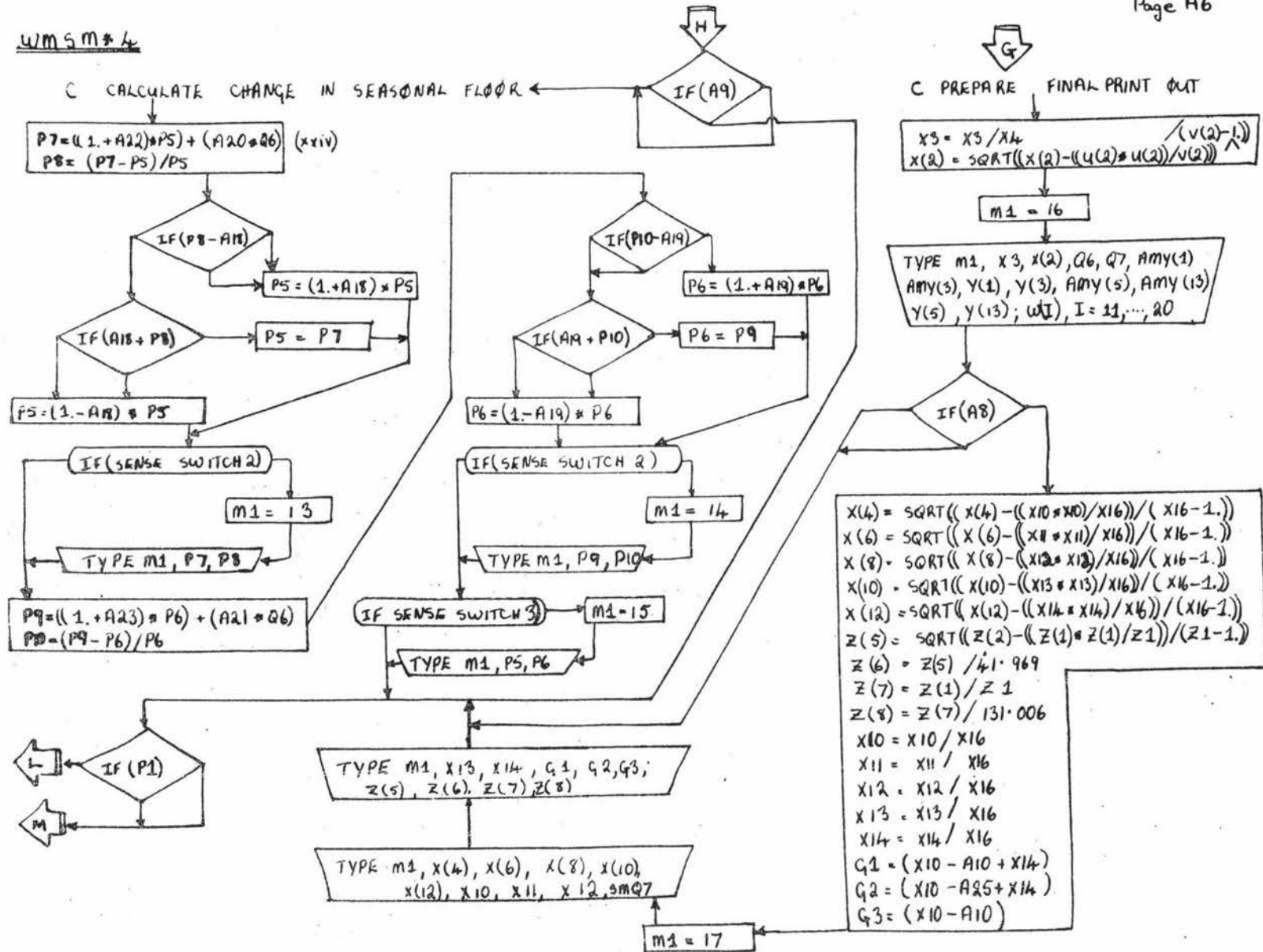


$$\begin{aligned} E(7) &= R2 \\ E(8) &= R2 \\ E(9) &= R9 \\ E(10) &= R9 \\ E(11) &= R11 \\ E(12) &= R11 \\ E(13) &= R2 \\ E(14) &= R2 \\ E(15) &= R9 \\ E(16) &= R9 \\ E(17) &= R11 \\ E(18) &= R11 \end{aligned}$$

$$\begin{aligned} X5 &= X5 + R2 \\ X6 &= X6 + R9 \\ X7 &= X7 + R11 \\ X8 &= X8 + R6 \\ X9 &= X9 + R7 \\ X(3) &= X(3) + (R2 * R2) \\ X(5) &= X(5) + (R9 * R9) \\ X(7) &= X(7) + (R11 * R11) \\ X(9) &= X(9) + (R6 * R6) \\ X(11) &= X(11) + (R7 * R7) \end{aligned}$$



WMSM#4



FLOW DIAGRAM - WMSM*6 - SHORTENED LINEARISED SIMULATION MODEL

C LINEARISED SIMULATION MODEL * WMSM*6
 C VERSION * 3
 C AFIT FORTRAN
 C SS1 FN FOR WEEKLY PRINT OUT
 C SS2 FN FOR DIAGNOSTIC PRINT
 C SS3 FN FOR ANNUAL PRINT OUT
 DIMENSION E(3), Y(13), X(2), V(2), U(2), Z(4)

READ, N2, A2, A3, A4, A5,
 A6, A7, A8, A9, A10, A11,
 A12, A13, A14, A15, A16, A17, A18
 A19, A20, A21, A22, A23, A25

TYPE LINEARISED SIMULATION MODEL * WMSM*6 RUN N2

READ, A1

TYPE A1

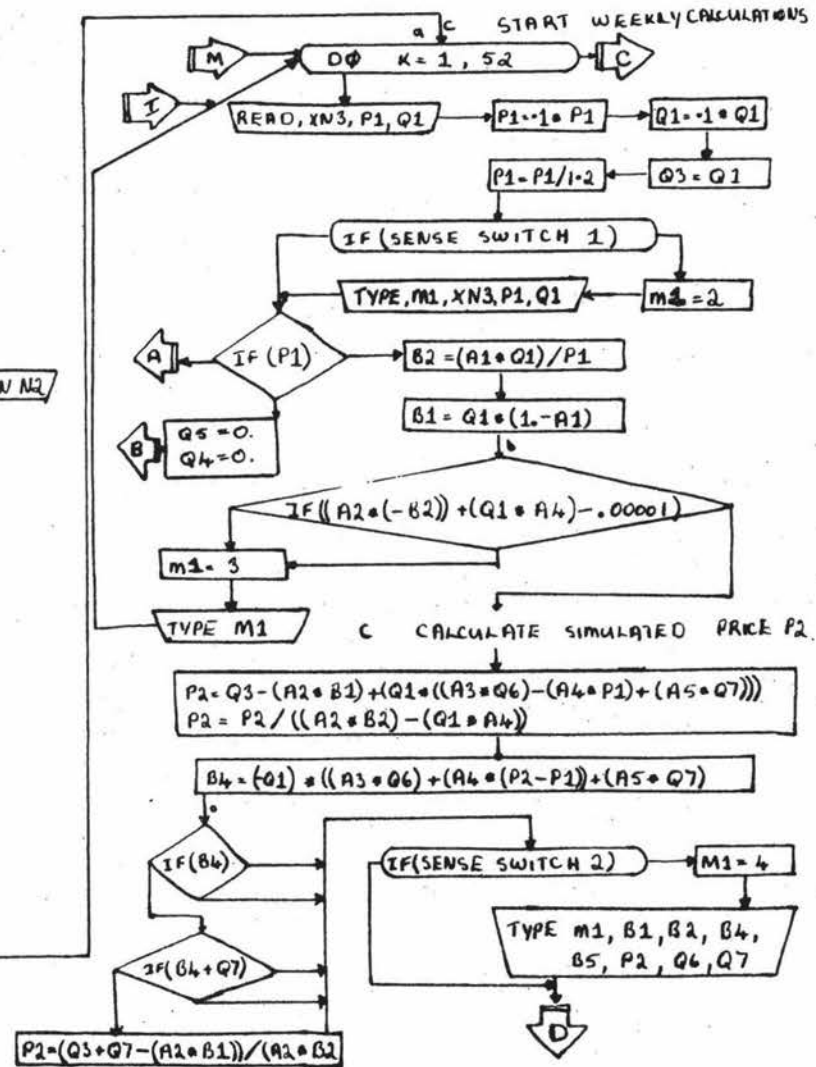
m1 = 1

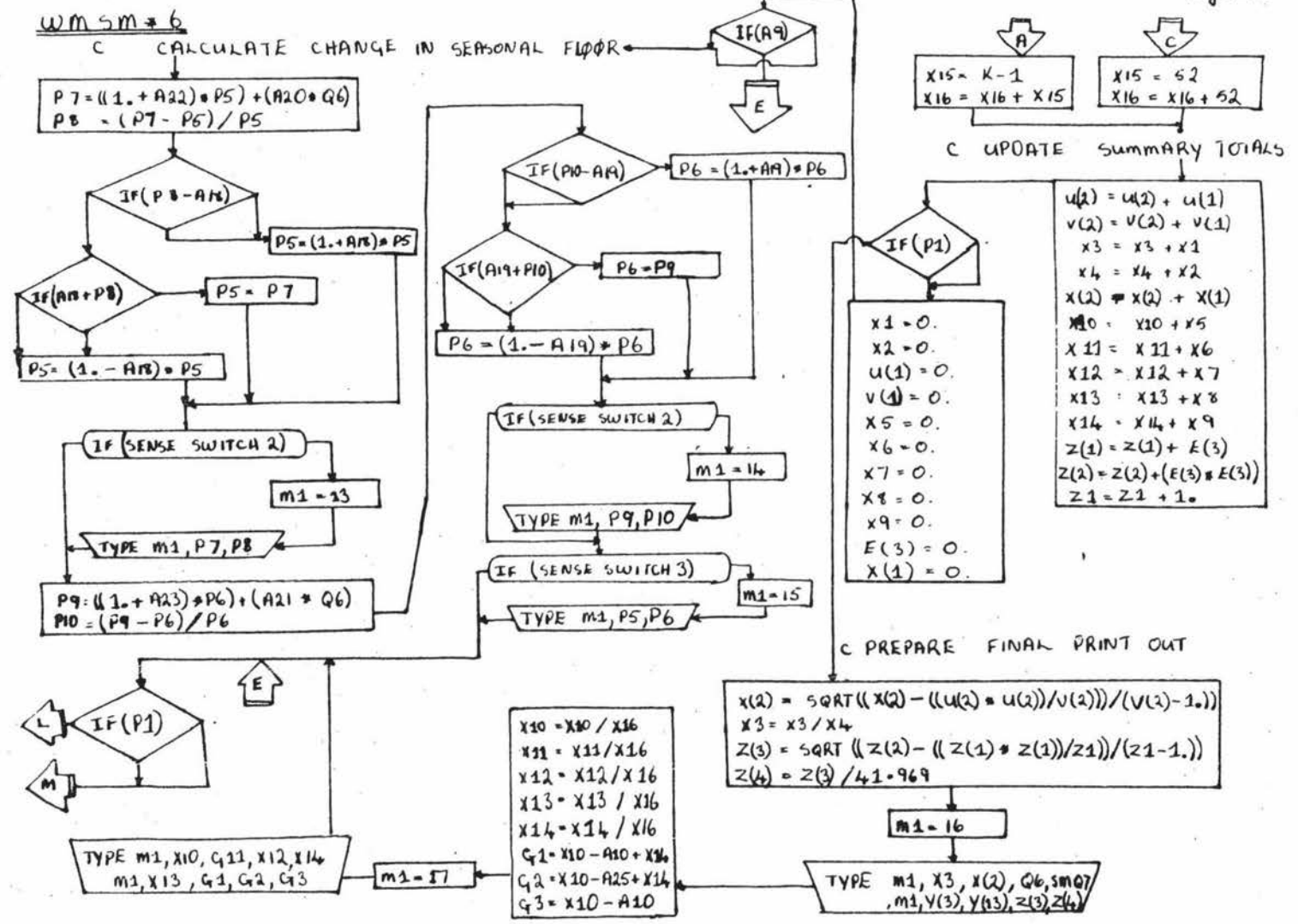
TYPE m1, A2, A3, A4, ... A23, A25

INITIAL; Q6 = Q7 = 0.; R4 = R6 = R7 = 0.;
 U(1) = 0, V(1) = 0, I = 1, 2; X(1) = 0, I = 1, 2;
 Y(1) = C, I = 1, ..., 12; Y(13) = 999999.; Z(1) = 0, I = 1, ..., 4;
 Z1 = 0.; E(3) = 0.; G1 = G2 = G3 = 0.; X1 = 0, I = 1, ..., 4;
 P3 = A12; P4 = A13; P5 = A12; P6 = A13;
 R2 = A10; X16 = 0; SMQ7 = 0.

RDOT = 1./52.

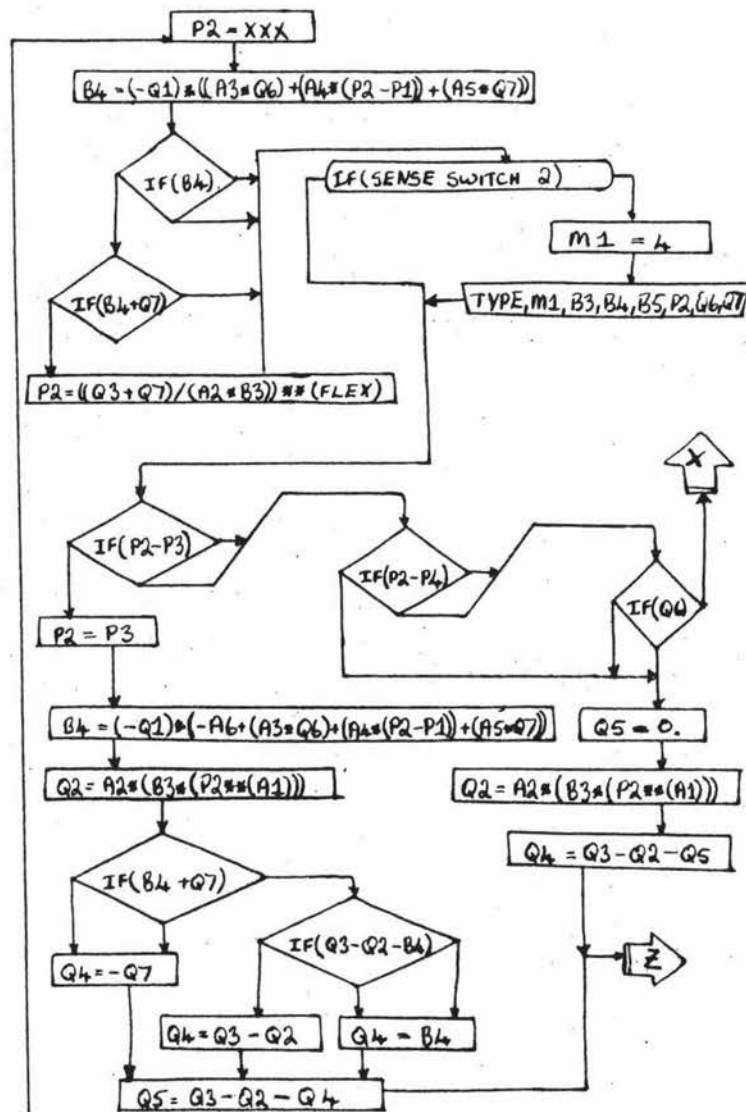
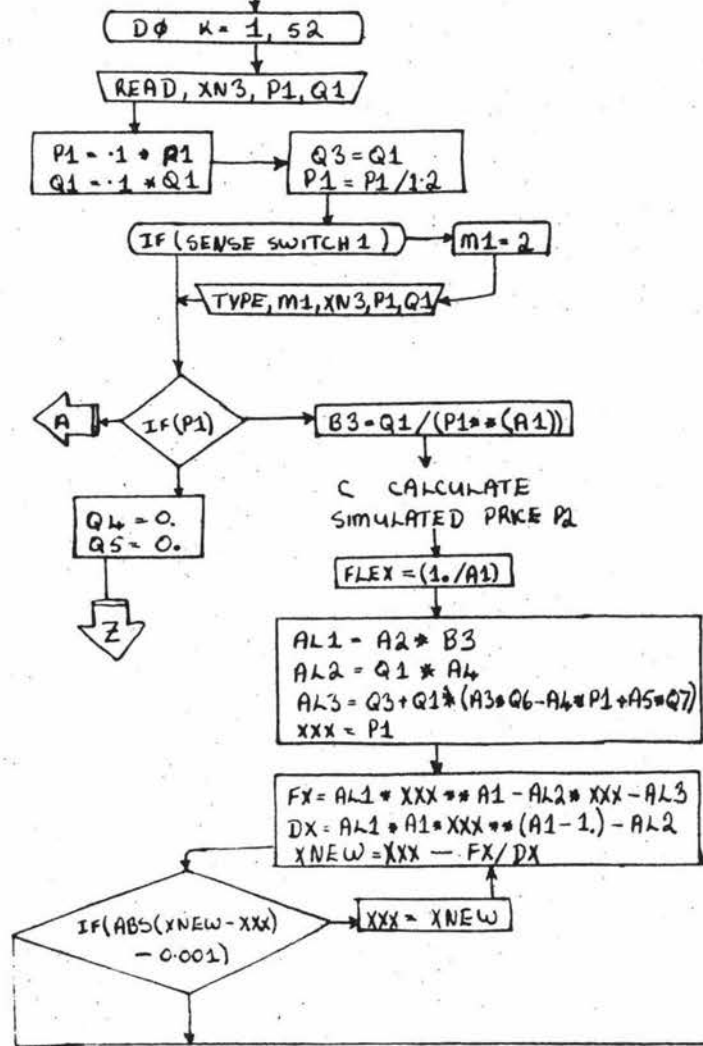
B5 = ((1. + A11) ** (RDOT)) - 1.

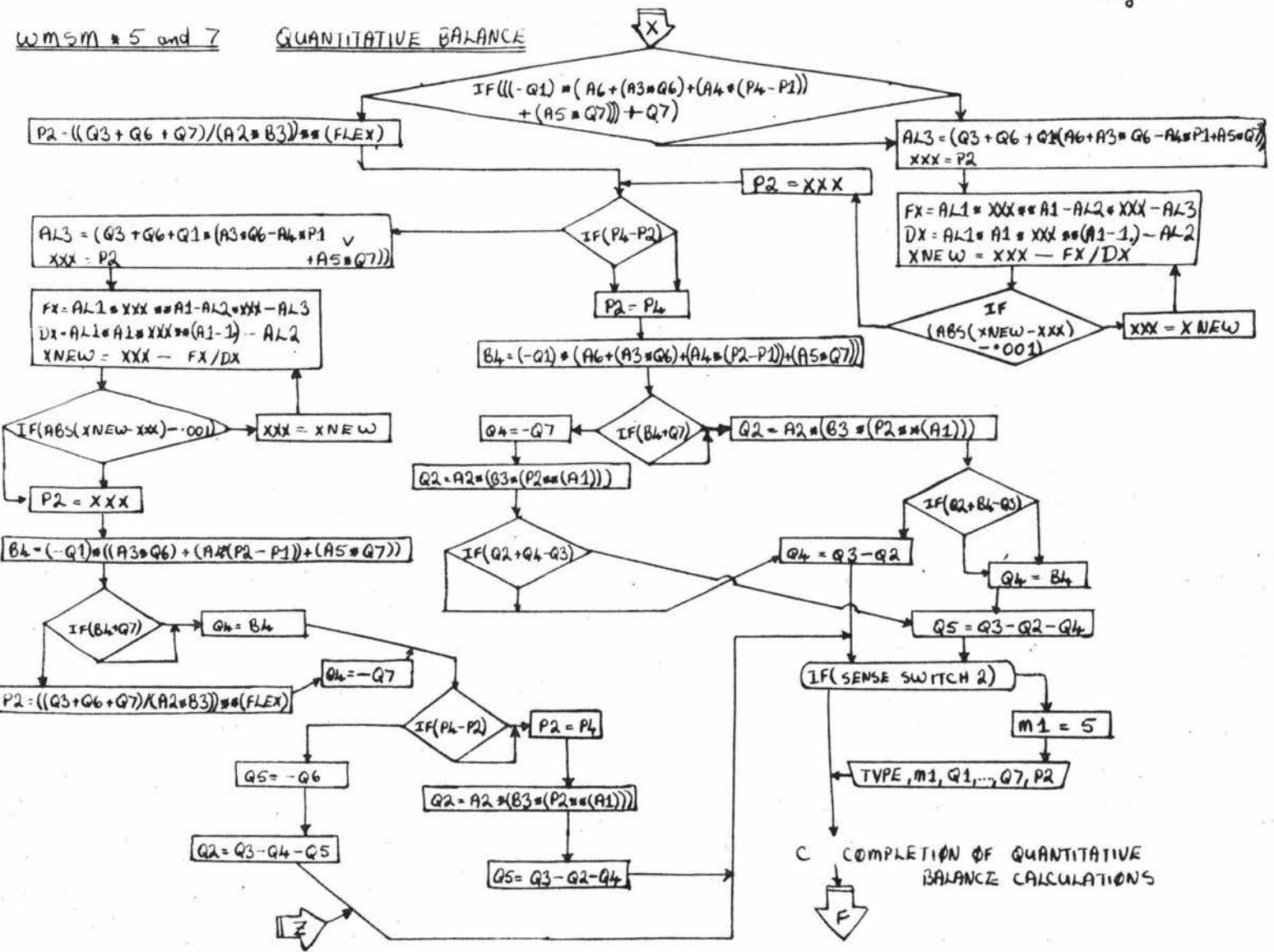




WMSM * 5 and 7 QUANTITATIVE BALANCE

C START WEEKLY CALCULATIONS.





C COMPLETION OF QUANTITATIVE BALANCE CALCULATIONS

NOTES OF THE FLOW DIAGRAMS

The following notes refer to the marked points on the preceding flow diagrams.

WMSM*4

- (i) The arrow C directs the computer to the seasonal calculations (after 52 weekly calculations). The arrow M indicates that the seasonal calculations have been completed and that the calculations of the first week of another season are to begin. The arrow I refers the computer from the end of one week's calculations to the start of the next.
- (ii) A negative value here leads to a negative simulated price P2, hence ignore this observation, but type out that a negative price was calculated.^{1/}
- (iii) The restraint of the net speculative demand/supply function is that sales cannot be greater than stocks. Therefore if $B4 + Q7 < 0$ then the simulated price is recalculated where all the net speculative stocks, Q7, are placed on the market.
- (iv) Is the simulated price less than the floor price.
- (v) If so, $P2 = P3$, and the net speculative demand/supply function is recalculated including +Q1.A6, the increase in net speculative demand at the floor. Q2, the quantity taken by the normal trade demand function is then calculated, and the quantity taken by the net speculators is determined. Finally, it is assumed that the Wool Commission always purchases the residual, Q5.
- (vi) If the simulated price is between the floor and the ceiling price, i.e. $P3 < P2 < P4$, then the Wool Commission's purchases are zero and the normal trade demand, Q2, and the net speculative demand, Q4, clear the market.
- (vii) If the simulated price is above the ceiling then the level of Wool Commission stocks is tested. If zero, then the market is cleared as in (vi).

^{1/} This error did not occur in any of the runs made. That is, price was never taken to be negative.

- (viii) Here the level of desired net speculative activity, B_4 , is tested against the availability of net speculative stocks for the situation where the simulated price is at the ceiling, and the net speculative demand function includes $-Q_1 * A_6$. If negative, i.e. the net speculators wish to sell more stocks than they possess, then $B_4 = Q_7$ and P_2 is recalculated with all the Wool Commission's stocks, Q_6 , placed on the market. If positive, the value of P_2 is determined accordingly, again with all the Wool Commission's stocks placed on the market.
- (ix) Is the simulated price, when all Wool Commission stocks have been placed on the market, higher or lower than the ceiling price.
- (x) If lower, then $P_2 = P_4$ and the net speculative demand, B_4 , is evaluated.
- (xi) If $B_4 + Q_7$ is less than zero, i.e. net speculators wish to sell more stocks than they own, then they sell all their stocks, and the level of normal trade demand Q_2 is calculated. If $B_4 + Q_7 > 0$ then Q_2 is again calculated.
- (xii) If the demand by net speculators and the normal trade demand is greater than the observed sales in that week, then $Q_4 = Q_3 - Q_2$. If less, as would be expected, then the Wool Commission places supplies on the market.
- (xiii) If the desired demand by net speculators and the normal trade demand together exceed growers' supply then $Q_4 = B_4$ and the Wool Commission supplies the residual. If less, i.e. $Q_2 + B_4 < Q_3$ then net speculators take the difference between growers' supply and normal trade demand, and the Wool Commission need not place any wool on the market to hold the ceiling price.
- (xiv) Where the simulated price is still above the ceiling when all Wool Commission stocks have been placed on the market, then P_2 is recalculated, excluding $-Q_1.A_6$ from the net speculative demand/supply equation.
- (xv) In the case where the recalculated P_2 is below the ceiling, then it is assumed that the Wool Commission holds the ceiling, but has lost the confidence of the net speculators who now react as though the ceiling did not exist. If the simulated price is still above the ceiling, then the Wool Commission sells

all its stocks and reduces the simulated price as much as possible.

(xvi) A8 refers to whether or not financial implications are to be calculated.

If $A8 \leq 0$, financial implications are not calculated.

(xvii) Are this week's values of the Wool Commission's funds, the level of compounded grower profit, or net speculative funds and assets a maximum or a minimum, for this season or overall.

(xviii) In the quantitative balance, if Q7 (net speculative stocks) becomes slightly negative then ~~the~~ quantitative balance gives incorrect results. This discrepancy in Q7 is due to rounding errors in the quantitative balance. If Q7 does become negative, it is equated to zero. This means wool disappearing and hence the amount of wool treated as such is summed.^{2/}

(xix) A7 refers to whether or not quantitative summary measures are to be calculated. If $A7 \leq 0$ the quantitative summary measures are not calculated.

(xx) The Wool Commission's stocks and net speculative stocks in this week are placed in categories according to their size (these categories were introduced as parameters). It is therefore possible, for instance, to evaluate in how many weeks Wool Commission stocks were between 150 and 200 thousand bales for a given parameter set. These calculations are made seasonally and overall.

(xxi) Is the difference between this season's foreign exchange earnings from wool and the situation where there is no Wool Commission interference in the auction a maximum increase (Z(3)) or decrease (Z(4)).

(xxii) Seasonal averages and variances of quantitative and financial variables are determined if A7 and A8 respectively are positive.

(xxiii) A number of seasonal summary measures are equated to zero and will be calculated again next season.

(xxiv) The flexible weekly and seasonal floor and ceiling price policies are dealt with in full in the main body of the thesis.

^{2/} In some cases, up to 2,000 bales disappeared over the 14 seasons for which calculations were made.

APPENDIX BINDEX OF SYMBOLS USED IN THE MODEL(i) Parameters

- A1 = The price elasticity of demand.
- A2 = Shift in the normal trade demand curve due to the activities of the Wool Commission in the wool market.
- A3 = Linear effect of the Wool Commission's stocks, Q6, on the net speculative demand/supply for wool.
- A4 = Linear effect of the spread between the simulated price, P2, and the world equilibrium price, P1, on the net speculative demand/supply for wool.
- A5 = Linear effect of the net speculative stocks, Q7, on the net speculative demand/supply for wool.
- A6 = A shift parameter indicating a change in net speculative demand/supply for wool when the simulated price, P2, is either at the floor or the ceiling price.
- A7 = Determines whether annual summary measures of prices and quantities are provided.
A7 = 1 summary; A7 = 0 no summary.
- A8 = Determines whether or not the financial implications are calculated.
A8 = 1 they are calculated; A8 = 0 they are ignored.
- A9 = Determines whether the floor and ceiling price are flexible or are fixed.
A9 = 0 indicates the floor and ceiling are fixed.
A9 = +1 indicates a flexible seasonal floor and ceiling price policy, and a flexible percentage weekly floor and ceiling price policy.

A9 = -1 indicates flexible seasonal floor and ceiling prices, and flexible weekly floor and ceiling prices dependent on Wool Commission stocks.

- A10 = Initial value of Wool Commission Funds (in \$m).
- A11 = Annual rate of interest expressed as a decimal.
- A12 = Initial floor price (in cents).
- A13 = Initial ceiling price (in cents).
- A14 = Percentage drop in the weekly floor price allowed.
- A15 = Percentage rise in the weekly ceiling price allowed.
- A16 = Linear effect of the Wool Commission's stocks on the weekly floor price.
- A17 = Linear effect of the Wool Commission's stocks on the weekly ceiling price.
- A18 = Maximum allowable percentage change in the floor price between seasons.
- A19 = Maximum allowable percentage change in the ceiling price between seasons.
- A20 = Linear effect of the Wool Commission's stocks on the seasonal floor price.
- A21 = Linear effect of the Wool Commission's stocks on the seasonal ceiling price.
- A22 = Seasonal increment in the floor price if zero Wool Commission stocks.
- A23 = Seasonal increment in the ceiling price if zero Wool Commission stocks.
- A25 = The final level of average Wool Commission funds - where there is no Wool Commission interference in the market (i.e., A9 = 0, A12 = 0, A13 = 100).

(ii) Variables calculated or used within the programmes

- B1 = The intercept of the linear normal trade demand function on the Q axis in the *i*th week.
- B2 = The term indicating the slope of the linear normal trade demand function in the *i*th week.
- B3 = The shift parameter determining the position of the constant elasticity demand curve in the *i*th week.
- B4 = The net speculative demand for, and supply of wool in the *i*th week. (The quantity of wool sold is subject to stocks being available).
- B5 = The rate of interest on a weekly basis - as a decimal.

C(1), ..., C(4) = class intervals for Wool Commission stocks.

D(1), ..., D(4) = class intervals for net speculative stocks.

E(1), ..., E(21) = Work cells.

AL1, AL2, AL3,)
 XXX, SNEW, FX, DX) Variables used in WMSM * 5 and 7 in the iterative
) calculation of the simulated price - defined in
) the programmes.

(iii) Summary Measures

- G1 = Average sum of Wool Commission and grower profit (in \$M).
- G2 = Average compounded value of Wool Commission and grower profit (in \$M).
- G3 = Average Wool Commission profit (in \$M).

(iv) Variables calculated or used within the programmes

M1 = Print out identification number.

N2 = The run number.

P1 = Observed average sale price, converted to cents/lb., in the

ith week.

- P2 = The simulated price, in cents/lb., in the ith week.
- P3 = The simulated floor price for wool in cents in the ith week.
- P4 = The simulated ceiling price for wool, in cents in the ith week.
- P5 = The seasonal floor price (in cents).
- P6 = The seasonal ceiling price (in cents).
- P7, P8, P9, P10 = Variables used in calculating changes in the seasonal floor and ceiling prices.
- Q1 = The observed sales in the ith week in thousands of (325 lb) bales.
- Q2 = The simulated normal trade demand for wool in the ith week, in ,000 of (325 lb) bales.
- Q3 = Supply of wool onto the market in the ith week in ,000 of (325 lb) bales.
- Q4 = Net speculative demand for wool in the ith week in ,000 of (325 lb) bales.
- Q5 = Net purchases (or sales) by the Wool Commission in the ith week in ,000 of (325 lb) bales.
- Q6 = Wool Commission stocks at the end of week i in ,000 of (325 lb) bales.
- Q7 = Net speculative stocks at end of week i in ,000 of (325 lb) bales.
- SMQ7 = In WMSM * 4 and -6, it sums the negative net speculative stocks which are subsequently equated to zero.
- R1 = Net cash income for the Wool Commission in ith week in \$M. (If $R1 > 0$ then Wool Commission gains cash).
- R2 = Total cash balance of Wool Commission at end of ith week in \$M.
- R3 = Net cash income of net speculators in the ith week in \$M.
- R4 = Total cash balance of net speculators at the end of week i in

\$M.

- R5 = Hidden gains or losses to growers, (or grower profit), in the i th week in \$M.
- R6 = Total sum of hidden gains and losses to growers (or grower profit) at the end of week i .
- R7 = Total compounded value of hidden gains and losses to growers (or grower profit) at the end of week i .
- R8 = Value of Wool Commission's stocks at the simulated price, P2, at the end of the i th week in \$M.
- R9 = Value of Wool Commission's total cash and assets balance, (stocks valued at the simulated price), at the end of the i th week in \$M.
- R10 = Value of net speculators' stocks at the simulated price, P2, at the end of the i th week.
- R11 = Total cash and assets of the net speculators (stocks valued at the simulated price) at the end of the i th week in \$M.
- U(1) = Seasonal total sum of simulated prices.
- U(2) = Overall total sum of simulated prices.
- V(1) = Seasonal number of price observations.
- V(2) = Total number of price observations.
- | | <u>Seasonal</u> |
|---|-----------------|
| W(1) = Weeks the Wool Commission stocks in category | 0 - C(1) |
| W(2) = " " " " " " " | C(1) - C(2) |
| W(3) = " " " " " " " | C(2) - C(3) |
| W(4) = " " " " " " " | C(3) - C(4) |
| W(5) = " " " " " " " | C(4) - ∞ |
| W(6) = Weeks the net speculative stocks in category | 0 - D(1) |
| W(7) = " " " " " " " | D(1) - D(2) |
| W(8) = " " " " " " " | D(2) - D(3) |

Seasonal

W(9) = Weeks the net speculative stocks in category D(3) - D(4)

W(10) = " " " " " " " D(4) - ∞

W(11), ..., W(20) = same as for W(1), ..., W(10) but overall not seasonal.

XN3 = Card identification number.

(v) Summary measurés

X1 = Seasonal average simulated price (in cents).

X2 = Seasonal total quantity sold to the trade and net speculators (,000 bales).

X3 = Overall average simulated price (cents).

X4 = Overall quantity sold to trade and net speculators (,000 bales).

X(1) = Seasonal sum of squares of prices.

X(2) = Total sum of squares of prices.

X5 = Seasonal average Wool Commission funds (\$M).

X6 = Seasonal average Wool Commission funds and assets (\$M).

X7 = Seasonal average net speculative funds and assets (\$M).

X8 = Seasonal average sum of hidden gains and losses to growers (or growers' profit), (\$M).

X9 = Seasonal average compounded value of hidden gains and losses to growers (or growers' profit), (\$M).

X10 = Total average Wool Commission funds (\$M).

X11 = Total average Wool Commission funds and assets (\$M).

X12 = Total average net speculative funds and assets (\$M).

X13 = Total average sum of hidden gains and losses to growers (or grower profit), (\$M).

X14 = Total average compounded value of hidden gains and losses to growers (or grower profit), (\$M).

X15 = Seasonal number of observations on funds.

- X16 = Total number of observations on funds.
- X(3) = Seasonal sum of squares of Wool Commission funds.
- X(4) = Total sum of squares of Wool Commission funds.
- X(5) = Seasonal sum of squares of Wool Commission funds and assets.
- X(6) = Total sum of squares of Wool Commission funds and assets.
- X(7) = Seasonal sum of squares of net speculative funds and assets.
- X(8) = Total sum of squares of net speculative funds and assets.
- X(9) = Seasonal sum of squares of sum of hidden gains and losses to growers (or grower profit).
- X(10) = Total sum of squares of sum of hidden gains and losses to growers (or grower profit).
- X(11) = Seasonal sum of squares of compounded hidden gains and losses to growers (or grower profit).
- X(12) = Total sum of squares of compounded hidden gains and losses to growers (or grower profit).
- Y(1) = Maximum simulated price, overall, AMY(1) = date occurred.
- Y(2) = Maximum simulated price, seasonal, AMY(2) = date occurred.
- Y(3) = Maximum overall Wool Commission stocks, AMY(3) = date occurred.
- Y(4) = Maximum seasonal Wool Commission stocks, AMY(4) = date occurred.
- Y(5) = Maximum overall net speculative stocks, AMY(5) = date occurred.
- Y(6) = Maximum seasonal net speculative stocks, AMY(6) = date occurred.
- Y(7) = Maximum total Wool Commission funds, AMY(7) = date occurred.
- Y(8) = Maximum seasonal Wool Commission funds, AMY(8) = date occurred.
- Y(9) = Maximum total Wool Commission funds and assets, AMY(9) = date occurred.
- Y(10) = Maximum seasonal Wool Commission funds and assets, AMY(10) = date occurred.
- Y(11) = Maximum total net speculative funds and assets, AMY(11) = date occurred.

- Y(12) = Maximum seasonal net speculative funds and assets, AMY(12) = date occurred.
- Y(13) = Minimum total Wool Commission funds, AMY(13) = date occurred.
- Y(14) = Minimum seasonal Wool Commission funds, AMY(14) = date occurred.
- Y(15) = Minimum total Wool Commission funds and assets, AMY(15) = date occurred.
- Y(16) = Minimum seasonal Wool Commission funds and assets, AMY(16) = date occurred.
- Y(17) = Minimum total net speculative funds and assets, AMY(17) = date occurred.
- Y(18) = Minimum seasonal net speculative funds and assets, AMY(18) = date occurred.
- Z1 = Total number of seasons.
- Z(1) = Overall sum of seasonal foreign exchange earnings from wool (\$M).
- Z(2) = Overall sum of squares of seasonal foreign exchange earnings.
- Z(3) = Maximum increase in seasonal foreign exchange earnings (\$M).
- Z(4) = Maximum decrease in seasonal foreign exchange earnings (\$M).
- Z(5) = Overall variance in seasonal foreign exchange earnings.
- Z(6) = Ratio of overall variance in seasonal foreign exchange earnings.
- Z(7) = Overall average foreign exchange earnings (\$M).
- Z(8) = Ratio of overall average foreign exchange earnings.

APPENDIX CPARTIAL LISTING OF DATA USED

Most of the data used in this study is listed in "Price Movements of New Zealand Wools and Related Futures, Tops and Yarn Prices 1952-1965", Background Paper 6 prepared by Professor Candler for the New Zealand Wool Marketing Study Group. The listing of data in this appendix gives the weekly measurements of average price (pence) and quantity sold (,000 bales) for the succeeding season 1965/66.

Data for the seasons 1966/67 and 1967/68 was not used.

TABLE C1 PARTIAL LISTING OF DATA

Year	Week	Average Price (pence)	Quantity Sold (,000 bales)	Year	Week	Average Price (pence)	Quantity Sold (,000 bales)
1965	21	38.7	16.8	1965	51	42.5	49.8
65	22	37.5	30.3	65	52	42.0	24.0
65	23	37.0	42.3	66	1	0	0
65	24	37.0	42.3	66	2	42.3	25.3
65	25	39.0	34.0	66	3	42.3	51.5
65	26	0	0	66	4	41.8	49.0
65	27	0	0	66	5	42.0	19.8
END OF SEASON				66	6	40.3	47.7
65	28	0	0	66	7	40.6	24.5
65	29	0	0	66	8	39.7	25.1
65	30	0	0	66	9	43.3	44.9
65	31	36.6	16.2	66	10	41.7	50.3
65	32	38.5	31.7	66	11	41.3	38.2
65	33	35.6	9.0	66	12	41.2	25.6
65	34	40.9	30.9	66	13	42.7	50.5
65	35	39.1	14.3	66	14	41.4	43.5
65	36	0	0	66	15	40.8	23.1
65	37	0	0	66	16	0	0
65	38	0	0	66	17	40.9	47.3
65	39	0	0	66	18	40.8	56.0
65	40	45.2	48.0	66	19	39.4	26.5
65	41	0	0	66	20	38.6	30.1
65	42	44.3	39.4	66	21	37.5	32.0
65	43	44.9	44.1	66	22	37.4	52.1
65	44	42.8	43.1	66	23	38.0	30.6
65	45	45.4	44.7	66	24	0	0
65	46	46.7	52.7	66	25	0	0
65	47	42.7	23.5	66	26	38.5	44.4
65	48	42.3	48.4	66	27	0	0
65	49	42.6	47.0				
65	50	44.2	54.9				