THE ESTIMATION OF THE DERIVED DEMAND SCHEDULE FOR RAW WOOL USING THE JUSTER SCALE

VOLUME ONE

- Chapters 1 - 8 and References

A thesis submitted in partial fulfilment
of the requirements for the degree of
Doctor of Philosophy in Marketing

Massey University

ERIC WILHELMUS ASSENDELFT

1994

ABSTRACT:

In this thesis the results of a two-season experiment using the Juster scale to elicit subjective probability estimates of raw wool purchases at auction in New Zealand for five discrete classes of wool are presented. The approach, which involves estimating the rate of purchase of a commodity at various prices, represents a radically different method of estimating demand slopes and price elasticities. Over sixteen four weekly periods during the 1991-92 and 1992-93 wool seasons, a panel of eleven buyers from wool exporting firms in New Zealand were interviewed to obtain four weekly raw wool auction purchase forecasts.

The results suggest that the use of a purchase probability scale to develop derived demand schedules for raw wool is possible. An average aggregate price elasticity of demand estimate of - 4.4 was generated for 1991-92 and - 4.6 for 1992-93. These values tend to be a little higher than those generated using an econometric approach and possibly reflect the nature of the wool market (i.e. falling prices and oversupply) and the higher 'information' content associated with the data generated through a survey instrument. It is shown that the panel's forecasts of aggregate wool purchases were reasonably accurate with an under-estimation of 8.3% and 12.9% respectively for 1991-92 and 1992-93. There was consistent under-estimation of aggregate purchases in the fine and fine-medium groups and consistent over-estimation of aggregate purchases in the coarse group. It is quite evident that the ability to forecast purchases within particular micron groups is fraught with difficulty due to the substitutability of wool types between the margins. Overall, the errors tended to fall over the study period reflecting, in part, a growing confidence by the respondents in the use of the survey instrument. An analysis of the qualitative data concurrently collected with the probability survey revealed a great degree of uncertainty and error in variables thought to be 'controllable'. The conclusion is reached that a great deal of the error in the results using the experimental survey instrument is a function more of uncontrollable external factors, rather than of the survey process.

ACKNOWLEDGEMENTS:

As with any research project of this size there are a number of people I would like to thank and acknowledge. Without their considerable help I would not have achieved anything.

First and foremost, I would like to thank my wife Carol for her support and encouragement, particularly through the final stages of this research. Her motivation and inspiration have been paramount in getting this thesis finished on time. With this 'burden' out of the way, we can now get on with our life together!

I must also thank the 'in-laws', Joy and John Palmer, who have been also given me the motivation, support and encouragement to keep going right through to the end. Their hospitality on my Napier visits was often the highlight of the monthly 'tour of duty'.

I would also like to thank the panel of buyers who I got to know quite well over the study period and who often went to great lengths to accommodate the interview times and provide commercially sensitive data. It is an understatement to say that without them this study would not have been possible. Unfortunately, for reasons of confidentiality, these buyers cannot be individually identified. However, it goes without saying that I thank each of them individually and wish them all well for their future success in an extremely testing industry!

My appreciation is also extended to Professor Phil Gendall, and the Marketing Department, Massey University for the financial and administrative assistance to this research. I would especially like to record my gratitude to Margaret Corlett for all her administrative help in coordinating and managing the 'expense account'. Additional funding support was also provided by the Massey University Research

Fund (MURF), and the Marketing Department of Otago University. As with any research requiring such extensive field work, suitable financial assistance makes the often, at times, arduous process of travelling and accommodation that much more comfortable!

I would also like to thank Stephen Britland of the New Zealand Wool Board who provided the statistics and background information on the New Zealand Wool Industry, often under short notice. I must also thank David Long of the New Zealand Wool Board for providing the sale and price data.

Last but not least I would like to thank my supervisors, Associate Professor Tony Lewis, Massey University and Associate Professor Rob Lawson, Otago University who provided me with helpful guidance and constructive comments without which this research would not have been fully realised.

DEDICATION:

To my mother, Bep Assendelft, who
sadly passed away before
this report could be finished.

PREFACE:

The Marketing Department of Massey University has been investigating the use of a purchase probability scale, known more widely as the Juster scale, over a number of years in order to more effectively estimate demand. Using the approach refined in 1966 by Thomas Juster while at the National Bureau of Economic Research, the Department has undertaken a number of studies into alternative forms of probability scales as well as its applicability to a range of product and service categories.

This study has its origins in this research programme with an attempt to apply the Juster scale to an undifferentiated commodity, namely raw wool. Coinciding with this part of the research programme was the decision in February 1991 by the New Zealand Wool Board to withdraw from the wool auction system through its indefinite abandonment of its minimum price scheme and market support scheme. A number of models had been developed earlier in the 1960's and 1970's to investigate the economic consequences of statutory intervention through a buffer-stock scheme. The generalised consequences of intervention were found to be essentially a function of the demand curve slope and elasticities in the buying and selling periods. Consistent estimates of the price elasticity of demand for raw wool however, were not possible due to a number of technical and mechanistic problems associated with the 'traditional' econometric approach.

It seemed appropriate therefore, that a 'marriage' between the two research issues would be sensible. In 1991 Associate Professor Tony Lewis of Massey University hypothesised that a purchase probability approach to slope and demand elasticity estimation may provide consistent slope estimates, and hence finally provide an answer to the implications of the New Zealand Wool Board's actions. This thesis presents the results of this hypothesis.

Eric W. Assendelft
December, 1994

CONTENTS:

VOLUME ONE:

VOLUME TWO:

VOLUME ONE

Chapter 1: INTRODUCTION

Chapter 2: PRICE STABILISATION AND BUFFER-STOCK SCHEMES

Chapter 3: SLOPE AND ELASTICITY ESTIMATION

Chapter 4: ELICITATION OF SUBJECTIVE PROBABILITIES

Chapter 5: BACKGROUND, SAMPLE & DATA COLLECTION

Chapter 6: RESULTS AND DISCUSSION - AGGREGATE DATA

Chapter 7: RESULTS AND DISCUSSION - INDIVIDUAL BUYERS

Chapter 8: SUMMARY & CONCLUSIONS

VOLUME TWO

APPENDICES:

FIGURES:

CHAPTER TWO:

CHAPTER THREE:

CHAPTER FOUR:

CHAPTER FIVE:

CHAPTER SIX:

CHAPTER SEVEN:

CHAPTER EIGHT:

TABLES:

CHAPTER TWO:

CHAPTER THREE:

CHAPTER FOUR:

CHAPTER FIVE:

CHAPTER SIX:

CHAPTER SEVEN:

CHAPTER ONE:
INTRODUCTION

CHAPTER ONE: INTRODUCTION

1.1 BACKGROUND

On the 12th of February, 1991, the New Zealand Wool Board formally withdrew from the wool auction market by suspending the Minimum Price Scheme and the Market Support at Auction system. This action by the Board followed the suspension of the Reserve Price Scheme of the Australian Wool Corporation[1].

The resultant debate on the merits, or otherwise, of the Board's actions opened up public discussion on what the role of the Board ought to be. As Lewis (1991a) noted, these issues, which are still being argued, had previously been "*...thoroughly debated in the early 1960's when there was another wool price crisis on*" (p. 75). One major area of contention in the publics' discussions centred on the Board's ability, or possible inability, to make profits on the wool they had been obligated to buy. In particular, questions were raised about the 'appropriate' role for the Board[2]. The difficulty for the participant's of the debate however, was compounded by the absence of any model on which the implications of the Wool Board's actions could be assessed in an impartial and objective manner. As Cartwright (1993) observed, there is a:

> "*...propensity for the two groups...to talk past each other. The result is a debate that is sometimes confrontational and seldom productive. The reason for this situation is that the two groups are using models based on different assumptions and logic*" (p. 2).

[1] Appendix A contains background summaries in the form of press reports of the events before and after the announcement by the New Zealand Wool Board.

[2] See Veeman (1972) for an earlier historical perspective on the arguments for and against agricultural marketing board's in New Zealand. More recent research dealing with this issue is contained in the ACIL (1992) and the Arthur D. Little (1992) reports.

Traditionally most economists have turned to welfare and utility analysis to address the distributive impacts of market intervention such as that offered by a buffer-stock scheme. However, this approach, by necessity often adopts a simplistic overview employing restrictive assumptions which make the widespread application of the results difficult (Newbury & Stiglitz, 1981). An alternative approach is to take a much simpler model which concentrates on measurable financial aspects only. One such model had been developed by Powell and Campbell (1964, 1962) in their contribution to the Philp Committee[3] in Australia[4]. Their model identified what they termed as 'hidden gains and hidden losses' associated with the operation of a buffer-stock system for wool over and above any visible accounting profits and losses. The extent of these gains and losses however, was dependent on the prevailing elasticity of demand at the time of purchase and resale. It was found, using the Australian market as an example, that gains would be made by an authority buying on a market characterised by an inelastic demand and selling on one with an elastic demand. Uncertainty remained however, on the appropriate value of the demand curve slopes, and hence price elasticities, to use in the model.

In the discussion above, it is apparent that knowledge of the shape and slope of the demand curve are important prerequisites towards resolving any debate such as that highlighted by the New Zealand Wool Board's actions. Typically economists have resorted to an econometric approach to provide numerical estimates of the demand curve. In spite of its long history and extended use, the lack of uniformity in the numerical values of the estimates and the use of restrictive assumptions have limited the broad application of any findings.

To overcome this limitation, an alternative approach to demand curve and slope estimation has been investigated in this study. A panel of eleven wool buyers who

[3] The Philp Committee was appointed in January 1961 by the Federal Government of Australia to investigate the merits of various marketing schemes for Australian wool, and in particular the merits of introducing a Reserve Price Scheme. The committee, which was comprised of Sir Roslyn Philp (Chairman), M.C. Butterfield and D.H. Merry, opposed the introduction of such a scheme.

[4] See Sturgess I.M. (1968) for a critique of this report.

are active in the New Zealand wool auction system was selected. These buyers, whose companies' objectives varied, were interviewed on a monthly basis over the 1991-92 and 1992-93 New Zealand wool seasons. The half-hour interview involved three stages. The first stage contained a set of questions of the buyer's expectations of key variables in the market such as exchange rates and wool prices over the forthcoming four weeks. The second stage was an experiment which assessed individual buyer behaviour in response to changes in prices and wool types. The third and final stage consisted of an open-ended general discussion on anticipated events which could impact on likely buying activities over that four week survey period. The key to this study was the second stage in which wool buyers made subjective probability assessments of purchases in response to a series of five wool prices for five separate wool categories. The probability assessments were derived using an 11-point purchase probability instrument known as the Juster scale. The results thus provided a series of five price-quantity points which were aggregated to estimate a derived demand schedule and hence, a demand function for the particular group of buyers for each of the five wool categories. The results however, do not provide an estimate of <u>total</u> demand for New Zealand wool, since the survey is composed of a small, but representative group of buyers.[5]

The proposed experimental survey-based method outlined in this study represents a radically different approach to those used in the past in estimating demand schedules, and hence, price elasticities for wool. The use of a purchase probability scale, or Juster scale as introduced above, has been successfully applied to a number of fast moving consumer goods (FMCG's) and durable goods (Day *et al*, 1991; Hamilton-Gibbs, 1989; U, 1991). However, its application to a commodity like wool, has not yet been tested in this way. Furthermore, the study is unique in the sense that it involves a longitudinal panel of 'expert' buyers *i.e.* substantive experts.

[5] The sample represented most of the major market participants and accounted for approximately 40% of auction purchases over the sixteen survey periods (see Chapter 5).

1.2 OBJECTIVES OF THE STUDY

The major objective of this study is to test an experimental method of estimating derived demand schedules for raw wool over the 1991-92 and 1992-93 wool seasons based on subjective probability assessments elicited from a panel of eleven wool buyers in New Zealand, using the Juster scale. More specific objectives of this study are:

1: To elicit subjective probability assessments of purchase quantities using the Juster scale for five classes of wool; Coarse (*i.e. 36 microns or more*), Coarse-Medium (*i.e. 33-35 microns*), Medium (*i.e. 29-32 microns*), Medium-Fine (*i.e. 25-28 microns*) and Fine (*i.e. less than 24 microns*).

2: To use the probability assessments in the estimation of derived demand schedules (and associated elasticities and slopes) for the five classes of wool throughout the 1991-92 and 1992-93 wool seasons.

3: To test the validity of the purchase forecasts against actual purchase data.

4: To determine whether the Juster scale is an efficient and appropriate technique in the estimation of the derived demand schedule for a commodity such as wool.

5: To isolate any potential shortcomings and limitations in the use of the Juster scale for commodity demand curve estimation.

1.3 AN OUTLINE OF THE STUDY

This thesis is structured in two volumes; Volume One contains the introduction, the research problem, the methodology, the results and discussion while Volume Two contains the supporting data.

VOLUME ONE:

The prime rationale for this study is on investigating the potential for an experimental survey-based approach to demand curve estimation as an alternative to the traditional econometric approach. Chapter One of this study provides an introduction to the topic of research and presents the objectives for the study.

Chapter Two introduces the background and discusses the rationale for the study. The actions of the New Zealand Wool Board in withdrawing from the wool auction system in February 1991 provided a timely forum for the public discussion on what the 'appropriate' role of the Wool Board ought to be. However, a review of the literature reveals that the empirical analysis of the discussion is stifled by the need to use either theoretical or assumed estimates of price elasticities and demand functions in addressing such issues. The chapter summarises the literature in the wool intervention debate by outlining the welfare approaches (Newbury & Stiglitz, 1981; Massell, 1969; Little, 1957), and the use of a narrower-based financial model which considers the revenue implications of a buffer-stock scheme. This latter model, which identifies 'hidden losses and hidden gains' in the operation of a buffer-stock scheme was developed by Powell and Campbell (1964, 1962) in their submission to the Philp Committee in the early sixties following similar debates in Australia. A number of empirical attempts which have subsequently been made over the years in order to validate the conclusions raised by Powell and Campbell (1962) are then summarised. It is concluded that demand estimates, to date, have been indeterminate because of the restrictive assumptions, the incorporation of only partial effects and technical/statistical constraints which have necessitated the limiting of any conclusions drawn from the models. This situation has previously been highlighted in the literature by a number of other researchers. The general conclusion is reached that only when reliable slope estimates have been established can any progress be made on furthering the economic debate on issues such as that raised by the actions of the Wool Board.

Chapter Three introduces the theory underlying derived demand in the context of wool. The theoretical issues underpinning elasticities are then discussed, including the role of substitutes. The chapter then goes on to deal with the issues surrounding the estimation of demand schedules, including the alternative approaches available [*the survey method, the experimental approach and econometric estimation*] and the limitations of these approaches. A summary of empirical attempts using the most popular method, the econometric approach, is then presented. The chapter goes on to briefly discuss the difficulties associated in adopting the econometric approach in demand and elasticity estimation. These difficulties, including violation of the statistical assumptions, misspecification and data problems are discussed. The chapter concludes that an alternative survey-based approach eliciting quantity purchase probabilities may be an appropriate instrument to collect the data required for the study.

Chapter Four introduces the area of subjective probability assessments. Subjective probabilities are defined in the context of the research objectives. Issues associated with the elicitation of these probabilities by assessors are discussed as well as the two types of probability assessments available; the direct and indirect methods. Techniques for the elicitation of subjective probabilities are outlined before a recommendation on the Visual Response Method is made. The chapter takes a slight tangent into the theory of consumer buying intentions in order an introduce a purchase probability instrument known as the Juster scale (Juster, 1966). This 11 point probability scale, developed in the 1960's, has been successfully used in the prediction of both frequently purchased consumer items, durables and services. Furthermore, it has been shown to be a superior predictor compared to the traditional five point purchase intentions scale or Top-box approach (Juster, 1966). The chapter concludes with the recommendation that the Juster scale provides an appropriate elicitation mechanism for the estimation of wool purchases by the panel in order to derive demand functions as per the research objectives.

Chapter Five provides a background to the New Zealand wool auction system. The unique characteristics of the buying process makes such an examination important in order to first, interview the appropriate respondents and secondly, to capture the desired data. The remainder of Chapter Five outlines the methodology and instruments used in the research process. Details of the eleven member panel are also covered. The chapter then discusses the role of the purchase probability instrument and associated questions used to collect the data needed to meet the objectives.

Chapter Six presents the results and discussion of the analysis of the aggregate data relating to the 1991-92 and 1992-93 wool seasons. Aggregated price-quantity relationships are formally developed and tested. Estimates of slopes and price elasticities are also developed. An aggregate estimate of price elasticity of demand for raw wool is established for the panel for each of the periods and for each of the two seasons. A test of the reliability of the approach is given by the accuracy of the expected purchases to the actual purchases. In Section 6.8, a consideration of these errors is given, as well as a statistical analysis of the sources of error. Section 6.9 considers the comparative ability of the purchase probability approach against a number of alternative time-series and regression models.

Chapter Seven looks at the results according to each of the eleven individual panel members. The results of the individual analysis are complemented by the consideration of the ability of the assessors to make forecasts on several other variables during the periods in question. These other variables include qualitative assessments on the direction and extent of movement in the exchange rate, the Wool Board's Indicator Price, the company's own stock and buying levels, and on the supply and demand conditions of the wool auction market. A quantitative assessment on the value of the Wool Board's Indicator Price at the end of the survey period is also addressed. It is suggested that some of the errors identified for particular companies can be attributed to switching of purchases between micron groups.

Furthermore, there was evidence that the 'poor' forecasters were considering a wider definition of the market than just the auction system *i.e.* auction + private. The chapter also shows that the panel members were making consistent errors in forecasting a range of other market variables implying that the errors made may be symptomatic of the general uncertainty in the macro environment rather than a deficiency of the research instrument.

Chapter Eight reviews the merits of the research approach in the estimation of price elasticities of demand and slope estimates for raw wool. The usefulness of the visual response approach in the elicitation of subjective probabilities is considered from the point of cost, buyer participation and the subsequent probability assessments. During the course of the fieldwork it became apparent that one of the fundamental assumptions on which the probability instrument is based upon, namely familiarity with probability concepts, was not being satisfactorily met. This assumption of probability knowledge and resultant decision action by the probability assessors was rather 'quickly' developed by Juster in his foundation research. Subsequent researchers and anecdotal evidence gained during the fieldwork however, have shown that this 'leap of faith' in the ability of the respondents to consider the underlying principles of probability may not be appropriate. In concluding, the chapter considers the implications of this observation and the buyer's interpretation of what the probability scale may mean. The chapter closes by outlining the limitations of the survey-based approach and suggestions for areas for further research.

VOLUME TWO:

Volume Two contains, by way of appendices, the supporting data and additional reference material in order to clarify or support the results presented in Volume One. A glossary is also included to define specific industry terms used in the discussion.

Appendix A provides an overview, through press clippings, of the New Zealand wool market immediately prior to the New Zealand Wool Board's withdrawal from the auction system in 1991. It serves to summarise some of the key issues at the time which led to the Board to abandon its market support operations.

Appendices B and C provide proof of two foundation models used for the distributive analysis of a buffer stock operation. These two models are Massell's (1969) model which represented the first attempt to jointly consider the economic welfare impacts on both producers and consumers of a buffer-stock scheme (Appendix B) and the Powell and Campbell (1962) model which identified 'hidden gains and losses' associated with the operation of a buffer-stock scheme (Appendix C)

Appendix D summarises the desirable properties required of regression estimators.

Appendix E summarises a range of studies which have used the proposed probability approach to elicit purchase intentions.

Appendices F to M and Appendix P contain elements of the survey and experimental instruments used in the collection of the probability data.

Appendix N provides an overview of the 1991-92 and 1992-93 wool season's. Its purpose is to summarise the key environmental factors which were considered likely to impact upon the purchase intentions data collected in this study.

Appendix O contains the graphs of derived demand curves estimated for each of the sixteen periods and for each of the five wool groups. The sixteen aggregate derived demand schedules are contained in Appendix Q.

Appendix R contains a comparison of the expected purchases with the actual purchases made for each of the wool groups over each of the periods for each panel member.

Appendix S describes Theil's statistic which is used in the qualitative analysis of forecasting ability of several key environmental factors in Appendix T.

CHAPTER TWO:

PRICE STABILISATION AND BUFFER-STOCK SCHEMES

CHAPTER TWO:

PRICE STABILISATION AND BUFFER STOCK SCHEMES

2.1 BACKGROUND

On the 12th of February, 1991, the New Zealand Wool Board formally withdrew from the wool auction market by suspending the Minimum Price Scheme and the Market Support at Auction system. In essence this meant that the Board would no longer 'guarantee' a minimum return for wool offered at auction, nor would it purchase any offerings in order to support the market[1]. This move was forced upon the Board following the suspension of the Reserve Price Scheme of the Australian Wool Corporation where stock piles of mainly fine wools had risen to the equivalent of just under a year's production. Pressure however, had started to build up prior to this move with New Zealand Wool Board purchases reaching an historically high level of more than half of the wool offered at auction (Figure 2.1). Furthermore, stock levels had risen dramatically, peaking at 655,000 bales (78,700 clean tonnes) just before the announcement. According to the ACIL report (1992), the Board was at fault for setting a minimum support price at the beginning of the 1990-91 season which turned out to be unsustainable given the consequent market conditions and the limited financial resources of the Board (Figure 2.2).

Some commentators immediately applauded the action of the Board in abandoning its role in the auction system. Commenting on the post-withdrawal improvement in prices, Michael Dwyer, Managing Director of Maircom at the time, is reported as saying "*..the recovery in prices and demand is a vindication of what exporters have been saying for years: that the free market will get the best prices for commodities*

[1] See Section 2.15 for a discussion on the mechanism's used by the New Zealand Wool Board prior to February 12, 1991.

FIGURE 2.1

Wool Board Purchases as a Proportion of Sales Immediately Prior to the NZWB Auction Withdrawal

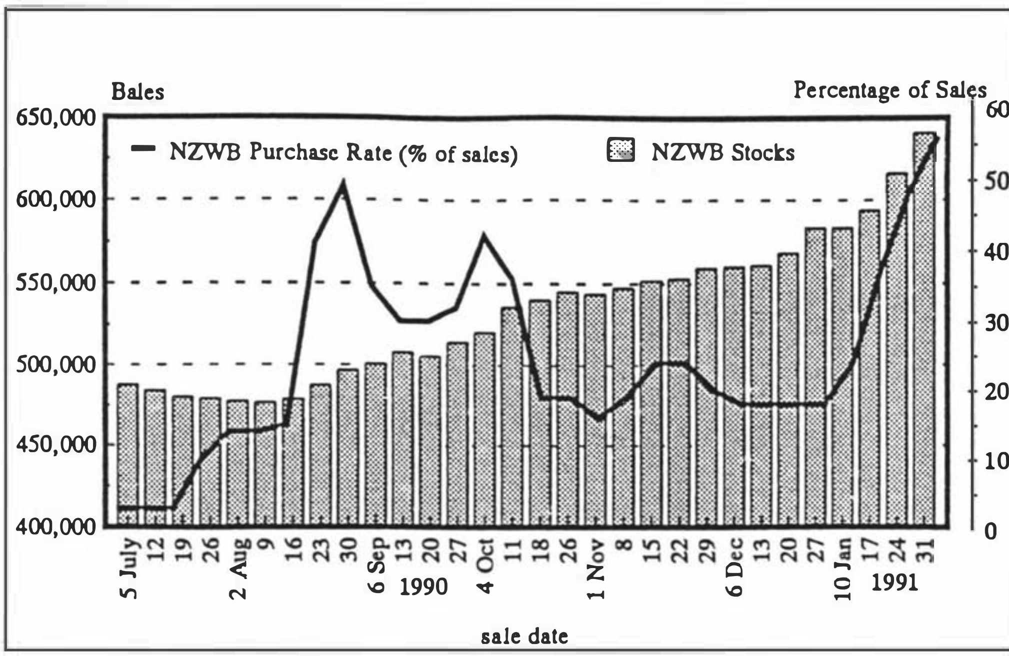
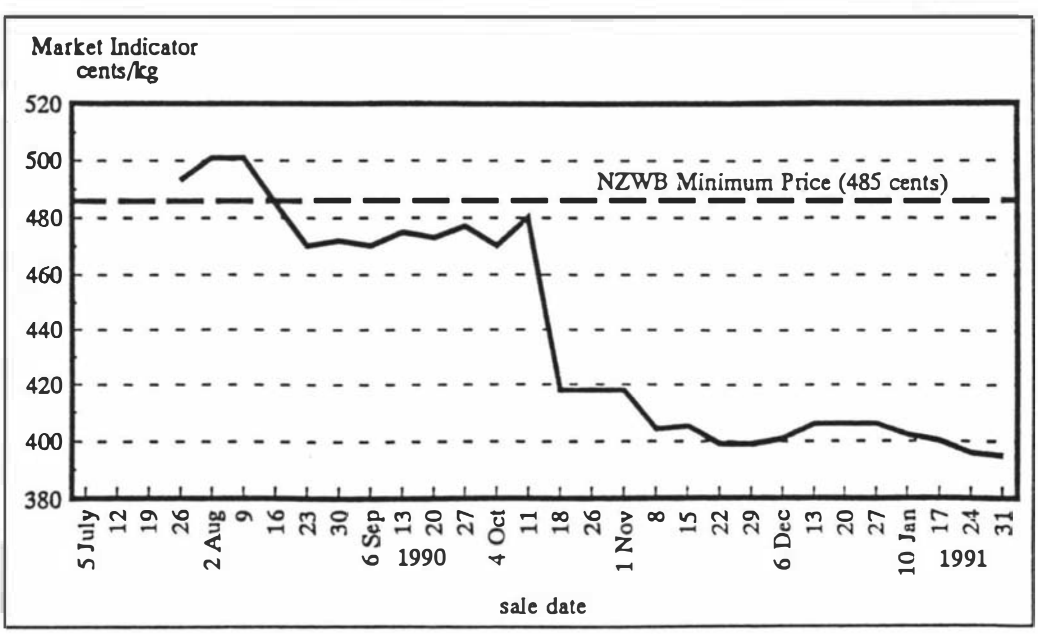


FIGURE 2.2

N.Z. Wool Board Market Indicator Prior to the NZWB Auction Withdrawal



in the long-run ..." (Evening Post, 1991). Others argued that the role of the Wool Board had simply become one of acting as nothing more than a grower-funded speculator, an activity which ran counter to its statutory objectives.[2]

The long-term impact this move has had on the industry in terms of its effects on growers, processors and consumers is still uncertain. Quite marked price fluctuations at auction, both within and between sales have however, become a feature. On a much wider level, the actions of the Board were considered to represent evidence that market intervention by statutory boards was inefficient, and provided empirical support to previous studies critiquing the role of New Zealand producer boards (ACIL, 1992; Watson, 1990; Woods, 1988; McKinlay, 1987; The New Zealand Treasury, 1984).[3]

2.2 JUSTIFICATION FOR STATUTORY INTERVENTION

Unfortunately, as observed by Cartwright (1993), the debate concerning the actions of the Board tended to ignore what the specific role of the Wool Board (or any other producer board for that matter) should be. A review of the literature reveals that the intervention of a statutory authority into the raw wool market could be justified for five reasons:

2.2.1 Reduction of Price and Income Instability

Price instability is a distinguishing feature of most primary product markets. Given the link between prices and farm income, an unstable price translates directly into an unstable income. As such it tends to be one of the major justifications in the

[2] Under the Wool Act 1977 the Board is expected to "*...engage in activities which maximise the long-term returns to New Zealand woolgrowers.*" It did this principally through, among other things, the operation of a price support and price stabilisation scheme (see Section's 2.15 and 5.3.7).

[3] Zwart (1988) provides a useful critique of these studies conclusions (excluding the ACIL (1992) and Watson (1990) reports) against export control by marketing boards.

literature for statutory or market intervention. Boyer (1962) argued that price stability was desirable for three main reasons:

> "*...it would help stabilise national income and growth patterns; it would decrease the ratchet effect which price fluctuations have on growers costs and may assist rural investment;* [and thirdly] *it seems capable of providing a greater net (national) return from wool, in the long run.*" (p. 521).

It is this second point, that of the effect of price instability on farm investment, which seems to be a key feature underlying discussion of price stability schemes. Elementary economic investment theory suggests that aggregate investment behaviour is a function of both the capital stock (autonomous investment) and prevailing real interest rates (induced investment) (Shapiro, 1978). For an agricultural producer, investment behaviour may be complicated by the intertemporal nature of much of the investment, and the considerable uncertainty about future planned income. This situation leads to what has been described as stop/go development (Philpott, 1965b). Girào *et al* (1972) showed investment behaviour to be influenced by instability of income, and that investment decisions under these conditions tended to be short-run in nature. Other authors have however, suggested that a fluctuating farm income may lead to higher (although not optimal) levels of investment through what has been termed the windfall income effect (Shapiro, 1978). Campbell (1964) rejects instability as a determinant acting against investment believing instead that farmers get 'used' to fluctuating incomes and behave without regard to short-run implications.

Philpott (1967), in evaluating the New Zealand situation, examined the relationship between changing levels of sheep farm income and changes in the level of real investment. He was unable to establish any conclusive relationship between income and investment, although he did acknowledge that the effects of technology and managerial innovations as well as the data available may have distorted any precise relationship.

The Wool Marketing Group (1967) did however, establish such relationships between firstly, deliveries of fertiliser and changes in gross farm income and secondly, applications of spring fertiliser and the previous year's income. Chaio (1987) warned that such behaviour should not be of too much concern since fertiliser has a high carry-over effect and variations in application may well be rational and optimal behaviour.

Overall, the literature remains unclear about any precise relationship between price stability and income[4].

2.2.2 Raise Average Prices and Incomes

The second reason used for intervention is to raise the average level of prices and incomes. Tomek and Robinson (1981) however, suggest that the effect on average returns is a function of the demand conditions at the time of acquisition relative to the time of sale, the cost of holding the commodities, and the length of time over which they are held. In general, farmers gain over a period of years from storing commodities only if demand shifts during the period by enough to cover storage costs and if the price elasticity of demand at the time reserves are sold is greater (or less inelastic) than when stocks are acquired (Tomek & Robinson, 1981; Campbell, Gardner & Haszler, 1980; Powell & Campbell, 1962; Gislason, 1959).

2.2.3 Improve Resource Allocation

The third justification for statutory intervention discussed in the literature is to improve the macro allocation of resources. Price instability, in some instances, is said to hide the 'true' underlying price signals which help guide resource allocation decisions (FAO, 1960). Inefficient allocations will therefore, occur when producers

[4] A comprehensive, but somewhat dated, review of the literature is given by Tomek (1969).

overdiversify in order to reduce risk.[5] Furthermore, farmers, in their investment behaviour, are thought to be risk-averters implying somewhat lower outputs than if average prices and yields could be known and stable (Hildreth, 1977; Lin, Dean & Moore, 1974; Officer & Halter, 1968). The Wool Marketing Group (1967) were also concerned at the inefficiencies associated with stop/go development attributable to fluctuating incomes and prices.

Price stability through intervention is also thought to overcome what has been termed 'capital rationing' (Johnson, 1947). This occurs when lenders reduce their levels of loans available to farmers in the face of uncertainty and risk of future returns. Alternatively, farmers may decide to borrow less than the optimal amount given their same anxiety about future returns. Under a stable price system, more capital would be employed leading to greater output and efficiency (Tomek & Robinson, 1981).

Intervention for allocative efficiency can also occur when there is an anticipated future upturn in agricultural commodity prices. It is a widely held belief, for example, that private decisions concerning future costs and revenues which are discounted with private interest rates tend to undervalue future benefits to society (Mishan, 1972). Statutory or public intervention may therefore, be instigated to ensure that land remains in agricultural production, rather than being 'locked' into urban usage. Even if the private decision maker had identical expectations to the public policy maker, it is believed that 'incorrect' production allocation decisions would still be made (Ritson, 1977).

Intervention may also be justified on the basis of market failures, particularly in terms of quality control, research and promotion. These spillover benefits and costs occur primarily due to the failure to establish appropriate property rights. The result is a divergence of social and private costs leading to the problem of 'freeriders' (ACIL, 1992; Mansfield, 1985).

---

[5] The consequence from an economic efficiency point of view is that a 'guaranteed price' scheme may tend to protect marginal producers who would otherwise exit the industry in a free and competitive system.

2.2.4 Extract Speculative Profits

The fourth reason given for statutory intervention is to make speculative profits (Leftwich, 1979). An intervening authority may take an active role in the buying and selling of the commodity over time acting in a such way as to make speculative profits. This assumes of course, that the authority has better information, is less risk averse, has speculation as its corporate objective and has the capital resources to participate in this activity.

2.2.5 Protection of a Strategic Industry

A final reason in favour of statutory intervention may lie in the protection of a strategic industry. This national security argument tends to be popular during periods of conflict when self-sufficiency may be of paramount importance (Kramer *et al*, 1959). Certainly some economists, such as Keynes (1938), advocated this rationale in the period immediately before World War II. Ross (1976) argued that price stability was an important objective for an economy like New Zealand's with a heavy dependence on exports of primary commodities. Export price fluctuations in a major industry within such an economy would inevitably lead to increasing problems of macroeconomic instability in wage inflation and productivity in other sectors. In more recent times however, this rationale has tended not to be popular given more liberal international economic policies (Södersten, 1980).

It is the first and second objectives of statutory intervention given above, that of price stability and income improvement, which are of prime importance within the Wool Act, 1977 and will be considered in the consequent discussion. However, before doing so the chapter addresses the problems of agricultural product prices and the arguments pertaining to price stability as an objective.

2.3 PROBLEMS OF AGRICULTURAL PRODUCT PRICES

Given that price instability, and hence fluctuating income, is used as a justification to intervene in a market, the question arises as to what causes these changes. According to the literature, it is evident that primary product price instability is the result of both supply and demand influences. The supply of agricultural products, at least in the short-run, is typically unresponsive to price changes (*i.e.* supply is inelastic) especially with regard to downward movements since current output is governed by decisions made in previous periods. A key feature of agricultural production is thus the lagged response relationship between the decision to produce and the realisation of output. This lag in production response can be anything from 1 month (in the case of chickens), to 4 years (for sheepmeats or wool) to 30 years (for forestry).

Any within-season deviation in supply and demand equilibrium therefore, tends to be reflected in price rather than through a planned output adjustment. The restoration of equilibrium between demand and supply as such takes much longer, with the resultant oscillation of prices very much wider than in the case of most manufacturing products, where supply can be adjusted quite quickly to short-run demand changes (Douglas, 1987; Leftwich, 1979; Porter, 1950).

Price instability originating from the supply side may also be compounded if producers base medium-term production decisions on short-run price signals, as demand conditions may well change once again before the revised level of output comes onto the market, thus making the level of supply again inconsistent with demand (Reserve Bank of New Zealand, 1979). This situation gives rise to the 'cobweb effect' whereby an ongoing cycle of alternating high and low prices is established.

Supply side inelasticity in the short term is also influenced by the decentralisation of production decisions by numerous individuals, the physical constraints of the production inputs[6] and the influence of independent joint product prices[7] (Tomek & Robinson, 1981; Kindleberger, 1958).

Agricultural commodities typically display a short-run price inelasticity of demand due mainly to the absence, in most cases, of close substitutes. This result leads to farm prices and total revenue varying directly, with a price increase increasing total revenue and *vice versa*. Furthermore, demand for agricultural commodities is a derived demand (see Section 3.2, Chapter 3). Demand therefore, tends to be less price inelastic than the demand for the products in which the commodities are embodied.

Price instability in agricultural commodities is also more exaggerated than for non-farm products due to the influence of international trade factors. Developments in domestic agricultural policies, such as farmer income support or subsidies, can often lead to large changes in supply and demand on the world market.

Price instability in agricultural commodities can also be traced to the high risk premia often required by speculators to induce them to store any surplus which may appear (Keynes, 1938). Costs associated with uncertainty about prices and trading conditions in future periods may be too high for individual entrepreneurs to bear.

The Wool Marketing Study Group (1967) specifically addressed the issue of price instability associated with wool. They recognised the fact that price fluctuations for wool are more a function of changes in demand rather than changes in supply. These changes in demand had their origins in cyclical changes in mill consumption of raw wool. This observation was also verified by Myers *et al* (1990) in an Australian context. Furthermore, these changes in demand are related to changes in the level of consumption of raw wool by textile mills and also on the wool trades expectations

---

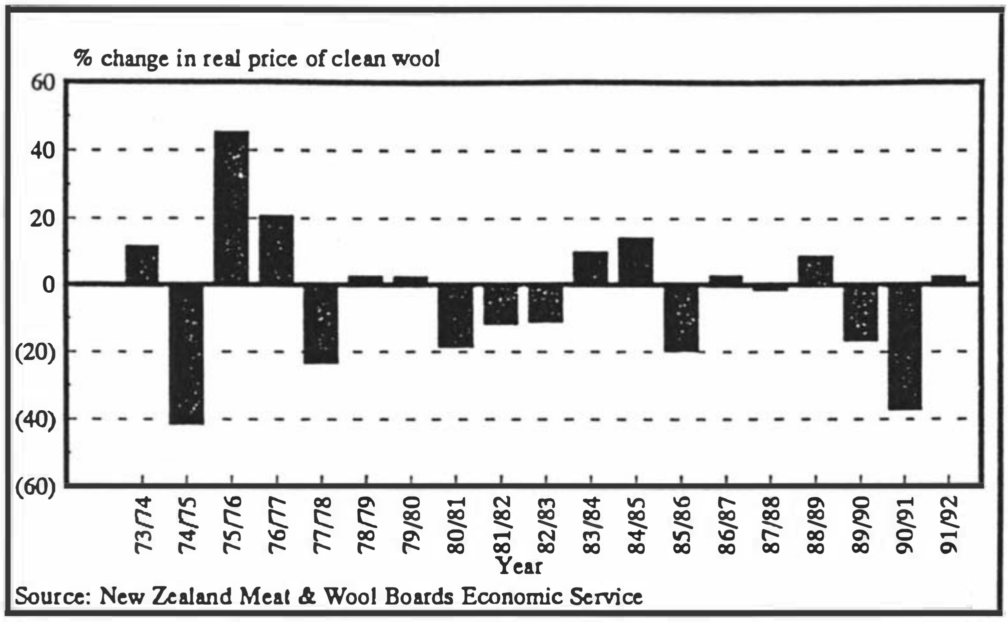
[6] Changes in the supply of livestock, for example, are limited by the availability of female stock and the time required to produce a new generation.

[7] Such as for wool and for lambs (meat).

about the future. The Study Group noted that, in a comparative study, wool prices tended to fluctuate considerably more than synthetic prices. This finding was also observed by Blau (1946) and B.A.E. (1973). Some sense of the dramatic inter-seasonal price changes possible in wool are illustrated in Figure 2.3 below.

FIGURE 2.3

Percentage Changes in Annual Average Real Wool Prices: 1985-92



Lapp and Smith (1992) suggest that the pattern of relative price variability such as that shown in Figure 2.3 above, increases uncertainty for producers and consumers. They believe that such variability may be due to changes in nominal prices between agricultural commodities, as well as actual and unexpected price inflation. Where such variability occurs, there exists a decrease in resource allocation efficiency and an increase in producers risk:

> *"As relative prices become more volatile, past relative prices provide less reliable guides to current resource allocation and the information in current relative prices becomes more obsolete more quickly. The result is that decision makers invest more heavily in search activity and end up with less useful information. Furthermore, the fact that*

producers have less information increases the risk associated with choosing which commodities to produce" (Lapp & Smith, 1992, p. 7).

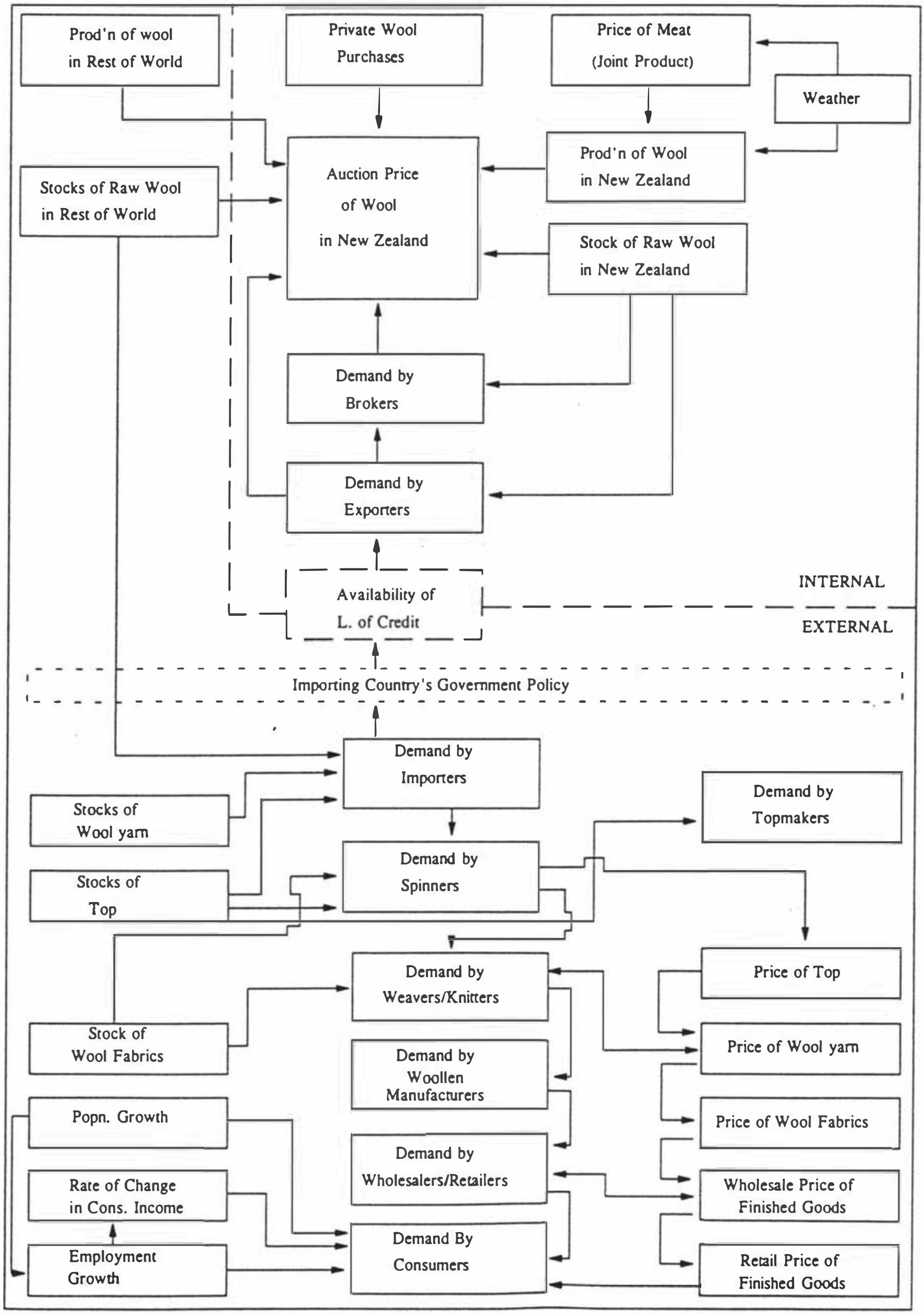
In this study attention is concentrated specifically on pricing aspects related to the raw wool market in New Zealand. Figure 2.4 overpage illustrates the economic relationships associated with the determination of the auction price for raw wool. It can be clearly seen that there are a considerable number of both internal and external forces which impinge upon the formation of the auction price. Furthermore, the value chain associated with wool marketing is quite long with the individual levels themselves being subject to a number of interrelated and uncontrollable forces. While a more detailed discussion of the linkages between these market components is left to Chapter Five, it is suffice to say from Figure 2.4 that the factors influencing the price of raw wool are many and varied.

2.4 PRICE STABILITY AS AN OBJECTIVE

The question as to the desirability of interventionist price stability is one which has a long history in economic debate. Proponents of price stability argue in favour of the need for a societal approach to somehow compensate producers for the inherent 'disadvantages' associated with the marketing of primary products (Zucker, 1965; Tisdell, 1963; Porter, 1950; Riefler, 1946; Keynes, 1974, 1938). In particular, concern is expressed at the long-term nature of production decisions, the high capital cost requirements and the uncertainty as a result of fluctuating prices and farm income. When the primary sector constitutes a major component of the economy, such as in the case of New Zealand, these arguments are more widely debated at both political and social levels and hence, a public good approach is often argued. Opponents of price stability however, question the distribution of the welfare effects and point to the 'undesirability' of public sector intervention and the associated economic efficiency costs in an otherwise 'free' market (ACIL, 1992; The New Zealand Treasury, 1984; Salant, 1983; Townsend, 1977; Helmberger & Weaver, 1977; Johnson, 1975; Tisdall, 1973, 1972; Candler & Yap, 1968; Oi, 1963, 1961).

FIGURE 2.4

The Economic Relationships in the Formation of the Price of Raw Wool at Auction in New Zealand



Price stability schemes typically involve some reduction in the level of prices during a boom period with a support of prices by supplementation during a recessionary period (Campbell & Fischer, 1986). This 'smoothing' of prices may be achieved through the use of either a stabilisation fund[8], an income equalisation fund[9] or a buffer-stock scheme[10].

The question of choice as to which policy instrument is appropriate is usually determined by the goals of the policy makers (Swinnen & van der Zee, 1993; Chambers, 1992). In the New Zealand situation, the Wool Board, prior to 1991, achieved its objectives through the use of a buffer-stock arrangement. A buffer-stock scheme operates so that a portion of thc output is stored in years of low prices and sold in years of high prices. The key difference between this approach and the other two funds previously mentioned is that a buffer-stock scheme achieves the stability objective using the transfer of the physical product, rather than through the transfer of money[11] [12]. Such storage programmes, operating as an 'Ever Normal Granary' have apparently been in existence for thousands of years (Porter, 1950).

2.5 INTRODUCTION TO BUFFER-STOCK LITERATURE

Most agricultural commodities have, at some stage during the past century, been subjected to some attempt to stabilise prices. The period immediately following World War II saw global acceptance of such trade agreements starting with the

---

[8] Producers' returns may be stabilised through the use of a 'tax' during a period of high prices and a supplement during periods of low prices.

[9] Receipts are pooled over a particular period.

[10] Moir & Piggott (1991) have recently investigated the effects of some combination of the three mechanisms.

[11] This immediately raises the issues of storage and intertemporal costs. These factors will be discussed later in the chapter.

[12] See also McNicol (1977) for a theoretical discussion on the nature of a pure buffer-stock arrangement.

Havana Charter of the ill-fated International Trade Organisation. International trade agreements have since been popularised, although to varying degrees of success. These include the General Agreement on Tariffs and Trade (GATT), the United Nations Conference on Trade and Development (UNCTAD), the Organisation of Oil Producing Export Countries (OPEC) and the Common Agricultural Policy (CAP) of the European Community (EC). Typically such agreements take the form of either a pure stabilisation scheme, contractual agreements[13] or export quotas[14]. In this review, consideration is given only to the impacts of a pure price stabilisation scheme using buffer-stocks.

The size of storage stocks required to achieve a degree of price stability, and hence estimates of the benefits and costs involved, depends on the variability of production and demand, the slopes of the demand and supply schedules and the extent of price stability being sought by the commodity authority. Unfortunately, much of the literature on price stability is limited by the need to make a number of broad assumptions about such basic concepts as inter-period elasticities and the type of stochastic disturbances in the supply and demand schedules[15]. Furthermore, the literature has developed down two seperate 'generations'. Simmons (1988) describes the first 'generation' as being based on missing markets[16] and the recognition of the importance of the role of private stocks in determining the effects of a buffer-stock on market stability. Buffer-stocks and speculative stocks operate in very similar ways (*i.e.* purchases are made when prices are low and sales made when prices are high).

[13] A contract is established between one or more exporting countries and one or more importing countries for the exchange of a commodity at a specified price and a specified quantity. The important difference is that price is stabilised for the contracting parties, while being destabilised for non-participants who operate in a market with fluctuations in production (Ritson, 1977).

[14] Quotas tend to be the most popular form of commodity agreement. In its simplest form, quotas are set on each country's export surplus in an average year, which allows for stockpiling during 'good years' and a release of stocks during 'bad' years.

[15] For example, is the error term in the demand or supply schedule estimates an additive function (*i.e.* a parallel shift) or a multiplicative function?

[16] A missing market refers to the situation in which a 'market' for risk (*i.e.* such as for futures) is absent or incomplete. In such cases a role is available for society (*i.e.* the government) to correct the market failure.

Assumptions in the related literature are thus made about the capacity of the former to displace the latter.

The second 'generation' suggests that the operation of stock transfers between periods lead to a redistribution of welfare between producers and consumers (depending upon the sources of price variation) and that generally the net societal gains are positive. Most of the studies rest upon the implicit assumption that the operation of buffer-stocks are largely self-funding and that there are no private markets for stocks.

Elements of both 'generations' have been raised as arguments in the current debate mentioned previously. As such, the chapter will touch upon some of the key issues in the literature associated with both arguments. Before doing so however, Section 2.6 provides a brief historical perspective of buffer-stocks to provide some context to the current literature.

2.6 HISTORY OF BUFFER-STOCKS

The period just before World War II saw the public emergence of support for the wide-scale use of buffer-stock schemes as a means of stabilising both national and international commodity prices (Porter, 1950; Riefler, 1946; Keynes, 1974, 1938). The orthodoxy of a *laissez-faire* economic system, which predominated economic policy development up to this point, had been rejected as a result of the global depression of the early 1930's. In addition, the unstable political environment made the case for stockpiling of raw materials and commodities for security more attractive.

Keynes (1938) expressed concern at the rather wide disparities inherent in the production and marketing of raw commodities particularly in terms of prices and stocks. He had observed, for example, that the average annual price range of four key commodities - wheat, rubber, cotton and lead - over the decade before 1938 had been as much as 67 per cent. Keynes made the comment that:

> " *It is an outstanding fault of the competitive system that there is no sufficient incentive to the individual enterprise to store surplus stocks of materials, so as to maintain continuity of output and to average, as far as possible, periods of high and low demand.*" (1938, p. 449).

Keynes also noted that when demand fluctuates:

> "*... a divergence immediately ensues between the general interest and the course of action in respect of stocks which is most advantageous for each competitive enterprise acting independently.*" (1938, p. 449).

Reasons for this occurrence included the high cost of storage and interest and the lack of an incentive for the manufacturer to purchase in advance. In summary he noted:

> "*Nothing can be more inefficient than the present system by which the price is always too high or too low and there are frequent meaningless fluctuations in the plant and labour force employed.*" (Keynes, 1938, p. 452).

Like Keynes, Porter (1950) also expressed concern at the violence of the fluctuations of prices which had been "*...characteristic of primary commodities since the turn of the century*" (p. 96). Part of this violence in prices could be accounted for by the risks involved in storing any temporary surplus which may appear, especially if the surplus was due to a temporary decline in the demand for industrial raw materials (Porter, 1950).

As a solution to this problem of price fluctuation, Riefler (1946), Porter (1950) and Keynes (1974) all advised the establishment of a central organisation to manage the operation of a buffer-stock scheme.

Keynes' proposal called for the Government to offer storage to all Empire producers of specified raw materials either free of warehouse charges and interest or for a nominal fee provided they ship their surplus produce to approved warehouses in the United Kingdom (Keynes, 1938). A subsequent proposal called for the establishment of an international organisation (Commod Control) to:

> "*...stabilise the price of ...world output... and to maintain stocks adequate to cover fluctuations of supply and demand in the world market*" (Keynes, 1974, p. 300).

The advantages of such a scheme lay in the relatively small cost to the Treasury, the provision of stocks would avoid time lags in production and the stocks would represent a form of foreign investment with apparent gains in prestige and security (Keynes, 1938). Furthermore, it would help facilitate the development of agreements with producers of raw materials and their governments[17].

An interesting, and perhaps rather important point in Keynes' proposal, was the allowance for the participation of the private sector in the acquisition and management of stocks. A reduction in uncertainty concerning the future course of prices of those commodities dealt with by the 'agency' would, according to Keynes, reduce the risks attached to the holding of stocks by merchants and speculators, so that they would be willing to hold larger stocks at higher current prices. The proportion of any surplus which the 'agency' would have to store would depend upon the expectations of future price movements made by dealers and speculators, compared with the buying prices of the 'agency' and the financial strength of the speculators and the size of the surplus.

In conclusion, Keynes was quick to point out that with buffer-stocks he was not advocating some restrictive and persisting expedient:

---

[17] Keynes did however, recognise that the objectives of stocks as a war insurance and of dampening down the trade cycle were partly in conflict.

> *"Our object should be to combine the long-period advantages of free competition with the short-period advantages of ensuring that the necessary changes in the scale and distribution of output should take place steadily and slowly in response to the steady and slow evolution of the underlying trends"* (Keynes, 1974, p. 309).

Riefler (1946) and Porter (1950) similarly advocated the establishment of a central organisation to manage the operation of buffer-stocks. The establishment of an international buffer-stock, according to Porter (1950) would reduce the risks:

> *"...attaching to the holding of stocks by merchants and speculators, so that they would be willing to hold larger stocks at higher current prices. ... [The Agency] ...would only have to take that part of it which was not taken by the market at its buying price"*
> (Porter, 1950, p. 98).

2.7 WELFARE IMPLICATIONS OF PRICE STABILITY - CONSUMERS

The work by Keynes and others on the desirability of centralised stock and price stabilisation systems immediately begged questions within the literature as to the economic welfare implications of such a proposal. The issues raised however, initially contrasted the benefits accruing to consumers and producers separately. The 'consumer' argument against buffer-stocks (and hence an implied level of price stability) was that consumers are apparently harmed by price stabilisation while they benefit from price instability.

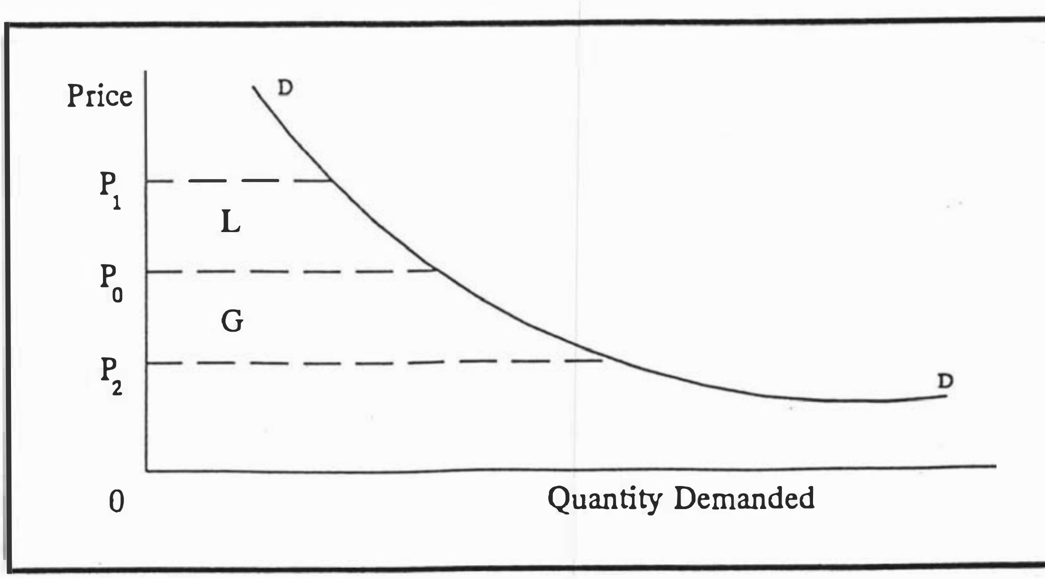
Waugh (1944; 1966) showed that with a negatively sloped demand curve, assuming consumers to be price takers and starting with a given price, consumers gain more from a price decline than they lose from a price increase (from a consumer surplus point of view). Consumers would thus, gain from price fluctuations and lose from price stabilisation.

The proof was simple:

> *"...consider any two prices, P_1 and P_2 which might be set in two consecutive weeks, years, or equal periods; and also the average price $P_o = {}^1/_2(P_1+P_2)$. We wish to compare two situations: first, one in which the price would be exactly stable; second, one in which the price would be P_1 in the first period and P_2 in the second period. In the period when the price is above P_o, the loss in consumer's surplus (as compared with the situation P_o) is represented by the area marked L in [Figure 2.5]. When the price is below P_o, the gain is represented by the area marked G. Since the distances P_1 - P_o and P_o - P_2 are equal, it is easy to see that G is always greater than L, if the demand curve slopes downward to the right."*
>
> (Waugh, 1944 p. 604)

FIGURE 2.5

Waugh's Hypothesised Consumer Benefits from Price Stability



Waugh concluded that:

> " *...if a consumer has a given sum of money to spend for all goods and services, and if he can distribute this expenditure as he pleases among n equal periods of time, he will be better off if all prices vary than he would be if all prices were stabilised at their respective arithmetic means.*" (1944, p. 608).

Other researchers however, made opposing assertions suggesting that each individual consumer would be worse off with varying prices than if the prices were stabilised at or below their weighted means. (Howell, 1945; Lovasy, 1945). Lovasy (1945) suggested that Waugh's proposition would hold true only as long as prices do not move in the same direction at the same time and that relative prices were thus different in different periods. Howell (1945) warned that the influence of price stability on the welfare of consumers would obviously depend on the level at which prices were stabilised, which itself would depend upon the influences of such stability on incomes to producers and on the quantity produced and consumed.

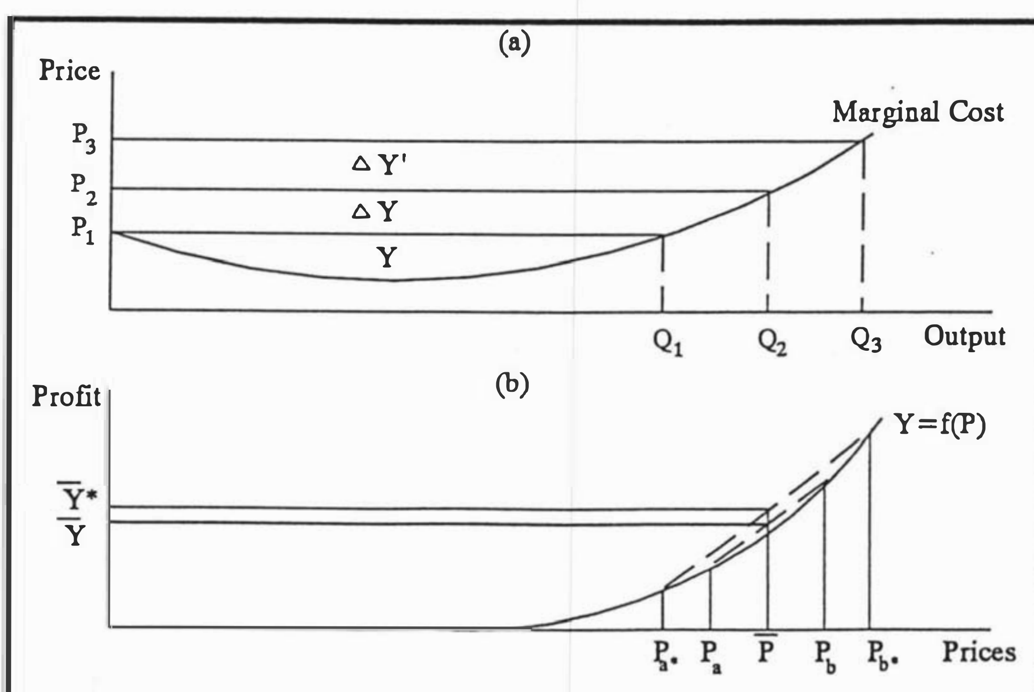
2.8 WELFARE IMPLICATIONS OF PRICE STABILITY - PRODUCERS

Intuitively one would expect that competitive firms would always prefer price stability to instability. After all, the difficulties associated with firms in an uncertain environment are well known, particularly in relation to managerial decision analysis (Douglas, 1987; Pappas & Hirschey, 1987).

However, Oi (1961) showed for firms with an upward sloping supply curve facing random selling prices due to stochastic shifts in demand, losses were likely (in terms of producers' surplus) if prices were stabilised at their mean. Furthermore, Oi demonstrated that instability of prices will always result in greater total returns if firms maximise short-run profits at each point in time. This constraint, which Oi describes as central to the analysis, is not too unrealistic and restrictive given that it is an accepted and universal assumption of classical microeconomic theory.

It is possible to illustrate Oi's finding using a firm in a perfectly competitive market with a stable cost function. To maximise short-run profits, a firm will produce at the point at which price (p) is just equal to marginal cost (mc) *i.e.* p = mc. The assumption of three prices (P_1, P_2, P_3) allows for the determination of three corresponding equilibrium output levels (Q_1, Q_2, Q_3). At any given price level, there is also a corresponding profit level (see Figure 2.6). The addition to total profit ($\Delta Y'$) as a result of a price increase will always exceed dY so long as the marginal cost is positively sloped over the relevant range.

FIGURE 2.6
Oi's Desirability of Price Instability



Oi's analysis however, requires an implicit assumption that production can be instantaneously adjusted to price changes. This assumption in itself assumes that producers and managers will be able to forecast prices correctly. However, in agriculture such instantaneous adjustment assumptions as previously mentioned, are unrealistic.

Tisdell (1963) attempted to overcome this problem by introducing a notion of price forecast uncertainty to generalise to an agricultural production situation. His results showed firstly, that in situations of complete uncertainty, increased price instability does not lead to greater average profits than can be earned with a stable price and secondly, that to maximise expected profit in this unstable-uncertain price situation, it is necessary to hold production constant at the output appropriate to the average of the fluctuating prices.

Oi (1963) later rejected this restriction as merely being a disagreement over imprecise terminology. He replied, without offering proof, that "*...evidence on crop yields seems to suggest considerable responsiveness to current price.*" (p. 248). Price instability may instead simply reflect some random fluctuation and some systematic fluctuation related to some exogenous variable, Z.

Thus the future price (P_t) is related to Z and a residual error U_t :

$$P_t = f(Z_t) + U_t \tag{2.1}$$

The total variance in price is thus, according to Oi at least, comprised of explained variance and unexplained variance. Tisdell's analysis of price instability therefore, reflects the unexplained variance and Oi's analysis is said to hold.

> "*So long as expected prices vary, output will also vary from period to period...[and if] ...price instability contains a systematic component greater price instability will lead to higher expected profits.*"
> (Oi, 1963, p. 248)

Zucker (1965) also rejected Oi's proposition. His thesis rested on the proposition that under the assumption of constant elasticity of supply, profit is invariant with respect to revenue instability. He demonstrated that far from an advantage accruing to entrepreneurs from price instability, definite disadvantages were more likely. These were likely to be reflected in additional costs as management attempted to control output variations.

Taking a much wider consideration of price stability, Nurkse (1958) suggested that:

> "*...stabilizing the prices received by producers interferes with the incentive to produce more when export prices are high, and serves perversely to keep up production for export when export prices are low. This is obviously not a pattern that maximises the producing country's proceeds over the business cycle*" (p. 149).

This view was challenged by Grubel (1964) who showed that generally the introduction of a buffer-stock scheme may or may not increase foreign exchange earnings from what they are under an unrestricted-market system. However, he did show that if demand is typically less elastic during periods of high demand than it is during periods of low demand, buffer-stock schemes would likely decrease foreign exchange earnings[18].

2.9 WELFARE IMPLICATIONS OF PRICE STABILITY - AGGREGATE EFFECTS

The discussion within the literature up to this point considered the welfare effects upon one group only, ignoring the welfare impacts price stability (or instability) may have on the other. Massell (1969) was amongst the first to take the ideas developed by both Waugh (1966; 1944) and Oi (1961) and integrate the two sets of results to consider the welfare effects of price stabilisation in a two-equation model containing

[18] Since stable prices over the cycle forgo the opportunity to exploit the inelasticity of demand during boom periods (Grubel, 1964, p. 384).

both producers and consumers. The model assumed however, that stabilisation could be achieved by a costless storage scheme. Private storage was thus not considered.

Massell's model took the following form:[19]

$$D(P_t) = A - aP_t + u_t \qquad a > 0 \qquad (2.2)$$

$$S(P_t) = B + bP_t^* + v_t \qquad b > 0 \qquad (2.3)$$

$$D(P_t) = S(P_t) \qquad (2.4)$$

where:

$D(P_t)$	=	quantity demanded in period t;
$S(P_t)$	=	quantity supplied in period t;
P_t	=	price in period t;
P_t^*	=	producer price incentive in period t-1 for production in period t;
u_t, v_t	=	independent, additive, random, serially uncorrelated disturbances with means zero and finite variances, σ_u^2 and σ_v^2, respectively.

The supply function (Equation 2.3) was later modified from the original model with a rational price expectation to show the more realistic situation with regard to agricultural production (Wright, 1979). This implies that the producer takes into account all available information within which the price is determined, as argued by Muth (1961) and takes the following form:

$$P_t^* = E_{t-1}(P_t) \qquad (2.5)$$

To measure respective welfare gains, Massell used for producers, the expected value

[19] See Appendix B for mathematical proof.

of producers surplus, and for consumers, the expected value of consumers surplus[20].

Massell's model was based on an atomistic market of consumers and producers where price fluctuations could arise from [parallel] shifts in either supply or demand, or both. Figure 2.7 illustrates the situation of price fluctuations in response to shifts in supply (as envisaged by Waugh (1944)). Both supply curves, S_1 and S_2 are assumed to occur with equal probability (*i.e.* 0.5). A buffer stock scheme is set up, setting the market price at u'P. A price fall to P_1 represents a gain to producers of $c + d + e$ and a loss to consumers of $c + d$. The result is a net gain equal to e. A price rise to P_2 is a gain to consumers of $a + b$ and a loss to producers of a. Once again there is a net gain of b. Stabilising the price at u'P provides a net gain to producers of $c + d + e - a$ and a net loss to consumers of $c + d - (a + b)$. Thus there is a net gain of $b + e$ to consumers and producers jointly[21] (Massell, 1969, p. 289).

If we consider price fluctuations caused by shifts in demand (as envisaged by Oi (1961)) and using an argument analogous to that in the supply situation, it can be shown that there is a net gain to consumers of $c + d + e - a$, a net loss to producers of $c + d - (a + b)$ and a net gain to the two groups jointly of $b + e$.

In terms of welfare, a net pareto improvement will have been realised since total welfare is increased[22].

In Massell's words:

> " *Waugh (Oi) is correct that stabilisation makes consumers*

[20] Massell made the assumption that the commodity formed a sufficiently small part of total producer sales and consumer purchases such that a change in it's price left the marginal utility of money unchanged.

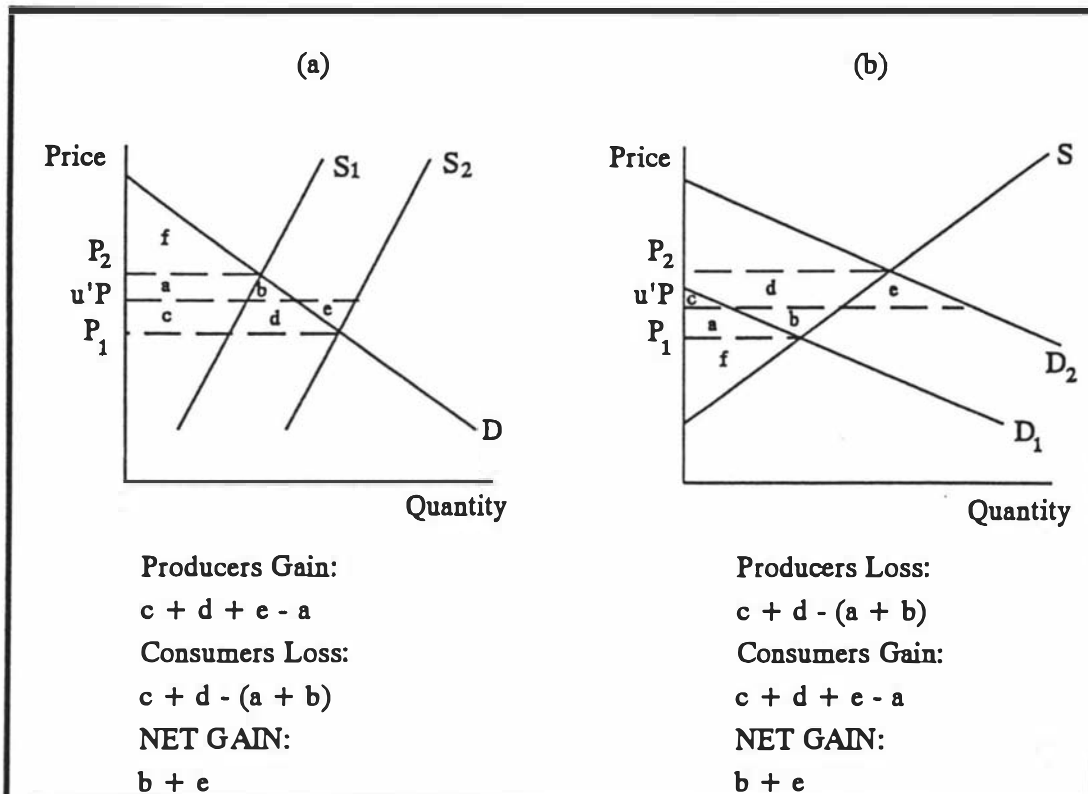
[21] Any storage costs will obviously reduce the gains from stabilisation.

[22] Since the compensatory variation of both groups is positive.

(producers) worse off if the source of the instability is shifts in the supply (demand) schedule. However, this is only half the story. If the instability is due to shifts in demand (supply) then consumers (producers) as a whole gain from a buffer-stock scheme that stabilises the price at u'P . And the gain to consumers (producers) is sufficiently large to permit compensation, leaving both parties better off." (Massell, 1969, p. 289).

FIGURE 2.7

Massell's Welfare Evaluation



Of direct importance are Massell's findings that producers are more likely to gain the larger the supply variance relative to the demand variance. Further, the likelihood of a gain is greater the steeper the supply curve relative to the demand curve. In the limiting case of either a vertical supply curve or a zero demand variance, producers, according to Massell, could not lose from price stabilisation.

The magnitude of the gains to producers is thus a reducing function of the supply variance and of the steepness of the supply curve. Although producers as a whole may benefit from price stabilisation, some producers may gain more at the expense of others[23].

The Waugh - Oi - Massell analysis is however, subject to seven key assumptions. According to Turnovsky (1978), the analysis assumes that the demand and supply functions depend upon the actual known market prices. In other words, complete information is available for both producers and consumers upon which decisions are made (even though this information is constantly changing) (Turnovsky, 1978).

Furthermore, the stochastic disturbances are additive, implying that the random disturbances consist of parallel shifts in the functions. Turnovsky (1976, 1974) however, discussed the distribution of welfare gains from a price stabilisation scheme where the random disturbances are multiplicative, as opposed to Massells' additive assumption. While in agreement that stabilisation leads to an overall welfare gain[24], he showed that, unlike the additive case, the gains were not dependent upon the source of price instability, but rather upon the shapes of the deterministic components of the demand and supply curves. This finding was also concluded by Just (1977) and Reutlinger (1976).

Thirdly, the analysis ignores the effect of stabilisation on the variance of producers and consumers incomes. If a stabilisation scheme increases the expected value of producers incomes but increases the variance as well, producers may suffer a welfare decline.

The fourth key point is that it assumes that the mean price level (u'p) is known and can be forecast with certainty, so that price could be stabilised at that level (Massell, 1969).

---

[23] The key point here is that the 'gainers' are able to compensate the 'losers'.

[24] Unless demand or supply is perfectly elastic.

The fifth limitation is that all costs associated with the operation of a buffer-stock scheme have been largely ignored within a formal model. These other costs include interest, administrative and capital costs.

Sixth, all results are based on simple linear relationships. Turnovsky (1978) showed that the conclusions obtained by Massell regarding the welfare gains are subject to relatively minor modifications if one assumes nonlinear demand and supply functions - as long as the stochastic disturbances are still additive.

Finally, all results are undertaken on a partial equilibrium basis. Thus repercussions in other commodity markets are ignored.

Massell's results using Equations (2.2) - (2.5) have been confirmed by other studies (Stein & Smith, 1977; Sarris & Taylor, 1976; Hueth & Schmitz, 1972). Subotnik and Houck (1976) however, suggest that producers neither gain nor lose from demand stabilisation since short-run supply (Equation 2.3) is completely inelastic.

Simmons (1988; 1987) working from an Australian context, demonstrated in a theoretical discussion that in comparison to buffer-fund schemes, a buffer-stock stabilisation scheme was superior for producers[25], while consumers may be better or worse off depending on the sources of price instability.

Turnovsky (1974) reported that any gains from price stabilisation depended on the way price expectations were developed. If price expectations are developed according to the rational expectations hypothesis[26], then Oi's proposition would continue to hold:

> *"...provided the demand fluctuations are either positively or negatively autocorrelated. If they are independently distributed, producer welfare*

---

[25] This assertion however, becomes ambiguous if producers are made to bear the costs of any trading losses.

[26] Rational expectations (Muth, 1961) assume forecasters use all available information efficiently.

will be unaffected by the introduction of price stabilisation" (Turnovsky, 1974, p. 715).

However, under an adaptive expectations hypothesis[27], Oi's proposition would not hold true. Both Massell's and Waugh's propositions however, would hold under either form of expectations hypothesis.

Similar conclusions about small gains under a rational expectations scheme were reported by Scandizzo *et al* (1983) and Fisher (1983). Gains under price stabilisation for other forms of expectations behaviour were however, found to be quite substantial.

2.10 THE DEVELOPMENT OF A MODEL TO VALIDATE THE IMPACTS OF A BUFFER-STOCK SCHEME

Attempts at the development of a model to validate the impacts of a buffer-stock scheme have essentially gone down two separate paths. One path of research has utilised applied welfare economics to develop estimates of either producer or consumer welfare redistributions (Quiggin & Fisher, 1989; Hincey & Fisher, 1988; Fraser, 1993, 1991, 1989; Wright & Williams, 1984; Scandizzo, Hazell & Anderson, 1983; Wright, 1979; Helmberger & Weaver, 1977; Turnovsky, 1976; Turnovsky, 1974; Wegge *et al*, 1971). Much of the work in this area has been based upon the utility framework developed by Newbury and Stiglitz (1981). However, even they admit in this approach the need for excessively restrictive assumptions to be made in order to isolate the distributional impacts of price stabilisation with a buffer- stock scheme. The result, as Anderson *et al* (1977) suggests, is that the results are

[27] Adaptive expectations suggests that changes in Y are related to changes in the 'expected' level of the explanatory variable X. X is however, a weighted average of the present level of X and the previous 'expected' level of X. The expected levels of X are adjusted period by period by taking into account present levels of X (Pindyck & Rubinfeld, 1981). According to Turnovsky (1974), while the adaptive expectations model is the most widely used of the autoregressive forecasting procedures, it is restrictive and inefficient in that the forecasting procedure does not allow for the full use of all available information (*i.e different weights are used*).

"*...increasingly indeterminate...*" (p. 909) although the literature does "*...tend to show that producers as a group are, on average, the main beneficiaries of price stabilisation*" (p. 909).

The other path of research has adopted a much narrower view looking at the financial implications of a buffer-stock scheme (Lewis, 1991a, 1991b, 1972; Richardson, 1982; Haszler & Curran, 1982; Campbell, Gardiner & Haszler, 1980; Duloy, 1965; Gruen, 1964; Powell & Campbell, 1962; Gislason, 1959). Much of this second path of work has been based on the model developed by Powell and Campbell (1962). It was this work which represented a major turning point in the intervention *vs.* non-intervention debate since it was expressly developed in response to the Australian Federal Government's investigation of various marketing schemes for wool (Watson (1980). The Philp Committee were particularly concerned about the apparent 'hidden gains and losses' attributable to the operation of a buffer-stock scheme over and above any speculative profits and losses. These 'hidden gains and losses are discussed in Section 2.12. However, before doing so it is useful to first consider the dynamics of a buffer-stock operation.

2.11 BUFFER-STOCK SCHEME DYNAMICS[28]

The dynamics of a buffer-stock operation are dependent on the assumption of a supply variance or a demand variance. Figure 2.8 illustrates the case as envisaged by Gruen (1964), namely that associated with a variable demand. The underlying assumption made is for the stocks purchased in the first period to be sold completely in the next period. The line D_1D_1 represents the demand curve in the buying period, and D_2D_2 the demand curve in the selling period. Given a constant supply of the commodity (*QE*), then P_1 and P_2 will be the prevailing prices in the absence of a buffer-stock scheme. Under a free market, the quantity OQ of wool is sold in the

[28] This graphical analysis is drawn from the work of Gruen (1964).

FIGURE 2.8

Buffer-Stock Dynamics - Variable Demand

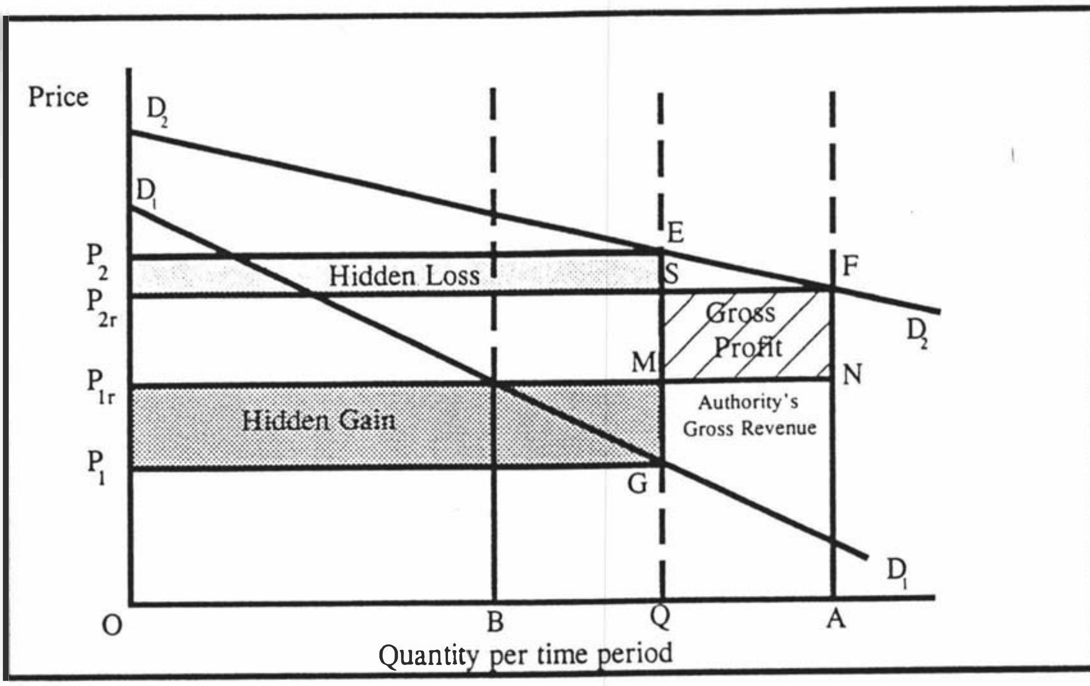
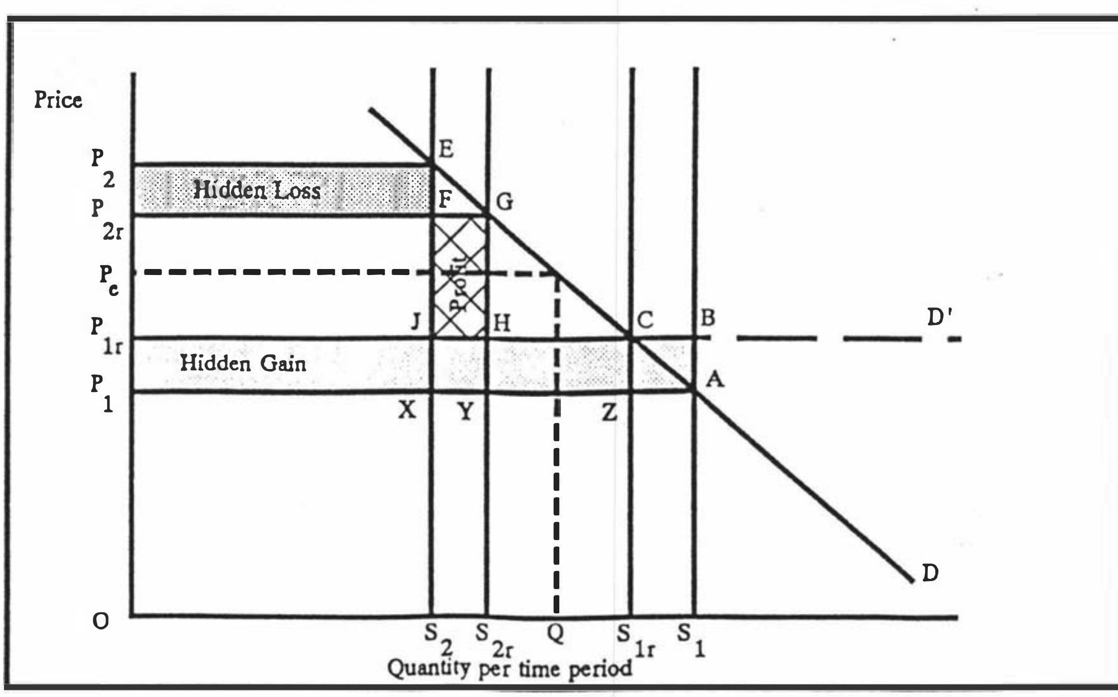


FIGURE 2.9

Buffer-Stock Dynamics - Variable Supply



first period at an average price of P_1. The gross returns to woolgrowers is given by the area OP_1GQ.

Under the operation of a buffer-stock scheme, price in the first period will be raised to P_{1r} with the Authority purchasing BQ units of wool. Gross returns to growers in this period is given by the rectangle $OP_{1r}MQ$. Following the improvement in the market in the second period (reflected in the shift of the demand curve from D_1D_1 to D_2D_2) the Authority sells the stocks back to the market ($AQ = QB$) additional to the normal supply (OQ). While price is reduced from P_2 to P_{2r}, price variability over the two periods has been reduced from P_1 to P_2 to a smaller range P_{1r} to P_{2r}.

These transactions result in the Authority making what is essentially a speculative profit given by the area *SFNM*. This profit is visible in the sense that it appears in the annual accounts of the Authority. Storage costs, administrative expenses and any interest charges on capital are met from this profit.

Price variability may however, also be due to changes in supply something which according to Lewis (1991b) was not considered by earlier analysts. Figure 2.9 illustrates the main features associated with the operation of a buffer-stock scheme with a variable supply. *DD* is the demand curve for the product while supply is fixed in the short run at Q. The equilibrium price, in the absence of any intervention in the market is P_e with a quantity of Q per time period traded.

Agricultural supply relationships typically show that changes in product prices are responsible for only a small proportion in total variation in output (Tomek & Robinson, 1981). Rather, short-run supply shifters such as pests and weather lead to unplanned variations in output. It is possible to assume that this erratic nature of supply takes the form of a random occurrence of 'good' (supply = S_1) and 'bad' (supply = S_2) years. In terms of Figure 2.9, it is possible to see the typical primary product market problem of an inelastic demand translating variations in the quantity supplied (between S_2 and S_1) into proportionately larger variations in price (between P_2 and P_1) (Ritson, 1977).

Assume that the first period is what may be termed a 'good' year *i.e.* $Q = S_1$.[29] The introduction of an Authority to purchase produce to stabilise prices entails the establishment of what is in essence, a 'floor price' designated by P_{1r}. A perfectly elastic demand curve at P_{1r} is therefore, created so that the demand curve facing producers becomes the sum of the normal demand curve (*EC*) and the Authority's demand curve *(CD')* (Grant and Shaw, 1980). In a 'good' year a quantity $S_{1r}S_1$ is purchased by the Authority, while a quantity $S_{2r}S_2$ is released back onto the market during a 'bad' year. In terms of revenues, in 'good' years the Authority pays out $S_{1r}CBS_1$ in commodity purchases and receives S_2FGS_{2r} in commodity sales in 'bad' years. A gross profit of *JFGH* is made.

It was assumed, as discussed previously, that any stocks purchased in the first period would be sold in the following period, so that no carry-over of stocks was involved.

2.12 HIDDEN GAINS AND LOSSES

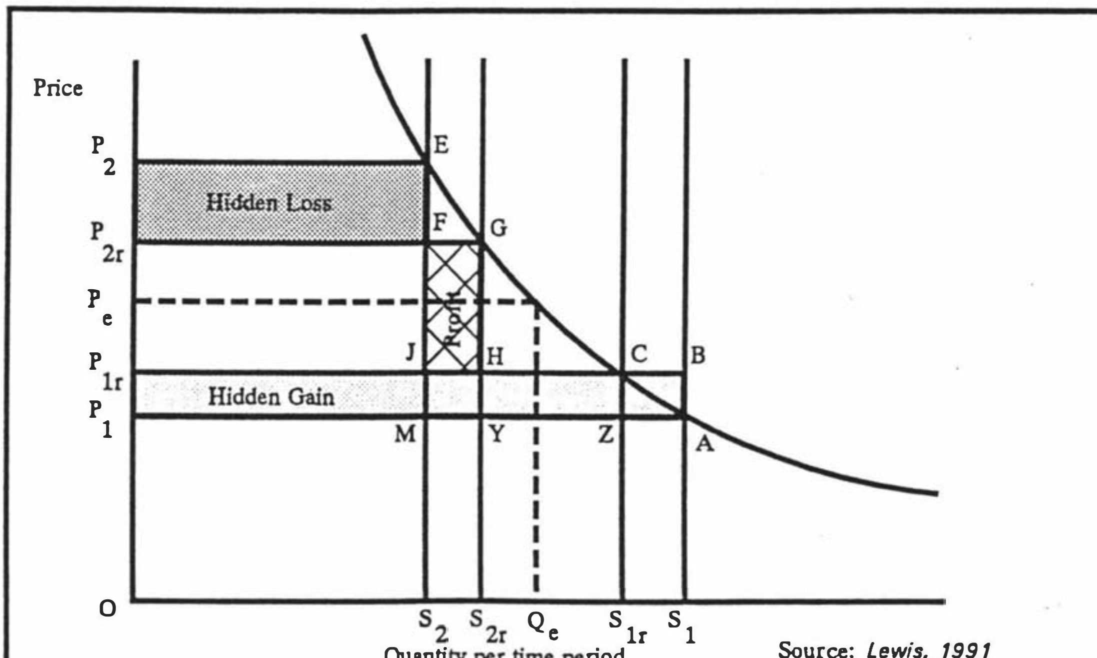
Irrespective of the source of variability, the actions of an Authority in operating a buffer-stock scheme result in the existence of non-speculative profits and losses. These profits and losses were termed 'hidden gains and hidden losses' by Powell and Campbell (1962) and are hidden in the sense that they do not appear in the Authority's accounts, nor are they apparent once the buffer-stock scheme is operating. It is possible to see the extent of these non-speculative profits under an assumption of a variable demand (Figure 2.8). In the first period for example, the purchasing actions of the Authority means that producer receipts are increased to the extent of $P_1P_{1r}MG$ (*i.e.* the hidden gain). In the following period the producer receipts are reduced by an amount equal to $P_{2r}P_2ES$ (*i.e.* the hidden loss), as the Authority disposes of the stockpile. Both of these gains and losses are independent of the speculative gains made by the Authority.

[29] It is possible to see an inverse relationship here between production and farm income. A 'good' year in terms of output (without any intervention in the market) is often translated into a 'bad' year in terms of farm income (as prices are reduced) and *vice versa*.

In Figure 2.9, under the assumption of a variable supply with a linear demand curve, it can be seen that the hidden gain will be equivalent to $P_{1r}BAP_1$, while the hidden loss will be equivalent to P_2EFP_{2r}. For the sake of simplicity, the analysis has used a straight line demand curve. As such it can be seen that the hidden gains will always outweigh any hidden losses, leaving a net positive effect of intervention. Figure 2.10 illustrates a more likely case of a curvilinear demand curve. The extent of the hidden gain in this situation is given by $P_1P_{1r}BA$ while the hidden loss is equivalent to $P_{2r}P_2EF$.

FIGURE 2.10

The Existence of Hidden Gains & Losses when Supply Changes with a Curvilinear Demand Curve.



Source: *Lewis, 1991*

In all three models discussed the emphasis, like most of the literature, has been on the impacts of the producer. However, using Figure 2.9, it is also possible to take the same framework and isolate the impacts upon consumers[30]. In year 1 when the buffer-stock authority purchases stocks, the consumer must pay a higher price than

[30] This analysis is derived from Sarris & Taylor, 1978.

under a 'free' market. The loss consumers' thus face is given by the area P_1ACP_{1r}. When the supply is low, and the stocks are placed onto the market (*i.e.* period 2), consumers' gain to the extent of $P_{2r}FEP_2$ from the reduction in price that they would be consuming at. In addition, they purchase the additional stocks placed onto the market gaining an additional EFG in benefits. The total benefits to consumers' is given by P_2EGP_{2r}. It can be seen then that the area of consumer loss (*i.e.* P_1ACP_{1r}) is greater than the consumer gain (*i.e.* P_2EGP_{2r}) and consumers' would lose out. However, if we were to assume that the welfare of consumers' and producers' is weighted equally, then the societal gain would be equivalent to the gains of the two groups *i.e.* MYGE - ZAC which is positive.

Under a curvilinear demand curve, the same analysis can be pursued. Using Figure 2.10 consumers' gain $P_{2r}GEP_2$ when the authority sells at the lower price in year 2. The consumer loss in year 1 is equivalent to P_1ACP_{1r}. The net surplus is given by:

$$P_{2r}GEP_2 - P_1ACP_{1r} = EFG + P_{2r}FEP_2 - MACJ \qquad (2.6)$$

The net gain to producers is given by:

$$P_1ABP_{1r} - P_{2r}FEP_2 \qquad (2.7)$$

According to Sarris and Taylor, it is not clear if the value of Equation 2.6 is positive or negative. It is possible to make some statement about the extent of gains through the following expression:

$$AB \quad \frac{P_1}{|\varepsilon_1|} - \frac{P_2}{|\varepsilon_2|} \qquad (2.8)$$

where:

AB is the average size of the stocks
ε_1 = the price elasticity of demand at A
ε_2 = the price elasticity of demand at E

"Producers will lose from stabilisation (and since total gains are positive, consumers will benefit) if:

$$\frac{P_1}{P_2} < \frac{|\varepsilon_1|}{|\varepsilon_2|} \tag{2.9}$$

Notice also that since $P_1 < P_2$, *it is not necessary for* $|\varepsilon_2| < |\varepsilon_1|$ *in order for producers to lose from stabilisation. In fact, an isoelastic curve will be sufficient to make producers lose from stabilisation (and correspondingly, consumers to gain) Even if* $|\varepsilon_1| < |\varepsilon_2|$, *it is quite possible for both producers and consumers to gain from stockpiling, since total gains are positive*" (Sarris & Taylor, 1978, p. 152).

2.13 THE TRANSACTIONS RELATIONSHIPS

A simplified two-year model was developed by Powell and Campbell (1964, 1962) with the supply of Australian wool taken as completely inelastic in the short-run (as Turnovsky (1974) later assumed), and the price elasticity of demand estimates allowed to vary over a wide range[31].

The net returns from the scheme were defined as total revenue accruing to woolgrower's under the scheme, minus the total returns which would have been secured in the absence of the scheme, plus (or minus) the trading profits (or losses) made by the Authority.

The transactions relationships as illustrated in Section's 2.11 and 2.12 can be summarised in the following tables:[32]

---

[31] These estimates, which were drawn from Horner (1952a) ranged from -0.9 to -3.0.

[32] Appendix C provides a fuller discussion of the relationships outlined in these tables.

TABLE 2.1

Aggregate Revenue of Woolgrowers

Year	Production	Revenue in the absence of the Scheme	Revenue under the Scheme	
			Commercial Sales	Purchases by the Wool Authority
0	q_0	$R_0 = p_0 q_0$	$R'_0 = \pi_0(1-r_0)q_0$	$K_0 = \pi_0 r_0 q_0$
1	q_1	$R_1 = p_1 q_1$	$R'_1 = \pi_1 q_1$	*Nil*
Total	$q_0 + q_1$	$R_0 + R_1$	$R_{0'} + R_1' + K_0$	

TABLE 2.2

Transactions of the Wool Authority

Year	Expenditure	Sales
0	K_0	Nil
1	Nil	$D1 = \pi_1 r_0 q_0$

Source: Powell & Campbell (1962) p. 374-75.

where:

R_i	= revenue in period i
q_i	= outputs of Australian wool in period i
p_i	= prices in the absence of the scheme
π	= corresponding p under the scheme
r_0	= proportion of Australian wool bought in year 1 by the Authority
K_0	= cost of wool purchased by Authority
D_1	= returns on wool stock sold the following year.

The Authority's trading profit on transactions (T_0) over the two years is given by:

$$T_0 = D_1 - K_0 - 2F - V_0 - m_o \qquad (2.10)$$

where:

F	= Annual fixed administrative costs
V_0	= Variable cost of handling, storing, and selling wool
m_o	= Interest on working capital (K_o).

Net returns (N_o) from the operation of the scheme will be given by:

$$N_o = (R_o' + R_1' + K_0) - (R_o + R_1) + T_0 \tag{2.11}$$

Thus if:

$$L_o = (R_1 - R_1') \tag{2.12}$$
$$H_o = (R_o - R_o') \tag{2.13}$$

and rearranging terms, we get:

$$N_o = D_1 - L_o - H_o - 2F - V_o - m_o \tag{2.14}$$

If the elasticity of demand in the buying period lies between 0 and -1, H_o assumes a negative sign, being a gain instead of a loss.

The results developed in Tables 2.3 and 2.4 were developed on the basis of the following four assumptions[33]:

(a) The existence of a Wool Authority does not affect the demand schedule for Australian wool;

(b) The Wool Authority sells its stocks at an average price approximately 7 pence per *lb.* higher than it buys them, this margin just being sufficient to enable the Wool Authority to meet all its trading expenses including a 6 per cent return on working capital;

(c) The short-run supply schedule for Australian wool is perfectly inelastic;

[33] These assumptions could be regarded as being unrealistically restrictive. Indeed, Powell and Campbell recognised this and allowed for the model to be multi-period. These modifications to this model are discussed in more detail in Appendix C.

TABLE 2.3

Hidden Gains and Losses resulting from the Floor Price Scheme
(expressed in millions of Australian £)
Two-Year Transactions Cycle: 5% of the clip acquired

E_pd during selling period	Elasticity of Demand during the Purchase Period							
	-0.5	*-0.7*	*-0.9*	*-1.0*	*-1.1*	*-1.5*	*-3.0*	*-10.0*
-0.5	-6.2	-14.8	-19.7	-21.4	-22.8	-26.7	-32.0	-35.8
-0.7	4.9	-3.7	-8.6	-10.3	-11.8	-15.6	-20.9	-24.7
-0.9	10.9	2.3	-2.6	-4.3	-5.7	-9.6	-14.9	-18.7
-1.0	13.0	4.4	-0.5	-2.2	-3.6	-7.5	-12.8	-16.6
-1.1	14.7	6.1	1.2	-0.5	-2.0	-5.8	-11.1	-14.9
-1.5	19.2	10.6	5.7	4.0	2.5	-1.3	-6.6	-10.4
-3.0	25.3	16.7	11.8	10.1	8.6	4.8	-0.6	-4.4
-10.0	29.5	20.9	16.0	14.3	12.8	9.0	3.7	-0.1

TABLE 2.4

Hidden Gains and Losses resulting from the Floor Price Scheme
(expressed in millions of Australian £)
Two-Year Transactions Cycle: 10% of the clip acquired

E_pd during selling period	Elasticity of Demand during the Purchase Period							
	-0.5	*-0.7*	*-0.9*	*-1.0*	*-1.1*	*-1.5*	*-3.0*	*-10.0*
-0.5	-15.4	-31.5	-40.9	-44.3	-47.1	-54.6	-65.3	-73.0
-0.7	7.9	-8.2	-17.6	-21.0	-23.7	-31.3	-42.0	-49.7
-0.9	20.3	4.2	-5.2	-8.5	-11.3	-18.9	-29.5	-37.3
-1.0	24.6	8.5	-0.9	-4.3	-7.1	-14.6	-25.3	-33.0
-1.1	28.1	11.9	2.5	-0.8	-3.6	-11.2	-21.8	-29.6
-1.5	37.1	21.0	11.6	8.2	5.5	-2.1	-12.8	-20.5
-3.0	49.2	33.1	23.7	20.4	17.6	10.0	-0.7	-8.4
-10.0	57.5	41.4	32.0	28.6	25.8	18.3	7.6	-0.1

(d) The Authority purchases wool in one wool-selling season and completely disposes of it in the next (Powell & Campbell, 1962, p. 378).

The results from Powell and Campbell (1962) showed that buying on a market characterised by an inelastic demand and selling on one with elastic demand will generally lead to gains. Further, the greater the difference between the elasticities at the time of buying (*t*) and the time of selling (*t+1*), the greater will be the gain or loss (see Tables 2.3 and 2.4).

The authors suggested:

> *"...the mere process of acquiring and selling buffer-stocks alters the Australian share of the market. Accordingly, the elasticity of demand for Australian wool (assuming a constant world elasticity) tends to be higher in years of stock-piling and lower in years of selling. This would be a force tending to lower overall returns from buffer-stock operations"* (Powell & Campbell, 1962, p. 382).

The conclusion was that:

> *"...the Authority's operations will be more or less a matter of chance ...[to the extent that]...the scheme becomes a lottery, with say 10 percent of the Australian wool cheque, or about 5 percent of Australia's export income, as stakes"*
> (Powell & Campbell, 1962, p. 382).

Not surprisingly the Committee rejected the proposition of a Wool Authority on the basis of this and other evidence[34] presented. There was a consensus by Powell and Campbell and others that while the outcome of the minimum reserve price scheme

[34] Powell & Campbell (1964) report that the Philp Committee also commissioned an unpublished parallel study by the Bureau of Agricultural Economics. The Bureau's conclusions were similar to that reported by Powell & Campbell (1962).

was uncertain, there was "... *a subjectively higher probability that hidden losses would be incurred rather than hidden gains*" (Powell & Campbell, 1964, p. 597).

However, the conclusions reached by Powell and Campbell (1962) were immediately challenged principally on the basis that the 'hidden gains' were likely to be underestimated (Lewis, 1972; Parish, 1964; Gruen, 1964).

Gruen (1964) rejected Powell and Campbell's line of argument suggesting that their work did not offer:

> "*...a very logical argument against a reserve price scheme because no action (i.e. non-adoption of a Reserve Price Scheme) will also produce an uncertain outcome. Thus we can reverse the tables by substituting pluses for minuses and minuses for pluses. The table then gives us the hidden losses and gains which result from not adopting a floor-price scheme.*" (1964, p. 184).

Other criteria in favour or against a scheme including the extent of capital outlay required, and the assurance of a minimum return during periods of poor demand and low prices were seen as more appropriate measures.

Gruen also raised two further revenue implications not considered in the Powell and Campbell model. First, he suggested that Reserve Authorities do not attempt to obtain their stocks at the lowest price possible. Second, the existence of a floor price (established after the Authority has put in it's bid) may make buyers willing to bid somewhat more for lots when they are secure in the knowledge that rivals will have to pay similar prices.

Further, Gruen suggests that the prevalence of hidden losses rather than gains in the Powell and Campbell calculations was due entirely to the use of elasticities as a measure of demand reactions rather than the slopes. He suggests that by using slopes of the demand curves (*i.e.* ordinary derivatives instead of logarithmic derivatives) the asymmetry of the hidden gains and losses disappears and all entries on the diagonal of Tables 2.3 and 2.4 become zero.

> *"This point can be shown easily by reference to Figure [2.8]. If the slopes of the two demand curves D_1D_1 and D_2D_2 are the same over the relevant range, the price raising effect of buying x million lbs. of wool will be numerically equal to the price depressing effect of selling the same quantity of wool. In other words [P_1,P_1GM] in Figure [2.8] will equal [P_2,P_2ES]. The reason why different results are obtained with elasticities is, of course, that an identical slope at points E and G on the two demand curves in Figure [2.8] implies a (numerically) higher elasticity at point E compared with point G.*
>
> *If:* $$\frac{dx}{dp_1} = \frac{dx}{dp_2}$$
>
> *then* $$\frac{dx}{dp_1} \cdot \frac{p_1}{x} < \frac{dx}{dp_2} \cdot \frac{p_2}{x} \qquad \text{if } p_2 > p_1$$
>
> (Gruen, 1964, p. 185)

Parish (1964), while in agreement with the decision of the Philp Committee, disputed the role of the hidden losses and hidden gains in Powell and Campbell's argument. Like Gruen (1964), Parish showed that simply reversing the signs of the entries in Tables 2.3 and 2.4 would:

> *"...serve equally well to show the hidden losses and gains of woolgrower's of not operating a reserve price scheme (or, of abandoning a reserve-price scheme that was already in operation)."*
> (Parish, 1964, p. 466).

However, as long as the wool Authority could cover its storage costs, then the operation of such a reserve-price scheme would tend to stabilise prices and revenue.

Lewis also challenged the Powell and Campbell results suggesting that the treatment of interest on capital was not consistent since:

> "*...if it was proper to charge interest on capital tied up in the scheme to the cost of operation, it was also proper to credit interest to those who receive payment earlier then they would have without the scheme*" (Lewis, 1972, p. 72).

Thus at elasticities more than -3.0 the Powell and Campbell model was seen to confer an erroneous disadvantage on the proposed scheme, a fact particularly relevant given that previous estimates of export elasticity demand for wool lay between -1.59 and -2.15.

2.14 THE ESTIMATION OF BUFFER-STOCK SCHEME COSTS

While it would be fair to say that the issues sparked by Powell and Campbell (1962) were not adequately resolved in terms of establishing conclusive evidence at least, the work nevertheless served to define some of the key issues towards establishing some of the costs associated the buffer-stock schemes. Prominent amongst these considerations was that the trading profits or losses of the buffer-stock authority were too narrow a criterion to measure the success or otherwise of a buffer-stock scheme. Other factors, such as the hidden losses and gains raised by Gruen (1964) and others, and the sectoral consequences, as the welfare analysts suggested, needed to be included.

Tisdell (1973, 1972) building upon the earlier work of Oi (1961) and Massell (1969) made a start to this challenge by asserting that the annual average surplus of both Australian wool growers and manufacturers of wool would fall as a result of price stabilisation. He argued that under stabilisation, the supplies of wool from the growers would be less variable, the prices they receive would be less variable, and hence, the surplus received by growers would be less variable. However, the stabilisation scheme would consequently lead to a reduction in the annual average surplus (net income) of manufacturers and processors. This situation arises out of the variability of the supplies of wool, which according to Tisdell, increases average processing costs, while leaving the revenues constant.

While this result may have looked appealing, Chapman and Foley (1973) successfully refuted Tisdell's assertion clearly demonstrating an opposite result; average total expenditure on wool purchases of that industry under an unstable price regime would be *higher* than under a stable one!

Campbell, Gardiner and Haszler (1980) attempted to address the central limitation of all the empirical analysis up to this point, namely the reliance on constant elasticities between periods (Ward, 1978) or the use of assumed elasticities. They attempted to overcome these constraints by analyzing demand for wool in eight OECD wool-consuming countries over the period 1974/75 to 1977/78 and developing elasticity estimates to calculate *ex ante* market prices with no price stabilisation in Australia. The results showed that while price variability had been reduced (up to 44 per cent), price stability had also lowered revenue from Australian wool sales by 2 per cent ($139 million). However, once again the results proved to be inconclusive with a consequent recognition by the authors and others that they had over-stated the conclusiveness of the results and misinterpreted Gruen's interpretation of the hidden components (Richardson, 1982; Haszler & Curran, 1982).

Philpott (1975) attempted to quantify the effects of the New Zealand Wool Commission's intervention into the New Zealand wool market when a large portion of the 1966-67 wool clip was purchased and then resold over the period 1969-73. The trading account of the Commission over the period showed a net loss of $2.1m. Philpott however, estimated a gross gain due to intervention of some $18.7m, with a net gain of the order of $10.6m. Unfortunately, some reservations were still expressed about the magnitude of the elasticities used.

More recently, the New Zealand Wool Board, through unknown means, has estimated that the cost of intervention through guaranteed prices and wool purchases totalled some $268 million (New Zealand Wool Board Annual Report, 1991-92). The cost of storage alone amounted to some $11 million (Rural News, 1993).

2.15 THE NEW ZEALAND WOOL BOARD'S MARKET SUPPORT AND MINIMUM PRICE SCHEMES

The discussion so far has concentrated on buffer-stock schemes in general. Before concluding the main issues of the chapter, it is worth outlining the specific characteristics of the New Zealand Wool Board's buffer-stock scheme. In order to achieve its objectives, the New Zealand Wool Board[35] had available two forms of market intervention; a minimum price scheme and a market support scheme. The Minimum Price Scheme was first established in 1952 under the auspices of the then New Zealand Wool Commission. Up until 1988 the Wool Board had a statutory requirement to operate a minimum price scheme. However, following the removal of concessionary financing and loan guarantees, this statutory requirement was removed.

The New Zealand Wool Board's Minimum Price Scheme and Market Support at Auction Scheme were operated interactively as a two-tier system. A description of the workings of the system in this two tier approach is given by the following excerpt from the Board:

> *"The market support system has been the more commonly used scheme in recent years. In most seasons it operates at prices higher than the minimum price scheme, and is designed to smooth out short term abberations in the market from auction to auction.*
>
> *With this scheme, the Board establishes what it considers to be*

[35] The role and objectives of the New Zealand Wool Board are covered in more detail in Chapter 5, Section 5.3.7.

reasonable short-term price levels, taking the market and currency conditions into account. If trade buyers fail to bid as high as the Board's reserve for a particular lot of wool on the auction day, the Board will buy that wool and stockpile it for later sale."

"The minimum price is the second tier of security for growers, with levels set at the beginning of the season....If actual market prices drop to less than the minimum price, the Board will supplement grower payouts to the minimum level.

Supplementation applies whether wool is sold through auction or privately."
(New Zealand Wool Board, 1990)

It is obvious then that the degree of intervention by the Board was a function of the level of minimum price set. The establishment of what was essentially a floor price required some forecast to be made about market conditions which were likely to prevail not only over the forthcoming season, but also for a number of periods ahead as well. Furthermore, this price level must have some underlying philosophy or objective attached to it (see Section 2.2). In the case of the New Zealand Wool Board, there has been a great deal of public debate about why particular price levels were set and how these price levels were arrived at for the periods immediately preceding the events of February, 1991. According to one industry report, the Board, post-1988, changed its objectives from one of removing short-term fluctuations to one of attempting to influence longer-term fluctuations[36]. In particular, the Board attempted to maintain prices through competitive bidding in a declining market. Figures 2.1 and 2.2 clearly illustrated the situation during this time. In the 1989-90 season, as the Market Indicator was falling, the Board bid on two-thirds of the offerings and purchased just under half of all wool sold at auction. At

[36] An extensive account of the background to this situation is given in pages 197-205 of the ACIL Report (1992).

the start of the 1990-91 season the Board did lower its minimum price by 7.5% to 485 cents as well as reducing its market support activity. However, as history subsequently revealed, this downward move was still not sufficient. Faced with the reality of declining reserves and the collapse of the Australian market, the Board suspended its market activities indefinitely in February, 1991.

2.16 SUMMARY

Before summarising some of the key issues to come out of this chapter, it is worth outlining the four generalised assumptions apparent in the literature. First, the models developed operate within a partial equilibrium framework. They therefore, ignore the repercussions of any impacts upon other markets within the economy. Secondly, the buffer-stock schemes are assumed to be self-funding with the excess of the revenue from the sale of the commodity over expenditure on purchases covering the cost of storage (F.A.O., 1960). In terms of Figure 2.8 (*i.e.* variable demand) this excess is given by *SFNM* while in Figures 2.9 and 2.10 (*i.e.* variable supply) the excess is given by *JFGH*. The third assumption made suggests that the stabilizing Authority chooses the fixed price at which they will buy and sell such that, at that price the long-run size of the buffer-stock will remain constant (*i.e.* no accumulation or decumulation of stocks). This implies that the random fluctuations in supply and demand are expected to even out. If the underlying demand and supply curves are linear, then the price is stabilised at its arithmetic mean (Turnovsky, 1978). Finally, the assessment of the impacts of price stabilisation may be undertaken within a pareto efficiency framework using the concept of expected producers' surplus and expected consumers' surplus. It is not intended to critique this approach suffice to say that this measure has well-known limitations and has long been the subject of criticism (Mishan, 1972; Little, 1957). It's use in this chapter however, is maintained since it allows for the discussion of broader principles.

As mentioned, the literature in relation to buffer-stocks can be roughly divided into two generations (Simmons (1988)). The first generation, building upon the contributions of Waugh (1944) and Oi (1963, 1961), showed that the operation of stock transfers between periods would lead to a redistribution of welfare between producers and consumers (depending upon the sources of price variation) and that the social gains were generally positive. Most of the results of these studies rested upon the implicit assumption that the operation of the buffer-stocks was largely self-funding and that there were no private markets for stocks (contrary to what Keynes had envisaged).

The second 'generation' of buffer-stock literature is based on missing markets and the recognition of the importance of the role of private stocks in determining the effects of a buffer stock on market stability. Buffer-stocks and speculative stocks are said to operate in very similar ways (*i.e. purchases are made when prices are low and sales made when prices are high*) and thus assumptions in the studies were made about the capacity of the former to displace the latter.

This chapter has briefly addressed issues related to both 'generations'. Unfortunately, while welfare economics provides a useful theoretical framework to address the impacts of intervention, there are deficiencies associated with it in empirical analysis. To overcome this problem, a narrower-based financial model was introduced which considers the revenue implications of a buffer-stock scheme. The model, which identified 'hidden losses and hidden gains' was developed by Powell and Campbell (1962) in their submission to the Philp Committee. The remainder of the chapter reviewed the literature related to attempts at empirically evaluating the implications of buffer-stock schemes. The development of a definitive theory on buffer-stocks however, remains unclear.

What is quite evident is that the debate concerning the welfare implications of a buffer-stock scheme has a long history. The early works by Keynes (1974; 1938), Riefler (1946) and Porter (1950), sparked considerable debate, particularly in terms of the theoretical considerations of the welfare transfers of such price stability schemes. Attempts at subsequent empirical analysis have not been widespread however, due to difficulties in establishing accurate and consistent estimates of demand elasticities between periods and the normative nature of the welfare or rent transfer analysis. Furthermore, any analysis has been restricted to a partial equilibrium framework predominately investigating the propositions of Oi (*i.e.* the effects on producers).

Of major note in recent years has been the absence of debate within the literature, possibly in line with the widespread acceptance of more liberal 'free market' economic policies. This 'oscillation' between support for buffer-stock schemes and their outright rejection essentially boils down to making a value judgement about which marketing functions can be better performed by a public body than by existing private firms. As Watson (1980) aptly describes it, "*It is a controversy in which different conclusions can be drawn according to which evidence the individual economist finds convincing*" (p. 86).

2.17 CONCLUSIONS

An analysis of the literature leads one to conclude that many of the empirical studies in demand estimation, to date, have largely been indeterminate for three main reasons.

Firstly, a lot of the research, particularly that related to the wool industry in Australia, has relied either upon theoretical or assumed elasticities or demand slopes. This was particularly evident in the Powell and Campbell model in which different buffer-stock consequences were apparent according to the different sets of elasticity estimates used for the buying and selling periods (see Tables 2.3 and 2.4, p. 50).

Secondly, many studies have failed to appreciate the full implications of price stabilisation schemes, including those issues associated with equity, efficiency and welfare. For example, price stabilisation policies can shield producers from dramatic short-run falls in demand and prices. However, such failures to act according to the 'rules' of the marketplace can impact quite heavily on both producers and consumers in the longer term. As Newbury and Stiglitz (1981) admit, the incorporation of such general equilibrium impacts is possible only with the inclusion of restrictive assumptions, something which defeats the purpose of such an approach!

Finally, there are issues related to consistency of terminology and functional specification. Turnovsky (1976, 1974) for example, has shown that non-linear supply and demand systems may produce welfare results different from those obtained from linear models.

In terms of research requirements, it is apparent that it is the first limitation, namely that of establishing reliable slope, and hence price elasticity of demand estimates for buying and selling periods, that is crucial to any further empirical demand analysis. This concern has been echoed by other researchers in the past (Thurmann, 1991; Heuth & Just, 1991; Just 1977; Just, Lutz, Schmitz & Turnovsky, 1977; Turnovsky, 1974). However, only when this issue is satisfactorily resolved can progress be made on establishing the extent of issues such as the hidden gains and losses associated with buffer-stocks. In Chapter Three of this study, the theoretical aspects of demand slope and price elasticity estimation will be outlined. Specifically, the issues of econometric estimation in the context of demand analysis will be outlined. The discussion will highlight the potential to consider another approach, more precisely that of a survey-based experimental approach.

Chapter Four will take outline this alternative and investigate the potential of the experimental approach in estimating price elasticities and slopes of demand curves.

CHAPTER THREE:

SLOPE AND ELASTICITY ESTIMATION

CHAPTER THREE:
SLOPE AND ELASTICITY ESTIMATION

3.1 INTRODUCTION

It is apparent from the conclusions drawn throughout Chapter Two that knowledge of the demand slope is crucial for resolution of such economic debate as that which surfaced following the actions of the New Zealand Wool Board. Using the Powell and Campbell (1962) study as an example, it was shown that buying on a market characterised by an inelastic demand and selling on one with an elastic demand generally led to gains. Furthermore, the greater the difference between the elasticities at the time of buying (*t*) and the time of selling (*t+1*), the greater the gain or loss (see Tables 2.3 and 2.4, page 50). It was clear from the tables that the extent of the speculative and non-speculative gains and losses from the operation of a buffer-stock scheme are functions of the prevailing demand slopes and elasticities in the buying and selling periods as well as the quantity bought and sold by the Authority. If the hidden loss exceeds the hidden gain then producers will have lost out through the operation of a buffer-stock scheme and *vice versa*.

The crucial question than, before consideration of such policy issues like the Wool Board's withdrawal can be addressed, is, what are these slopes, and hence the elasticity of the demand curves in the buying and selling periods, likely to be?

This chapter starts by outlining the theory associated with demand analysis and more specifically derived demand analysis. The discussion turns to price elasticities as an appropriate measure of demand analysis, although there are apparent limitations which need to be considered. Three approaches to estimating demand schedules are briefly introduced, namely the survey-based approach, the experimental approach and the econometric approach. It is this final approach, that of regression analysis, which has been the most popular over the past forty years. The chapter briefly reviews a number of key econometric studies highlighting not only their contributions, but more importantly the difficulties associated with this particular approach. The chapter concludes with the recommendation that a survey-based approach be tested as a possible procedure to meet the objectives of this study.

3.2 DERIVED DEMAND

The demand schedule for a commodity or product simply describes an inverse relationship between the price consumers are prepared to pay for a product and the aggregate quantity that they would be willing to consume at that price. Consumer behaviour theory asserts that individual consumers will choose between various offerings in the market place so as to maximise their marginal utility per dollar.

However, in dealing with the demand for wool, this level of analysis is not appropriate. The demand for raw wool by mill processors is determined by, and in effect derived from, the demand by final consumers for wool products, such as carpets and apparel.[1] Marshall defined derived demand as:

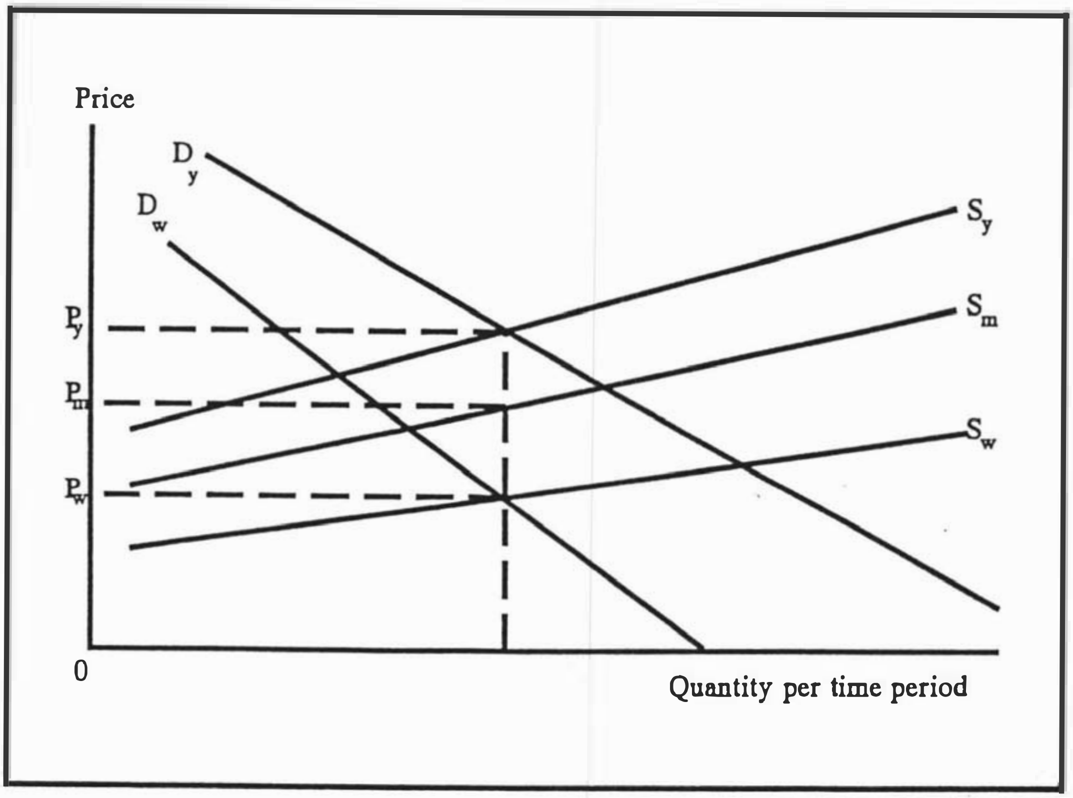
> *" The price that will be offered for anything used in producing a commodity is, for each separate amount of the commodity, limited by the excess of the price at which that amount can find purchasers, over the sum of the prices at which the corresponding supplies of the other things needed for making it will be forthcoming. To use the technical terms, the demand schedule for any factor of production of a commodity can be derived from that for the commodity by subtracting from the demand price of each separate amount of the commodity the sum of the separate prices for corresponding amounts of other factors."*
> (Marshall, 1961, p. 383).

[1] This theory was first developed by Marshall, 1961.

It is possible to establish this relationship with reference to Figure 3.1[2]. For simplicity it is assumed that the production of final wool products for retail sale requires two factor inputs - raw wool and a composite set of 'other factors' - which are combined in constant proportions. Figure 3.1 illustrates a set of supply curves for final wool products and the two prescribed factors of production as well as the demand curve for wool products.

FIGURE 3.1

The Derived Demand for Raw Wool



The three supply curves show the minimum prices at which given quantities of the final product and the two factors of production will be forthcoming. With the assumption of constant proportions, the supply curve for wool products (S_y) will necessarily equal the vertical sum of the supply curve for wool (S_w) and 'other factors' (S_m).

[2] Much of this section is based on the work of Emmery, 1967.

The demand curve, D_y, shows the maximum prices which consumers are willing to pay for given quantities of wool products. The intersection of S_y and D_y gives the equilibrium price and quantity of wool products, and also the equilibrium quantities of the two factors of production; prices of the latter are determined simultaneously.

To derive the demand curve for raw wool (D_w) it is possible to see that the maximum price which purchasers would be willing to pay for the given quantity of raw wool is equal to the maximum price which consumers would be willing to pay for the corresponding quantity of wool products, less the minimum price at which owners of labour and other factor inputs would be willing to supply the corresponding quantity of 'other factors'. In other words, D_w is equal to the demand curve for wool products (D_y) less the supply curve of 'other factors' (S_m), the difference being measured vertically (Emmery, 1967, p. 5-6).

It is possible to conclude in this model that any shifts in the retail demand curve for wool products and/or shifts in the supply curve for 'other factors' will impact upon the demand curve for raw wool[3].

To generalise the model shown in Figure 3.1, it is necessary to first make allowances for the fact that shifts in the derived demand of manufacturers may be a response to shifts in the demand curves for stocks of semi-processed and final wool products held by textile manufacturers, brokers, wholesalers and retailers. In other words, some of the derived demand may be, in fact, only an adjustment in the 'pipeline' stocks.

The second adjustment required is the removal of the assumption of constant input proportions. This, in effect, introduces the more realistic situation of synthetic fibre competition in the textile or apparel production function. However, the extent of synthetics as a direct competitive threat is uncertain and will be raised again as an

---

[3] Emmery (1967) provides further discussion on the relaxation of the model's assumptions to incorporate varying input proportions and to allow for the presence of stocks in semi-processed and final wool products at the production and distribution levels (p. 6-8).

issue at a later stage in this chapter (Section 3.4).

A generalised model for the demand for raw wool in line with the model illustrated in Figure 2.4 (page 23) will therefore, take the following form:

SUPPLY

$$S_y = g\ (P_w, Z_s, P_y) \tag{3.1}$$

DEMAND

$$D_y = h\ (P_y, Z_d) \tag{3.2}$$

CONSUMPTION

$$C = f\ (P_w, Z_d, Z_s) \tag{3.3}$$

STOCKS

$$D_s = k\ (P_w, P_w^*) \tag{3.4}$$

where:

P_y = the price of wool product outputs;

P_w = the price of raw wool inputs;

P_w*= expected price of wool inputs;

Z_d = those factors responsible for shifts in the demand curve for wool product outputs;

Z_s = those factors responsible for shifts in supply of 'other factors' inputs.

Equilibrium in the product market, *i.e.* $S_y = D_y$, will give:

$$P_y = j\ (P_w, Z_d, Z_s, P_w^*, D_s) \tag{3.5}$$

Equilibrium in the input market, *i.e.* $S_w = D_w$, will give:

$$P_w = m\ (P_y, Z_d, Z_s, P_w^*, D_s)4 \qquad (3.6)$$

3.3 PRICE ELASTICITY OF DEMAND

The demand curve, as outlined above, is simply that:

> "*... part of the demand function that expresses the relation between the price charged and the quantity demanded, holding constant the effects of all other variables*" (Pappas & Hirschey, 1987, p.78).

In terms of 3.5 and 3.6:

$$D_y = j\ (P_y) \qquad (3.5a)$$
$$D_w = m\ (P_w) \qquad (3.6a)$$

where:

D_y = Demand for wool product outputs

D_w = Demand for raw wool inputs

When the price of a commodity, such as wool, goes up in price, it is assumed in its capacity as a normal good that the quantity demanded of that commodity will fall and *vice versa (ceteris paribus)*.

However, the extent of this response of quantity demanded to a price change is not that clear. The different units of measurement used in the demand schedule (*i.e.* dollars for price and kilos or units or bales for quantity) make a direct comparison from the algebraic expression (if this is known) between different commodities difficult. To facilitate direct comparisons, economists use the concept of own-price elasticity of demand which is simply the:

"...ratio which expresses the percentage change in quantity associated with a given percentage in price" (Tomek and Robinson, 1981, p.45).

Mathematically, own price elasticity is given by:

$$E_p d = \frac{dQ/Q}{dP/P} \cdot \frac{P}{Q} \tag{3.7}$$

The own price elasticity of demand coefficient for any commodity can be interpreted as the percentage change in quantity demanded (Q) given a very small change in the price (P) of that commodity, other factors held constant (Mansfield, 1985). Since the demand curve is negatively sloped the own price elasticity of demand coefficient will have a negative sign.

If the demand curve is linear, then dQ/dP, or the slope of the demand curve, will be constant. The ratio P/Q will however, vary along the length of the demand curve. If the demand curve is logarithmic (*i.e.* non-linear), then the elasticity is the same at every point on the curve.

The range of the own price elasticity will be between zero to minus infinity for normal goods. Three classification groups are significant however. If the coefficient is greater than minus one, demand is said to be elastic. In other words, the percentage change in quantity demanded is much greater than the percentage change in price. The limiting case occurs when elasticity is infinity, the demand curve is horizontal and demand is said to be perfectly elastic.

If the own price elasticity is less than minus one, demand is said to be inelastic. The percentage change in quantity demanded is less than the percentage change in price. Quantity demanded is therefore, relatively unresponsive to price changes. The limiting case occurs when elasticity is zero, the demand curve is vertical and demand is said to be perfectly inelastic.

The final classification occurs when the percentage change in quantity demanded is just offset by the percentage change in price. In this case, demand is said to exhibit a unitary elasticity.

While the own price elasticity of demand will tend to vary in magnitude along the demand curve,[4] for the sake of convenience it is often common to speak of the demand for a commodity as being either elastic or inelastic. Such categorisations however, are strictly defined for a *particular range of prices.*

The price elasticity of demand is also defined for a specific source of demand (*i.e.* whether national or global), a specific source of supply (*i.e.* whether national or global) and the stage at which the elasticity is to be measured (*i.e.* at auction, mill or final consumer level).

According to Marshall (1961), there are four principles governing the price elasticity of the derived demand for a factor of production. The demand for an input factor will be more inelastic:

(i) the more essential the factor is to the production of the final commodity;

(ii) the more inelastic the demand for the commodity;

(iii) the smaller the share of the final costs of the commodity contributed by the factor concerned;

(iv) the more inelastic the supply of the other factors of production.[5]

Figure 3.1 can be used to illustrate these points. Given that the demand curve for the factor input of raw wool, D_w, is derived from the vertical difference between the demand curve of the final product, D_y, and the supply curve of other factors, S_m, it

[4] Except in the limiting case of a straight horizontal line ($E_pd = 0$) or a straight vertical line (E_pd is undefined).

[5] Douglas (1975) offers proof of each of these propositions.

can be seen that D_w will have a steeper slope (*i.e.* be more inelastic);

(i) the steeper the slope of D_y, *i.e.* the more inelastic is D_y;[6]

(ii) the smaller the ratio OP_w/OP_y, the smaller is wool's contribution to the final cost of the commodity,[7] and;

(iii) the steeper the slope of S_m, *i.e.* the more inelastic is S_m.[8]

Table 3.1 reports a summary of the likely influences on the elasticity of raw wool.

TABLE 3.1:

Effects of Competition From Substitutes and of Periods of High Prices on the Price Elasticity of Demand for Raw Wool

Influence	Direction of effect of competition and high prices on E_pd as indicated by Marshall's principles				Hypothesised net effect
	1st principle	2nd principle	3rd principle	4th principle	
Increasing degree of fibre competition	increase	increase	neutral	neutral	increase
High prices	neutral	neutral	increase	possible decrease	increase

Source: Emmery, 1967. p. 14

[6] There has been a widespread increase in the availability of substitutes for final wool products, implying that the demand for raw wool is likely to be more price elastic.

[7] Fead (1961) and Howell (1965) report that the proportion of raw wool to the final cost of wool products is in the range of 10% to 13%. Thus, the demand for raw wool will be more elastic in periods of high raw wool prices.

[8] Emmery, 1967 p. 12-13.

3.4 PROBLEMS IN THE USE OF PRICE ELASTICITIES OF DEMAND

It has been shown in Section 3.3 that price elasticities are a useful measure particularly given the different units of measurement in the price and quantity variables. Furthermore, elasticity coefficients provide a useful classification system for economists to measure the degree of substitutability with other products.

However, there are several issues associated with the use of elasticities of demand which should be raised at this stage. The most obvious point is the requirement for '... *a very small change...*' in the price of a commodity, *ceteris paribus*. In most cases the differences between observed prices tends to be quite wide. Even in experimental studies where price is a controlled variable, the price changes between tests are necessarily large to first, induce some respondent reaction and second, to prevent or minimise respondent fatigue. Arc elasticities may provide a solution to this, but they 'suffer' from only being able to provide an elasticity at an average between two points.

Foote (1958) highlights the point that elasticity estimates, except for logarithmic functions, differ at every point on the curve given the ratio of quantity to price as shown in Equation 3.7. Furthermore, the estimates differ:

> "*... depending on the particular values assumed by the other variables in the analysis. This problem frequently is ignored, in a sense, by computing the elasticities when all other variables are at their average values. But, in comparing results from one analysis with those of another, this practice is undesirable because the average values depend on the particular years on which the analysis is based. More reliable comparisons could be obtained from elasticities for a uniform year or period of years. In such computations, use should be made of calculated values for the dependent variable rather than the actual values*" (Foote, 1958, p. 83).

The use of elasticities of demand, as mentioned earlier, provides a classification system on the degree of substitutability. However,:

> *"... moderate changes in relative prices might not cause measurable changes in relative consumption of two commodities. But sharp increases in the price of one or a continued wide price differential might lead to a substantial and possibly cumulative or irreversible shift from this commodity to another"* (Foote, 1958, p. 82).

Based on these points, doubts must be raised about the effectiveness of relying on such price elasticity estimates. Equation 3.6 shows that the elasticity estimates are the product of the first derivative of the price function[9] and the price/quantity ratio. Given the necessary pre-condition by Marshall (1961) of an infinitesimal change in P, it is safe to assume that most of the emphasis on elasticity determination is derived from the slope component or dQ/dP. A more useful point of discussion may therefore, be served by focusing on slope estimates rather than the more traditional emphasis on price elasticities of demand. Indeed, this issue has been raised previously by other researchers (Just, 1977; Just *et al*, 1977; Gruen 1964).

In this study the emphasis will be on the development of relationships between sets of price and quantity pairs (see Section 5.6, Chapter Five). Slope estimates will, in a sense, be the first output of any analysis and, as such, will be the focus of discussion (see Chapters Six and Seven). However, the bulk of the literature, as covered in Chapter Two, has centred on the development of estimates of price elasticity of demand. More importantly the initial work by Powell and Campbell (1962, 1964) was based on such price elasticity of demand estimates. In order to maintain consistency in discussion, price elasticity estimates are also derived with the full knowledge of the inherent deficiencies as raised in this section.

---

[9] The function is $Q_i = f(P_i| P_j$, Population, Income, Taste, ...). All independent variables, with the exception of own price (P_i) are assumed constant.

3.5 THE ROLE OF SUBSTITUTE FIBRES

Marshall's first principle, as discussed in Section 3.3, reflects the debate about the role of substitute factors and more specifically synthetics, in the demand for raw wool. It states quite simply the degree to which substitute inputs will enter the textile production function as a result of absolute and relative changes in the price of raw wool. One line of thought believes that synthetics are likely to have made significant inroads into the market previously occupied by wool (Arthur D. Little, 1992; Mullen *et al*, 1989; Philpott, 1957). Emmery (1967), for example, suggests:

> *"...that whatever status wool used to have as an essential factor in production, it must surely have been lowered, and ceteris paribus, the demand for wool made more price elastic"*(p. 14).

A clear indication of the influence of substitute fibres as direct competition to wool in the production process remains uncertain, although the long-term trends in wool prices have been downward (Arthur D. Little, 1992; Tier & Kidman, 1971). In its broadest sense wool could simply be considered to be one of a number of fibre inputs which could be used within the textile production function. The choice of wool as a pure fibre or as a blend may be seen in this case as one purely of comparative costs.[10] In a more narrow sense however, wool as a natural fibre may be seen as without having any direct substitutability. Both 'green' and fashion conscious consumers may, for example, demand only woollen textiles for their carpets or apparel. Furthermore, synthetics have been:

> *"...unable to adequately duplicate some of the more desirable characteristics of wool such as its resilience and draping properties, its natural resistance to heat and flame, its excellent dyeing*

[10] Grubel (1964) suggests that when the demand for a product is high, firms will be less willing to substitute factor inputs because of technical uncertainties and time lags. This implies therefore, that there is a tendency for a raw material to become more price inelastic when its product price is high making a more essential product. Emmery (1967) rejects this proposition on the basis that the technical difficulties associated with wool - synthetics substitution are not that great.

properties, its resistance to soiling, and its moisture absorption properties." (Hewlett *et al*, 1989, p. 20).

Powell *et al* (1963) asserted that the role of price in the adjustment of the United States textile market to synthetic fibre substitutes for wool had been of minor importance. While they believe the promotional activity of producers of synthetic fibres may have masked the true role of price, they nevertheless disregarded any continuation of market share loss for wool from relative price cuts as unlikely[11].

Polasek and Powell (1964) were unable to make any generalisations about the impact of synthetic fibres in the countries that they surveyed, suggesting that the technological pressures at the time had yet to adjust to a long run equilibria.

Jarret and Dent (1966) reported that the fibre substitution that had taken place was not always synthetics for wool. Rather, synthetic market growth, had for some products, been at the expense of cotton. In addition, for some end uses, wool use had grown relative to rayon acetate and cotton. Finally, they noted that while there may have been substitution of wool, for some end uses it was not of equal importance. Substitution of wool in women's coats for instance, had a far greater impact than substitution of wool in men's socks.

The New Zealand Wool Marketing Study Group (1967) surveyed manufacturers to measure the extent to which they altered their fibre mix as a result of relative price changes. Most respondents indicated that they took no action to substitute between fibres unless prices changed by more than 10 per cent. At price changes greater than 20 per cent only 60% of respondents indicated that they would make some change to their fibre mix. Apparently the firms reported a wish to maintain consistency in their output, without the hassles of technical and production changes. This finding appeared to be in line with similar unreferenced findings from the United States, Germany and Britain.

---

[11] They believed that the 50% market share captured by synthetics had plateaued.

Even within the 'pure' wool market itself, there appears to be doubt about the substitutability of wool types. Beare and Meshios (1990) found that the range over which wools of different diameter could be regarded as direct substitutes was very small, namely 4 microns. In other words, certain wools are used to produce yarns for specific purposes. Even the issue of non-virgin wools (*i.e.* rags) as raised by Horner (1952a), can be dismissed on the basis of the small quantities involved, if any.

Angel *et al* (1990) reported that no (price) differences existed between New Zealand and Australian wools due to country of origin. Rather:

> *"...differences in wool prices in both New Zealand and Australia could be explained by differences in physical attributes of wool which affect its spinning characteristics and suitability for different end uses."* (p. 78).

Furthermore, the degree of substitutability of similar wool types was dependent upon the degree of competition (and costs) between export suppliers. This finding was backed up by anecdotal evidence observed during the course of this study.

3.6 ESTIMATING ELASTICITIES AND SLOPES

Elasticities and slope estimates are usually derived from knowledge of the demand function. This implies that some form of empirical estimation of the structural form and parameters of the demand function must be undertaken prior to any analysis. There are three approaches generally used to estimate the parameters of the demand function. These are the survey-based approach, the experiment based approach and the econometric/regression approach.

3.6.1 The Survey Approach

The survey method essentially involves the questioning of a firm or a group of firms, and their customers and potential customers to try and estimate some relationship between a group of variables which may be important for marketing purposes, such as price or promotion, and the demand for the product.

Often this approach may involve a simple intentions to purchase question whereby the consumer is asked whether they "expect" or "intend" to buy a product over the next six or twelve months.

According to Juster (1966),

> *"...the basic idea behind surveys of consumer anticipations is that consumer purchases are subject to fluctuations that are to some degree independent of movements in observable financial variables such as income, assets, income change and so forth. Fluctuations in these postponable types of expenditures are thought to be more accurately foreshadowed by changes in anticipatory variables that reflect consumer optimism or pessimism, or by changes in anticipatory variables in conjunction with financial variables, than by financial variables alone. And the extent of consumer optimism or pessimism, it is hoped, can be directly measured by surveys of consumer anticipations - either of intentions to buy or of the more general indicators of financial well-being and attitudes"* (p. 2).

Such surveys of consumer anticipations have been widely used as the development of rational expectations has entered the microeconomic literature. Unfortunately, consumers are sometimes unwilling or simply unable to provide hypothetical responses to how they would react to changes in key demand variables such as price. Even if they do honestly intend to buy a product at the time of the interview, circumstances can change to alter the consumer's expected reaction. Such changes in circumstances have led to suggestions that between 70 to 99 per cent of eventual purchasers are likely to be initially classified as 'non-intenders' (Juster, 1966, p.11).

A number of sampling and non-sampling errors are also evident in this research approach. Sampling error occurs because of chance variation and is generally unavoidable, particularly with small samples. Non-sampling errors are those that occur due to aspects related to the research design and mistakes which occur during the research itself. Such errors may arise because of *"...errors in conception, logic, interpretation of replies, statistics, arithmetic, tabulation, coding or reporting"* (Churchill, 1991, p.542).[12] An efficient research design and effective interviewing procedures are thus, vital prerequisites to the success of such an approach.

An extension of the anticipatory survey questioning procedure which has met with some success in estimating demand relationships is the Juster scale.[13] This survey instrument requires respondents to make probability judgements about their expected purchase intentions for a particular product. More will be said about this approach in Chapter Four.

3.6.2 Market Studies and Experimentation

The second common approach to estimating demand schedules is through experimentation (Savage *et al*, 1979). The form of the experiment can take place either in an artificial laboratory situation or a more realistic field situation. In the former case, respondents can be exposed to a range of controlled marketing variables and their behaviour monitored in response to these changes in stimuli (Sawyer *et al*, 1979; Winter, 1975). These changes could include elements of the product, promotion, price and distribution and their relationship towards intent to purchase (usually). A typical example could be wherein the consumers are invited to shop in

---

[12] For a detailed discussion of this, see Zikmund, 1991, p.629-642.

[13] See for example U (1991), Hamilton-Gibbs (1989), Day (1987), Gan *et al* (1985), Pickering & Greatorex (1980), Pickering (1975), Pickering & Isherwood (1974), Theil & Kosobud (1965), Klein & Lansing (1955).

a simulated store or market environment. The experiment could involve giving the respondents a fixed 'budget' and asking them to choose amongst a range of goods, or it could just require them to indicate the likely quantity to be purchased of a good at various prices.

The other experimental approach mentioned above involves a field situation where the objective may still be concerned with observing the consumer's response to changes in marketing stimuli and sales. However, full control of the independent variables (*i.e.* the marketing stimuli) is not assured and may be subject to interference from extraneous elements. For example, prices may be altered in a number of test stores or areas and the level of sales (if that is the desired dependent variable) observed in these respective test and control experiments. However, the researcher has little direct control over all other marketing and non-marketing variables which may impact upon the purchase decision. How, for example, can you isolate the impact of a competitors price discounting strategy during the test period?

Issues of internal and external validity thus become of major importance with researchers having to trade-off one against another. Generally, laboratory experiments tend to be high in internal validity while field experiments have less internal validity but more external validity.

Both field and laboratory experiments tend to be very expensive in terms of the set-up costs involved, the products to be tested, the personnel involved and the time taken to conduct the experiment. As such sample sizes tend to be small and may not be representative of the population response under study.

3.6.3 Regression Analysis

The final approach used in estimating demand relationships is that of regression analysis. Regression analysis involves the development of a statistical relationship between a single dependent variable (*usually price*) and several independent explanatory variables (*i.e.* substitute product prices, income, tastes, population and so on.)

The specification of the explanatory variables and the functional form of the relationship or model need to be established by the researcher prior to the analysis. The set of variables used may be developed from microeconomic theory, previous knowledge of the phenomenon being investigated or in some cases availability of data. Regression analysis also makes extensive use of some critical assumptions regarding the randomness of the errors and the parameters estimated[14] (See Appendix D).

By far the majority of empirical studies into wool demand analysis (and demand analysis in general for that matter) have adopted this final approach, namely that of regression analysis, in estimating demand relationships and hence elasticities. Section 3.7 summarises some of these previous studies to demonstrate the range of estimates produced.

3.7 PREVIOUS ECONOMETRIC STUDIES

3.7.1 Introduction

Econometric investigations into raw wool demand elasticities have been undertaken at regular intervals over the past 40 years. A summary of the key features and estimates of some of the more significant econometric investigations are outlined in Table 3.2 below. While this is not intended as a comprehensive listing, it nevertheless serves to show the depth and scope of some of the major pieces of econometric research carried out over the past fifty years or so. It is also not intended to discuss each of these studies separately suffice to say that they represent a wide range of markets, time periods and explanatory variables.

---

[14] See any econometrics text; Intrilligator, 1978; Wonnacott & Wonnacott, 1979; Johnston, 1972.

TABLE 3.2

Econometric Estimates of Raw Wool Demand Elasticities

AUTHOR/S	PERIOD	AREA	DATA	INDEPENDENT VARIABLES	E_pd
Horner (1949)	1938	U.S. U.K.	Cross-sectional	Output of finished product Price of wool Index of other prices Time	-.21 to -.90 -.26 to -.93
Horner (1952a)	1922-39 1924-38	U.S. U.K.	Annual	2 equations, 1 identity: *(a) Consumer demand* National income Clothing price index Index of retail prices *(b) Manufacturers* Price of wool	-.37 -.42
Horner (1952b)	1938	U.K. U.S.	Cross - sectional	3 equations: *(a) Consumer Demand* Real income Price of final product Index of retail prices *(b) Manufacturers* Index of output Price of raw mat. *(c) Price of final prod.* Price of raw mat.	-.45 (U.K) -.54 (U.S.) -.50 (all others)
Philpott (1953; 1955; 1965b)	1870-19	New Zealand	Annual	*Long Run:* Raw wool consumption Price of raw wool Real income *Short run:* Mill consumption Supply of wool	*Long run:* -.67 to -1.0 *Short run:* -.50 to -.73
Philpott (1957)	1921-56	New Zealand	Annual	Per capita synthetics Per capita production Real cotton price Per capita wool supply	-.55 *(estimate)* -.40 *(derived)*
Ferguson & Polasek (1962)	1954(I) - 1960(II)	U.S.	Quarterly	Real price of raw wool Real manu. textile sales Real synthetic price Demand shift factor	-.1.321 (-1.2 to -1.4) *(Import demand)*
Donald *et al*(1963)	1920-60	U.S.	Annual	Per capita real income Dom. wool consumption Change in income Ratio stocks to orders Weighted fibre prices Time (1950=1)	-.32

Powell, Polasek & Burley (1963)	1954-62	U.S.	Quarterly	Per capita income Population Relative wool price Synthetic market share Wool price Synthetic Price Synthetic consumption Wool consumption	-.27 to -.63
Jenkins (1964) (see B.A.E. 1973)	?	E.E.C.	?	?	-0.30
Philpott (1965a)	1920-60	22 countries	Annual	Real per capita income Per capita wool supply Per capita synthetic supply Time (1920=1)	-.40
McKenzie (1966)	1952-64	N.Z.	Quarterly	?	*Short run:* -2.0 to -10
Emmery (1967)	1952-64	U.K.	Quarterly	Raw wool mill cons. Supply of raw wool Real wool price Real disp. income Per capita wool sales Per capita wool supply Ratio wool tops to consumption Per capita supply of synthetics	-.23 to -.30
McKenzie *et al* (1969)	1952(I) to 1966(IV)	9 Major non-comm. countries	Quarterly	Wool supply Mill consumption Wool stocks Seasonal dummy	*short run:* -1.4 *Long run:* -5.8
Lewis (1971)	1949-64	Group I[a] Group II[b]	Annual	Average cotton price Average wool price Avge. synthetic price Money income Population	*Short run:* Grp I -.242 Grp II -.538 *Long run:* Grp I .140 Grp II .378
B.A.E. (1973)	1946-68	World	Annual	Raw wool content of Imports Current & lagged price Synthetic Price U.S. population U.S. per capita Income Wage rates Dummy (Korean War)	-0.22
Dudley (1973)	1953-70	U.S.	Annual	Ratio wool to non-cellulosic price Time (1964=1) Total fibre demand	-0.4[c] (H/hold furnishings)
Smallhorn (1973)	1961-72	Japan	Quarterly	Real wool price Ratio inventories of yarn to consumption Real per capita consumer expenditure Interest rates Real price of synthetics % change in synthetic consumption	-0.12 to -0.32 (avge: -0.23)

Scobie (1973)	1947-70	New Zealand	Annual	World demand for wool World supply of wool World Epd for wool World Eps for wool[d] NZ Prop'n of world trade	-0.42 Export demand for cross-bred wool)
Dalton (1974)	1963(III) to 74(I)	Australia	Quarterly	Clean 21 m wool price Expected wool price (t+1) Diffusion index (t-4) Synthetic price (t-4) Time	-1.0 to -2.2
Dalton & Taylor (1975)	1963(II) to 73(IV)	Australia	Quarterly	Clean 21 m wool price Expected wool price (t+1) Synthetic price (t-4) Diffusion index (t-4) Time	*Short run:*[e] -.12 to -.52 *Long run:*[e] -.23 to -1.0
Philpott (1975)	1952-73	New Zealand	Quarterly	Supply of wool Gen. commodity prices Real price of wool (t-1)	-1.2
Sanford (1988)	1960-86	U.S.	Annual	Ratio of wool price to Synthetic price (t-1) Time (1961=1)	-5.6 (Apparel)
USDA (1988)	?	U.S.	Annual	Total fibre use Real personal income Competing fibre price Trend	-5.6
Mullen *et al* (1989)	??	Non-centrally planned economies	Annual	Ratio of wool top price to other fibre prices Price of other inputs Income Dummy (1973)	-.45 (wool tops) -1.75 (wool)
Hewlett *et al* (1989)	1936-85	U.S.	Annual	Price of clean wool Per capita income Dummies - wars - synthetics World price of raw wool Tariff on raw wool Tariff on clean wool Time (1936=1)	-4.03 to -.32 (Avge: -.45)

Notes:

a Group I countries include Australia, Belgium, Denmark, Finland, France, West Germany, Italy, Netherlands, Norway, Sweden, Switzerland, United Kingdom, New Zealand, Canada, and Japan.

b Group II countries include Columbia, Mexico, Brazil, Peru, Argentina, India, Pakistan, Spain, Portugal, Greece, Ireland, Turkey, U.A.R., Israel, and Taiwan.

c Unsuccessful and insignificant estimates were attempted for men's and women's apparel, other consumer's products and industrial uses.

d E_ps is the world elasticity of supply for the commodity.

e These estimates are of price flexibilities, which strictly speaking are not equivalent to elasticities.

f In some cases the publication used to source the estimates did not contain all the details.

3.7.2 Scope of Historical Analysis

Much of the initial work in wool price elasticity estimation was undertaken by Horner (1952a; 1952b; 1949) whose studies looked primarily at pre-war historical trends and the development of a formal method of price elasticity estimation. Unfortunately, his studies were hampered a great deal by the data constraints which were a feature of the time, with the consequence that his results were left wide open to criticism (Zentler, 1953; Harris, 1953).

Horner's work did however, provide a stimulus for investigations through the late 1950's and early 1960's which saw elasticity estimates being developed in order to predict the consequences of primary sector expansion following the post-war boom. Philpott (1957), for example argued in favour of wool production on the grounds that it would reduce the incentive for further research into synthetic substitutes. Powell's (1959) study showed that a 10% increase in the output of Australian export wool would improve gross wool revenue by some 5.6% with a 3.2% increase in export earnings. Philpott (1965) suggested that a long term increase in wool production to 5% (up from the average 3%) could be accommodated without any significant change in wool price, assuming that the world production of synthetic fibres did not increase by more than 10% per annum.

The earlier debate on the interventionist consequences of a statutory marketing authority discussed previously in Chapter Two served as a further rallying point. Jenkins (1964), Duloy and Parish (1964) and Philpott (1975) all attempted to develop elasticity estimates to quantify the extent of the hidden costs and gains. Emmery (1967) however, disputed the proposition that significant differences were likely to exist between the elasticities at high and low prices.

Elasticity estimates were also being derived for forecasting purposes. Philpott (1957) investigated both the supply and demand for wool, speculating that wool demand in 1975 would be 81% higher than in 1956. Dudley (1973) attempted, without success, to investigate the determinants of wool demand in the U.S. in order to develop expected demand levels. Dalton (1974), and Dalton and Taylor (1975) looked at forecasts of short-term price movements in auction prices to isolate the impact of the Australian Wool Corporation's buying activities.

Other motives for research into demand elasticities have been in answering the issues related to the 'pessimism doctrine'[15] (Scobie, 1973; Lewis, 1971; Ferguson & Polasek, 1962; Horner, 1952b) and the extent of synthetic fibre substitution (Mullen *et al*, 1989).

By far the bulk of the literature relates to an investigation of the determinants of raw wool prices (Hewlett *et al*, 1989; Sanford, 1988; Smallhorn, 1973; McKenzie *et al*, 1969; Emmery, 1967; McKenzie, 1966; Horner, 1952a). Early studies confined explanatory variables to own price, price of synthetics, income and population (Emmery, 1967; McKenzie, 1966; Horner, 1952a). However, more recent studies have seen the introduction of more complex explanatory variables including interest rates (Smallhorn, 1973), tariffs (Hewlett *et al*, 1989) and relative price ratios. (Sanford, 1988). While the R^2 statistics for the majority of these models is relatively high (*i.e.* > .90), most have resorted to a time or trend variable to help 'explain' most of the variation in raw wool demand.

3.8 PROBLEMS IN ECONOMETRIC ESTIMATION OF ELASTICITIES

3.8.1 Introduction

A review of the literature related to econometric estimation of demand elasticities provides sufficient evidence to see that this approach is fraught with difficulties, both in terms of practical and theoretical considerations. Problems inherent in this approach basically fall into four groups. These are incorrect specification of the relationship under test, concerns about data, violations of the statistical assumptions

[15] The term arises out of the unexpected worsening of the balance of payments following a currency devaluation, if the absolute sum of the export and import demand elasticities is less than one.

and other miscellaneous problems. The remainder of Section 3.8 briefly considers each of these aspects.

3.8.2 Misspecification

The demand for wool, as illustrated in Figure 2.4 (page 23), is influenced by a wide range of factors. In specifying a demand relationship it is important to consider all such factors over the period of analysis. This consideration however, needs to extend beyond the more usual theoretical considerations of price, income, competitor prices and population. Changes in such variables as consumer taste and fashions, and government policies may impose considerable influence upon the consumption of a particular commodity. While acknowledging that such factors are difficult to measure over time, failure to include them in the analysis will not only result in:

> "... *the explanation obtained [being] made poorer, but there will be a tendency for the variation properly attributable to them to be absorbed by other determining variates with which they are correlated, with the result that the coefficients of these other variates will be distorted from the values which would emerge from a complete analysis*" (Stone, 1945, p. 291).

In other words, the omission of relevant variables thus causes the OLS estimates of the remaining variables to be biased (Intrilligator, 1978). The naive solution would be to include as many variables as one could find to ensure that as many explanatory factors are included in the model. This is also appealing given that such actions are unlikely to affect the unbiasedness properties of the OLS estimators. Unfortunately, inclusion of irrelevant variables in the model leads to an increase in the sample variance of the estimators of the coefficients. The result will be distortions in statistical testing of significance (as degrees of freedom are 'consumed') and problems relating to multicollinearity.

Additional considerations must also be given to the form of the relationship between the variables, such as linearity, the correct specification of the error term, such as whether or not it is additive or multiplicative, and the *a priori* specification of the causation between the variables.

Regression analysis requires that independent variables are included in the right hand side of an equation. Following the convention of the Marshallian demand curve, this implies therefore, that the *a priori* direction of causation will be from quantity to price. Equations 2.2 - 2.4 (p. 35) illustrated the behaviourial equations (*i.e.* 2.2 & 2.3) and identity equilibrium equation typically associated with a simple supply and demand model. If we were to use individual consumer data, we would estimate equations 2.2 or 2.3 without fear of what is termed simultaneous equation bias, since individuals are assumed to be price-takers (*i.e.* Pw is exogenous)[16].

If we were interested in the aggregate supply and demand model however, then we run into this problem of simultaneous equation bias. Using market equilibrium (*i.e.* equation 2.3) we can see that the equilibrium price and quantity exchanged are mutually determined. In other words, both the market demand curve and market supply curve determine the observed quantity exchanged and the price. It would be incorrect therefore, to treat price as an independent variable and quantity as the only dependent variable in the estimation of either structural equation.

Without going into the mathematical details, the direct estimation of either structural equation price would violate an important assumption of the Gauss-Markov theorem (see section 3.9), namely the assumption that the error terms are independent of the right-hand (dependent) side variables. The result is that the estimated coefficients are biased and inconsistent.

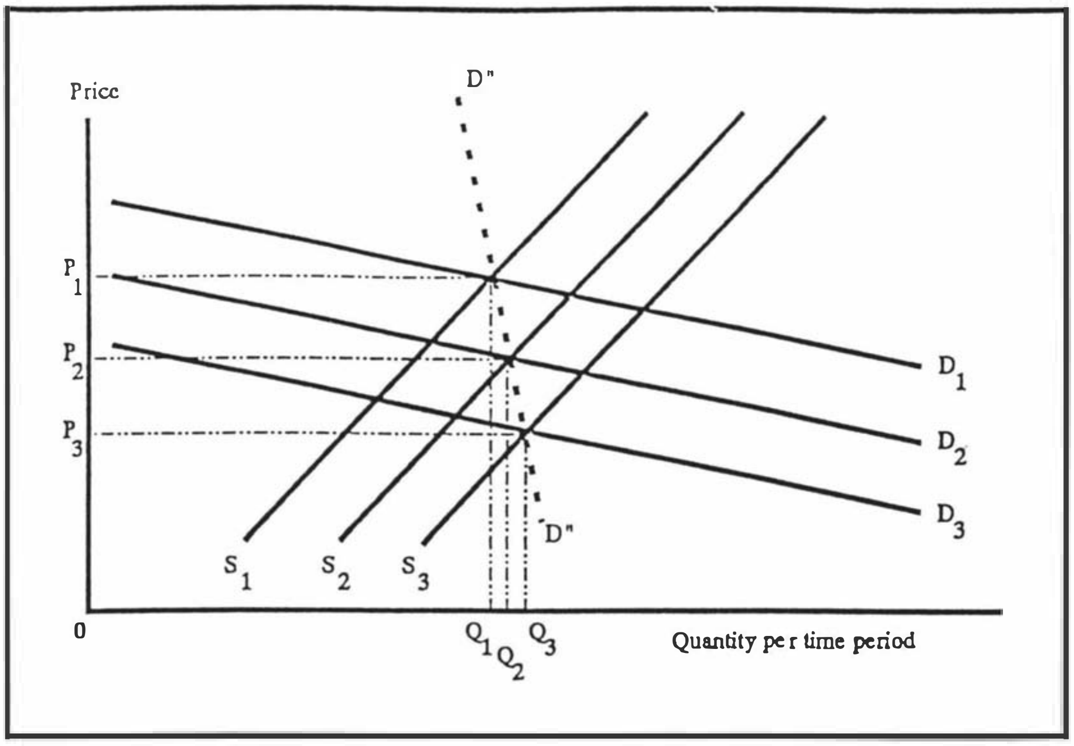
We can estimate the parameters in a simultaneous equation system indirectly by estimating the parameters of the reduced form equations using two-stage least squares (2SLS). To do so however, requires the individual equations to be *identified.*

[16] The equilibrium $Q_d = Q_s$ is not relevant on an individual level since quantity demanded (Q_d) need not equal quantity supplied (Q_s) by an individual firm.

To illustrate this, consider Figure 3.2.

FIGURE 3.2

The Problem of Identification When Both Supply & Demand Change Over Time



Observed price is typically an average equilibrium price while quantity is the equilibrium quantity exchanged. A time-series will therefore, contain a series of equilibrium points between demand and supply. Over time these demand and supply functions are bound to shift in response to such things as weather, tastes, population, and so on. If the demand curve remained static, then it would be possible to trace out the supply curve and *vice versa*. However, if **both** functions shift, then the explicit recognition of the 'true' demand and supply curves is difficult to isolate. This problem is referred to as the identification problem and was first discussed by Working (1927) If the shifts in the two curves are caused by different exogenous variables, then both curves can be identified. However, if the two curves shift in response to the same exogenous variable, then neither curve can be identified[17].

[17] See Brennan (1987) or Pindyck & Rubinfeld (1981) for further discussion on the use of 2SLS to address identification of the reduced form model.

3.8.3 Data Problems

Having *correctly* specified the model in terms of the underlying theoretical basis, the next stage requires the researcher to collect the data to verify the hypothesised relationships. However, a number of problems at this stage are evident. One of the more common problems is inadequate data coverage. Time-series samples of data in economic studies are typically small with most studies having only about 15 to 20 annual observations. Obviously data collection beyond this size is not possible or practical in many situations. Furthermore, economic data tends to be secondary in its nature, possibly collected as part of a wider scale business census. As such there is no opportunity to directly measure the response, or increase the variation in the dependent variable (*i.e.* price) in relation to changes in the dependent variables as is possible in an experimental situation. This also raises the issue of instability in the relationships (*i.e.* structural changes) between all the hypothesised variables, making a partial analysis extremely difficult.

Situations may also arise when the desired data is not in the form required, and may need to be 'massaged' or not even available at all. The empiricism of expectations theory is further hampered by the difficulty in obtaining such data. Often proxy variables are included, or the variables are excluded from the final form model. The unfortunate result of these constraints is that researchers will conduct their investigations over periods where data is available, rather than over a period of particular interest (Mullen *et al*, 1989; Sanford, 1978; Smallhorn, 1973).

The small sample sizes inherent in time series regression analysis also raise serious issues associated with degrees of freedom. Traditional demand models usually include such variables as the price of the product, income levels of the consumers, prices of substitute products, some indication about market size or growth (*i.e.* population) and possibly stocks. In addition to this are possible dummy variables relating to structural shifts, (Hewlett *et al*, 1989; Lewis, 1971) or extra variables signifying lags (Dalton, 1974; McKenzie *et al*, 1969). Unfortunately, each additional variable 'consumes' a degree of freedom, influencing the statistical test of significance. The researcher is thus, forced to 'compromise' and trade-off variables, and hence reduce R^2 or to include more variables and lower statistical significance.

Finally, there is the problem of choice of appropriate dependent variable. Wool has many combinations of diameter, colour, length and breed. The question which then must be asked is, is it appropriate in estimating demand relationships to take an aggregative approach or should each wool type be modelled?

3.8.4 Other Data Problems

In establishing an econometric model, it is recognised that the focus is on the probabilistic nature of regression. In other words, for a given observed value of X (*i.e.* the independent variable) there are a number of possible values of Y (*i.e.* the dependent variable). To formally allow for this situation, a random error component is added to the model of the form as shown in Equation 3.33.

$$Y_i = a + b\,X_i + e \qquad (3.33)$$

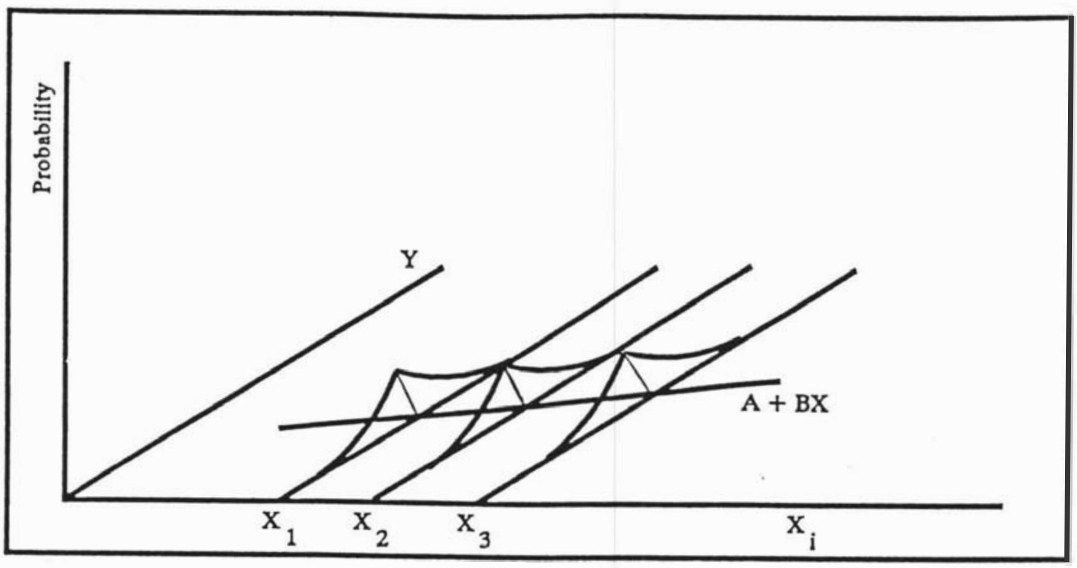
In many cases where survey-based data is collected a trade-off is often required between the many forms of sampling and non-sampling error. Realistically errors cannot be eliminated but need to be minimised according to the researcher's criteria of cost *vs.* coverage (Churchill, 1991; Zikmund, 1991).

The random error term in Equation 3.33 is due to a combination of factors. In the first instance, the model is necessarily a simplification of reality. Even if the model has been correctly specified, there are difficulties involved in including **all** possible independent variables. Figure 2.4 (page 23) in Chapter Two clearly showed the extent of interaction in the formation of the auction price for raw wool. There are also difficulties in collecting and measuring data with the data being subject to what is termed measurement error. This refers to inaccurate observations and data being used in one or more of the explanatory variables and may arise due to inaccurate recording of the observation, improper data collection techniques, inaccurate responses to surveys or to the use of proxy variables to represent variables that have not or cannot be measured.

Figure 3.3 below illustrates the situation in the use of a stochastic relationship where for each valuc of X there exists a probability distribution of e and hence a probability distribution of the Y's.

FIGURE 3.3

Stochastic Distribution of a Two-Variable Probabilistic Regression Model



3.9 VIOLATION OF THE STATISTICAL ASSUMPTIONS

In using a statistical approach to demand estimation, a number of assumptions are made about the data, the estimates and their properties. These include elements of efficiency of the estimates, unbiasedness and equal error variance, or homoscedasticity. The following is a list of these assumptions:

(a) The relationship between Y and X as shown in equation 3.33 is linear;

(b) The X_i's are non-stochastic variables and have values which are fixed[18];

(c) i: The error term has a zero expected value and constant variance for all observations; that is;

$E(e_i) = 0$ and $E(e_i^2) = \sigma^2$

ii: The random variables, e_i, are uncorrelated in a statistical sense;

$E(e_i, e_j) = 0$ for $i = j$

iii: The error term is normally distributed.

With the exception of the last assumption, this list describes what is termed the classical linear regression model. The Gauss-Markov theorem shows that OLS produces estimates which are 'best' in the sense of minimum variance. Appendix D outlines further these desirable properties of regression estimators.

Unfortunately, the nature of stochastic time series and cross-sectional data may result in the presence of autocorrelation, heteroscedasticity and multicollinearity.

Autocorrelation occurs when the error term in one time period is correlated with the error terms for one or more previous time periods. Autocorrelated errors are prevalent in time-series data and usually appear due to the slow passage of underlying structural changes. They occur in response to shocks, such as weather cycles, industrial action or government policies which occur over one measurement period. Autocorrelation may also be caused by the omission of relevant variables, use of an inappropriate functional form or a failure to use distributed lag forms. With autocorrelation, the OLS estimates remain unbiased, but are no longer the most efficient estimates.

Heteroscedasticity occurs when the error terms do not occur randomly but exhibit some form of systematic relationship with one or more of the independent variables. Usually heteroscedasticity, which is more prevalent in cross-sectional data, manifests itself in the form of unequal error variances. The result, as with autocorrelation, is

[18] This assumption is generally unrealistic. In this particular study, this assumption is relaxed (see Section 5.6, Chapter Five).

unbiased but inefficient estimates, which result in misleading standard errors, and hence statistical tests, and is likely to overstate R^2.

Multicollinearity arises when two or more independent variables are highly correlated with each other. If they do vary together, due to some dependence on each other or on another variable, the coefficient assigned to each of the variables by the estimated solution may have no relationship to the 'true' marginal influence of these variables upon the dependent variable (Douglas, 1987). The regression analysis is thus unable to detect the true relationship and assign an arbitrary value to the coefficients. Multicollinearity is a common problem in time-series data since many economic variables tend to move together and may be overcome, to some extent, by the simple removal of one of the correlated variables.

As mentioned previously, regression analysis requires the *a priori* direction of causation to be one way. However, in many demand analysis situations, the dependence between the variables may be two way. To overcome this, a second equation may be added to the original with the two becoming a simultaneous system of equations. However, under such situations, the OLS estimates are likely to be biased with the bias remaining as the sample size increases.

3.10 OTHER ECONOMETRIC PROBLEMS

A final group of miscellaneous problems in econometric estimation include issues related to the coefficient of determination, and the implicit difficulties in applying a static model to a dynamic situation.

One of the tests employed by econometricians' in deciding upon the appropriateness of their models is the use of the R^2 statistic. This provides an indication of how much of the variation in the independent variables is contributing towards explaining the variation in the dependent variable. Obviously a desirable case would be where the R^2 was equal to one and the variance in the dependent variable was fully explained. However, such occurrences are rare and most models will still have some 'unexplained' variation. The question of appropriateness of the model is really a subjective assessment as to the magnitude of R^2. Adding additional explanatory variables to the model may help in explaining the 'unexplained' part of the model. However, this practice is inappropriate on two counts. First, additional variables in the model may lead to potential interdependence between variables in which two or more variables are correlated. Secondly, each additional variable 'consumes' one degree of freedom.

There are a also range of issues which need to be considered by the researcher in developing and interpreting the results of their static models in a dynamic environment. Time raises a number of problems relating to changes in the purchasing power of money. The common procedure is to deflate the monetary variables by some price series to develop real values. The question remains however, which price deflator is the most appropriate? The consumer price index (C.P.I.) is often used, but what direct relevance does the change in price of a basket of shopping goods have to the price of wool for example? Maybe the producers price indices for outputs and inputs are more relevant deflators. However, even these indices tend to be an agglomeration of industry groupings. The dilemma facing researchers is highlighted in Philpott (1957) in which he used a number of deflators in his ten equations, each producing different results.

Researchers also need to cope with the assumption that the behaviour exhibited by the data in the past is going to remain stable into the future. This is not only a problem for forecasting models, but also explanatory models. The data may not reveal slow structural change, such as the 'greening' of consumers in recent years. Furthermore, there are shocks to the system which need to be incorporated into the analysis. For example, many researchers have included additional dummy variables into their models to account for the introduction of synthetics (Hewlett *et al*, 1989) or wars (B.A.E. 1973).

This instability of the environment is a key feature of the primary industry which is fraught with difficulties in terms of time-series data since it is often the target for government intervention through subsidies, production controls or regulation. The resultant output levels may therefore, not be in response to changes in the *a priori* specified model, but some other factors which are difficult to incorporate into the model.

3.12 SUMMARY

Chapter Three has summarised the literature related to own price estimate of demand elasticities for raw wool. The introduction provided one rationale for the need for such estimates to be developed. However, it is obvious from the literature reviewed that the econometric estimation of demand elasticities is fraught with difficulties. The various estimates made only confirm that wool tends to have a relatively inelastic own price elasticity of demand.

An alternative approach to demand schedule estimation may help to overcome these technical difficulties and make some progress towards answering the questions raised in the Introduction and in Chapter Two. One such alternative which may be considered is the use of the Juster scale, a probability based survey instrument which has proved to successfully estimate purchase levels for consumer items and durables. However, before doing so it is useful to introduce the area of subjective probabilities and how they can be utilised in the proposed survey-based approach. This is done in Chapter Four.

CHAPTER FOUR:

ELICITATION OF SUBJECTIVE PROBABILITIES

CHAPTER FOUR:
ELICITATION OF SUBJECTIVE PROBABILITIES

4.1 INTRODUCTION

It is widely accepted that beliefs in relation to uncertain events form the basis of many decisions (Wheelwright & Makridakis, 1977). Furthermore, many of these beliefs may be expressed in the context of a probability statement; *i.e.* " *a fifty-fifty chance*". Questions need to be asked as to "*How do decision-makers form these probabilities?*" and "*On what basis can they develop an informed opinion?*". This chapter introduces the notion of subjective probabilities and their role in the decision making process[1]. It is shown that when asked to estimate a subjective probability of an event occurring, errors are likely to be included in the elicitation procedure. These errors can originate from both the measurement procedure and the respondent. Issues associated with errors in the measurement procedure include those of validity, reliability and sensitivity. Respondent errors occur through either cognitive or motivational bias. Cognitive bias is the result of the way respondents use heuristics or unconscious rule-of-thumb processes in the way they form judgements. Motivational bias is an adjustment by the respondent to their subjective probability according to some system of reward. These threats to the accuracy of an elicited subjective probability which are important in establishing the effectiveness of purchase intentions are discussed in some detail.

With an understanding of the difficulties in eliciting subjective probabilities, the chapter then goes on to outline a popular technique, known as the Visual Response Method. This technique is introduced in the context of several successful applications in the field of agricultural economics. The chapter then takes a slight tangent into the area of consumer intentions and the theory of purchase probability. An indirect

[1] See Fischhoff (1988) for a useful overview of subjective forecasting theory.

probability elicitation technique, known as the Juster scale is introduced as an appropriate method by which the data required for this study could be obtained. Empirical tests of the Juster scale show it to be a more reliable estimator of purchase quantities than the standard 'Top-box' intentions scale. The chapter concludes with the recommendation that this scale be applied in the data collection process in order to meet the objectives of the study.

4.2 SUBJECTIVE PROBABILITIES

Subjective probabilities[2] have been defined as beliefs held by individuals which reflect their degree of uncertainty about some idea, event or proposition (Bessler, 1984). Such events are usually non-repetitive with the probability simply being a number in the range zero to one (Francisco & Anderson, 1972). The subjectivity of these probabilities therefore, implies that probabilities of the occurrence of the same event are likely to vary amongst individuals according to the degree of information that each individual has (Machina & Schmeidler, 1992). In other words, the probability of an event is simply what the assessor believes it to be (Hogarth, 1975). This difference in probability assessments between individual's provides a clue to the character of subjective probabilities (Norris & Kramer, 1990).

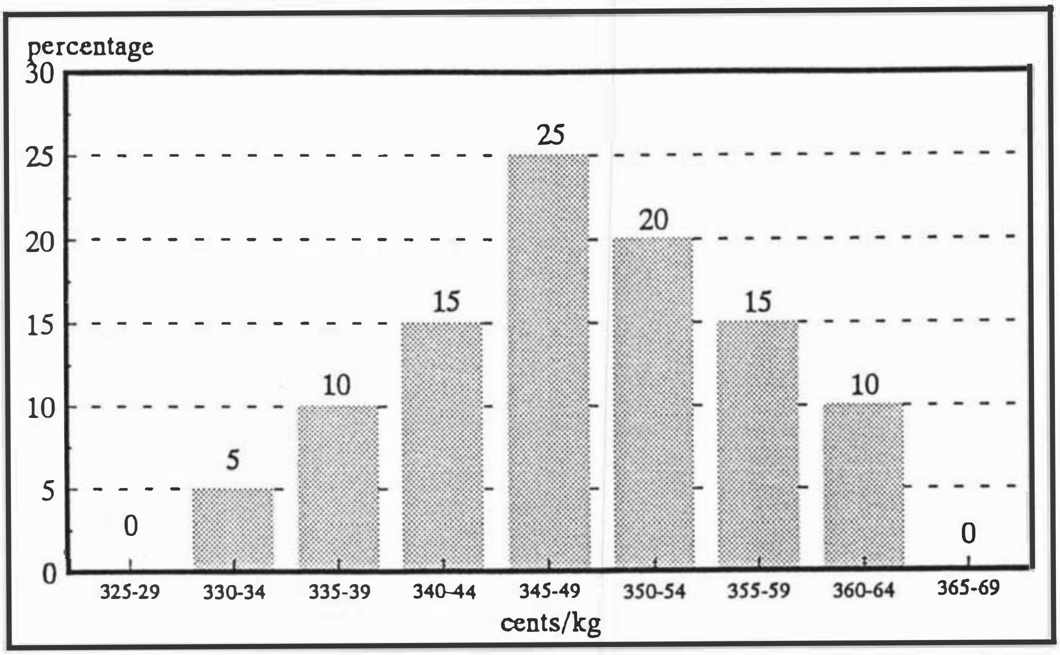
The estimate of a subjective probability can take one of two forms; a point estimate or a probability distribution. In the context of this research for example, a buyer could estimate, with 95% probability, that the final indicator price for wool at the end of the month will be 342c/kg. Only one point or value on a continuum has been chosen and a probability attached to it. However, there may be several factors which the buyer is uncertain about which leads him to estimate that the final indicator price is likely to be within a range, say 330 c/kg to 360 c/kg. Even within this range however, there are different levels of confidence associated with particular values. All values within the range are thus, assigned probabilities according to the buyer's

[2] A subjective probability differs from an objective probability in that an objective probability requires a long series of trials under identical conditions to determine probabilities with reasonable accuracy.

subjective assessment of their likelihood. As shown in Figure 4.1, the buyer has indicated a 5% probability of the final indicator price being in the range 330 c/kg

FIGURE 4.1

Hypothetical Example of a Subjective Probability Distribution for the Market Indicator Price in Four Weeks



to 334 c/kg, a 10% chance of the final indicator price being in the range 335 c/kg to 339 c/kg and so on. According to Norris and Kramer (1990), such a distribution is referred to as a subjective probability distribution and is defined as "*...a set of subjective beliefs defined over a number of mutually exclusive and exhaustive events*" (p.128). Given the presence of uncertainty in many real world decisions, it should not be too surprising that probability distributions tend to be more commonly used.

When the number of possible outcomes is very large, it is appropriate to assess the entire subjective probability distribution (Norris & Kramer, 1990). This is because relative probabilities can be easily established as well as ensuring the probability axiom that the sum of probabilities adds to one. Such distributions can take the form of either a cumulative distribution function (CDF) or a probability density function (PDF). In estimating a CDF, respondents are typically asked to determine intervals such that an event is deemed to occur equally in each interval. For example, one could start by asking the respondent to estimate the value for which there is a 50 per cent chance that the true value will be above or below it (Norris & Kramer, 1990). From this initial quantity, it is possible to establish quartiles or any other equal probability level. This approach, known as successive subdivision has been used successfully in the past (Moskowitz & Bullers, 1979; Ludke *et al*, 1977; Carlson 1970; Stael von Holstein, 1972.) When estimating a PDF, probabilities are assessed for a few outcomes and a curve is fitted to those points which agree with each individual's decision as well as the perceived relationship among the individual probabilities (Schlaifer, 1969). PDF's have been established in the case of both specific outcomes (Seaver *et al*, 1978; Ludke *et al*, 1977) and to intervals (Bessler, 1980; Kabus, 1976; Lin, 1973).

The literature reveals that the choice of either function has been well debated. However, some researchers have found respondents' to be more comfortable with the PDF method and that in comparison to CDF's, gave better results in terms of reliability criteria (Chesley, 1978; Ludke *et al*, 1977; Winkler, 1967a).

In order to assess probability accurately such distributions must satisfy two conditions: coherence and compatibility.

The coherence condition requires that the assessed probabilities be consistent with the axioms, rules and calculus of probability. In other words, the following conditions must be met:

a) The probability of a given event is a number between 0 and 1 inclusive;

b) The sum of the probabilities of all possible events is equal to one;
and
c) If two events are mutually exclusive, then the probability that at least one of the two events will occur is the sum of the individual probabilities.

Compatibility requires that judgements are compatible with the assessor's true beliefs regarding the event under consideration. Furthermore, such expressed subjective beliefs must be consistent with all other beliefs held by the individual. In other words, the respondent is assumed to provide an 'honest' response which, if repeated, would be consistent given their understanding of the current and future environment.

4.3 THE ASSESSMENT OF SUBJECTIVE PROBABILITY ESTIMATES

The elicited subjective probability (z) is comprised of two components, a true value (t) and an error term (e) (Ravinder, 1992; Musser & Musser, 1984):

$$z = t + e \tag{4.1}$$

In the short term, t is assumed to be fixed[3]. The random error, e, has a mean ß and a standard deviation σ. According to Ravinder (1992) it is the mean ß which represents the bias present in the elicitation z. Bias "*...in its simplest sense is the difference between the true*[4] *value of the elicitation and its expectation*" (Ravinder, 1992, p.622). The bias is due to transient issues associated with either the measurement procedure or the respondent. Errors associated with the measurement procedure concern aspects of reliability, validity and sensitivity. Errors associated with the respondent concern aspects of bias.

Reliability refers to issues associated with the consistency and accuracy in a measurement procedure[5]. Of particular interest is reliability over time and

[3] The 'true' value t is actually comprised of two components; t_t, which is the true value of the characteristic being measured and t_s a systematic error. Given that the systematic error, if present, is constant than the sum of the two components is also a constant.

[4] Ravinder (1992) suggests that the true value could be a historical standard that is being updated constantly i.e. the notion of probability calibration. Thus a person who assigns a probability p to each of several events of which a fraction p will occur, is said to be calibrated (p. 622).

[5] See Peter, J.P. (1979) for a fuller discussion.

consistency within a procedure. Reliability over time, sometimes known as test-retest reliability, is concerned with the ability of the elicitation procedure to produce similar results for the same respondent at different times (McDaniel & Gates, 1993). Reliability issues associated with internal consistency consider the relationship between items within the measurement procedure. Essentially the measurements from the procedure are split randomly into two halves and a measure of the two scores from the two halves computed. A procedure is said to be internally consistent if the scores for the two halves are similar (Aaker & Day, 1991).

Validity concerns the simple question of whether the procedure is measuring what it is supposed to measure. A measurement is said to be valid if $z = t$ and there is no error (*i.e.* e = 0) (Ravinder, 1992). The problem facing the researcher is to develop an instrument which actually records the 'true' value of the characteristic under measurement. According to Churchill (1991), this relationship between the measurement and the 'true' value is never established unequivocally but is always inferred. Inference takes place through indirect tests of reliability or direct tests of validity. These tests of validity are numerous and can take many forms[6]. Face validity is simply given when the measurement so self-evidently reflects aspects of the characteristic that there is no doubt as to its truth (McDaniel & Gates, 1993). Concurrent validity is established if there is a high correlation between the measurement and some other variable measured at the same time (Churchill, 1991). Construct validity:

> "*...aims first to define the concept or construct explicitly and then to show that the measurement, or operational definition, logically connects the empirical phenomenon to the concept.*"
> (Aaker & Day, 1991, p. 299).

The third issue associated with measurement procedures is sensitivity. This refers to the ability of the procedure to discriminate among meaningful differences in the

[6] For more discussion on measures of validity see Aaker & Day, 1991; Churchill, 1991; Zikmund, 1991.

variable under measurement. Sensitivity is improved by increasing the number of categories within a scale. However, increasing the number of categories comes at a cost of lowering reliability.

Errors may also be attributable to measurement problems associated with respondents, otherwise known as bias. As suggested earlier, the error term, *e*, in Equation 4.1, has a mean β and a standard deviation σ. It is β that represents the bias present in the elicitation z (Ravinder, 1992). Bias can take the form of two types; Cognitive and Motivational:

> "*Cognitive biases represent adjustments introduced consciously or unconsciously because of the way information is processed by the assessor. Motivational biases are systematic adjustments of elicitations by the assessor in accordance with some perceived personal system of rewards.*" (Ravinder, 1992, p. 621).

The issue of motivational biases, sometimes known as scoring rules, is discussed later in Section 4.13.

Cognitive bias is the result of the way assessors use what are described as heuristics in the way they form judgements. Because many decision situations do not have appropriate formal models for assessing probabilities, decision makers often rely on intuitive judgements. The literature reveals that the assessors or decision makers rely on these judgements or heuristic principles in order to simplify decision situations and to form some assessment of the subjective probabilities associated with the choices. These heuristics are inexact or rule-of-thumb processes which may be used unconsciously in thinking (East, 1990). Heuristics help facilitate often complex thought processes by making use of past experiences, intuition and foresight. Three heuristics are typically employed; Representativeness, Availability and Anchoring and Adjustment. While these principles are quite intuitive, they may sometimes "*...lead to severe and systematic error*" (Tversky & Kahneman, 1974, p.1124). The resultant biases attributable to these heuristics come in two forms; first a displacement bias, in which the assessed distribution is completely shifted, and secondly, a variability bias, in which the variance of the assessed distribution is altered. Each of these three judgemental heuristics and their limitations will be discussed in turn.

4.3.1 Representativeness

A person is said to follow this heuristic by evaluating the probability of an uncertain event by the degree to which it is:

> *"(a) similar in essential properties to the parent population*
>
> *and (b) reflects the salient features of the process by which it is generated."*

(Tversky & Kahneman, 1982, p.33)

The representativeness heuristic works on the basis by which an event A resembles or is representative of a process B:

> *"For example, when A is highly representative of B, the probability that A originates from B is judged to be high. On the other hand, if A is not similar to B, the probability that A originates from B is judged to be low"* (Tversky & Kahneman, 1974, p.1124).

In other words, there is a tendency to link a particular case to a particular class based on assumptions about the class. This tendency is common in the way people 'categorise' other people according to their style of dress and manner. For example, a young man wearing a suit is recognised as a business person simply because business people tend to wear suits while labourers do not. There is no other information available to 'categorise' this person except a reliance on stereotypes which have been developed in the past.

Reliance on representativeness of an event as an indicator of its probability introduces two kinds of systematic error into the judgement. First, it may give undue influence to variables that affect the representativeness of an event, but not its probability and second, it may decrease the importance of variables that are crucial to determining the event's probability but are unrelated to the events representativeness (Bar-Hillel, 1982).

The bias that results from such an approach to probability assessments can take several forms. For instance, decision makers may be insensitive to information related to prior probability of outcomes when making a particular assessment. It has been demonstrated in experiments for example, that prior probabilities have been 'correctly' utilised when no other information is available. However, when an assessment is supplemented with additional information, regardless of its quality, prior probabilities have tended to have been ignored[7]. Furthermore, Tversky and Kaheneman (1982) highlight an 'insensitivity to sample size' which, although *"...a fundamental notion of statistics is [nevertheless] evidently not part of people's repertoire of intuitions."* (p. 1125). There is a tendency to view a sample, irrespective of size, which has been randomly drawn from a population to be representative of the population in all major elements (Tversky & Kahneman, 1971). It is obvious that for a large random sample, this notion will tend to be true. However:

> *"...people's intuitions about random sampling appear to satisfy the law of small numbers, which asserts that the law of large numbers applies to small numbers as well"* (Kahneman *et al*, 1982, p. 25).

Thus, there is the likelihood of assessing a sample result by the similarity of this result to the corresponding parameter without any regard to its 'robustness' (Kahneman & Tversky, 1982).

The problem of representativeness is also manifest in peoples misconceptions of chance. Probability assessments may be influenced by the so-called gambler's fallacy

---

[7] See Kahneman, D. & Tversky, A., Psychological Review, 80 (237), 1973.

in which chance is viewed as a self-correcting process in which a deviation in one direction induces a deviation in the opposite direction. For example, after observing a sequence of heads (*i.e.* H,H,H,H,H,H,) there may be a belief that a toss of tails has a much higher probability, since the previous six tosses did not adequately reflect the 'fairness' of the coin.

Decision makers may be asked to predict the outcome of an event on the basis of information or a description available to them. A description of a financially strong company, for example, is likely to engender an outcome of high profits as being most representative of that description and *vice versa.*

> "*The degree to which the description is favourable is unaffected by the reliability of that description or by the degree to which it permits accurate prediction. Hence, if people predict solely in terms of the favourableness of the description, their predictions will be insensitive to the reliability of the evidence and to the expected accuracy of the prediction*" (Tversky & Kahneman, 1974).

As discussed above, some decision makers are also guilty of predicting, with a high degree of confidence, a particular outcome that is most representative to a particular input without regard to any other factors, particularly the quality of information on the inputs. This so-called illusion of validity persists even when the assessor is aware of the factors that limit the accuracy of their predictions (Tversky & Kahneman, 1974).

Finally, decision makers also have a tendency to not recognise the standard statistical phenomenon of regression towards a mean, mainly because they do not expect it to occur in the context of the particular situation. This phenomenon is clearly illustrated in the following example.

> " *Suppose a large group of children has been examined on two equivalent versions of an aptitude test. If one selects ten children from*

among those who did best on one of two versions, he will usually find their performance on the second test to be somewhat disappointing. Conversely, if one selects ten children from among those who did worst on one version, they will be found, on the average, to do somewhat better on the other version. More generally, consider the two variables X and Y which have the same distribution. If one selects individuals whose X score deviates from the mean of X by k units, then the average of their Y scores will usually deviate from the mean of Y by less than k units." (Tversky & Kahneman, 1974, p. 1126)

4.3.2 Availability

The assessment of the probability of an event can also be helped by instances which can be bought to mind (Tversky & Kahneman, 1973). This seems intuitively appealing given the extent of such behaviour modifications like the learning curve. Furthermore, repeated exposure to the same 'experiment', which forms the basis of long-run objective probability distributions, should allow the decision maker to be more accurate in their prediction of an event. However, there are several prediction biases possible in this judgemental heuristic.

First, the retrievability and salience of instances both play a major role in the level of subjective probabilities. An event that is more easily remembered will appear more numerous than an event of equal frequency whose instances are less easily retrieved. Tversky and Kahneman (1974) give the examples of seeing a house burning or a traffic accident as having greater impact than reading about it, and consequently leads to a rise, albeit temporary, in the subjective probability of such events happening personally.

Sometimes instances may need to be developed given that experiences with particular situations have never occurred or are too distant to be recalled. Usually, 'alternatives' may be generated and the most likely event chosen. However, the probabilities attached to these 'alternatives' may not bear any relationship to the actual frequency of the events, thus leading to bias.

4.3.3 Anchoring and Adjustment

Any prediction of some quantity requires an estimate of an initial quantity which may or may not be adjusted or refined to give a final value. This choice of the starting point may be guided by some theory or formulae or may simply be a 'stab in the dark'. In either case, adjustments from the initial point tend to be minimal. The result is that the final value chosen is a function of the initial point chosen. In other words, different starting points will yield different final values. This problem of anchoring inevitably leads to bias in any probability estimates which are being developed.

4.4 IMPLICATIONS FOR SUBJECTIVE PROBABILITY ASSESSMENT

The previous discussion has raised a number of important implications in determining the research approach for this particular study. The key issues appear to be who do we ask and how do we ask the 'appropriate' questions so as to minimise bias? According to Wallstein and Budescu (1983), there are two areas of subjective probability study. The first concerns the large number of studies associated with subjective probability assessment of the general population. More specifically, the experiments deal with respondents who have no experience in the events being assessed or any experience in probability assessment. The second area of study is that of experiments with 'experts'. Experts, in this case, refer to people who have had some degree of training, experience or knowledge significantly greater than that of the general population (Wallstein & Budescu, 1983). The category of experts càn be broken into two distinct groups;

(a) Substantive Experts - a person is said to be a substantive expert if they have an in-depth knowledge of a particular field of expertise.

(b) Normative Experts - a person is said to be a normative expert if they are knowledgeable about probability theory and are thus, able to express their opinions in probabilistic form.

Given the nature of this study it is evident that the sample group will have substantive expertise as opposed to normative expertise. While on the surface this may appear to be a problem in getting respondents to establish their assessments in a probabilistic format, the literature suggests otherwise. This issue is discussed in more depth later in Section 4.12 and again in Chapter's Seven and Eight in relation to the ability of a survey technique to elicit 'correct' data from the respondents.

The other major implication from the discussion above is the issue related to **how** to ask the right question. It is obviously important when eliciting the subjective probability that the respondent is as fully aware as practically possible of **all** factors likely to impact upon their probability assessments. This knowledge could have been developed through their own history of similar events, and current knowledge of the factors they think are likely to impact upon the decision parameters. This simple request immediately highlights the representativeness and availability heuristics which may bias any subsequent probability assessments. By actively suggesting to the respondents in this study, for example, to think about the upcoming wool auction sales is to possibly encourage them to extrapolate their most recent sales experiences into the forecast period (whatever this may be). This ignores the relative position of the last sales experience in terms of say, the sales levels for the last month, the last quarter, the season so far, or the same sale period last year. If the sale had a high composition of premium priced fine wools, for example, then the expectation is for the next sale to possibly be as similarly high priced. However, a consideration of the sales patterns over the past month or quarter, or at the same time last year, could show that this event was an abberation and was unusual in the context of 'normal' sales offerings. The objective, thus, should be to encourage the respondents to think about the context of the events about which the probabilities are being elicited. Furthermore, it would be useful to actually know at the time what the major influences were on the probability assessments. In terms of the anchoring and adjustment heuristic, the question of 'appropriate' pricing levels and starting points also needs to be carefully considered.

The discussion above obviously has some serious implications in relation to the sample design and the research instrument to be used. Section's 4.5 and 4.6 below, consider the mechanism's available which could be used to extract subjective probabilities in the context required for this study. Section 5.6, Chapter Five considers the issues related to sample design.

4.5 ELICITATION OF SUBJECTIVE PROBABILITIES

Given that subjective probabilities are cognitive beliefs, some form of extraction mechanism is required. This mechanism, described in the literature as an elicitation technique, can effect how the respondent views the problem, as well as the accuracy and consistency of their responses (Chesley, 1978).

There are two alternative approaches in eliciting subjective probabilities; direct methods and indirect methods.

The direct method involves the direct questioning of respondents regarding their perceptions of the probability of an event or outcome. The questions asked may require numbers as answers, in the form of either outcomes or probabilities.

The indirect method makes inferences from preferences or choices between possible decisions or alternatives.

There are a variety of forms[8] of indirect measurement including gamble methods,[9]

[8] Chesley (1978) provides a useful performance comparison of five elicitation techniques.

[9] Questions are asked in terms of betting odds, and subjective probabilities are inferred from the odds required to make the respondent indifferent between two offered bets (Carlson, 1978, 1970; Chesley, 1978).

odds methods[10], weighting methods[11], ranking methods[12], smoothing methods[13] and visual response methods. According to Norris and Kramer (1990), it is this final method, that which uses visual response, that has been the indirect technique most widely used in agricultural economics research.

The Visual Response Method, not surprisingly, makes use of visual tools in helping a respondent assess a PDF. The most common tools used are counters and a showcard. A range of possible outcomes obtained from the respondent is divided into several equal intervals. The respondent is then asked to distribute a fixed number of counters over the different intervals in accordance with their belief of the occurrence of each interval. The probability assigned to each interval is calculated as the ratio of the number of counters assigned to the interval to the total number of counters available (Francisco, 1971).

4.6 USE OF THE VISUAL RESPONSE METHOD

A number of studies have used the Visual Response Method as a means to elicit subjective probability distributions. Francisco and Anderson (1972) interviewed a sample of 21 pastoralists operating in the Darling River area of New South Wales, Australia to determine their degrees of preference and belief in expected wool prices, lambing percentage and annual rainfall. For each variable, the respondent's minimum and maximum values were first established, and the range split into equal intervals.

[10] Respondents are asked to assign odds to an events occurrence (Seaver *et al*, 1978; Spetzler & Stael von Holstein, 1975).

[11] Respondents are required to assign a weight or score, for example a number between one and ten, indicating their strength of conviction that the outcome will occur in each of a set of intervals covering the range of possible outcomes (Young, 1983; Nelson & Harris, 1978).

[12] The respondent divides the range of all possible outcomes into a number of intervals and then ranks the intervals in order of ascending probability (Ludke *et al*, 1977).

[13] Using historical relative data as preliminary estimates, revisions are undertaken to reflect the respondent's general beliefs about the shape of the distribution, while the set of revised estimates is kept as close as possible to the original estimates (Hampton *et al*, 1973; Schlaifer, 1969).

The respondent was then asked to distribute 25 counters over the different intervals in accordance with their degree of belief of the occurrence of each interval. This approach allowed for the successful development of several discrete probability distributions although the distributions were quite variable with different levels of mean, variance, skewness and kurtosis characterising the degrees of belief of the different respondents. The results suggested that such subjective probability distributions could be readily elicited from respondents. The authors concluded that the use of the visual response approach was readily accepted by the respondents' who were able to place the counters without difficulty.

Hearth *et al* (1982) sought to interview two groups of forty rice growers in two different areas of Sri Lanka in order to develop probability distributions of net income from traditional varieties and modern varieties of rice. However, the researchers were only able to obtain 17 interviews in the wet zone area and 23 interviews in the dry zone area due mainly to difficulties in the respondents' unfamiliarity with the concepts and procedures used. In spite of this setback, the procedure did allow for the development of net income distributions which were incorporated, under the assumption of price certainty, into three different decision models.

Grisley and Kellogg (1985, 1983) attempted to obtain subjective probability distributions of price, yield, and net income of selected crops in the Chiang Mai valley of northern Thailand. Thirty nine small semi-commercial farmers (average holdings were .85 ha) in two villages were interviewed during 1978 using a similar Visual Response Method as developed by Francisco and Anderson (1972). The procedure however, differed in the fact that farmers were offered a monetary reward if their stated expectations turned out to be accurate. Each farmer was asked prior to planting to reveal their beliefs about minimum and maximum values that each uncertain event (*i.e.* price, yield and net income) could take at harvest time. This range was divided into five equal discrete intervals and presented to the farmer on paper. They were then given 25 one Baht coins, which was equivalent to the average daily wage in the area, and asked to distribute them among the five intervals in accordance with their strength of belief about the occurrence at harvest.

The respondent's were told that, at harvest time, the actual value would be checked, and they would be paid the number of coins allocated to the correct interval. To minimise cognitive bias, the farmers were given up to a week to make their allocative decision. Furthermore, they were told to consider the quantity and costs of all inputs they expected to use.

The results, according to Grisley and Kellogg, showed once again the feasibility of obtaining farmers subjective probability distributions, and that these distributions are "*...generally realistic and logical*" (Grisley & Kellogg, 1983, p. 81).

Sri Ramaratnam (1985) also used the visual response approach of Francisco and Anderson (1972) to obtain subjective probability distributions for grain sorghum prices and yields in an analysis of optimal fertilisation rates. Twenty seven farmers in the Texas Coastal Bend region, United States, were interviewed to obtain price and yield distributions according to four separate nitrogen fertiliser levels. Intervals of 10 and 12 were developed from likely ranges of prices and yields, respectively. The farmers were then invited to distribute 20 counters over the intervals according to their price and yield expectations. The resultant distributions were incorporated into an expected utility function allowing for the optimal level of nitrogen fertiliser to be determined[14].

It is apparent from the previous discussions that the elicitation of subjective probabilities is indeed feasible if sufficient care is applied to minimise potential sources of bias. A key aspect throughout this however, is that respondents are able to effectively 'communicate' these probabilities. Section 4.7 is somewhat of a slight tangent from the current discussion in that it introduces a probability scale, the Juster scale, to help facilitate or verbalise the subjective probability estimates of respondents.

[14] The results did however, suggest that the expected yield distributions were generally optimistic relative to data obtained by experiments.

4.7 CONSUMER BUYING INTENTIONS

In making purchase decisions, microeconomic theory asserts that a consumer will allocate his or her expenditures in such a way that they maximise their marginal utility per dollar within a given budget[15]. Using all relevant information available, consumers are thus assumed to be able to form consistent and rational decisions about what they would like to purchase. Throughout this purchase process, consumers also develop expectations not only about the particular commodity in question, but also about all other variables which may impact on the buying process. These expectations may include changes in observable variables such as disposable income, as well as changes in the non-observable psychological variables such as a change in the degree of job security, or financial well-being. In doing so it can be said "*...that they* [the consumers] *do not act arbitrarily or without thought in their economic life.*" (Dornbusch & Fischer, 1987, p. 22). The key to understanding consumer behaviour, it seems, is to be able to measure these expectations accurately if future purchase intent data is required. The problem is how?

Juster (1966) provided a useful insight into this question. He suggested that:

> *"...fluctuations in these postponable types of expenditures [i.e. durables] are thought to be more accurately foreshadowed by changes in anticipatory variables that reflect consumer optimism or pessimism, or by changes in anticipatory variables in conjunction with financial variables, than by financial variables alone. And the extent of consumer optimism or pessimism, it is hoped, can be directly measured by surveys of consumer anticipations - either by intentions to buy or of the more general indicators of financial well-being and attitudes."* (Juster, 1966, p. 2)

Attitudes towards purchase can be isolated through a variety of instruments including

[15] See, for example, any elementary microeconomics text *e.g.* Begg *et al*, 1987; Mansfield, 1985; Lipsey, 1979; Samuelson, 1975.

an investigation of awareness levels, forced switching, paired comparisons or constant sum measures (Churchill, 1991; Haley & Case, 1979). However, the widespread applicability of these techniques in terms of sensitivity, stability and predictive power has been called into question (Axelrod, 1968).

The other approach is to look at consumer buying intentions (McDaniel & Gates, 1993; Gabor & Granger, 1972; Heald, 1970; Murray, 1969; Juster, 1960; Tobin, 1959). Buying intentions studies usually involve asking the consumer 'how likely' or 'with what probability' they would purchase a particular good over a prespecified period. Responses may be open-ended or take the form of a likert-scale type instrument.

In its most common form buying intentions are found using a five point scale[16] which the respondent uses to describe how they feel about buying the product. Such a scale may take the form as shown in Figure 4.2.

FIGURE 4.2

The Traditional 'Top-Box' Approach to Eliciting Purchase Intentions

How likely would you be to buy this product? Would you say you ...

*	Definitely would buy it
*	Probably would buy it
*	Might or might not buy it
*	Probably would not buy it
*	Definitely would not buy it

[16] There can, of course, be a lot more or less points but five seems to be the most common.

It is assumed that those responses to either of the first two categories are defined as 'intenders' or those who show some inclination towards purchase. Conversely, those responses to the last three categories are typically defined as 'non-intenders'. The use of this scale has become popular because of its relative ease of use and its widespread applicability (Zikmund, 1991; Churchill, 1991).

The usefulness of such an intentions survey can be gauged by relating variations in the fraction of one or more of the groups of purchase intenders to variations in the proportion reporting purchases. Often however, a substantial proportion of the expenditure variation remains unexplained with consumers typically answering as a 'non-intender' *i.e.* the bottom three categories of the above scale (Clawson, 1971).

Several studies have concluded that intentions data provide a reasonably accurate forecast of purchase behaviour than attitudes, particularly in short-term cross sectional studies (Adams, 1964; Tobin, 1959; Klein & Lansing, 1955). The practical nature of the use of such an intentions measure in this case has been well debated. Different interpretations by respondents using the same scale however, raise doubt as to reliability (Worcester & Burns, 1975). The respondent is asked whether they '*expect*', '*plan*' or '*intend*' to buy, for example a car, over a period, such as the next 12 months. The respondent is likely to make some statement based on his or her current and expected financial position over the period, the need for a new car, and any other factors which they may consider relevant. However, four key issues are immediately obvious. First, the fact that such forecasts are dealing with future events immediately introduces a degree of uncertainty into the actual behaviour. Changes in financial position, for example, can introduce major forecast errors. Obviously the longer the forecast period the greater the extent of any such errors being introduced. The second issue is that some answers may well be respondent's indicating what they *would like to do* rather than what they *will do*. Thirdly, some respondent's may get the impression that such intentions questions are relevant only to *"...those prospective purchases that have received some detailed and explicit examination within the households decision framework."* (Juster, 1966, p.7). Finally, there is the usual problem of measurement errors in recording purchase information, as outlined in Section 3.8.5, Chapter Three (Churchill, 1991; Zikmund, 1991; Neter, 1968).

The end result is that often there is some confusion and error within such anticipatory results that make the accurate and meaningful interpretation of the data very difficult. An example to illustrate the extent of this dilemma was clearly given by Theil and Kosobud (1965). Between 1961 and 1965, they interviewed 4,000 households on a quarterly basis to obtain information on car buying intentions. The same households were reinterviewed again after 12 months. A total of nineteen sets of reinterviews were thus obtained. The form of the question was simply an expectation to purchase a car within the next 6 to 12 months. Those answering "Maybe" or "Yes" were deemed to be the intenders. The data obtained took the:

> *"...form of a double dichotomy: there are those who plan to buy and subsequently do buy, those who plan but do not buy, those who do not intend to buy but nevertheless do buy, and those who do intend to buy and behave accordingly"* (Theil & Kosobud, 1965, p. 51).

The average frequencies over all 19 surveys are outlined in Table 4.1.

TABLE 4.1
Average Frequencies of Car Purchase Intentions

	BEHAVIOUR		
INTENTION	No Purchase	Purchase	*Marginal*
Don't intend	.849	.068	.917
Intend	.051	.032	.083
Marginal	.900	.100	1.00

Source: Theil & Kosobud, 1965

Those reporting intentions to purchase a car varied between 6% and 11% (average was 8.3%) while those reporting purchase varied between 8% and 12% (average was 10.0%). Of particular interest is the point that those who indicated an intention to purchase and subsequently did so averaged 3.2%. Those who indicated an intent to purchase and then did not purchase averaged 5.1%. On the other hand, those who indicated no intention to purchase and subsequently did purchase averaged 6.8%. This proves, according to the authors:

> "*...the well-known fact that only some of the intenders actually buy a car ... and that a considerable number of purchases are actually made by the nonintenders*" (Juster, 1966, p. 52).

> "*Predictors of purchase rates yielded by an intentions survey - the proportion of intenders and non-intenders in the population - are inefficient predictors because the mean purchase probabilities of intenders and non-intenders are not constant over time. That is the probability that a member of say, the non-intender group will actually buy is not zero, nor does it remain constant. This is a major drawback because the non-intender group typically accounts for a large fraction of total purchases and of the variance in purchases rates over time*" (Juster, 1966. p. 3).

Furthermore, Juster (1966) states

> "*...the most reasonable general interpretation is that plans or intentions to buy are a reflection of the respondents' estimate of the probability that the item will be purchased within the specified time period ... Thus consumers reporting that they 'intend to buy A within six months' can be thought of as saying that the probability of their purchasing A within X months is high enough so that some form of 'yes' answer is more accurate then a 'no' answer, given the particular questions asked*" (p. 7).

This leads to the suggestion that a probability based intentions instrument may be an appropriate mechanism to assess intentions.

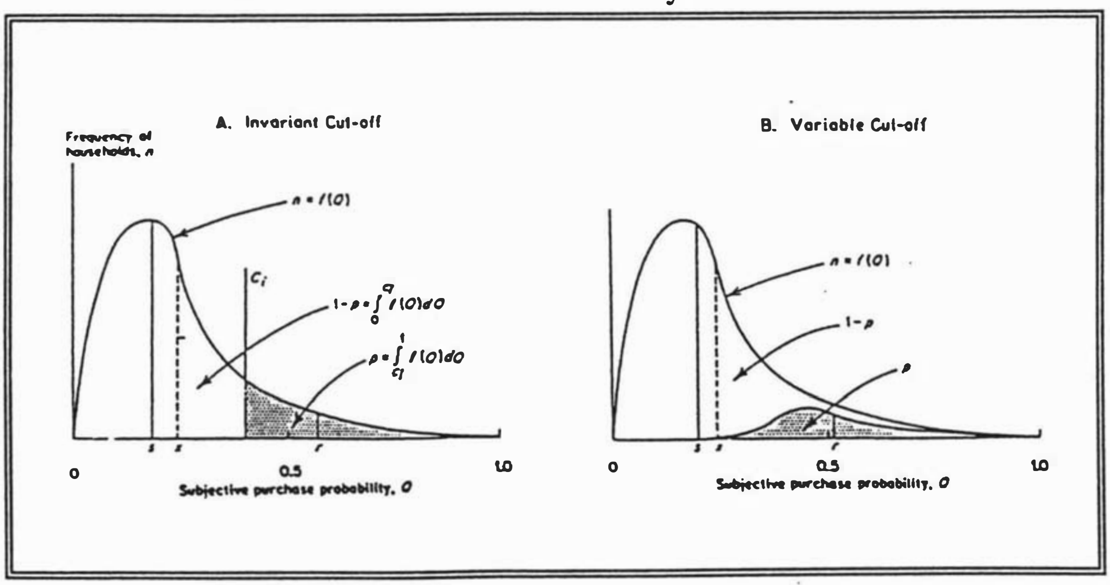
4.8 PURCHASE PROBABILITY THEORY

Juster hypothesised that all consumers, in response to a buying intention question, have some 'threshold' probability (C_i). Given that this 'threshold' level was likely to vary amongst consumers, it would be possible to observe therefore, a set of two overlapping distribution patterns as shown in Figure 4.3. There is a proportion of consumers who will be designated as 'intenders' (p of the sample) and a proportion who will be designated as 'non-intenders' (1-p). The p intenders will have a mean purchase probability of r, the 1-p non-intenders a mean probability of s, and the sample as a whole a mean of x.

Intenders are therefore, simply described as those consumers with purchase probabilities higher than some minimum level and non-intenders those with purchase probabilities lower than some minimum level.

FIGURE 4.3

Consumer Purchase Probability Distributions



Source: Juster, 1966.

Juster uses this theoretical proposition to make clear a number of points. First, a good predictor of population purchase rates may be the mean purchase probability in the population rather than the proportion of intenders. Second, intentions surveys may well serve to complicate the variables being measured. Juster states the point that:

> "*...if responses to intentions questions rest on a comparison of the respondents' purchase probability with the probability threshold implied by the question, respondents are being asked to make two difficult judgements when the first (actual probability) is the only one of any real use*" (1996, p. 8).

Third, an intentions survey provides no information at all about the distribution of purchase probabilities among households below the threshold, *i.e.* the non-intenders.

An ideal intentions survey should thus yield an estimate of mean probability which is equal to the observed purchase rate. The forecasting problem then becomes one of attempting to develop a model which allows one to incorporate these influences on purchase rates of largely uncertain, although known, events.

Juster proposed a move towards a survey of explicit purchase probabilities on the basis of empirical evidence against intentions survey data. He suggested that the data obtained from a cross-sectional intentions survey tended to show:

1) intender purchase rates were always higher than those of non-intenders.
2) the smaller the proportion of households classed as intenders, the higher the purchase rates of both intenders and non-intenders and the smaller the proportion of total purchases made by intenders.
3) the vast majority of households (70-99%) were always classified as non-intenders (see, for example, Theil & Kosobud, 1965).

and finally

4) a majority of actual purchases were made by households classified as non-intenders (Juster, 1966, p.11).

A survey of explicit purchase probabilities must therefore, be able to distinguish households with *ex-ante* probabilities of zero from those with probabilities that are low but greater than zero, and to reduce the variation in *ex-ante* probability within the several intender classes by facilitating the construction of homogenous classifications. And if the probability response are unbiased estimates of the true but unobservable probabilities in the population, the mean of the distribution should, on average, be equal to the purchase rate (Juster, 1966).

If this approach is utilised, Juster suggested that researchers would find;

1) fewer households would report zero purchase probabilities than would report the absence of intentions to buy.
2) the observed purchase rate among zero-probability households will be less than the purchase rate among intenders, and the observed purchase rate among households in the highest probability classification is greater than the purchase rate among any class of intenders.
3) the proportion of total purchases accounted for by zero-probability households will be less than the proportion accounted for by non-intenders.

and

4) the correlation between purchase probability and actual purchase will be higher than that between intentions to buy and actual purchases. (Juster, 1966)

4.9 DEVELOPMENT OF AN APPROPRIATE PROBABILITY SCALE

One of the first empirical attempts at developing an appropriate probability scale was a study conducted as part of the Consumer Savings Project in 1958-59 (Ferber & Piskie, 1965). Panel members were interviewed at three monthly intervals over five periods on purchase intentions related to fourteen categories of expenditure. Respondents were asked the following question:

"Do you plan to purchase any of these goods (whether owned presently or not) between now and [next period]. Let's take the first one. How likely are you to purchase it during this period?"

Respondents were then shown a "Plan-o-meter" with eleven gradations from zero to ten (Figure 4.4) The card was expressed in terms of making a purchase, although only three adjectives were used.

FIGURE 4.4

"Plan-o-meter" used in Savings Study Experiment (1958-59)

10	Certain
9	
8	
7	
6	
5	Fifty-fifty
4	
3	
2	
1	
0	No plans at all

The results of the study led to tri-modal distributions with peaks occurring at both extremes and the middle. Furthermore, the proportion of non-intenders appeared to be at levels observed in a comparable study for a buying intentions question (Juster, 1966). Ferber and Piskie (1965) concluded that the results provided only partial support for the use of subjective probabilities in obtaining data on consumer buying intentions. They recommended a forced answer scale to encourage answers away from the extremes and to improve the overall value of the information obtained.

This recommendation was followed through in a second study carried out in November, 1963, known as the Detroit Experiment. This study was a pilot test undertaken by the United States Bureau of the Census on a nonrandom selection of 192 consumers. Respondents were asked the following question:

> *"During the next (6, 12, 24) months, that is between now and next ...., what do you think the chances are that you or someone in the household will buy a ....?*

An eleven point probability scale (zero to 10) was used with descriptions given for each scale value (Figure 4.5).

In line with Ferber and Piskie's hypothesis, the distributions obtained were smoother, although a peak at '5' was still observed. According to Juster (1966), this peak was due to two reasons. First, all descriptions with the exception of that opposite '5' (*i.e.* fifty-fifty) were qualitative, implying different levels of even chance. This led Juster to conclude that these descriptions were of little help in selecting the most appropriate choice (Juster, 1966). Second, it appeared that interviewer bias apparently encouraged confused respondents to choose the 'fifty-fifty' option.

A third study was conducted in July, 1964 along similar lines to the Detroit Experiment as part of the Quarterly Survey of Intentions by the Bureau of the Census. A random sample of 800 households was selected[17], interviewed and

[17] The households selected had actually participated in the Quarterly Survey of Intentions a few days previously. The 'reinterviewing' was thus piggy-backed on top of the usual field supervision check which was normally conducted at this time.

FIGURE 4.5

Probability Scale Used in the Detroit Experiment (1963)

10	Absolutely certain to buy	10
9	Almost certain to buy	9
8	Much better than even chance	8
7	Somewhat better than even chance	7
6	Slightly better than even chance	6
5	About even chance (fifty-fifty)	5
4	Slightly less than even chance	4
3	Somewhat less than even chance	3
2	Much less than even chance	2
1	Almost no chance	1
0	Absolutely no chance	0

reinterviewed six months later in January 1965. The following question was put to respondents:

> "*Taking everything into account, what are the prospects that some member of your family will buy a .... some time during the next .... months; between now and next ....?*

A revised probability scale was then put to the respondents (Figure 4.6).

Following the outcomes of the previous two experiments, a number of refinements were made. Most obvious is the expansion of the scale to incorporate both qualitative and quantitative expressions. The use of the qualitative adjectives appeared to give all choices on the scale the same degree of 'visibility' (Juster, 1966, p. 15).

Furthermore, the extreme limits were reworded away from '*Absolutely certain*' or '*Absolutely no chance*' to reflect the possibility [in every circumstance] of uncertainty in decision making. Quantitative descriptions were also included next to the scale adjectives to further clarify and reinforce the "*...precise intended meaning of the scale points*" (Juster, 1966, p. 16).

To help in the data collection stage, a detailed introduction to the scale was presented to the respondent. Respondent's were also given the opportunity to familiarise themselves with the instrument with some 'dummy' questions. Finally, the number of periods each respondent was asked to consider was reduced.

FIGURE 4.6

Probability Scale Used in the QSI Experiment (1964-65)

Certain, practically certain (99 in 100)	10
Almost sure (9 in 10)	9
Very probable (8 in 10)	8
Probable (7 in 10)	7
Good possibility (6 in 10)	6
Fairly good possibility (5 in 10)	5
Fair possibility (4 in 10)	4
Some possibility (3 in 10)	3
Slight possibility (2 in 10)	2
Very slight possibility (1 in 10)	1
No chance, almost no chance (1 in 100)	0

Perhaps the most important hypothesis under test in this third experiment was the question as to whether explicit purchase probabilities were a more efficient measure of purchase than the standard intentions to buy.

Respondents were analysed in respect of their intentions towards purchasing a car and a group of durables[18]. In terms of the anticipated car purchases, it became apparent that households classed as nonintenders were able to be distributed into more homogenous subgroups by the probability approach (Juster, 1966, p. 23). This was further reflected in the probability scales having much higher purchase levels than even the most broadest intender classes. Table 4.2, for example, shows that the typical intender classification (definitely, probably, or might buy) accounted for just under a third of total purchases. The narrowest probability class, on the other hand, accounted for over half of the purchases made by households with nonzero probabilities. In terms of the durables, similar results were evident although, due to several data problems, the *"...differentials among probability groups [were] not as large as for automobiles"* (Juster, 1966 p. 27)[19].

In conclusion Juster, stated *" ...that purchase probabilities are apt to be a better time-series predictor of purchase rates than are buying intentions"* (1966, p. 37).

One final issue associated with the development of the technique has been the appropriate format of the Juster or probability scale. Clawson (1971) experimented with a 100 point scale, before deciding upon a 0-10 scale for comparative purposes. Pickering and Isherwood (1974) adopted a scale similar to the Detroit experiment with descriptive adjectives only at the extremes. This 'incomplete' scale however, gave quite accurate aggregate predictions, primarily because a smaller proportion of households reporting zero purchases probabilities actually purchased. Gabor and Granger (1972) suggested that given the similarities in purchase rates amongst

---

[18] These durables included air conditioners, clothes dryers, dishwashers, television sets, refrigerators, and washing machines.

[19] Similar findings were subsequently reported by Clawson (1971) and Byrnes (1964).

adjacent probability groups, the probability scale could be reduced from 11 points down to 4 points without loss of accuracy. Subsequent studies however, have tended

TABLE 4.2

Proportion of Car Purchases Made by Specified Categories of Households

Classification of Households	No. of Purchases	% of total
INTENDER GROUPS:		
Six-month definite + probable.	13	19
Six-month definite, probable, maybe, D/K.	21	31
Six-month plus 12 month intenders.	25	37
Six-month plus 12 month intenders + D/K.	35	52
PROBABILITY GROUPS:		
Nonzero 6 month probabilities	39	58
Nonzero 12 month probabilities	49	73
Nonzero 24 month probabilities	59	88
ALL GROUPS:	67	100

Source: Juster, 1966, p. 25

to lend support to the fuller scale based on Juster's (1966) format (U, 1991; Gendall *et al*, 1991; Day, 1987; Dobbs, 1986; Haley & Case, 1979; Clawson, 1971; Gruber, 1970; Clancy & Garsen, 1970). Day (1987), in a comparative study of two versions of the Juster scale, found respondents to be more comfortable and the results more accurate in the fully labelled version of the scale compared to the unlabelled 'Detroit' type scale.

4.10 EMPIRICAL VALIDATION OF THE JUSTER SCALE

The results of the QSI Experiment were sufficiently robust to convince the United States Bureau of the Census that they should switch their intentions surveys to the probability approach (Pickering & Isherwood, 1974; Clawson, 1971).

A number of researchers adopted similar probability approaches in their assessments of purchase intentions. Appendix E summarises the results of these studies. The study by Pickering and Isherwood (1974) appears to have been the first 'comprehensive' survey undertaken. Previous studies could not provide conclusive validatory evidence due to the lack of a reinterview (Gruber, 1970), poor survey management (Stapel, 1968) or interference from extraneous factors (Gabor & Granger, 1972). Pickering and Isherwood's (1974) research comprised a one and a half hour survey of 386 heads of households carried out in early 1971 in which a range of questions were asked on the ownership and state of the stock of durables, the level of confidence of the respondent, and their current financial position. Respondents were asked their purchase intentions on a range of 18 durable goods for each of three periods - 3, 6 and 12 months. The 0-10 probability scale used however, contained a verbal description of '*no chance*' at 0 , '*completely certain*' at 10 and no other verbal descriptions in between. However, an explanatory card that read " *a score of 8 would mean that you were 80% certain, a score of 1 that you were 10% certain and so on*" was used.

In line with previous studies, the pattern of purchase probabilities exhibited a reverse J shape with a peak occurring at the midpoint for all three periods. One of the key findings was the discovery that high and low probability values conveyed different types of information according to the type of product and its ownership level.

> "*For example, it seems that a low probability value on a low ownership product indicates an awareness of the item and some interest at purchasing at some future date, whereas high probability values especially on high ownership items may indicate a strong*

buying intention or the existence of a buying plan."
(Pickering & Isherwood, 1974, p. 224).

Studies since this point have tended to be concerned with potential applications to a range of products and measuring instruments.

4.11 RELIABILITY OF PROBABILITY DATA

In assessing the feasibility of this approach as an instrument to collect subjective probability estimates, one must be concerned with the degree of accuracy in the predictions. The results of past studies have been mixed. It would appear that most studies have shown that probability data tends to have underestimated actual purchase levels (U, 1991; Hamilton-Gibbs, 1989; Ferber & Piskie, 1965; Brynes, 1964). Only one study has reported that probability data overestimated purchase data (Clawson, 1970). The obvious conclusion to be drawn is that a large proportion of actual purchases have still been unpredicted (Pickering, 1975; Pickering & Isherwood, 1974; Gabor & Granger, 1972). The reasons for this are widespread and concern matters related to the environment as well as aspects associated with data collection.

At first glance, one could hypothesise that the most obvious source of prediction error comes in the length of the forecast horizon. The longer the forecast period, the greater the opportunity for extraneous influences to alter expectations. It would be rare for a perfect match to exist between expectations and realisations even under the best of circumstances. Changes in measurable factors, such as financial wellbeing and psychological factors, such as confidence, are all likely to impact upon, and alter the plans. Studies conducted in the past have covered a variety of time periods. These range from 1 week (Becker & Greenberg, 1978; Roshwalb, 1975), 4 weeks (U, 1991; Hamilton-Gibbs, 1989), 3 months (Gan *et al*, 1985; Pickering & Isherwood, 1974; Clawson, 1970), 6 months (Day, 1987; Morrison, 1979; Pickering & Isherwood, 1974; Juster, 1966), 12 months (Morrison, 1979; Pickering &

Isherwood, 1974; Juster, 1966) and 24 months (Morrison, 1979; Juster, 1966).

Based on the literature, the choice of an appropriate time period would appear to be closely related to the type of product under investigation. Hamilton-Gibbs (1989) for example, recommended a four week period for frequently purchased items in order to maximise the amount of information collected. Any shorter time period would not generate sufficient data, as well as running the risk of forward telescoping[20] by respondents (Churchill, 1991). Juster (1966) did not consider a 6 month horizon for household durables suggesting that it was too short a period for serious consideration of such infrequent purchases.

Even careful consideration of time periods can lead to measurement errors. Juster (1966) investigated purchase probabilities over three periods for cars (6, 12 and 24 months) and two for household durables (12 and 24 months). He reported that:

> *"...if a household reports a zero probability of purchasing within six months but a nonzero probability of buying within twelve months (say, three chances out of ten) the "true" probability of its buying within six months seems to be higher than zero.....In effect, households typically seem to underestimate their purchase probabilities for any specified period of time, and tend to assign probabilities for any specified period of time that "should" have been assigned to somewhat shorter periods."* (Juster, 1966, p. 35)

A further factor reported as leading to potential errors has been the need to provide the respondent with a strict definition of what their expectations are to be based on. Pickering and Isherwood (1974), for example, noted that the generic description of 'Furniture' was too broad and did not allow respondents to adequately consider all possible purchases that may have come into this category. Gabor and Granger (1972) noted the use of the definition of 'purchase' in the case of a house move where an

[20] Telescoping occurs when the respondent believes that past events happened more recently than they actually did.

existing appliance was considered to have been 'purchased' greatly exaggerated the number of 'actual' purchases at the end of the period.

Gabor and Granger (1972) also highlighted the fact that a high proportion (80%) of purchases made by respondents with zero probabilities were replacement purchases due to unforeseen breakdowns. This discrepancy in behaviour was particularly noticeable for those respondents who already owned the durables. Pickering and Greatorex (1980) and Pickering (1975) in follow-up studies looked at possible reasons as to why particular purchases were or were not made. In many cases the failure to purchase was the result of changes in financial situation, planning or difficulties in obtaining particular styles or models.

One rather apparent consideration, which was initially raised by Juster (1966) and repeated by U (1991), was that respondents need to be made explicitly aware of all variables that may influence purchase decisions. This could involve either a verbal prompting of important variables or a physical listing of all information relevant to the task prior to the assessment being made (Hogarth, 1975).

> *"Thus a survey which, prior to asking about probabilities, contains questions on the households' income, income prospects, asset holdings, stocks of durables, repair experiences on durable stock, actual and prospective labour market participation, etc., may obtain accurate judgements than a survey which does not."*
> (Juster, 1966, p. 38)

Finally, there needs to be some consideration of the need for probability assessors to be *au fait* with the axioms of probability in order to make effective and consistent judgements. Roshwalb (1975) surveyed 48 stage I statistics students who could be classed as normative experts and thus would presumably be familiar with the topic of probability. His results showed that a good deal of his sample did not know how to calculate even simple probabilities casting doubt on members of the general public to make even more sophisticated subjective probability statements. Tversky and

Kahneman (1974) also point out that, while the:

> *"...statistically sophisticated avoid elementary errors...their intuitive judgements are liable to similar fallacies in more intricate and less transparent problems"* (p. 1130).

This was ably demonstrated by Winkler (1968) who undertook an experiment with three groups at the University of Chicago. The first group comprised graduate business students with only an introductory course in statistics, the second group were graduate business students with at least a course in business statistics that emphasised Bayesian methods, while the third group consisted of Ph.D. candidates and a professor in statistics. While the third group was much superior, Winkler found little difference between the performance of the first and second groups.

4.12 SUBSTANTIVE *vs.* NORMATIVE ABILITIES

As mentioned earlier, the respondents that will be interviewed in this study are likely to be substantive experts (*i.e.* they have an in-depth knowledge of a particular field, in this case the wool market) rather then normative experts (*i.e.* they are knowledgeable about probability theory). At first glance it would seem that, based on the evidence of Roshwalb (1975) and Winkler (1968), reliable probability assessments would be difficult to elicit unless the respondent was familiar with probability theory. This, after all, seems intuitively reasonable. However, this problem need not be a major concern (Büyükkurt & Büyükkurt, 1991; Hogarth, 1975).

Hogarth (1975) offers some comfort which will still allow this approach to be considered for this study. He reviewed several experiments comparing the judgemental ability of substantive and normative experts. He found that weather forecasters, for example, (*i.e.* substantive experts) demonstrated as much statistical expertise as statisticians (*i.e.* normative experts) in forecasting the weather. This behaviour was apparently due to the frequent feedback on prediction that weather forecasters receive. In other words, the outcomes of probability estimates on, say rain, could be verified within a day. Given that such forecasts are made on a daily basis, the forecaster could eventually 'finetune' their probability estimates and hence become more successful at correct predictions. This learning effect due to feedback and experience was also confirmed in similar studies by Nelson (1980). Büyükkurt and Büyükkurt (1991) also report that bias seems to persist even when the subjects are well trained in statistics.

For this particular study ongoing monthly surveys were conducted. Given that many of the respondents have had considerable experience in the wool industry and given that the auctions are held weekly, the ability to obtain 'feedback' in the sense of price and purchasing relationships was already well entrenched. While the explicit consideration of probabilities may not be apparent to many of the respondents, it was expected that they themselves could implicitly form consistent and reliable probability statements in response to the particular price scenarios. This assumption was given further substance with the use of frequent and regular surveys of a panel over the two seasons using a carefully developed survey instrument. Furthermore, the use of ten counters, with each counter representing .10 probability, physically constrains any probability distribution to one, thus satisfying at least one of the axioms. It was also expected that the respondent's would go through a series of exercises prior to the first survey to familiarise them with the instrument and the context of the study.

4.13 MOTIVATIONAL BIAS AND SCORING RULES

The mere questioning of respondents as to their purchase intentions may be said to actually change their liklihood of subsequent purchase (Morwitz *et al*, 1977). Furthermore, somehow rewarding the respondent for this subsequent purchase can lead to an overestimation of purchase rates. This bias, known as motivational bias, occurs when adjustments are made in the elicitation process by the assessor in response to some reward system. This reward system involves the use of a monetary incentive, so that the more accurate the assessor, the more money they are to receive. Motivational rewards, in effect, set a bet with the assessor such that an explicit outcome can be determined (*ex post*) and a payoff given relative to that outcome (Bessler, 1984). The rule outlining this requirement is known as the scoring rule. Such a rule can take one of two forms; the quadratic rule (de Finnetti, 1962), in which all probabilities are assessed or the logarithmic rule (Good, 1952), in which only a single probability is assessed[21]. The use of such scoring rules has been successfully used in the past (Sri Ramamratnam, 1985; Grisley & Kellogg, 1983).

To effectively use the scoring rules, certain assumptions need to be made:

> *"1. He never violates the postulates of coherence. Following Savage...this person is idealized; unlike you and me, he never makes mistakes, never gives thirteen pence for a shilling, or makes a combination of bets that he is sure to lose no matter what happens.'*
> *2. He fully understands both the methods used to obtain his probability assessments and the methods used to encourage careful assessments. That is, he understands the alternatives open to him and the implications of each alternative.*
> *3. He has a utility function which is linear with respect to money in the relevant range (that is, the range of monetary amounts used in conjunction with the assessment procedure). Furthermore, he chooses his responses in such a way as to maximise his expected utility"* (Winkler, 1967b, p. 1107).

Intuitively, this reward procedure should be expected to motivate the assessor into providing their 'true' beliefs. However, a number of concerns are apparent. First, there is an assumption that there is only one 'true' underlying distribution for an assessor. Hogarth (1975) suggests that often assessors themselves do not know

[21] For a more detailed discussion on these scoring rules, see Bessler, D.A., 1984.

exactly what their 'true' probabilistic opinion is. This point is given further weight when it is recognised that opinions and attitudes are constantly changing. The second concern given to using scoring rules is that they are often not understood by those without a mathematical background. The use of simpler evaluation systems to overcome this issue may lead to inefficiencies in data collection or worse, incorrect outcomes. Finally, there has been some concern expressed about the sensitivity of some scoring rules (Jensen & Peterson, 1973; Murphy & Winkler, 1970). The payoffs, in some cases, have been considered insufficiently small to encourage careful assessments.

Given that there remains some confusion in the literature with regard to the use of scoring rules it was decided that this study would not consider the use of scoring rules as a motivational factor in the elicitation of subjective probabilities. However, as mentioned previously, given the effort expended on the development of the data collection instrument (Chapter Five), and the longitudinal surveying of a panel as opposed to differing sample units, the absence of such scoring rules should not lead to any significant errors in the data collected. Furthermore, the study maintained a high degree of co-operation throughout the sixteen survey periods (see Chapter Eight). There was strong anecdotal evidence that the respondents did take the research process seriously, and hence could be assumed to have given sufficient consideration of the scenarios. On the face of it, scoring rules would probably not have improved the data collection process.

4.14 SUMMARY

This chapter had the objective of outlining the role of subjective probabilities in estimating future purchase intentions. The definition of subjective probabilities was established, along with some of the difficulties in their measurement. These heuristics, which affect the way assessors form judgements, need to be considered in any elicitation procedure. The use of the Visual Response Method coupled with the use of a probability scale (*i.e.* the Juster scale) appeared to offer a useful way of eliciting the data required for this study. Previous studies have shown a tendency for the use of a probability scale to underestimate actual purchases. However, it would appear that much of the discrepancy is due to problems associated with 'controllable' factors. A reduction in this motivational bias should help improve the application of the probability scale to the research objectives.

CHAPTER FIVE:
BACKGROUND, SAMPLE & DATA COLLECTION

CHAPTER FIVE:
BACKGROUND, SAMPLE & DATA COLLECTION

5.1 INTRODUCTION

It is apparent from the previous chapters that a survey-based approach would be the appropriate format for the collection of data in this study. The next logical step is to determine first, who to ask and second, what to ask them? To do this, it is imperative that a sufficient understanding of the unique characteristics of the industry is gained. This chapter starts by outlining the role and importance of wool within the New Zealand economy. Wool, by virtue of its long history and comparative production advantage, represents a key industry in New Zealand, in terms of income, employment and production. Section 5.2 goes on to provide a background to the components of the New Zealand wool industry and auction system highlighting some of the issues which need to be considered in establishing an efficient data collection process. Having established the desired sample frame, the chapter then introduces the sample and method sections of the research process. Given the longitudinal and qualitative nature of the data required, a panel of respondents is deemed to be appropriate. Section 5.3 deals with the area of sample selection including a discussion on the panel characteristics. Section 5.4 then introduces the methodology and instrument used to collect the data given the implications of subjective probability assessment as raised in Chapter Four.

5.2 BACKGROUND TO THE NEW ZEALAND WOOL INDUSTRY

5.2.1. New Zealand's Role in the World Market

New Zealand is the largest producer of crossbred wools in the world and the second largest overall producer behind Australia. World production of wool in 1992-93 totalled some 1.664 million clean tonnes, down 4% on the previous year. The biggest falls in production were recorded in South Africa (- 70%), New Zealand (-26%), and Australia (-12%). Availability of wool (production plus opening stocks) declined to 2.29 million clean tonnes due to the considerable quantity of stocks held by Australia (470,000 clean tonnes), Argentina (68,000 clean tonnes), New Zealand (53,000 clean tonnes), and South Africa (4,000 clean tonnes).

Around 193 thousand tonnes of clean wool was produced in the 1992-93 season by New Zealand. This represented 11.6% of world output, second only to Australia (33.7%)[1]. Table 5.1 summarises the output of major wool producers.

In terms of the New Zealand economy, the wool industry represents an important component. Wool generates around $900 million in export receipts or 4.9% of total export earnings (1992-93). In terms of gross agricultural production, wool accounts for 20% while in terms of total GDP, wool represents 1% of production.

There are just over 38,000 sheep farms in New Zealand occupying 27% of total farmland (June, 1992). Figure 5.1 illustrates the distribution of sheep by region. Canterbury (18.3%), Southland (15.3%), Manawatu-Wanganui (15.1%) and Otago (14.8%) account for almost two-thirds of the total flock.

[1] New Zealand has the fourth largest flock, but the second largest production due to higher clip yields as a result of the coarser wool produced and lower levels of grease and other contaminants.

TABLE 5.1

World Wool Production

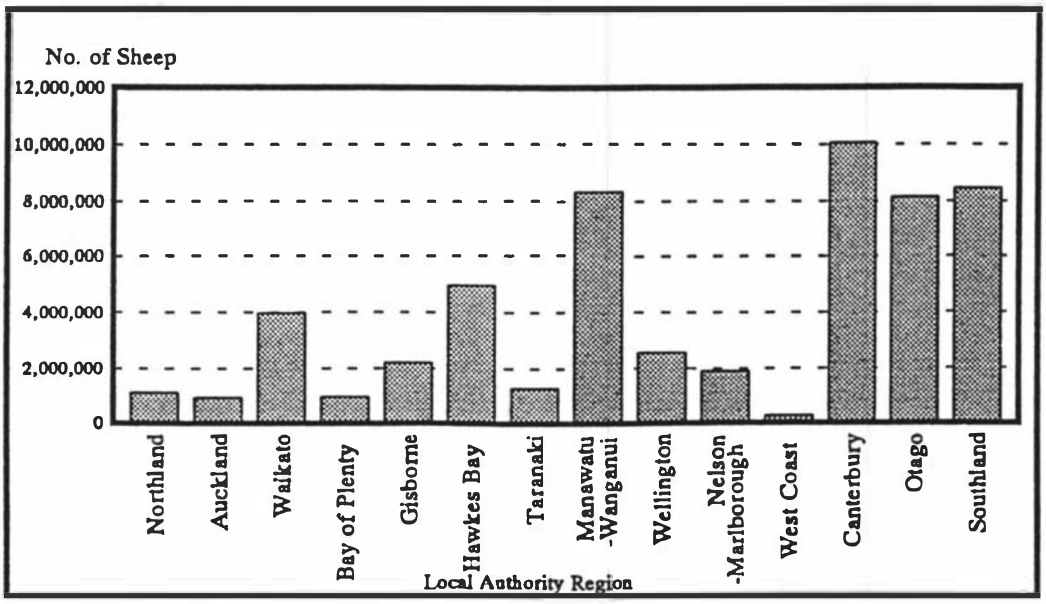
('000 clean tonnes)

Country	1992-93	1991-92	% change
Australia	561	574	- 2.2%
New Zealand	193	221	- 12.7%
C.I.S.	170	188	- 9.6%
China	124	120	+ 2.5%
Argentina	68	73	- 6.8%
Uruguay	55	57	- 3.5%
South Africa	44	49	- 10.2%
TOTAL WORLD PRODUCTION	1664	1727	- 3.6%
Merino	784	804	- 2.5%
Halfbred	413	408	+ 1.2%
Crossbred	467	515	- 9.3%

Source: New Zealand Wool Board, 1992-93 Statistical Handbook

FIGURE 5.1

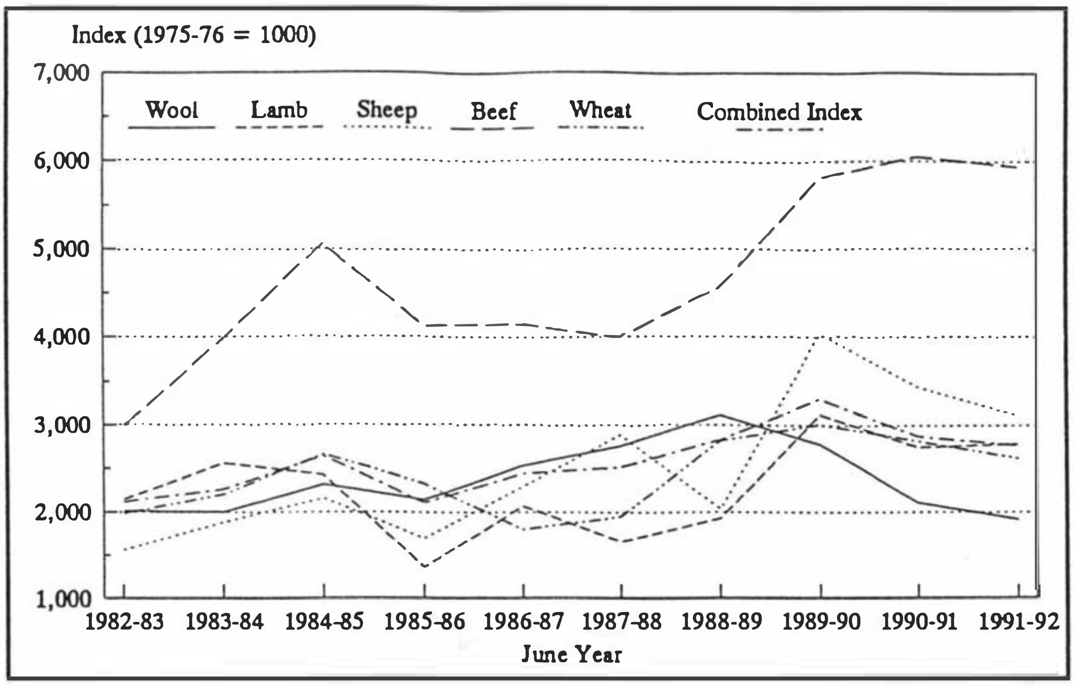
Distribution of the Flock by Region



Source: New Zealand Wool Board, 1992-93 Statistical Handbook

FIGURE 5.2

Relative Farm-Gate Returns: 1983-92



Source: New Zealand Meat & Wool Board's Economic Service Annual Review of the Sheep & Beef Industry, 1991-92.

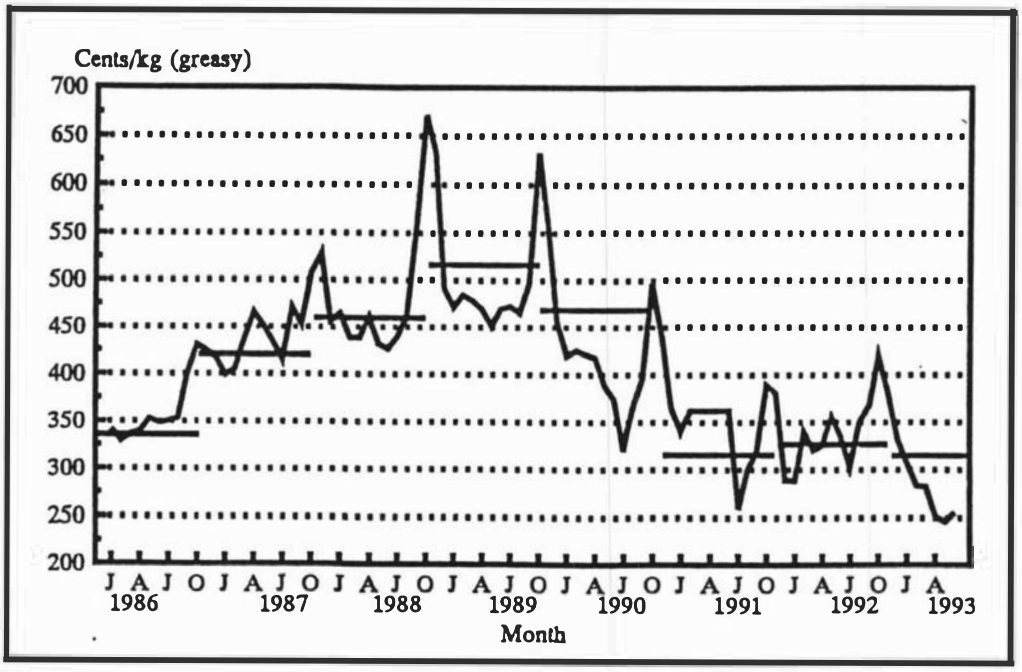
New Zealand agriculture has undergone some major structural changes in the past decade.[2] Previously, Government intervention, in the form of financial assistance, was substantial, peaking at 33% of output in 1982-83. In 1984 the unsustainability of this fiscal commitment was acknowledged when first, National, and then the newly elected Labour Government, announced a programme of support termination with the abandonment of the Supplementary Minimum Price Scheme (SMP) and withdrawal of concessionary financing to the Producer Boards. The devaluation of the New Zealand dollar during 1984-85, coupled with favourable overseas prices for major agricultural commodities provided some support to producers through the early stages of this transition process. However, from late 1985 through to 1988 high

[2] For a good account of this industry reformation see Sandrey, R. & Reynolds, R. *Farming without Subsidies*, 1990.

domestic inflation, appreciation of the exchange rate and a continuation of the removal of production assistance impacted unfavourably on the agricultural sector in particular. The result was quite evident on the wool industry. Figure 5.2 shows that, in terms of prices received at farm gate, relative wool returns have, since 1988, remained well below that of other agricultural outputs, particularly beef. This is in spite of some gradual strengthening of farm-gate returns for wool in recent years (See Appendix N for a more detailed analysis of the 1991-92 and 1992-93 seasons). Figure 5.3 illustrates the general decline in the auction price for wool in the period 1986-93.

FIGURE 5.3

Average Auction Price of Greasy Wool - Cents/kg



Source: Department of Statistics

5.2.2 Composition of the New Zealand Flock

The New Zealand sheep flock currently numbers 52.6 million (1992-93), a fall of 4.7% on the previous season. This number of sheep is the lowest in the past 16 years. Figure 5.4 shows that sheep numbers reached a peak of 70.3 million in 1982-83 when subsidies and supplementary prices were prevalent.

The majority of the flock are New Zealand Romney's. Table 5.2 outlines the composition of the New Zealand flock by breed. The Romney and related breeds (*i.e.* Coopworth and Perendale) produce what are termed 'Crossbred' wools which range in diameter from 30 to 40 microns, with the bulk being in the 35 to 38 micron range. Merinos, which account for 4% of the national flock, produce fine wool in the 18 to 24 micron range. Halfbred and Corriedales were developed by cross-breeding the Merino with one of the strong wool breeds. The result is that the wool falls in the medium micron range *i.e.* the 25-33 micron range. Figure 5.5 illustrates the fibre diameter range associated with each major breed.

TABLE 5.2

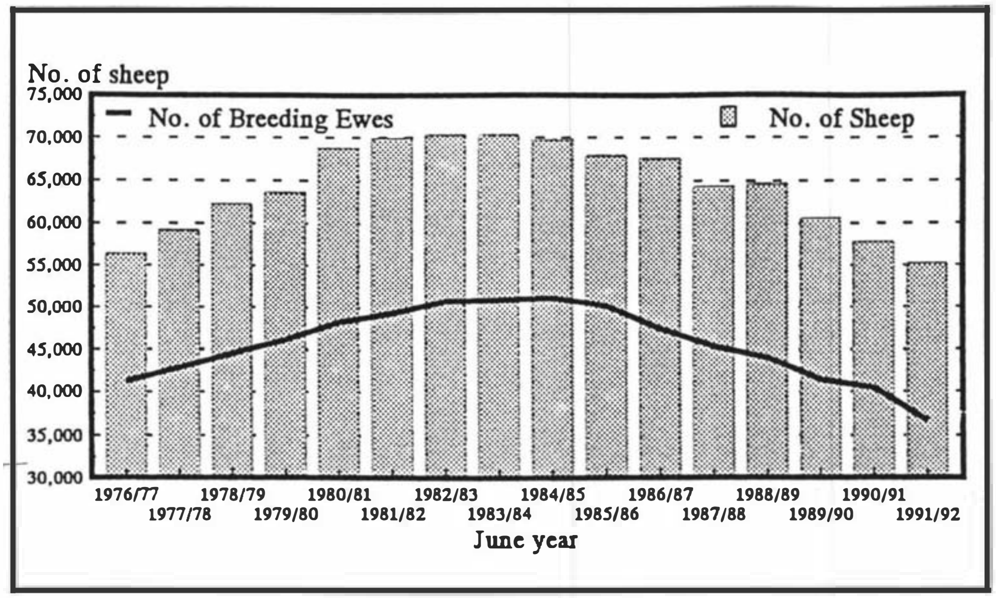
Composition of the National Flock

Breed	1984 Census of Agriculture		1989 Census of Agriculture		% Change
	Total Sheep ('000)	% of Flock	Total Sheep ('000)	% of Flock	
COARSE					
Romney	27,688	39.70	27,709	45.75	0
Coopworth	13,454	19.29	7,572	12.50	-44
Perendale	10,641	15.26	4,782	7.89	-55
Drysdale	571	0.82	547	0.90	-4
Border	731	1.05	525	0.87	-28
Leicester	1,386	1.99	516	0.85	-63
Borderdale					
MEDIUM	3,844	5.51	2,736	4.52	-29
Corriedale					
Halfbred	2,459	3.53	2,312	3.82	-6
FINE					
Merino	1,441	2.07	2,481	4.10	72
Other Breeds	7,524	10.79	11,392	18.80	66
Total	69,739	100.00	60,572	100.00	-13%

Source: Department of Statistics

FIGURE 5.4

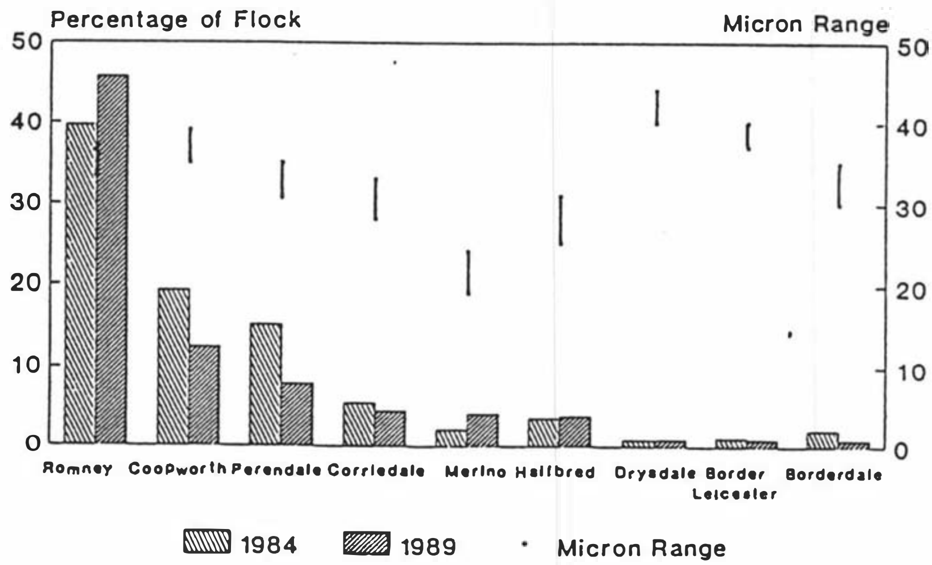
The New Zealand Sheep Flock



Source: Department of Statistics

FIGURE 5.5

Composition of the Sheep Flock and Fibre Diameter Range



Source: New Zealand Wool Board Statistical Handbook, 1991-92.

5.2.3 Wool Production and Exports

An important point to recognise is that wool is a joint product with sheepmeat. Wool production decisions are therefore, influenced by both wool and sheepmeat (particularly lamb) returns. As mentioned earlier, total wool production during the 1992-93 season was some 193,001 tonnes clean (255,542 tonnes greasy), down 12.6% on the previous season. Table 5.3 shows that while production has tended to fall over the past five seasons, the 'supply' of wool has been tended to be maintained due to increases in stocks.

Virtually all of the wool produced in New Zealand is exported. Because of the nature of the stock producing wool, New Zealand is the largest exporter of coarse wools, while Australia is the largest exporter of fine wools. The coarseness of the wool produced means it tends to be used primarily for interior textiles, such as carpets, rugs, blankets and furnishings. Just on a third of the wool produced goes towards the production of apparel. Figure 5.6 illustrates the end-uses of New Zealand wool.

China is by far the leading export destination for New Zealand wools. During 1992-93, China purchased $185 million or 1/5 th of the wool exports. The New Zealand wool fibre is used mainly in conjunction with local wools through blending to produce handknotted carpets and rugs. Other major export destinations include the traditional trading partners such as the United Kingdom ($74m) and Japan ($78m) as well as newer markets such as Nepal ($82m), India ($44m) and Hong Kong ($44m). The Asian and Indian sub-continent markets now account for 57% of New Zealand's wool fibre exports compared with 42% five years ago. Total wool exports in 1992-93 were $0.887b compared to $1.057b in 1991-92. The average FOB value however, was $4.91/kg in 1992-93 compared to $4.80/kg in 1991-92. Scoured wool exports remained the main form of wool export from New Zealand, accounting for 79% of wool fibre exports compared with 63% five years ago. Figure 5.7 illustrates the major markets for New Zealand wool. The export of wool and wool products during the 1992-93 year represented about 4% of total merchandise exports.

TABLE 5.3

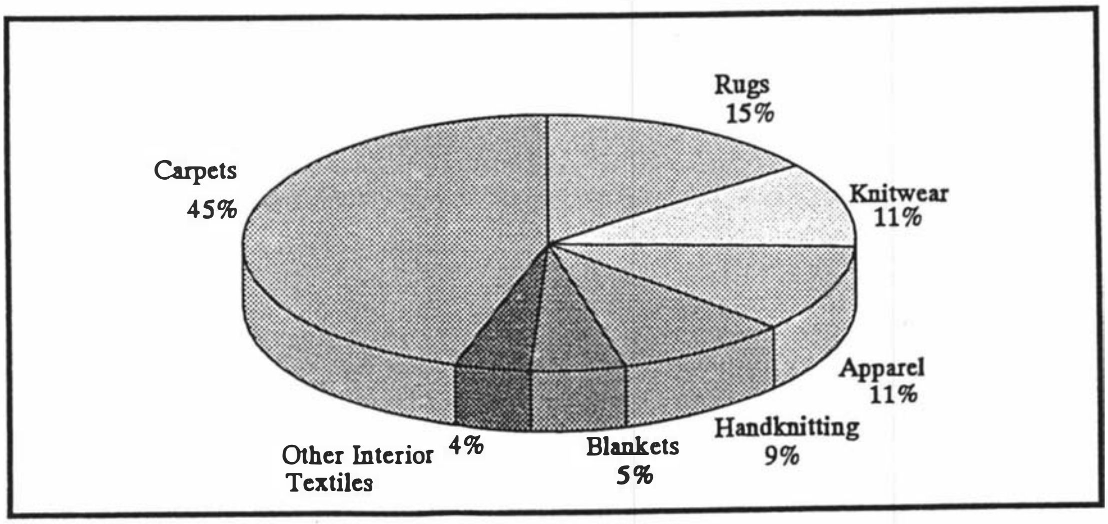
New Zealand Wool Production and Wool Availability
('000 tonnes clean)

	1987-88	1988-89	1989-90	1990-91	1991-92	1992-93
Growers wool sold at auction	167.1	164.1	154.4	153.3	140.1	116.4
Growers wool sold privately	63.7	62.4	51.2	44.1	51.9	48.5
Slipe	26.3	27.6	23.8	27.8	29.7	25.4
Sheepskins	2.0	2.2	1.4	1.0	1.1	0.7
Change in stocks	0.4	-2.1	2.0	1.3	-2.1	+2.0
TOTAL PRODUCTION	259.5	254.2	232.8	227.5	220.8	193.0
NZWB Opening Stocks	3.9	12.9	11.8	60.4	72.0	53.4
TOTAL WOOL AVAILABILITY	263.5	268.1	242.5	287.9	292.8	246.4

Source: New Zealand Wool Board.

FIGURE 5.6

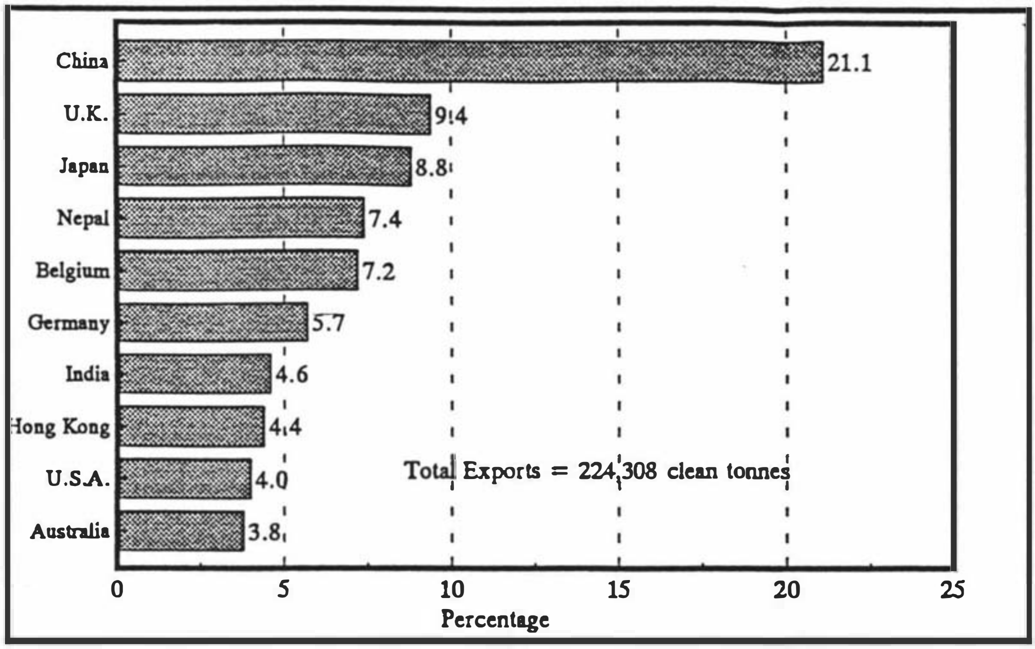
End-Uses of New Zealand Wool



Source: New Zealand Wool Board.

FIGURE 5.7

Major Markets for New Zealand Wool - 1992-93
(% of total clean tonnes)



Source: New Zealand Wool Board.

5.3 THE WOOL MARKETING SYSTEM IN NEW ZEALAND

5.3.1 Selling Options Available to the Grower

Currently, there are three alternative ways in which the woolgrower can dispose of wool. These are through direct sales to a private merchant or wool processor, indirectly to meat processors who remove the wool from pelts as slipe wool or through the public auction system. A fourth option, which used to be available to growers and was known as the Growers' Alternative Selling Scheme (GASS), is basically a variant on private sales. Introduced in 1988-89 and run by the New Zealand Wool Board, the scheme was specifically tailored for small lots (*i.e.* up to four bales) made up mostly of oddments. The Board bought the lots and recombined them into larger lots to be sold to the trade as private sales. By far the majority of wool is sold through the auction system (67%). Just under a fifth of the wool (19%) is sold to private merchants while the remainder is sold as slipe (14%). Figure 5.8a and Figure 5.8b show the supplies of wool onto the market throughout the 1991-92 and 1992-93 seasons.

FIGURE 5.8a

Wool Supplies onto the Market: 1991-92 Season

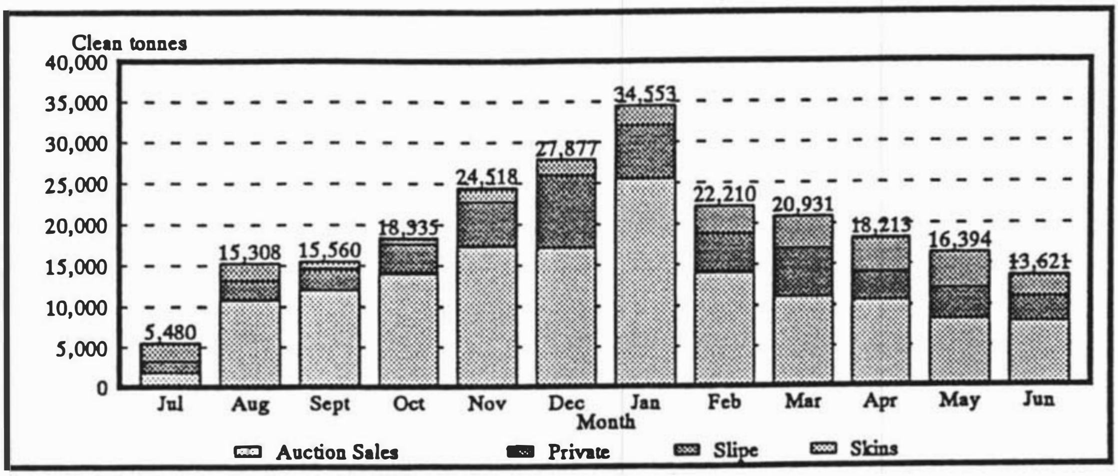
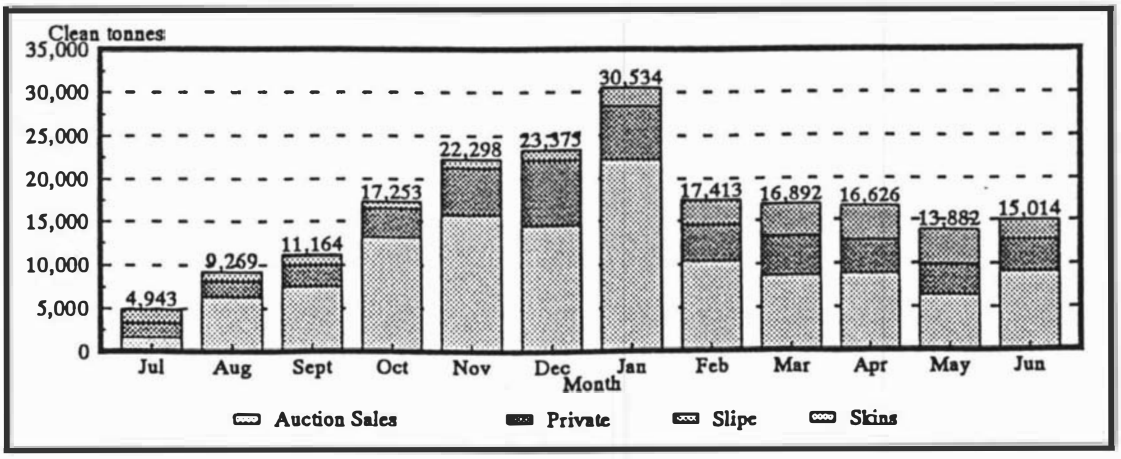


FIGURE 5.8b

Wool Supplies onto the Market: 1992-93 Season



Source: New Zealand Wool Board

Figures 5.9 and 5.10 illustrate the flows of wool and information from the growers through to the processors.

As can be seen from Figures 5.9 and 5.10 overpage there are a large number of participants in the marketing system with each having a specific role. Sections 5.3.2 to 5.3.7 of this chapter discuss the role of each of these participants within the system.

5.3.2 Certification and Testing

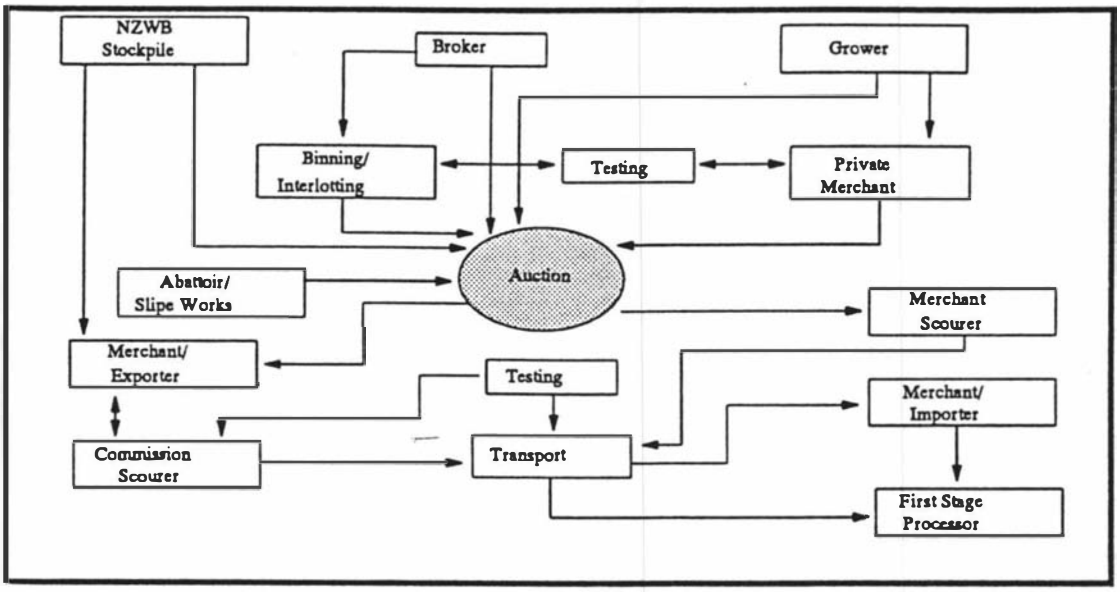
There are potentially over 2000 combinations of wool available. Each wool type possesses a range of strength, colour & length attributes which all influence the value of the wool (See Appendix M for details). The administration of the market process in this situation would involve considerable risks for both buyer and seller, as well as imposing other significant transaction costs. In an attempt to standardise the wool being offered for sale into some consistent and objective measurement system, virtually all wool offered for sale must have an accompanying sale certificate.

The New Zealand Wool Board will only allow wool which has been tested by an accredited testing agency to be entered into the sale system. Such accreditation is gained from a organisation known as TELARC (Testing Laboratory Registration Council of New Zealand). Currently the testing of wool is undertaken by either one of two companies; SGS Wool Testing Services Ltd., or the New Zealand Wool Testing Authority Ltd.

Testing of the wool involves taking a core sample from each bale. Measurements are then taken for fibre diameter (*i.e.* the micron), yield, vegetable matter and colour.

FIGURE 5.9

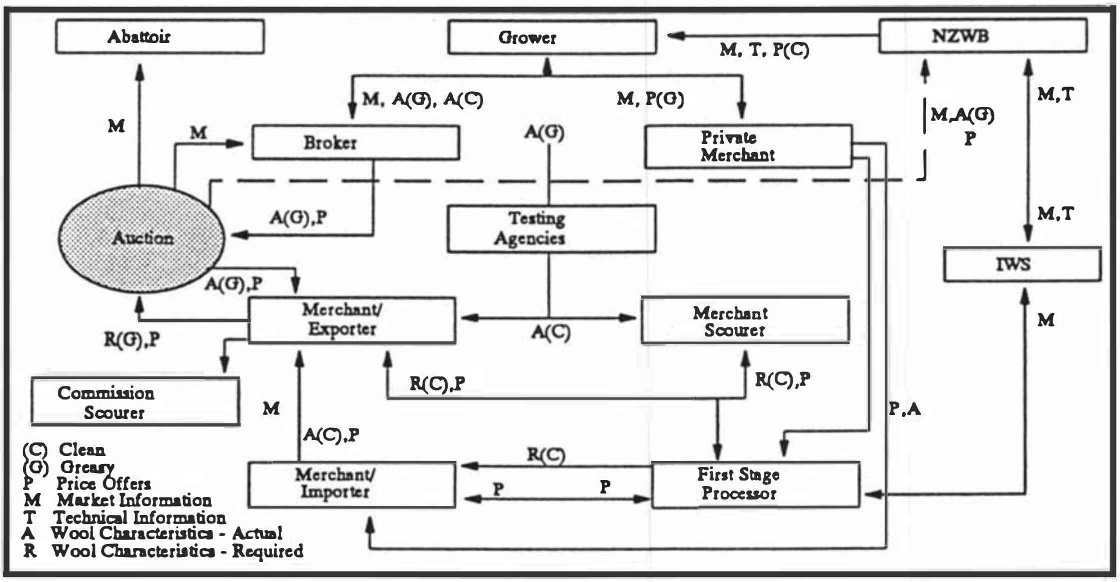
The Flow of Wool from Grower to Processor



Source: Arthur D. Little Report, 1992,p. 9

FIGURE 5.10

The Flow of Information From Grower to Processor



Source: Arthur D. Little Report, 1992, p. 9

5.3.3 Pre-Auction System

The wool which is to be offered for sale is usually received direct from the grower by brokers. Brokers receive the wool into their wool stores. Each grower's offering is referred to as a 'lot'. Sometimes these lots may need to be reclassed or 'binned'. Reclassing may be necessary for particularly large lots in which more precise divisions are required in terms of style and quality. Binning refers to a process in which the similar wools from different growers are mixed together to form larger lots.[3] Individual growers lots may also be 'interlotted', that is combined into one bigger lot.

The broker is responsible for presenting the wool prior to the auction sale so that it can be appraised by the buyers. In most cases, a 5 kg. 'representative' sample drawn from a lot is displayed along with a testing certificate. Sometimes, a proportion of the bales within each lot (*i.e.* up to a third) may be stacked in the display room and made available for inspection by the buyers. Buyers have access to these wool displays up to three days before the auction is held. Using their own subjective assessments and/or the objective certification information, valuations or 'limits' are developed and written into catalogues made available by the brokers. This valuation, in effect, represents the maximum price the buyer is prepared to pay for each lot.

The auction process takes place in a selling hall in which each lot is sold to the highest bidder. Bids are taken in ½ cents per kilogram steps up to 100 cents, and in 1 cent increments per kilogram after that. Growers may also make a reserve price applicable to their particular lots. If the bidding does not reach the reserve price, the wool is 'passed in'. The proportion of wool offerings which are passed in ranges from around 10% to 30% per sale dependent on the time of the year and grower expectations. In the 1992-93 season, passings reached levels over 50% as a result of poor quality wools, high grower price reserves and lack of demand for some lines. Wool that has been passed in may be reoffered at a later date, or sold privately.

[3] In this case the proceeds are distributed according to the proportion of the growers offering into the composite lot.

5.3.4 Wool Exporters

The majority of wool in New Zealand is purchased by exporters. An exporter must be licensed by the New Zealand Wool Board. A licence is usually given to anybody deemed to be 'financially viable'. While there are over 140 licence holders at present, most of the trade is accounted for by about 20 exporters.

Generally, the exporter buys wool to fulfil some future order. These orders may come from local or overseas processing mills or other merchants. Such orders may involve specific contracts three to six months ahead. These orders are known as 'commission orders' with specified quantities, wool types and prices. Wool purchases may also be made on 'indent orders' which are short-term orders made on the day of or just before the auction sale. Alternatively, the buyer may purchase wool in the hope that the price will subsequently rise enabling a speculative profit to be made.

The exporter has the choice to either purchase privately or purchase through the auction system to fulfil the orders. Judgements must therefore be made by the exporter as to anticipated supplies, prices and demand conditions. Stockholdings, credits, foreign exchange cover and futures are instruments which may also be used to facilitate contract supply management.

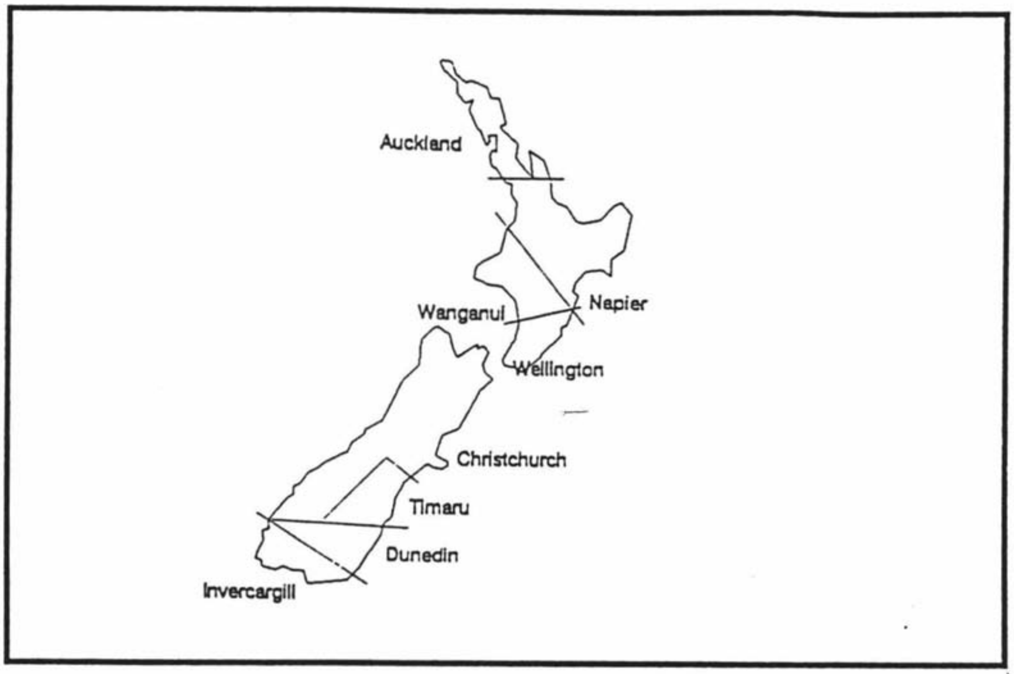
5.3.5 The Wool Auction System

There are seven auction centres designated throughout New Zealand. These seven centres and their sources of supply are shown in Figure 5.11. For efficiency purposes however, the actual auction process is conducted either from Napier or Christchurch[4]. Subject to supply conditions, these auctions are usually held on a weekly basis throughout the season (September to July) with one sale in the North Island and one in the South Island. These sales are usually not held on the same day however. If there is insufficient wool for a viable sale (*i.e.* 15,000 bales), offerings

[4] There is currently a proposal to evolve the system into a single selling centre, based at either Napier or Christchurch.

FIGURE 5.11

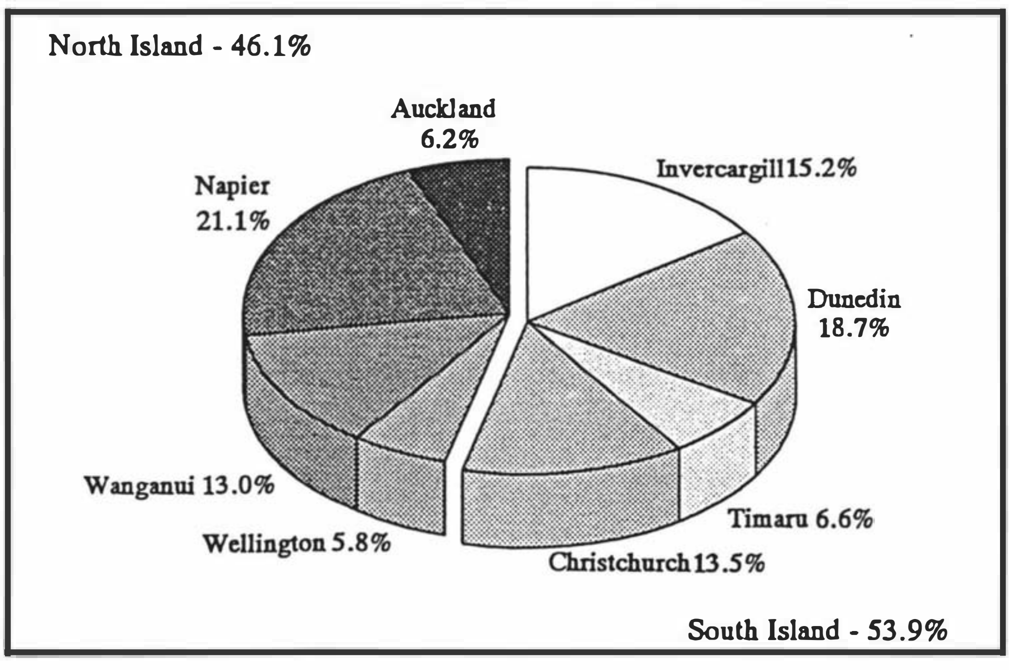
Wool Auction Centres and Supply Areas



Source: New Zealand Wool Board.

FIGURE 5.12

Proportion of Wool Sales by Auction Centre: 1991-92 Season



Source: New Zealand Wool Board.

from both centres may be combined at the one sale. Alternatively, if there is too much wool available for a particular centre, then a two-day sale may be held. Limits on the amount of wool and the number of lots which may be offered in the one day are set to ensure that the selling days are not too long and that too much wool is not offered over a short period which may have an undue effect on price.

Generally, the auction sales are attended only by recognised wool buyers. At the beginning of the season, seats are allocated according to the quantities of wool purchased in the previous season. Therefore the buyer who purchased the most wool is given the first choice of the best seat, and so on. On average, there are about 30-40 buying firms at a sale.

The largest selling centre is Napier which last season sold some 30,000 tonnes of wool. Auction sales are conducted under the auspices of an auction sales committee which comprises representatives of the New Zealand Wool Board, the New Zealand Woolbrokers Association, and the New Zealand Council of Wool Exporters. The committee is responsible for drawing up and supervising an annual roster of wool auctions.

5.3.6 Post-Auction Systems

After the sale, buyers are required to pay for any purchases on or before 'prompt' date, which is usually about 18 days after each sale. The bales which had been put on display are repacked. The wool may then be either shipped direct to the customer, or sent to a scouring plant. The wool may also be tested after scouring to check for the features mentioned previously as well as length-after-carding and bulk.

Bales of wool which are destined for overseas buyers are often 'dumped'. Dumping refers to the process of pressing bales of wool together to compress the bulk. The wool is then usually placed into a container and shipped to the importing country.

5.3.7 The Role of the New Zealand Wool Board

The role of the New Zealand Wool Board has changed quite considerably in the last two seasons. The Board, which operates under the Wool Industry Act, 1977, is charged with getting the best possible long-term returns for New Zealand woolgrowers. It does this by promoting the use of New Zealand wool, encouraging efficiencies in the preparation, handling, distribution and selling of wool, and by undertaking research and development into wool and wool products. More specifically the Board is involved in the:

(1) *operation of a price support stabilisation scheme which involves intervention to sell wool (market support), and a guaranteed minimum price scheme to growers* (See Section 2.15, Chapter Two);

(2) *funding to the international Wool Secretariat which is a joint venture organisation with Australia, South Africa and Uruguay to promote the demand for wool internationally;*

(3) *funding and management of R & D in marketing, processing and product development, and wool production;*

(4) *licensing of all wool exporters and the determination and policing of quality standards and selling methods;*

(5) *negotiating and determining maximum freight rates and minimum services, and designating carriers (or influencing these outcomes indirectly in some instances), for the transport of export wool;*

(6) *investing in activities which have the potential for commercial returns or which may contribute indirectly to achieving the Board's objectives;*

(7) *coordinating the industry activities in regard to collation of statistics,*

publication of technical and market information, shearer training and lobbying governments.

(Arthur D. Little Report, 1992, p. 195)

The two grower support schemes, the Minimum Price Scheme and the Market Support at Auction Scheme, were suspended indefinitely in February, 1991.

The Board is funded by two major sources. Most of the income is derived from a compulsory grower levy of 6% set on all wool at its first point of sale in New Zealand. The other source of income is interest derived from investments. Since 1988[5], the Government has provided no direct financial support to the Board.

5.4 IDENTIFICATION OF THE APPROPRIATE DATA COLLECTION UNIT

As shown in Figures 5.9 and 5.10, the value chain of the wool industry is relatively long with many participants contributing various elements to the overall marketing process. In terms of meeting the objectives of this study however, it is apparent that it is the buyers at auction, or brokers, which will provide the necessary experimental data. More specifically, the person within the exporting/broking company who is responsible for setting the limits on purchases will need to be identified and interviewed. The remaining sections of this chapter describe the sample and methodology that was used to collect the data.

[5] In 1988, the Government removed access to concessional finance from the Reserve Bank and loan guarantees.

5.5 SAMPLE

The sample frame consisted of licensed wool exporters as outlined in the New Zealand Wool Board's 1991 Statistical Handbook. Information obtained from the New Zealand Council of Wool Exporters was then used to stratify exporters by the extent of wool purchases made at auction during the 1990-91 season. The sample frame was restricted to exporters in Wellington, Napier and Christchurch primarily for reasons of interviewing efficiency. It was felt that restriction of the sample frame to these three areas would not be detrimental given that the Head Offices, and hence the chief buyers, of almost all the major companies were in these localities. A list of potential respondent addresses was compiled from the Yellow Pages of the telephone book and an initial phone contact made to solicit participation in the study. Appendix F outlines the panel recruitment procedure. Two of the largest buying firms refused to participate in the study. In both instances, representatives of the firm could not guarantee their continued availability or time over the study period.

The respondents in all cases were the buyers associated with the firm who had responsibility for setting the limits of prices for the purchase of raw wool through the auction system. Depending on the size of the company, these buyers may either attend the auctions themselves, or send a representative agent with guidelines as to purchase requirements and price limits.

A sample of eleven wool buyers was finally selected using a convenience sampling approach reflecting a useful mix of size, purpose and ownership. Three firms were selected in Napier, two in Wellington and six in Christchurch. The panel of 11 firms purchased between 30-40% of the wool offerings during the 1991-93 seasons. A separate questionnaire was distributed in June 1993 to collect demographic information (Appendix H). Tables 5.4 to 5.11 below summarise the key sample characteristics.

TABLE 5.4

Sample Characteristics - Turnover ($m)

	Number	Percentage
Less than $1m	0	0
$1m - $20m	4	36
$21m - $50m	4	36
More than $50m	2	18
Refused	1	9

TABLE 5.5

Sample Characteristics - Ownership

	Number	Percentage
New Zealand owned	4	36
Foreign owned	7	64

TABLE 5.6

Sample Characteristics - Major Purpose of Company

	Number	Percentage
Purchase wool for local processors	0	0
Purchase wool for overseas processors	10	91
Purchase wool for speculative purposes	1	9
Purchase wool on behalf of overseas merchants	0	0

TABLE 5.7

Sample Characteristics - Major Markets

	Number	Percentage
Australia	7	64
Belgium	10	91
China	10	91
Germany	9	81
Hong Kong	10	91
India	9	81
Japan	10	91
South Korea	7	64
Nepal	6	55
Pakistan	6	55
United Kingdom	9	81
United States	6	55
Other European[a]	11	100
Other Mid East[b]	11	100

Notes: a Predominately Turkey, France, Netherlands
b Predominately Iran

TABLE 5.8

Sample Characteristics - Primary Market

	Number	Percentage
China	4	36
Hong Kong	1	9
Iran	1	9
Japan	2	18
Nepal	1	9
United Kingdom	1	9
More than 1	1	9

TABLE 5.9

Sample Characteristics - Years Company has been involved in New Zealand Wool Market

	Number	Percentage
Less than 10 years	2	18
11 - 20 years	1	9
21 - 30 years	1	9
31 - 40 years	1	9
More than 41 years	6	55

TABLE 5.10

Sample Characteristics - Years Personally been involved in New Zealand Wool Market

	Number	Percentage
Less than 10 years	1	9
10 - 15 years	2	18
16 - 20 years	3	28
21 - 25 years	2	18
26 - 30 years	1	9
More than 30 years	2	18

TABLE 5.11

Sample Characteristics - Years Experience in Trade

	Average (Years)	High (Years)	Low (Years)
Company Operating in N.Z.	38.0	70	3
Experience in wool trade	22.5	46	9
Employment with current company	14.2	30 (x2)	2

5.6 METHOD

5.6.1. Questionnaire Development

The development of the questionnaire represented a critical part of the study. A review of the literature showed the need to avoid ambiguous questions, and to be clear in terms of the questions and their relationship to the objectives set (Churchill, 1991). The format of the introduction to the questioning procedure was based on previously successful studies of probability elicitation. A draft survey was pre-tested for ease of understanding and clarity on a group of five post-graduate students at Massey University. Furthermore, colleagues within the department, which itself has a strong research orientation and record, were able to comment on particular aspects related to questionnaire design.

The interviewing process went through three stages. First, respondents were asked to answer some general questions related to the wool market. Next, the respondents worked through a series of price scenarios for different types of wool. Finally, the respondents were questioned on aspects of the wool trade in a largely free-ranging discussion. Each of these stages will be discussed in turn.

5.6.2 Section One - General Questions

The literature reveals the need for respondents to be fully aware of all factors which are likely to impact on their decision making process when a researcher is attempting to elicit subjective probabilities (U, 1991; Clawson, 1971; Juster, 1966). To help facilitate this, respondents were asked three general questions related to various aspects of the wool market. In the first four surveys (October, 1991 to January, 1992) three qualitative questions relating to amount of total wool available to purchase, total amount of wool purchased and movements in the USD/NZD exchange rate were asked[6]. From February 1992 to July 1992, a fourth qualitative question regarding expectations about the New Zealand Wool Board's Full Indicator Price for wool was added. A fifth general open-ended question on factors which may change expected buying levels over the next four week period was also asked. The idea behind these supplementary questions was to encourage the respondents to think about likely events over the forecast horizon as well as provide additional information for the data calibration at a later stage.

At the beginning of the 1992-93 season, it was decided to expand the range of questions being asked for two reasons. First, it became apparent that the decision parameters being considered by the elicitation of the subjective probabilities often encompassed more than just the next four weeks. In many cases, forward orders over the next two months, or anticipated changes in wool offerings and types available later in the season were being explicitly considered. To incorporate this into the data collection process, additional questions related to the following month in comparison to current month were asked. These qualitative questions covered quantity of wool purchased, amount of wool being offered, private stockholdings and movements in the Indicator Price. The second reason for the inclusion of these questions was that it allowed some, albeit modest, test of the respondents' forecasting ability by allowing a comparison of their expectations with the actual realisations at the end of each period. This 'test' was further developed by the inclusion of a question relating to the expectation of the New Zealand Wool Board's Indicator Price, in cents, at the end of the four week forecast horizon. A copy of the questionnaire is included in Appendix H (Part A).

5.6.3 Section Two - The Elicitation of Subjective Probabilities

The most crucial part of the data collection procedure, that of the elicitation of the probabilities, occurred at the second stage. The surveying procedure made use of four items;

[6] Conway (1989) suggests that up to 75% of the variation in the indicator price is attributable to changes in the USD/NZD exchange rate.

(a) **Seven showcards** with ranges of wool purchases that could be made over a four week period. Appendix K details these cards.

E1 - up to 60 bales per month
E2 - up to 120 bales per month
E3 - up to 600 bales per month
E4 - up to 1200 bales per month
E5 - up to 6000 bales per month
E6 - up to 24,000 bales per month
E7 - up to 60,000 bales per month

(b) **A showcard illustrating a probability scale.** It was decided to adopt the form of the probability scale developed by Juster (1966) and validated by Gendall *et al* (1991). In other words, the probability scale levels were fully qualitative and accompanied by quantitative descriptions (see Appendix L).

(c) **25 flip cards** with price levels for greasy wool in cents per kg. (Appendix J). This was included to serve as a prompt for the respondent about the exact parameters of each scenario.

(d) **10 plastic counters.** The use of 10 plastic counters, with each representing 1/10th probability, ensured that the probabilities added to one. Other studies had dealt with up to 25 counters (Sri Ramaratnam, 1992; 1983) but it was felt that this many would have led to respondent fatigue.

The first three surveys (October, 1991 to December 1991) used a set of four prices for three groups of wool. These wool groups are given in Table 5.12. The wool groups were chosen as representing distinct types of end-use. For example, fine wools tend to be used in apparel while the coarse wools tend to be used in carpets. It was felt that this would provide more useful results given the difficulties encountered in previous studies which tended to aggregate all types of wool into one category (See Section 3.6).

TABLE 5.12

Wool Categories Used - October 1991 to December 1991

CATEGORY	DEFINITION
Fine Wools	less than 24 microns
Medium Wools	25 to 32 microns
Coarse Wools	33 microns or more

Four price levels were presented to the respondent to invoke some reaction in terms of buying intentions. The price levels chosen were set at ± 5% and ± 10% of the prevailing market price at the beginning of the forecast period. It was considered that this range would be sufficiently large to engage buyer reaction to first, prices just above or below the prevailing level and second, prices substantially lower or higher than the prevailing level. The individual price levels were determined by taking the prevailing price at the latest North and South Island auctions for a 'representative' wool type within each category. These representative wool types, which are shown in Table 5.13, were chosen after consultation with the New Zealand Wool Board. Appendix M gives details of the wool type codes.[7]

After the first three sets of interviews it became apparent that the three wool categories being used were too broad for the respondents. This was particularly the case in the coarse wools group where forecasting decisions were being made on wools with completely different purposes and where the prices being used bore no relation to the predominant wool types on offer.

---

[7] The Wool Board have an inventory and appraisal system based on a series of codes relating to micron, category, style and length. e.g. 37 - F - 3 - D.

Micron	The tested diameter (*i.e. 37 microns*).
Category	Describes from which part of the body the wool comes from (*i.e. F = main body wool*).
Style	A broad term used to combine characteristics of colour, crimp, condition, strength, degree of vegetable matter and processing faults (*i.e. 3 = average wool*).
Length	The length of the staple (*i.e. D = 100-150 mm.*)

TABLE 5.13

Representative Wooltypes for Price Setting

- October 1991 to December 1991

CATEGORY	REPRESENTATIVE WOOL TYPE
Fine Wools	22F1W
Medium Wools	28F2W
Coarse Wools	37F3D

From January, 1992 the coarse wools category was split into two groups; medium-coarse and coarse (Table 5.14).

At the beginning of the 1992-93 season, and after consultation with the respondents, further adjustments were made to the wool groups. A fifth category was created to refine the medium category and several new representative prices used to better reflect the structure of the market offerings (Table 5.15). Furthermore a fifth price

TABLE 5.14

Wool Categories Used - January 1992 to July 1992

CATEGORY	DEFINITION	REPRESENTATIVE TYPE
Fine Wools	less than 24 microns	22F1W
Medium-Fine Wools	25 to 32 microns	28F2W
Medium-Coarse Wools	33 to 35 microns	35C3O
Coarse Wools	36 microns or more	37F3D

level, the prevailing price for the particular wool type, was added. In total, respondents were now expected to answer to five price scenarios for five categories of wool (*i.e.* 25 questions in total), in comparison to the four price scenarios for three categories at the start of the study (*i.e.* 12 questions in total).

TABLE 5.15

Wool Categories Used - October 1992 to June 1993

CATEGORY	DEFINITION	REPRESENTATIVE TYPE
Fine Wools	less than 24 microns	21F1W
Fine - Medium Wools	25 to 28 microns	25F1W
Medium Wools	29 to 32 microns	29F2W
Medium-Coarse Wools	33 to 35 microns	35F3E
Coarse Wools	36 microns or more	37F3D

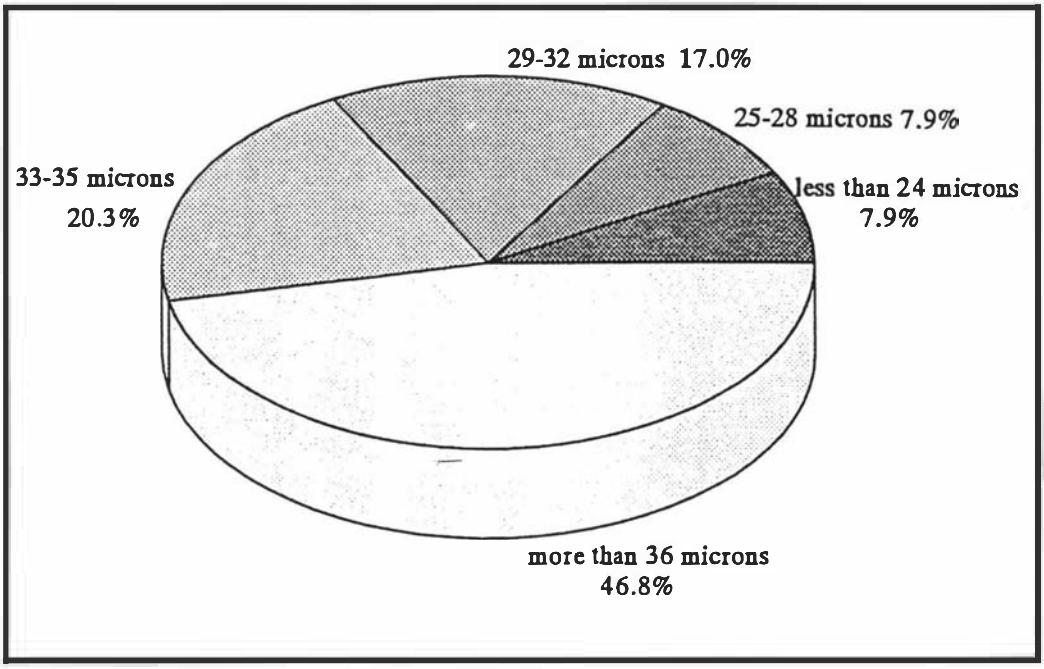
Figures 5.13a and 5.13b show the proportion of wool sold according to these five categories during the 1991-92 and 1992-93 seasons.

At the first interview, respondents were presented with an explanatory card (Appendix G) outlining the data collection procedure that was to be used. After reading this, the respondents were allowed to run through a few 'dummy' runs to become familiar with the research instruments. At subsequent interviews, this procedure was repeated although by the third or fourth interview, the majority of the panel had become familiar with the instruments.

Respondents were asked to consider the next four week period and "*...taking everything into account...*" to make some subjective estimates on the quantity of wool (*i.e.* the number of bales) that they would buy at the price being shown to them.

FIGURE 5.13a

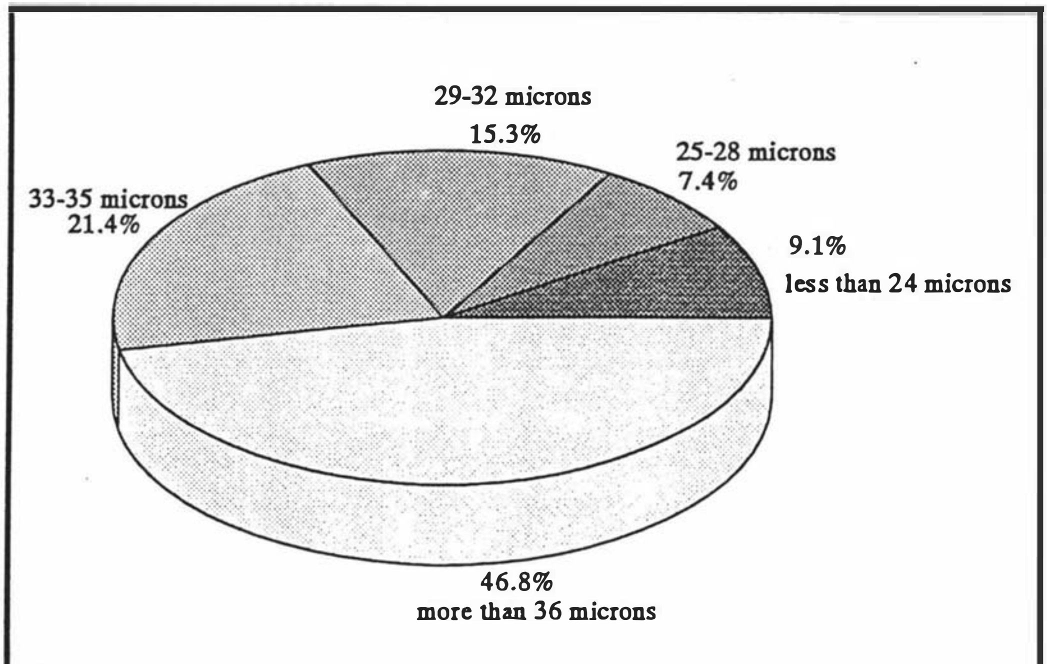
Wool sold by Micron Group - 1991-92



Source: New Zealand Wool Board.

FIGURE 5.13b

Wool sold by Micron Group - 1992-93



Source: New Zealand Wool Board.

The question took the following form:

*" I would now like to ask you some questions regarding **YOUR INTENTIONS** to purchase various quantities of wool over the **NEXT FOUR WEEKS** at various prices."*

*" We will run through twenty five questions in total and I would like you to consider **ALL THE THINGS** that may be likely to affect your purchases of wool at these particular prices."*

" You should use the two cards together to work out how many counters you should place on the maximum quantities you would buy."

*" Remember, if you think there is only a very slight possibility of buying, **AT MOST, THAT QUANTITY AT THAT PRICE,** you should put 1 counter on that row. If you are uncertain as to what your exact intentions would be, choose an answer as close to '0' or '10' as you think is appropriate."*

" In all cases the sum of the probabilities must add up to '1'. In other words, all 10 counters must be used."

" Finally, you should remember that there is no right or wrong answer, only what you think is most likely."

*" The first series of five questions relates to [**FINE WOOL ONLY.** By fine wool, I mean any wool 24 microns or less].*

" Imagine that the price of [fine wools, that is wools less than 24 microns], was being offered at the auction is [$6.00/kg] C.O.F."

" Could you please place the counters on the board to show the probabilities of purchasing bales of [fine wool at $6.00/kg] over the next 4 weeks?".

Using one of the showcards E1 to E7 (Appendix K), respondents were left to arrange the 10 counters on particular maximum quantities of wool that they would buy.

An example of one completed interview is shown in Figure 5.14.

FIGURE 5.14

An Example of a Completed Interview

SHOWCARD E4:

0 to 1200 Bales per month

	Probability of Purchase *(Chances out of 10)*									
No. of Bales	1/10	2/10	3/10	4/10	5/10	6/10	7/10	8/10	9/10	10/10
0	1	2	3	4	5	6	7	8	9	10
100 (Q1)	1 ●	2	3	4	5	6	7	8	9	10
200 (Q2)	1 ●	2	3	4	5	6	7	8	9	10
300 (Q3)	1 ●	2 ●	3 ●	4 ●	5	6	7	8	9	10
400 (Q4)	1 ●	2 ●	3	4	5	6	7	8	9	10
500 (Q5)	1 ●	2 ●	3	4	5	6	7	8	9	10
600 (Q6)	1	2	3	4	5	6	7	8	9	10
700 (Q7)	1	2	3	4	5	6	7	8	9	10
800 (Q8)	1	2	3	4	5	6	7	8	9	10
900 (Q9)	1	2	3	4	5	6	7	8	9	10
1000 (Q10)	1	2	3	4	5	6	7	8	9	10
1100 (Q11)	1	2	3	4	5	6	7	8	9	10
1200 (Q12)	1	2	3	4	5	6	7	8	9	10

In this example, the respondent has indicated:

a slight possibility of purchasing, at most, 500 bales (*i.e.* 2/10)
a slight possibility of purchasing, at most, 400 bales (*i.e.* 2/10)
a fair possibility of purchasing, at most, 300 bales (*i.e.* 4/10)
a very slight possibility of purchasing, at most, 200 bales (*i.e.* 1/10)
a very slight possibility of purchasing, at most, 100 bales (*i.e.* 1/10)

The pattern of responses was then recorded on a coding sheet as outlined in Appendix I. The respondent was then shown the next (higher) price for the wool group and asked the same question. Respondents were then free to rearrange, if necessary, their probability distribution in response to this new information. Five such prices were used for each group, leading to a set of 5 price-quantity estimates per respondent. Of course, the respondent had the option of buying no wool over the next 4 weeks by assigning probabilities to zero. This process was repeated for each of the five categories of wool. On average, respondents took about 20 minutes to run through all twenty five price scenarios. Verbal comments made by the respondents during this process were also written onto the coding sheets to provide a further source of information and data verification.

5.6.4 Section Three - Free Ranging Discussion

As mentioned previously, it is important that the respondent considers all factors likely to impact upon their subjective assessments during the interviewing procedure. Questions to help focus the respondent on specific aspects of these factors were covered in Section 5.2.1 above. In addition to this however, respondents were engaged in a free ranging discussion to first, help in this focusing process and second, to help the researcher understand some of the external factors influencing the decisions that were being made. These topics of discussion included everything from the weather right through to the influence of the New Zealand Wool Board, as well as international events.

5.7 SUMMARY

This chapter has introduced the New Zealand wool industry and the role of its major participants. It can be seen that the industry is relatively small and auction buying activities tend to be restricted to about 20 companies. Most of the wool sold in New Zealand goes through the auction system, although consideration also needs to be made of the private sales system. Wool purchased through the auction system tends to be exported, and thus demand is likely to be a function of international factors. The distribution of exported wool tends to focus on the wool buyers who attend the weekly auction sales. In terms of targeting the desired respondent for this study it is apparent that it is those people responsible for authorising purchases and setting buying limits that will need to be interviewed. Section 5.4 introduced the characteristics of the eleven member panel that was selected by the convenience sampling approach. This panel represented a good mix of buyers currently operating in the New Zealand auction system. Section 5.5 outlined in some detail the methodology and survey instrument to be used in the four weekly collections of data in order to meet the objectives of this study. The survey was comprised of three sections; the first dealt with qualitative observations on the wool market, the second section involved the elicitation of subjective probabilities for wool purchase forecasts and the third section involved a general open-ended discussion of the wool market.

CHAPTER SIX: RESULTS AND DISCUSSION - AGGREGATE DATA

CHAPTER SIX:
RESULTS AND DISCUSSION
- AGGREGATE DATA

6.1 INTRODUCTION

In Chapter Two, the Powell-Campbell model was introduced as a model which could be used to make some statement about the policy implications of the New Zealand Wool Board's withdrawal from the New Zealand wool auction system. It was seen that 'hidden gains' and 'hidden losses' were generated with the operation of a buffer-stock scheme. The key was to isolate an appropriate demand slope or price elasticity of demand estimate for each of the buying and selling periods. Chapter Three outlined the econometric history of wool price elasticity of demand estimates and concluded that an alternative approach could be applied. The use of a purchase probability instrument (*i.e.* the Juster scale) was outlined in Chapter Four. In Chapter Five, the New Zealand wool market was described before discussion moved onto the development of a sufficient sampling frame and the appropriate sampling unit.

This chapter introduces the analysis of the aggregated data derived from the sample of buyers, as outlined in Chapter Five, over the two seasons. Section 6.2 serves to introduce the development of the calculation of expected purchase levels. Section 6.3 takes each of the four (1991-92) or five (1992-93) price-quantity points and summarises the aggregate derived demand schedules calculated for each of the wool groups in response to the predetermined price changes, as outlined in Chapter Five. Section 6.4 takes these schedules and transforms them into derived demand curves using simple regression analysis. However, in order to establish the 'expected' level of purchases to be made by the panel of buyers it is necessary to first establish a prevailing price. Section 6.5 discusses the use of the New Zealand Wool Board's data on average representative clean prices as a suitable proxy for the prevailing price for each of the wool groups. Having established an 'expected' level of purchase and given a prevailing price, point estimates of the price elasticity of demand for each of the wool group schedules can then be calculated. These are summarised in Section 6.6 for fine, medium and coarse wools. It is shown that the elasticity estimates are logically consistent and show some temporal relationship with supplies. Each of the monthly wool schedules from Section 6.3 and 6.4 are then aggregated into a total wool demand schedule for the panel (Section 6.7). Elasticity estimates for the aggregated wool schedule are also derived. It is shown that these aggregate elasticity estimates are reasonably consistent throughout the two seasons under study averaging a value of 4.5. This value is slightly higher than those developed in more recent econometric studies. Possible reasons for this could be the generally depressed economic conditions facing the buyers, particularly during 1993, and the possible 'richness' of the data developed from the study *i.e.* there is a lot more 'price response information' contained in the observations than one would observe in an econometric approach.

The true test of the instruments usefulness in this study however, is to compare the expected level of purchases with the actual level of purchases. Section 6.8 uses auction purchase data supplied by the New Zealand Wool Board to establish the reliability of the instrument. It is shown that percentage errors differ across the wool groups and across time. The fortunate aspect of the errors is their tendency to become relatively smaller over time. Buyers on a seasonal, aggregated basis under-estimated purchases in both seasons. On an individual wool group basis, the panel of buyers tended to under-estimate purchases of the finer wools and over-estimate the purchases of coarser wools. One possible reason put forward for this behaviour is switching of purchases between wool groups as a result of changes in price relativity. An investigation of the panel data also reveals that, in some cases, it is only one or two larger companies who are consistently making substantial errors in their forecasts. As such, the aggregate results may reflect characteristics about certain companies or individuals rather than deficiencies in the procedure or instrument. This aspect of the research is covered in more detail in Chapter Seven.

An important aspect of this research is to compare the comparative forecasting ability of the proposed probability approach with alternative forecasting procedures. In Section 6.9, a number of alternative time-series and regression models are measured against the purchase probability approach for comparative forecasting ability.

6.2 THE CALCULATION OF EXPECTED PURCHASE QUANTITIES

Respondents were asked to provide over each one of the sixteen survey periods[1], probability assessments on purchase quantities at various prices. Details of the interviewing procedure and instrument were discussed in Chapter Five. The resultant data allows for the calculation of expected purchase quantities of wool from the auction system for a particular wool group given a particular price. The following example illustrates the calculation of these expected purchase rates (See Appendix R for details of each periods estimates).

In Section 5.6.3 of Chapter Five, mention was made of the methodology used to elicit the subjective probabilities using a purchase probability scale. Respondents were presented with a price level (*i.e.* 600 cents/kg) for a particular group of wooltypes (*i.e.* fine wools 24 microns or less) and asked to assign probability levels to purchase quantities. An example of a completed interview was shown in Figure 5.14, Chapter Five (page 169).

In that particular example, the respondent had indicated that, at 600 cents, there is:

a very slight possibility of purchasing, at most, 100 bales of fine wool;
a very slight possibility of purchasing, at most, 200 bales of fine wool;
a fair possibility of purchasing, at most, 300 bales of fine wool;
a slight possibility of purchasing, at most, 400 bales of fine wool;
and, a slight possibility of purchasing, at most, 500 bales of fine wool.

---

[1] Some buyers did not participate in all sixteen surveys due mainly to absence from the country on business. One buyer who dealt in specialist wools only supplied expectations data for the medium-coarse wools (1992-93) and coarse wools (1991-93) categories.

An expected purchase quantity is given by using the probability estimates as weights. In this case the expected purchase quantity at 600 cents is:

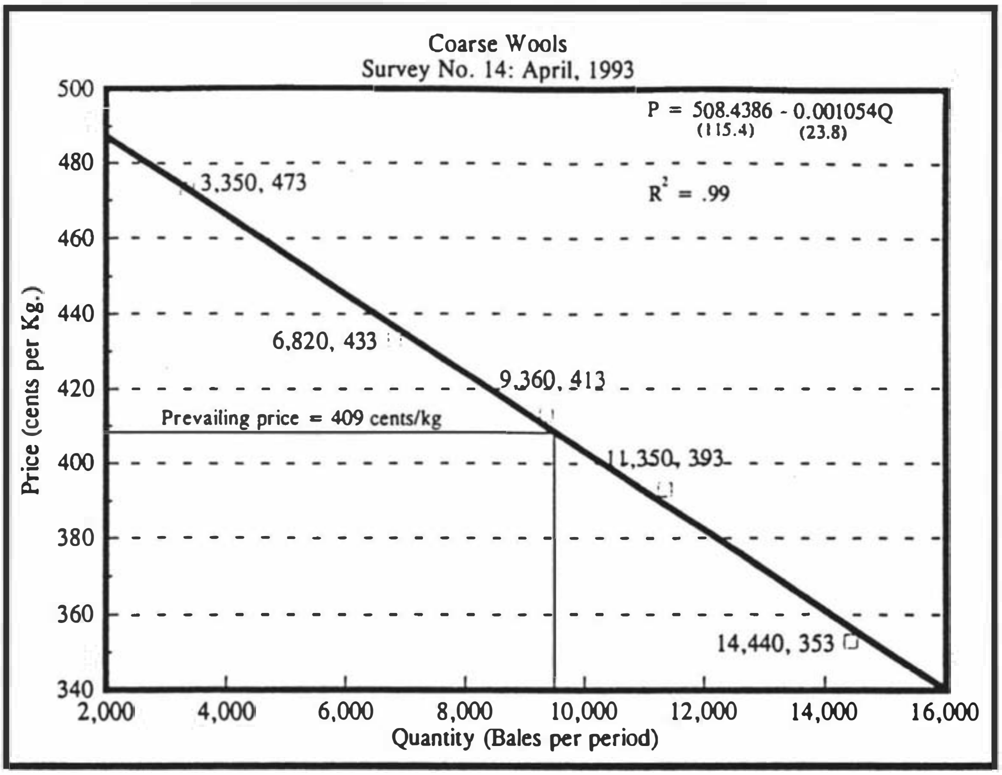
$$
\begin{aligned}
E(q) &= 0.1(100) + 0.1(200) + 0.4(300) + 0.2(400) + 0.2(500) \\
&= 10 + 20 + 120 + 80 + 100 \\
&= 330.
\end{aligned}
$$

Thus the buyer expected to purchase 330 bales of fine wool given a price of 600 cents over the four week period. This process was repeated with successively higher prices for the same wool group. The respondent was free to rearrange, if necessary, their purchase estimates given the higher price. Four (1991-92) or five (1992-93) price and quantity points were thus established for each buyer for each period (see Section 6.3). As shown in Figure 6.1, a simple regression can then be undertaken on the four or five points to formalise the relationship between the price-quantity points (see Section 6.4). These four (1991-92) or five (1992-93) price-quantity relationships can then be horizontally aggregated to establish a demand schedule for the panel for that particular wool group. These individual aggregate schedules for each wool group can also be consolidated into an aggregate wool demand schedule which is constrained for prevailing prices and prevailing quantities available to purchase on the auction market (see Section 6.7). Given the regression equations for the individuals, the woolgroups and the aggregate wool schedule, it is possible to estimate 'expected' purchase quantities given a particular price (see Section 6.5). This allows for the establishment of the forecasted purchase quantity of wool, given a particular price. In Figure 6.1, the prevailing price for this particular wool group and period is 409 cents/kg. With the price-quantity relationship developed (*i.e.* $P = 508.4386 - 0.001054Q$), the expected quantity to be purchased is 9,426 bales. Furthermore, a point price elasticity of demand can also be calculated (Epd = - 4.9).

Appendix O contains the regression information and relationships for each of the woolgroups for each period over the two seasons.

FIGURE 6.1

The Establishment of a Linear Relationship Between the Price-Quantity Points



6.3 AGGREGATE DERIVED DEMAND SCHEDULES

Tables 6.1 to 6.10 present the aggregate price-quantity points established for each of the five wool groups over the two seasons. Section 5.6, Chapter Five covered the experimental approach used in establishing these points.

TABLE 6.1

Aggregate Price-Quantities for Fine Wools

***(24 microns or less)* 1991-92**

Period		P_1	P_2	P_3	P_4	n
1	P	600	640	680	720	5
	Q	4,055	2,920	895	375	
2	P	600	640	680	720	9
	Q	7,563	7,335	7,185	2,195	
3	P	880	980	1085	1190	10
	Q	1,400	1,110	810	790	
4	P	810	910	1010	1110	10
	Q	856	454	183	96	
5	P	840	940	1040	1140	9
	Q	2,455	935	189	95	
6	P	920	1010	1100	1190	9
	Q	107	107	86	48	
7	P	750	830	910	990	9
	Q	92	92	92	69	
8	P	750	830	910	990	9
	Q	870	480	198	20	

Notes for Tables 6.1 to 6.5:

n Number of buyers in sample
Q Aggregated expected purchase quantities (Bales per period)
P_n Price in clean cents per kilogram

TABLE 6.2

Aggregate Price-Quantities for Medium Wools

(25 microns - 35 microns) **1991-92**

Period		P_1	P_2	P_3	P_4	n
1	P	390	420	560	590	5
	Q	24,820	18,400	13,780	11,490	
2	P	490	520	560	590	9
	Q	35,445	31,325	15,198	11,178	
3	P	590	650	720	790	10
	Q	25,180	18,150	15,920	13,280	

TABLE 6.3

Aggregate Price-Quantities for Fine-Medium Wools

(25 microns - 32 microns) **1991-92**

Period		P_1	P_2	P_3	P_4	n
4	P	570	640	710	780	10
	Q	14,260	8,080	6,070	4,770	
5	P	635	710	780	855	9
	Q	8,255	6,270	5,156	4,043	
6	P	665	745	825	905	9
	Q	5,424	4,700	3,770	2,300	
7	P	630	700	770	840	9
	Q	1,418	1,377	926	570	
8	P	645	720	790	865	9
	Q	3,093	2,341	1,460	790	

TABLE 6.4

Aggregate Price-Quantities for Medium-Coarse Wools

***(33 microns - 35 microns)* 1991-92**

Period		P_1	P_2	P_3	P_4	n
4	P	255	285	315	345	10
	Q	20,980	14,700	10,870	9,030	
5	P	285	320	390	425	9
	Q	37,690	32,690	27,950	24,860	
6	P	295	330	365	400	9
	Q	11,234	11,025	7,800	3,660	
7	P	295	330	365	400	9
	Q	17,830	17,470	14,710	11,740	
8	P	325	365	405	445	9
	Q	15,320	13,690	11,050	8,600	

TABLE 6.5

Aggregate Price-Quantities for Coarse Wools

(36 microns or more) **1991-92**

Period		P1	P2	P3	P4	n
1	P	330	350	370	390	5
	Q	23,190	21,530	18,920	15,940	
2	P	330	350	370	390	10
	Q	34,540	31,310	21,370	15,080	
3	P	330	370	410	450	11
	Q	51,870	34,550	23,410	20,210	
4	P	300	335	370	405	11
	Q	33,560	26,450	16,070	10,630	
5	P	380	420	460	500	10
	Q	34,750	24,500	10,540	3,980	
6	P	360	400	440	480	10
	Q	13,020	12,000	8,670	2,240	
7	P	360	400	440	480	10
	Q	26,650	25,170	19,830	14,400	
8	P	405	455	505	555	10
	Q	16,670	14,380	12,260	10,620	

TABLE 6.6

Aggregate Price-Quantities for Fine Wools

(24 microns or less) 1992-93

Period		P_1	P_2	P_3	P_4	P_5	n
9	P	700	785	825	865	945	9
	Q	4,220	2,990	2,310	2,110	1,350	
10	P	625	695	730	765	835	10
	Q	8,530	6,360	3,900	2,240	1,160	
11	P	635	710	745	780	855	10
	Q	6,420	3,410	2,340	1,670	160	
12	P	640	715	752	790	865	9
	Q	1,335	350	280	205	165	
13	P	590	660	695	730	800	9
	Q	355	250	200	155	125	
14	P	547	612	645	678	743	10
	Q	380	380	300	85	65	
15	P	547	612	645	678	743	9
	Q	0	0	0	0	0	
16	P	547	612	645	678	743	10
	Q	650	390	345	255	110	

Notes for Tables 6.6 to 6.10:

n Number of buyers in sample
Q Aggregated expected purchase quantities (Bales)
P_n Price in clean cents per kilogram

i.e. P_3 = prevailing price at start of period
P_2 & P_4 = ± 5% of prevailing price at start of period
P_1 & P_5 = ± 15% of prevailing price at start of period

TABLE 6.7

Aggregate Price-Quantities for Fine-Medium Wools

***(25 to 28 microns)* 1992-93**

Period		P_1	P_2	P_3	P_4	P_5	n
9	P	570	640	675	710	780	9
	Q	12,460	10,145	6,680	5,870	5,180	
10	P	580	640	670	710	760	10
	Q	6,720	5,475	4,930	4,110	3,095	
11	P	530	590	620	650	710	10
	Q	8,816	8,306	7,406	4,806	210	
12	P	567	633	666	699	765	9
	Q	2,115	1,285	845	470	200	
13	P	567	633	666	699	765	9
	Q	535	460	420	405	355	
14	P	468	523	550	577	632	10
	Q	1,320	680	480	360	155	
15	P	468	523	550	577	632	9
	Q	390	285	240	180	140	
16	P	468	523	550	577	632	10
	Q	2,690	1,345	530	500	150	

TABLE 6.8

Aggregate Price-Quantities for Medium Wools

(29 to 32 microns) **1992-93**

Period		P_1	P_2	P_3	P_4	P_5	n
9	P	525	585	615	645	705	9
	Q	17,605	12,965	9,030	6,660	5,820	
10	P	525	585	615	645	705	10
	Q	16,060	10,580	8,310	7,000	6,390	
11	P	525	585	615	645	705	10
	Q	9,589	7,584	6,048	5,135	4,845	
12	P	499	558	587	616	675	9
	Q	6,885	5,065	3,080	2,290	1,690	
13	P	499	55	587	616	675	9
	Q	7,050	6,120	5,620	5,170	4,670	
14	P	425	475	500	525	575	10
	Q	7,472	5,732	3,310	1,880	555	
15	P	425	475	500	525	575	9
	Q	6,600	5,740	5,186	5,096	4,515	
16	P	425	475	500	525	575	10
	Q	4,815	3,675	2,910	1,810	380	

TABLE 6.9

Aggregate Price-Quantities for Medium-Coarse Wools

***(33 to 35 microns)* 1992-93**

Period		P_1	P_2	P_3	P_4	P_5	n
9	P	365	405	425	445	485	10
	Q	17,560	13,220	7,300	6,160	4,750	
10	P	385	425	445	465	505	11
	Q	15,455	12,525	10,680	8,815	7,715	
11	P	355	395	415	435	475	11
	Q	18,815	14,835	11,720	10,560	9,415	
12	P	352	394	415	436	478	10
	Q	3,355	2,695	1,820	1,325	645	
13	P	320	360	380	400	440	11
	Q	5,490	5,255	3,284	2,180	1,090	
14	P	350	390	410	430	470	11
	Q	6,494	5,836	5,240	3,288	1,138	
15	P	330	370	390	410	450	10
	Q	7,855	7,127	6,813	6,208	5,338	
16	P	330	370	390	410	450	10
	Q	4,853	3,815	3,135	2,440	960	

TABLE 6.10

Aggregate Price-Quantities for Coarse Wools

(36 microns or more) **1992-93**

Period		P_1	P_2	P_3	P_4	P_5	n
9	P	340	380	400	420	460	10
	Q	31,830	24,455	17,174	15,115	9,855	
10	P	315	355	375	395	435	11
	Q	29,005	24,605	18,390	12,130	8,595	
11	P	330	370	390	410	450	11
	Q	28,225	25,210	20,695	18,890	16,365	
12	P	352	394	415	436	478	10
	Q	18,244	15,604	12,724	8,781	6,324	
13	P	349	389	409	429	469	10
	Q	10,295	7,640	6,285	5,687	4,954	
14	P	353	393	413	433	473	11
	Q	14,440	11,250	9,360	6,820	3,350	
15	P	345	385	405	425	465	10
	Q	13,285	12,320	10,910	8,840	7,340	
16	P	345	385	405	425	465	10
	Q	11,421	9,131	7,121	4,886	2,976	

6.4 DEVELOPING AN AGGREGATE PRICE-QUANTITY RELATIONSHIP

The price and quantity points as outlined in Section 6.3 allow for the possibility of establishing some formal relationship between the price changes and the actions of the buyer in terms of expected purchase quantities. It is possible to start by assuming that the raw data, as with all surveys, contains observations which are comprised of some 'true' value plus some random error. To meet the objectives of this study it is necessary that some generalised indication of this price-quantity response is generated which isolates the underlying 'true' values. One possibility is the assumption of a linear relationship between the points which gives a line of best fit. Such a line would essentially summarise the 'expected' purchase quantities of the panel given a particular price. Tables 6.11 to 6.20 summarise the regression statistics for the wool groups over the two seasons.

The justification for this approach is simple. While there are obvious statistical weaknesses in terms of robustness with a small data set, the objective should be to show how the buyers *expect* to react in terms of purchases in response to some price level. In almost all cases the data relationships, when visually checked, were approximately linear. In those few cases where a non-linear relationship was evident an appropriate logarithmic function was developed. It should be noted that the adjusted R^2, as an indicator for the 'goodness of fit', was also relatively high (*i.e.* above .80) for a good many of the cases. The *t-test* statistic, as shown in Tables 6.11 to 6.20, was against the value of the coefficient being equal to zero. Not one slope or intercept estimate over the study period was rejected on this null hypothesis.

Figures O.1 to O.69, which are located in Appendix O, Volume Two, illustrate the derived demand curves generated from the schedules. The horizontal axis for each wool group has been fixed so that it is possible to observe the extent of movements and changes in the slope of the curves throughout the season.

TABLE 6.11

Regression Statistics for the Derived Demand Schedule for Fine Wools

(*24 microns or less*) - 1991-92

Period		Coefficient	t-test	adj R^2	n
1	*a*	720.3268	64.6	.96	5
	b	-0.02928	-6.6		
2	*a*	758.2209	14.1	.66	9
	b	-0.01618	-1.9		
3	*a*	1487.01	13.9	.91	10
	b	-0.44113	-4.4		
4	*a*	1104.634	31.3	.93	10
	b	-0.36409	-5.1		
5[n]	*a*	36.065		.98	9
	b	-11.16			
6	*a*	1388.837	13.1	.84	9
	b	-3.83721	-3.3		
7[o]	*a*	1470.0	4.2	.60	9
	b	-6.95652	-1.7		
8[o]	*a*	977.7161	59.3	.96	9
	b	-0.27479	-8.4		

Notes for Tables 6.11 to 6.20:

a intercept
b slope
n Non-linear estimation
i.e. $Log Q = \alpha + \beta Log P$
o The price is outside the experimental price range

TABLE 6.12

Regression Statistics for the Derived Demand Schedule for Medium Wool (*24 to 35 microns*) - 1991-92

Period		Coefficient	*t-test*	adjR^2	n
1	*a*	665.2087	33.9	.94	5
	b	-0.00731	-6.6		
2°	*a*	624.256	45.8	.94	9
	b	-0.00362	-6.8		
3	*a*	979.3201	29.6	.90	10
	b	-0.01609	-4.0		

TABLE 6.13

Regression Statistics for the Derived Demand Schedule for Fine-Medium Wools (*25 to 32 microns*) - 1991-92

Period		Coefficient	*t-test*	adjR^2	n
4	*a*	841.6806	17.4	.87	10
	b	-0.02011	-3.7		
5	*a*	1052.735	31.1	.98	9
	b	-0.05189	-9.4		
6	*a*	1091.04	29.3	.97	9
	b	-0.07559	-8.6		
7	*a*	966.3527	19.4	.88	9
	b	-0.21566	-4.9		
8	*a*	934.4678	130.7	.99	9
	b	-0.09342	-23.3		

TABLE 6.14

Regression Statistics for the Derived Demand Schedule for Medium-Coarse Wools

(*33 to 35 microns*) - 1991-92

Period		Coefficient	*t-test*	adjR^2	n
4	*a*	398.8515	21.6	.94	10
	b	-0.00711	-5.6		
5	*a*	701.9396	19.0	.97	9
	b	-0.01127	-9.5		
6	*a*	448.9066	16.9	.89	9
	b	-0.01203	-4.1		
7	*a*	583.6746	11.6	.92	9
	b	-0.01530	-4.8		
8	*a*	596.4676	40.6	.98	9
	b	-0.01738	-14.7		

TABLE 6.15

Regression Statistics for the Derived Demand Schedule for Coarse Wools

(*36 microns or more*) - 1991-92

Period		Coefficient	*t-test*	adj R^2	n
1	*a*	520.8883	36.7	.98	5
	b	-0.00809	-9.6		
2	*a*	432.4748	44.4	.97	10
	b	-0.00283	-10.1		
3	*a*	502.5468	19.8	.92	11
	b	-0.00346	-4.7		
4	*a*	447.1055	54.2	.99	11
	b	-0.00436	-12.4		
5	*a*	508.25996	34.3	.98	10
	b	-0.00370	-10.2		
6	*a*	510.2988	21.3	.84	10
	b	-0.01005	-4.2		
7	*a*	614.3265	19.1	.93	10
	b	-0.00903	-6.2		
8	*a*	810.7946	46.6	.99	10
	b	-0.02454	-19.3		

TABLE 6.16

Regression Statistics for the Derived Demand Schedule for Fine Wools

(*24 microns or less*) - 1992-93

Period		Coefficient	*t-test*	adj R^2	n
9	*a*	1039.847	44.8	.97	9
	b	-0.08315	-9.9		
10	*a*	842.226	47.2	.95	10
	b	-0.02529	-7.4		
11	*a*	840.6753	60.5	.95	10
	b	-0.03417	-8.6		
12[n]	*a*	22.3162		.59	9
	b	-6.899			
13	*a*	877.1593	31.3	.94	9
	b	-0.83944	-6.9		
14	*a*	745.8561	21.6	.72	10
	b	-0.41676	-3.4		
15	*a*	N/A	N/A	N/A	9
	b	N/A	N/A		
16	*a*	771.8957	56.0	.97	10
	b	-0.36255	-10.34		

Notes for Table 6.16:

N/A Not Available. All expected values were equal to zero.
n Non-Linear relationship
i.e. $LogQ = \alpha + \beta LogP$

TABLE 6.17

Regression Statistics for the Derived Demand Schedule for Fine-Medium Wools

(*25 to 28 microns*) - 1992-93

Period		Coefficient	*t-test*	adj R^2	n
9	*a*	865.5189	20.2	.84	9
	b	-0.02362	-4.7		
10	*a*	914.4889	409.6	.99	10
	b	-0.04983	-112.0		
11	*a*	723.6659	26.1	.86	10
	b	-0.01754	-4.2		
12	*a*	759.83	49.8	.95	9
	b	-0.09545	-7.5		
13	*a*	1136.591	26.0	.98	9
	b	-1.08182	-10.9		
14	*a*	628.5056	38.1	.92	10
	b	-0.13106	-5.7		
15	*a*	702.1579	39.2	.96	9
	b	-0.61602	-9.0		
16	*a*	607.9504	34.0	.82	10
	b	-0.05556	-4.3		

TABLE 6.18

Regression Statistics for the Derived Demand Schedule for Medium Wools

(*29 to 32 microns*) - 1992-93

Period		Coefficient	*t-test*	adj R^2	n
9	*a*	751.5551	28.0	.88	9
	b	-0.01311	-5.5		
10	*a*	768.9553	20.6	.82	10
	b	-0.01592	-4.4		
11	*a*	830.4231	19.6	.87	10
	b	-0.03244	-5.2		
12	*a*	698.2851	32.1	.89	9
	b	-0.02927	-5.8		
13	*a*	992.8368	28.1	.97	9
	b	-0.07088	-11.6		
14	*a*	573.598	52.2	.96	10
	b	-0.01942	-8.0		
15	*a*	878.4810	20.1	.96	9
	b	-0.06973	-8.7		
16	*a*	588.5505	92.9	.99	10
	b	-0.03257	-16.0		

TABLE 6.19

Regression Statistics for the Derived Demand Schedule for Medium-Coarse Wools

(*33 to 35 microns*) - **1992-93**

Period		Coefficient	*t-test*	adj R^2	n
9	*a*	501.2446	28.3	.85	10
	b	-0.00778	-4.8		
10	*a*	602.1386	30.1	.96	11
	b	-0.01424	-8.3		
11	*a*	562.3618	21.0	.92	11
	b	-0.01128	-5.7		
12	*a*	499.6524	55.0	.94	10
	b	-0.04301	-10.4		
13	*a*	456.9806	28.5	.87	10
	b	-0.0225	-5.4		
14	*a*	496.0712	29.1	.91	11
	b	-0.01957	-5.5		
15	*a*	701.9410	39.6	.99	10
	b	-0.04678	-17.8		
16	*a*	482.4896	96.8	.99	10
	b	-0.03041	-20.2		

TABLE 6.20

Regression Statistics for the Derived Demand Schedule for Coarse Wools

(*36 microns or more*) - 1992-93

Period		Coefficient	*t-test*	adj R^2	n
9	*a*	501.0399	41.9	.96	10
	b	-0.00513	-9.0		
10	*a*	470.4798	33.9	.95	11
	b	-0.00515	-7.4		
11	*a*	589.0385	22.6	.94	11
	b	-0.0091	-7.8		
12	*a*	531.7075	36.1	.96	10
	b	-0.00946	-8.4		
13	*a*	550.7459	21.1	.88	10
	b	-0.02033	-5.6		
14	*a*	508.4386	115.4	.99	11
	b	-0.01055	-23.5		
15	*a*	592.4308	22.8	.95	10
	b	-0.01778	-7.4		
16	*a*	499.0491	57.3	.98	10
	b	-0.01323	-11.7		

6.5 DEVELOPMENT OF EXPECTED PURCHASE LEVELS

As suggested earlier, the regression lines developed in Section 6.4 provide some formal relationship between a range of possible prices faced by the buyers and the 'expected' purchases of wool to be made at these prices. However, in order to establish what this 'expected' purchase level is, it is necessary to first establish a single prevailing price for the wool group over the period. The question is which price to choose?

In Chapter Three, reference was made to the diversity of wool types and enduses. There are over 2000 combinations of length, colour, diameter and style of wool available. Each of these wooltypes commands a premium or discount based primarily upon its enduse. To simplify the study, the wool types were aggregated into five wool groups, the details of which were covered in Chapter Five (Section 5.5.3). However, even within these groups there is some diversity in terms of the price differentials. As a compromise, a 'representative' wool type from each category was selected (see Tables 5.6 to 5.8). These 'representative' wool types can also be used as a proxy for the prevailing price for each of the five wool groups throughout each survey period. Appendix P details these weighted average representative prices during each of the sixteen survey periods.

There may be some criticism in using this approach as it may not effectively represent the movements in prices in the wool types within each of the groups. However, there are a number of data constraints which make this idealised approach uneconomic in terms of the time involved and the accuracy obtained. Furthermore, the price response data obtained in the interview specifically asked the respondent to consider all auction purchases of wool within the group according to a price range, which itself was based on a 'representative' price. If a particular wooltype within that group lay outside this defined price range, then presumably the buyer would not include it in their quantity expectations.

Substituting this prevailing price into each of the regression models developed in Section 6.3 allows for the calculation of the 'expected' quantity to be purchased. These price-quantity points are illustrated for each of the derived demand curves shown in Figures O.1 to O.69 in Appendix O. In essence, the points show that given a price of X cents, the panel of buyers would have been expected to purchase Y bales over the period.

Unfortunately, there were three occasions when the expected purchase quantity of the panel exceeded the quantity available to purchase on the market:

36 mics or more	Period #1	E = 18,842, A = 8,159
33-35 mics	Period #5	E = 31,092, A = 24,261
36 mics or more	Period #9	E = 16,458, A = 14,182

Overall, the panel was making an aggregate purchase expectation of about 42% and 37% of the quantities being offered onto the market for 1991-92 and 1992-93 respectively. The actual purchase rates were 40% and 34% respectively. Expected fine wool purchases were underestimated while expected coarse wool purchases were over-estimated in both seasons.

TABLE 6.21

The Expected Proportion Purchased at Auction *vs.* The Actual Proportion Purchased

	1991-92		1992-93	
	Expected %	Actual %	Expected %	Actual %
Fine	14	19	14	27
Fine-Medium	20	42	36	35
Medium	36	44	56	30
Medium-Coarse	72	48	29	39
Coarse	70	46	51	38
TOTAL	42	40	37	34

6.6 SLOPE AND PRICE ELASTICITY ESTIMATES FOR THE DERIVED DEMAND CURVES

The combination of a demand schedule and a 'prevailing price' allows for the calculation of point price elasticities of demand to measure buyer responsiveness to price changes. The logic underlying this approach and the formula for the point elasticity was outlined in Chapter Three. However, following the points raised by Gruen (1964) in Chapter Two and Chapter Three, discussion of the slope estimates is also addressed. These slope and elasticity estimates will be discussed in three groups; fine, medium and coarse.

6.6.1 Fine Wool Price Elasticities of Demand and Slope Coefficients

Table 6.22 summarises the slope and price elasticity estimates for fine wool (*i.e.* 24 microns or less). The elasticity estimates range from -94.1 (April, 1993) to -1.7 (December, 1991). The extreme value of -94.1 should be taken with some caution since only one buyer in the panel indicated any purchases at all prices in this period. The high value is also indicative of the problems in using elasticity measures with the average representative price during the period at the high end of the particular period's price range. In all cases, the coefficient tends to show an elastic price elasticity of demand, particularly in the 1992-93 season. This elasticity value tends to decrease throughout the season probably reflecting the reduced supplies of finer wools onto the market. The early months of the season (October - November) tend to see a significant proportion of merino wools in the fine wool offerings. From December to March, fine lambswools make up the bulk of the fine wool offerings, although offerings of this type do become coarser towards the end of the season.

The systematically higher elasticity for fine wools during the 1992-93 season may also be reflective of a general downturn in the market (see Appendix N). The slope estimates for the fine wool schedules reflect a similar pattern ranging from -.01618 (November, 1991) through to a high of -6.9562 (May, 1992). The slopes tend to be quite 'flat' early on in the season and then become 'steeper' in the middle.

In Figure 6.2, the relationship between the elasticity of the derived demand schedule and wool fine wool supplies is illustrated. It is difficult to establish any pattern of consistent temporal relationship between the elasticity estimates and the supply of wools onto the market. This could, in part, be due to the nature of the fine wools, and, in part, the nature of the market. The merino component of fine wools is essentially a specialist type of wool with a 'season' of three months (October-December). For some types there are significant premiums attached to the purchase of the wool. Coupled with the relatively small volumes being traded on the market, it would appear that price is a comparatively less important factor for this group due to the lack of substitutability. The lambswool market, while in the finewools segment, is a different type of market to the merino wools and faces more competition from competing micron widths and other fibres.

FIGURE 6.2
The Temporal Relationship Between Wool Supplies and Price Elasticity of Demand for Fine Wools

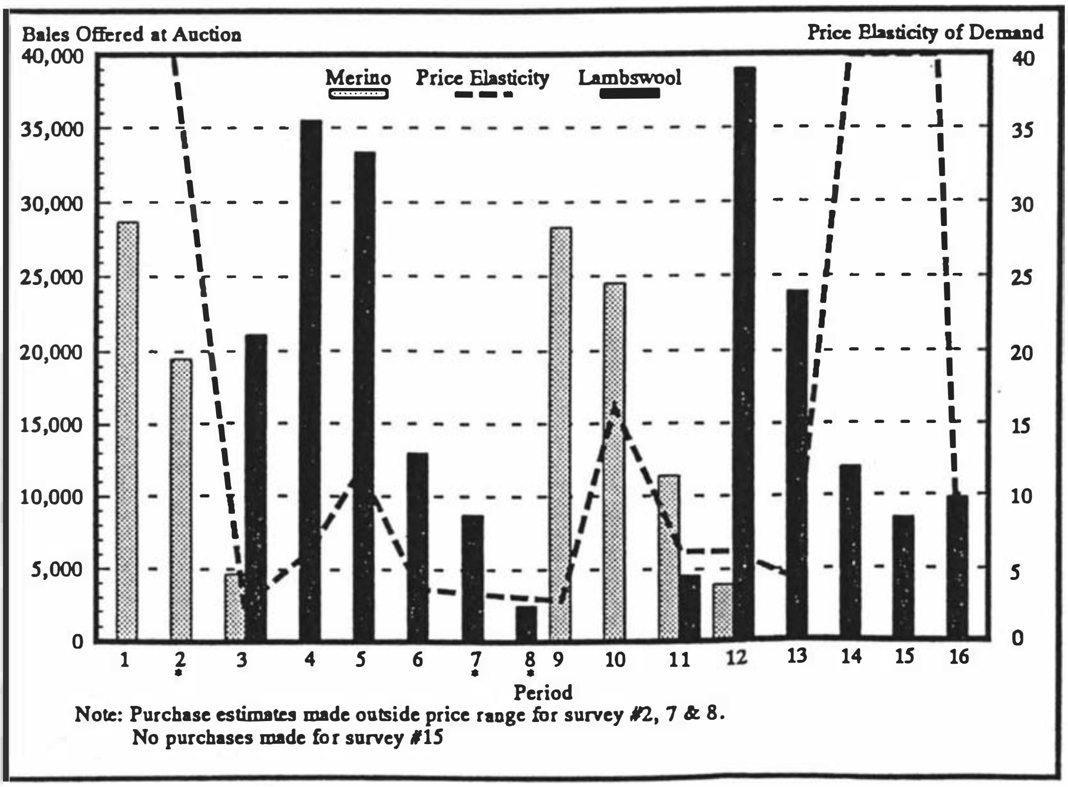


TABLE 6.22

Price Elasticity and Slope Estimates for Fine Wools (less than 24 microns)

PERIOD	SLOPE	ELASTICITY ESTIMATE
1991-92 Season		
1	-0.02928	-49.3
2	-0.01618	O/S
3	-0.44113	-1.7
4	-0.36409	-6.6
5[n]	-6.9	
6	-3.83721	-3.2
7	-6.95652	O/S
8	-0.27479	O/S
1992-93 Season		
9	-0.08315	-2.7
10	-0.02529	-16.1
11	-0.03417	-5.5
12[n]	-6.9	
13	-0.83944	-5.5
14[a]	-0.41676	-94.1
15[b]	N/A	N/A
16	-0.36255	-5.4

Notes:
a Only one buyer indicated any purchases in this period.
b No purchases expected within the experimental price range
n Non-linear relationship
i.e. $LogQ = \alpha + \beta logP$
O/S Representative price is outside the experimental bounds

6.6.2 Medium Wool Price Elasticities of Demand and Slope Coefficients

As mentioned previously in this study the medium wools category is a particularly broad grouping of wool types and uses. Recognition of this fact was made in splitting the group first, into two and then, three separate micron ranges. The wool which is sold into these three groupings is termed halfbred wool. Wool at the bottom of the range is used for knitting yarns, worsteds and apparel, but where less care is given to the fineness and closeness of the finished cloth. Wool at the upper end of the range tends to be used for purposes where durability is paramount such as carpets, rugs and furnishings. The elasticity estimates however, display no great divergences among the groups, although there is more volatility in the 25-28 micron range. In all three categories the relative elasticities indicate an elastic demand, which is not surprising given the end uses and substitutability with synthetics.

It is noticeable that there is a high degree of correlation exhibited between the elasticities in the fine wool group (less than 24 microns), and the fine-medium (25-28 microns) groups (r = .99). This is perhaps indicative of the substitutability of these type of wools, particularly at the coarser end of the fine wools (*i.e.* lambswool types). This correlation is also evident between the fine-medium and medium (28-32 microns) groups (r = .75) and to a lesser extent between the medium-coarse (33-35 microns) and the coarse (36 or more microns) groups. No correlation is evident at all between the medium and medium-coarse groups (r = .09), although removing survey # 13 improves this to r = .50.

Figure 6.3 illustrates the temporal relationship between the value of the elasticity and the relevant supplies of medium diameter wools onto the market.

FIGURE 6.3

The Temporal Relationship Between Wool Supplies and Price Elasticity of Demand for Medium Wools

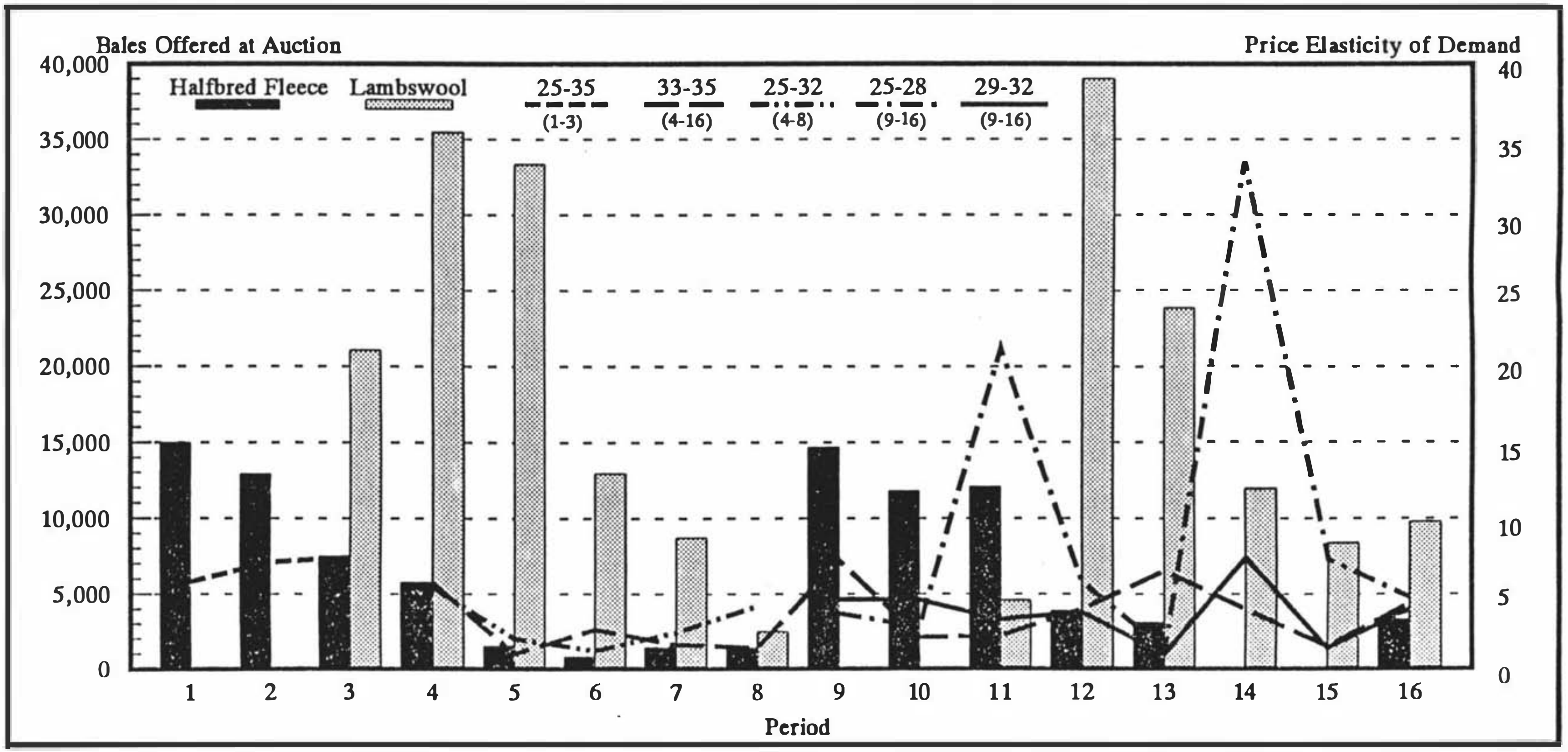


TABLE 6.23

Price Elasticity and Slope Estimates for Medium Wools

(25-35 microns)

<table>
<tr><td></td><td colspan="4">SLOPE</td><td colspan="2">ELASTICITY ESTIMATE</td></tr>
<tr><td colspan="7">1991-92 Season</td></tr>
<tr><td>1</td><td colspan="4">-.00731</td><td colspan="2">-5.8</td></tr>
<tr><td>2</td><td colspan="4">-.00362</td><td colspan="2">-7.1 (O/S)</td></tr>
<tr><td>3</td><td colspan="4">-.01655</td><td colspan="2">-7.4</td></tr>
<tr><td></td><td colspan="4">25-32 microns</td><td colspan="2">33-35 microns</td></tr>
<tr><td></td><td colspan="2">Slope</td><td colspan="2">Epd</td><td>Slope</td><td>Epd</td></tr>
<tr><td>4</td><td colspan="2">-.02011</td><td colspan="2">-5.4</td><td>-.00711</td><td>-5.7</td></tr>
<tr><td>5</td><td colspan="2">-.05189</td><td colspan="2">-2.0</td><td>-.01127</td><td>-1.0</td></tr>
<tr><td>6</td><td colspan="2">-.07559</td><td colspan="2">-1.2</td><td>-.01203</td><td>-2.6</td></tr>
<tr><td>7</td><td colspan="2">-.21566</td><td colspan="2">-2.4</td><td>-.01530</td><td>-1.6</td></tr>
<tr><td>8</td><td colspan="2">-.09342</td><td colspan="2">-4.2</td><td>-.01738</td><td>-1.4</td></tr>
<tr><td colspan="7">1992-93 Season</td></tr>
<tr><td></td><td colspan="2">25-28 mics</td><td colspan="2">29-32 mics</td><td colspan="2">33-35 mics</td></tr>
<tr><td></td><td>Slope</td><td>Epd</td><td>Slope</td><td>Epd</td><td>Slope</td><td>Epd</td></tr>
<tr><td>9</td><td>-0.02362</td><td>-3.7</td><td>-0.01311</td><td>-4.6</td><td>-0.00778</td><td>-7.2</td></tr>
<tr><td>10</td><td>-0.04983</td><td>-2.8</td><td>-0.01592</td><td>-4.6</td><td>-0.01424</td><td>-2.2</td></tr>
<tr><td>11</td><td>-0.01754</td><td>-21.2</td><td>-0.03244</td><td>-3.3</td><td>-0.01128</td><td>-2.2</td></tr>
<tr><td>12</td><td>-0.09545</td><td>-5.8</td><td>-0.02927</td><td>-3.8</td><td>-0.04301</td><td>-4.0</td></tr>
<tr><td>13</td><td>-1.08182</td><td>-1.3</td><td>-0.07088</td><td>-1.0</td><td>-0.02250</td><td>-6.5</td></tr>
<tr><td>14</td><td>-0.13106</td><td>-33.8</td><td>-0.01942</td><td>-7.4</td><td>-0.01957</td><td>-4.0</td></tr>
<tr><td>15</td><td>-0.61602</td><td>-7.3</td><td>-0.06973</td><td>-1.4</td><td>-0.04678</td><td>-1.5</td></tr>
<tr><td>16</td><td>-0.05556</td><td>-5.1</td><td>-0.03257</td><td>-4.0</td><td>-0.03041</td><td>-4.4</td></tr>
</table>

6.5.3 Coarse Wool Price Elasticities of Demand and Slope Coefficients

The relative values of the coarse wool elasticities are much lower than for the other two groups. This is because there is not as much within season volatility of supply as in the case of say, fine wools. Furthermore, any potential shortfall in the supplies of this type of wools onto the market can be met more easily from stocks of either privately held wool, New Zealand Wool Board stocks or stocks held by the buyer. As Table 6.24 shows, the elasticity values tend to be less elastic at the beginning and end of the season and more elastic during the peak of the season when the quantity of wool on offer is greater and hence the selection is wider. Overall, the estimates indicate an elastic elasticity recognising the availability of competing substitute fibres for the end uses for these type of wools such as furnishings and carpets. Figure 6.4 illustrates the temporal relationship between the value of the elasticities and the supply of coarse wools onto the market.

FIGURE 6.4

The Temporal Relationship Between Wool Supplies and Price Elasticity of Demand for Coarse Wools

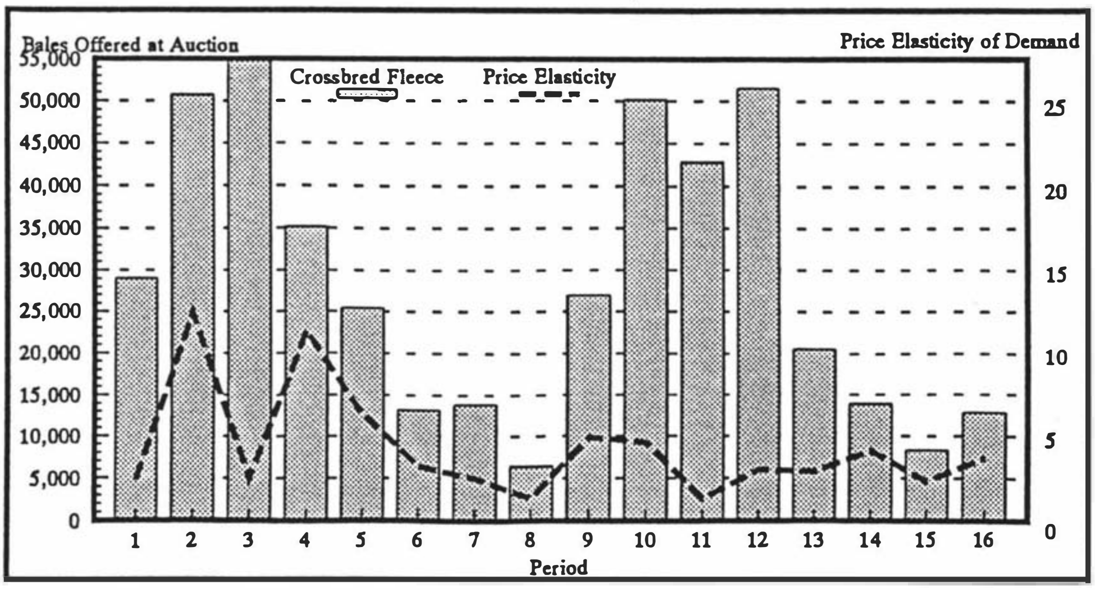


TABLE 6.24

Price Elasticity and Slope Estimates for Coarse Wools

(More than 36 microns)

PERIOD	SLOPE	ELASTICITY ESTIMATE
1991-92 Season		
1	-0.00809	-2.5
2	-0.00283	-12.4 (O/S)
3	-0.00346	-2.5
4	-0.00436	-11.3
5	-0.00370	-6.3
6	-0.01005	-3.2
7	-0.00903	-2.5
8	-0.02454	-1.3
1992-93 Season		
9	-0.00513	-4.9
10	-0.00515	-4.6
11	-0.00910	-1.8
12	-0.00946	-3.0
13	-0.02033	-2.9
14	-0.01055	-4.1
15	-0.01778	-2.3
16	-0.01323	-3.7

6.7 AN AGGREGATE WOOL DEMAND SCHEDULE

In Section 6.3, demand schedules were developed for each of the wool groups over the two seasons. Section 6.4 formalised these schedules and developed appropriate linear or non-linear relationships for each group. In this section a total wool demand schedule is established for the panel combining the schedules from all the four or five wool groups. Each of the demand schedules were horizontally aggregated over the relevant price range for each period. Quantity constraints, particularly at the low price end for some groups were imposed up to the level of wool available to purchase on the market during the period. Appendix Q summarises each of these schedules for the two seasons. Examination of the data revealed that in most cases a non-linear relationship between price and quantity demanded existed. To establish elasticity and slope estimates, a logarithmic model was developed of the form:

$$Log\ Q = \alpha + \beta log P \qquad (6.1)$$

where:

Q = quantity demanded (bales)

P = price (clean cents per kilogram)

In this model the price elasticity of demand is simply the ß coefficient. Table 6.25 presents the regression coefficients each of the survey periods.

As the table illustrates, the price elasticity of demand estimates suggest an elastic demand schedule for raw wool. These estimates also tend to be more elastic in the second season (1992-93), possibly reflecting the lower level of aggregate demand for New Zealand wools (see Appendix N). On an average basis, the elasticity estimate for 1991-92 is -4.4, while for 1992-93 it stands at -4.6. However, there is far more variability exhibited in the estimates for the second season with a range of 4.2, compared to 2.4 in the first season.

The elasticity estimates obtained in this study tend to be much higher than the short-run estimates obtained from previous econometric studies (see Section 3.6.1, Chapter Three). This could be due to differences in underlying economic conditions, namely the persistent downturn in prices and demand over the study period. Furthermore, the 'richer' information contained in the quantity responses obtained in this qualitative study may more accurately reflect buyer behaviour than a time series quantitative approach (see Section 8.4.7, Chapter 8).

TABLE 6.25

Elasticity Estimates for the Aggregated Demand Schedule

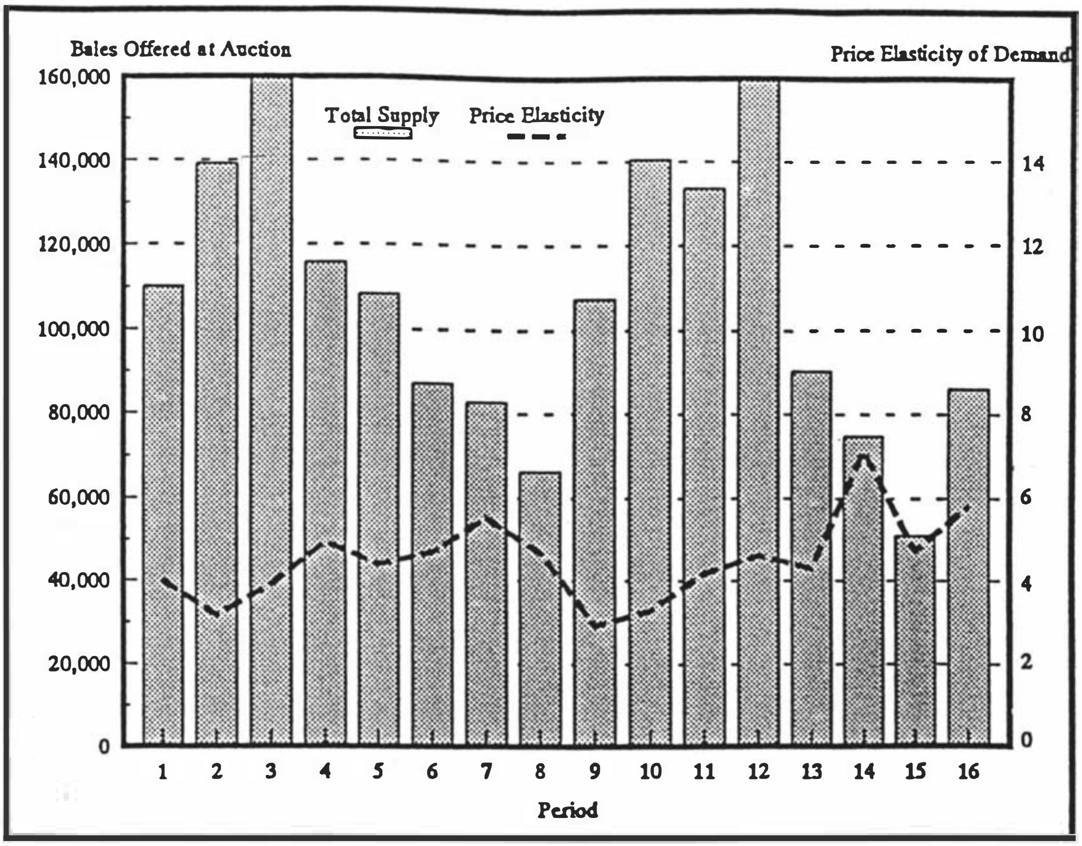
Period	α	ß	R^2
1991-92 season			
1	14.84719	-3.97606	.73
2	12.90362	-3.14373	.76
3	14.85954	-3.8817	.86
4	17.36613	-4.9200	.84
5	16.01644	-4.3852	.86
6	16.56064	-4.6787	.80
7	18.59461	-5.5152	.91
8	16.58833	-4.6808	.77
1992-93 season			
9	12.19500	-2.9101	.80
10	13.27676	-3.2784	.74
11	15.53899	-4.1652	.76
12	16.34583	-4.6071	.86
13	15.31718	-4.2920	.73
14	22.46139	-7.1188	.86
15	16.38408	-4.7358	.60
16	19.10002	-5.7987	.89

Figure 6.5 shows the temporal relationship between the aggregate price elasticity estimates and the total supply of wool onto the market.

FIGURE 6.5

The Temporal Relationship Between

Total Wool Supply and the Aggregate Price Elasticity of Demand for Wool



Figures 6.6 to 6.13 illustrate the aggregated demand schedules for each of the sixteen survey periods. The schedule is constrained at the maximum level of each type of wool that was offered onto the market during each period. Furthermore, the upper price level for each group is taken to be the maximum experimental price offered. These two procedures ensure that the logarithmic relationship is considered over an appropriate 'relevant range' of values. Details of the individual aggregate schedules are provided in Appendix Q.

FIGURE 6.6

Aggregate Derived Demand Curves for Survey 1 & 2

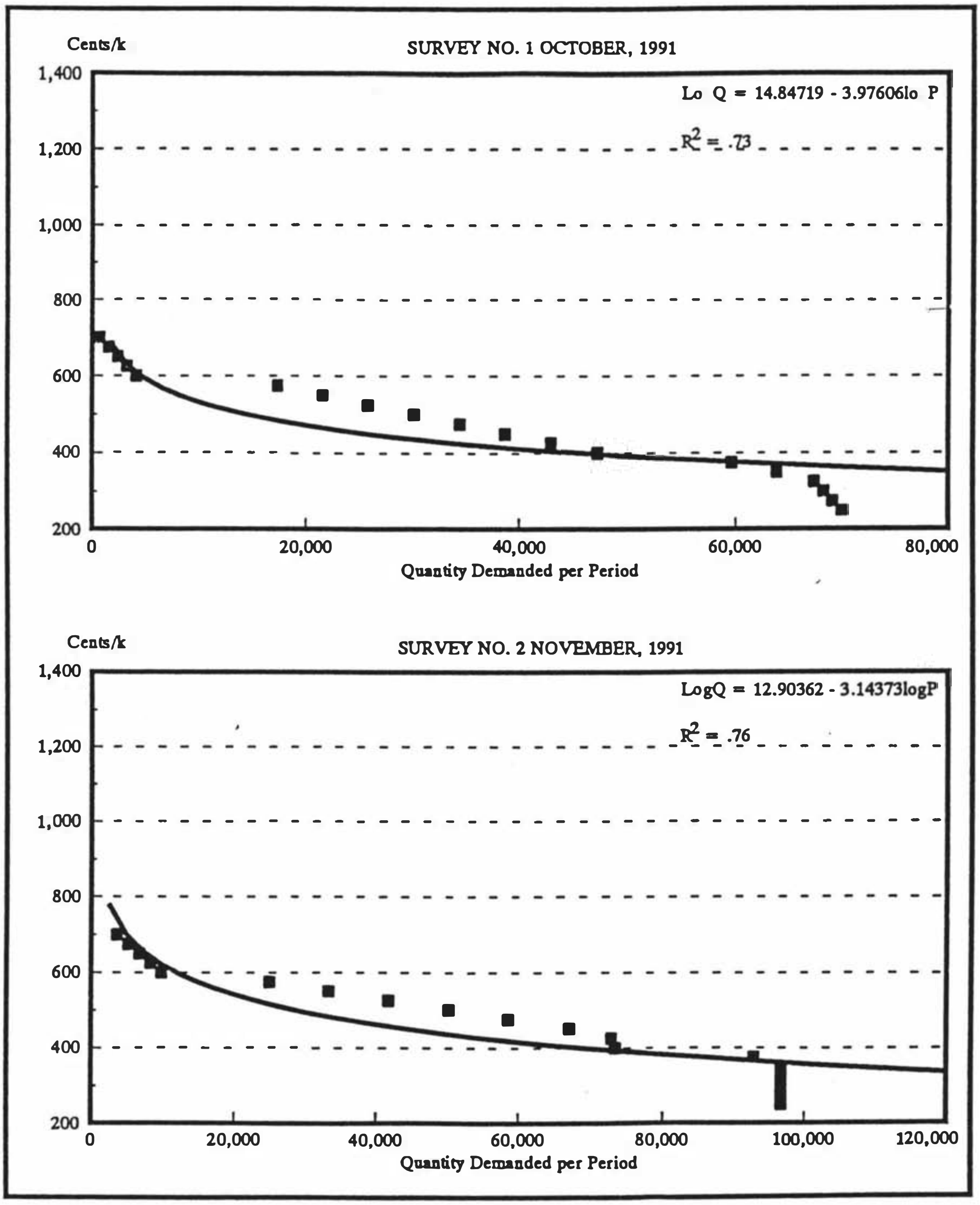


FIGURE 6.7

Aggregate Derived Demand Curves for Survey 3 & 4

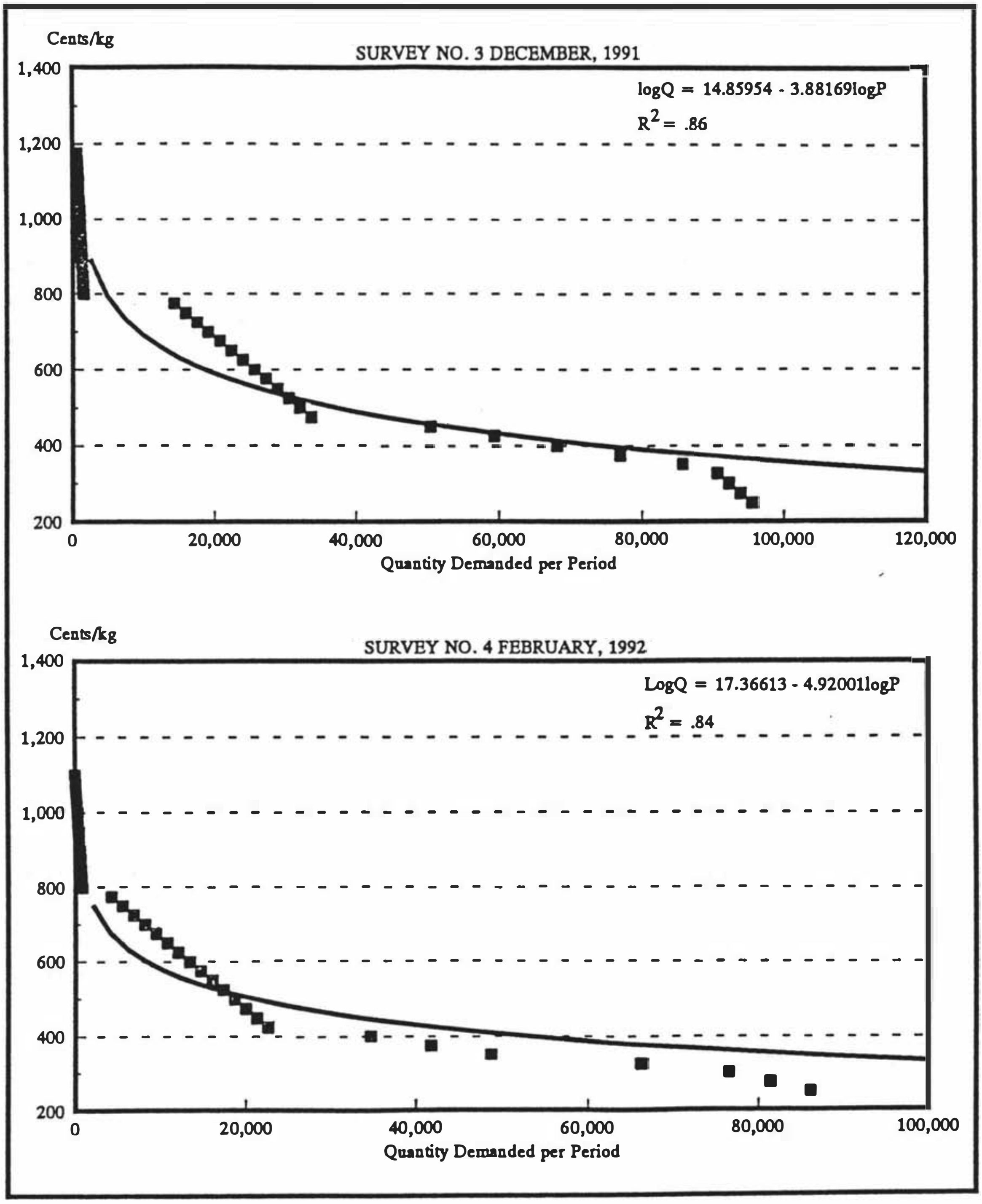


FIGURE 6.8

Aggregate Derived Demand Curves for Survey 5 & 6

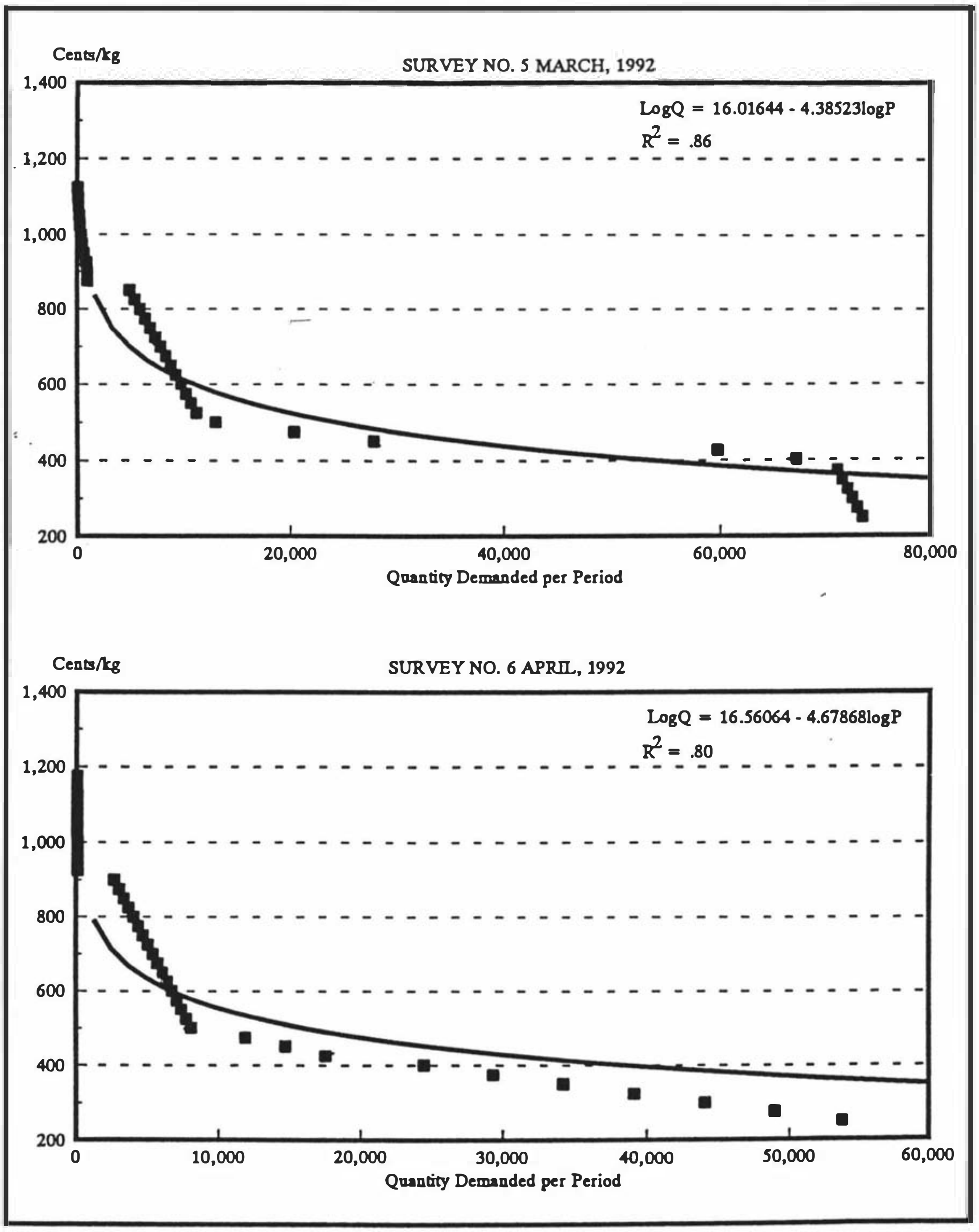


FIGURE 6.9

Aggregate Derived Demand Curves for Survey 7 & 8

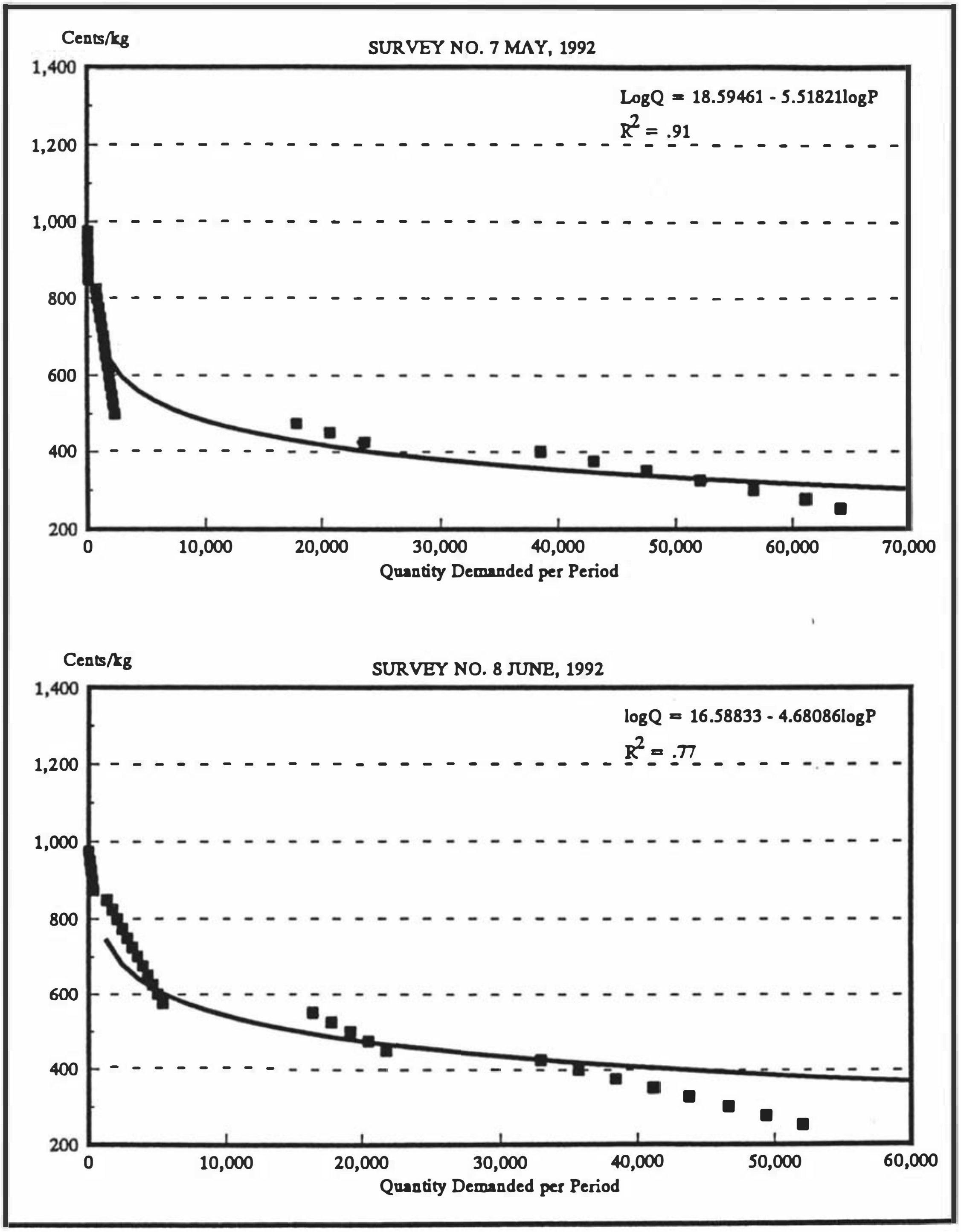


FIGURE 6.10

Aggregate Derived Demand Curves for Survey 9 & 10

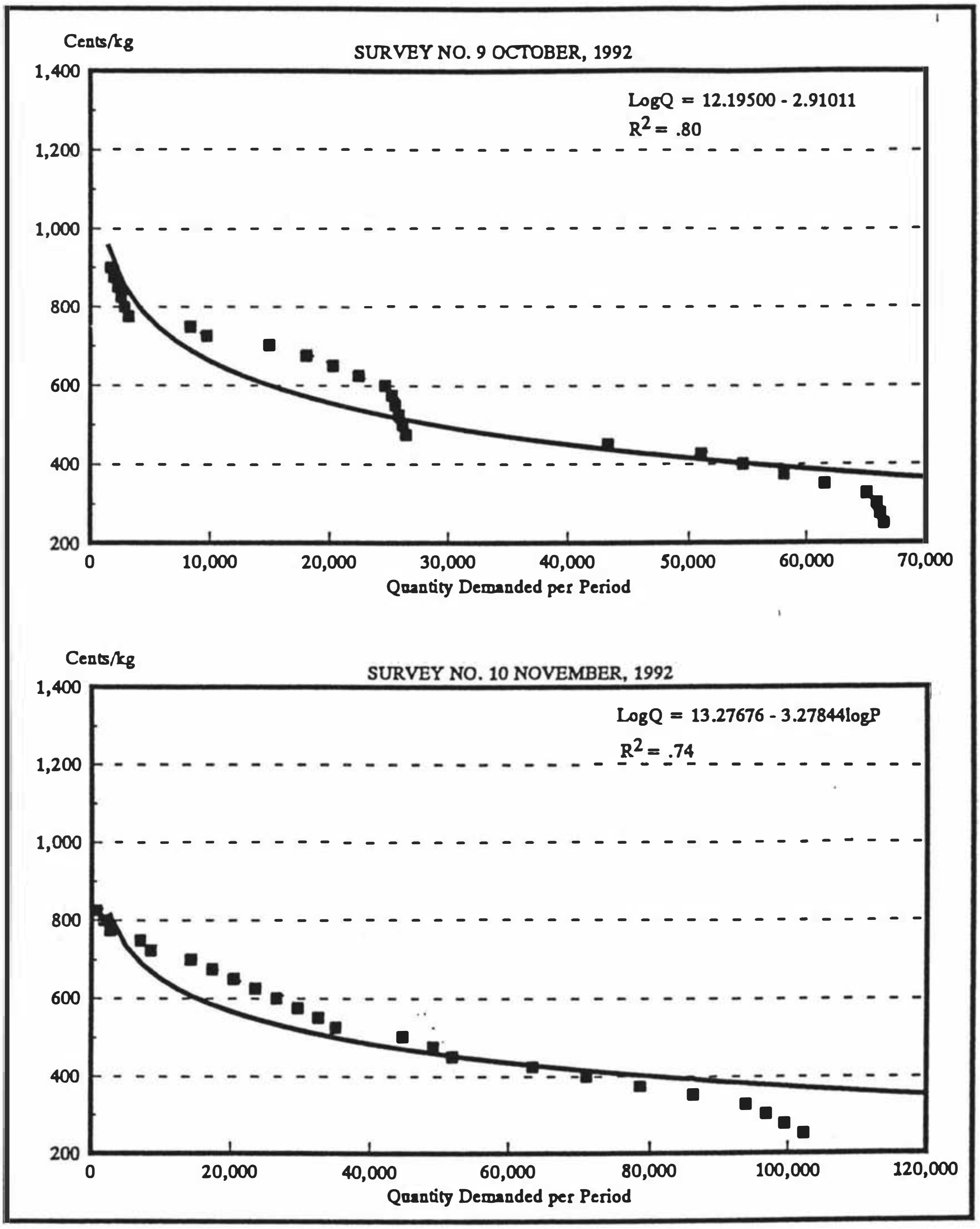


FIGURE 6.11

Aggregate Derived Demand Curves for Survey 11 & 12

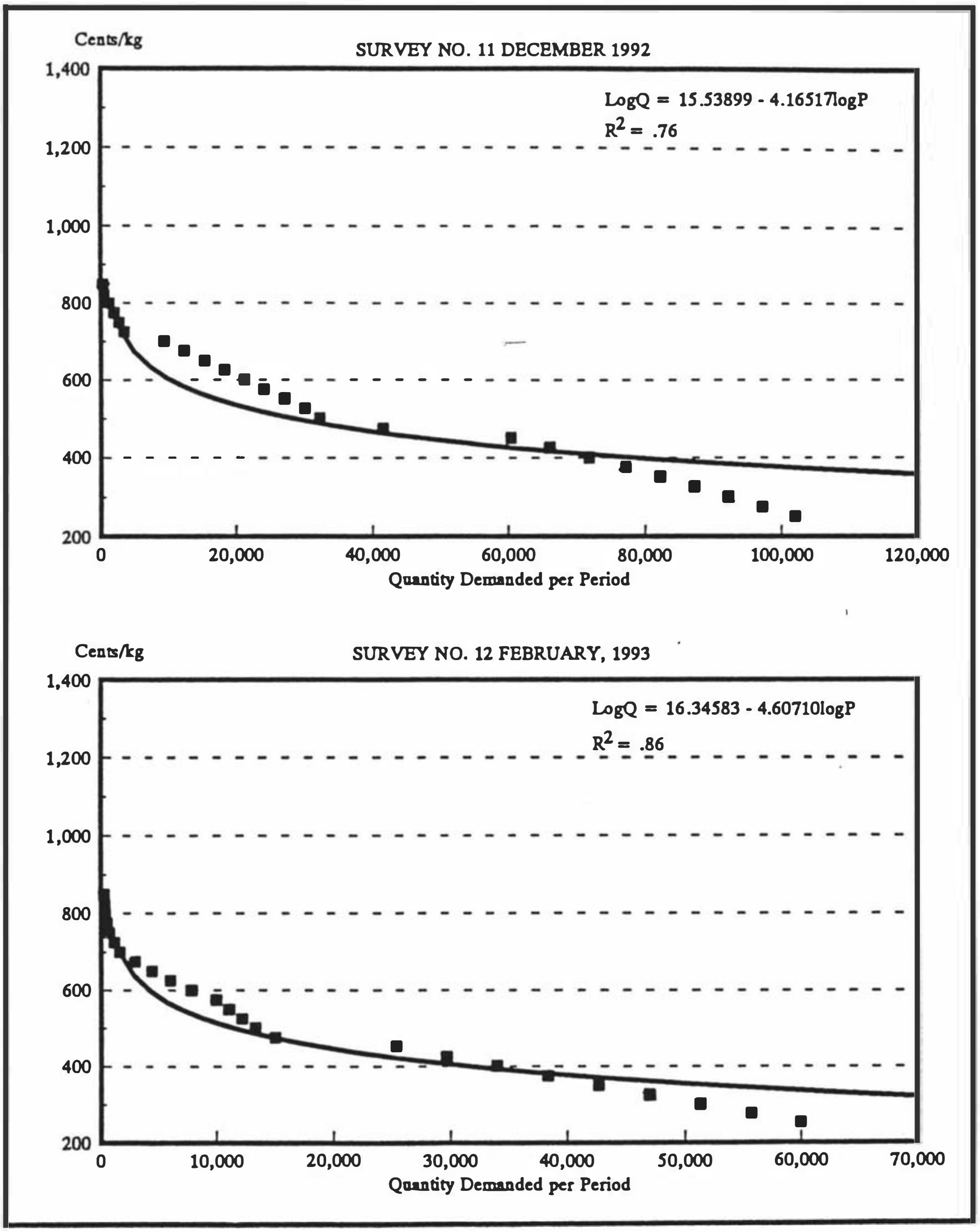


FIGURE 6.12

Aggregate Derived Demand Curves for Survey 13 & 14

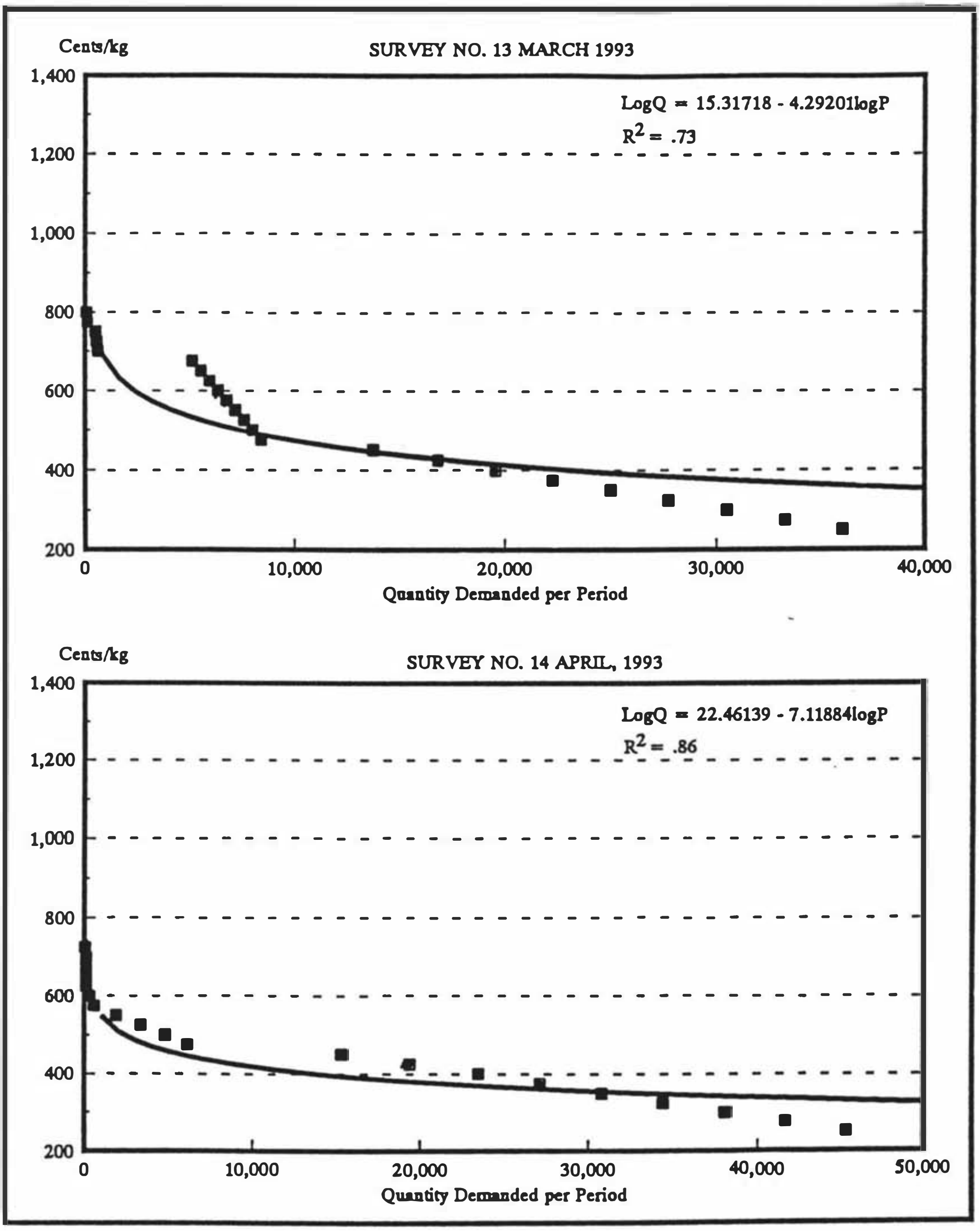
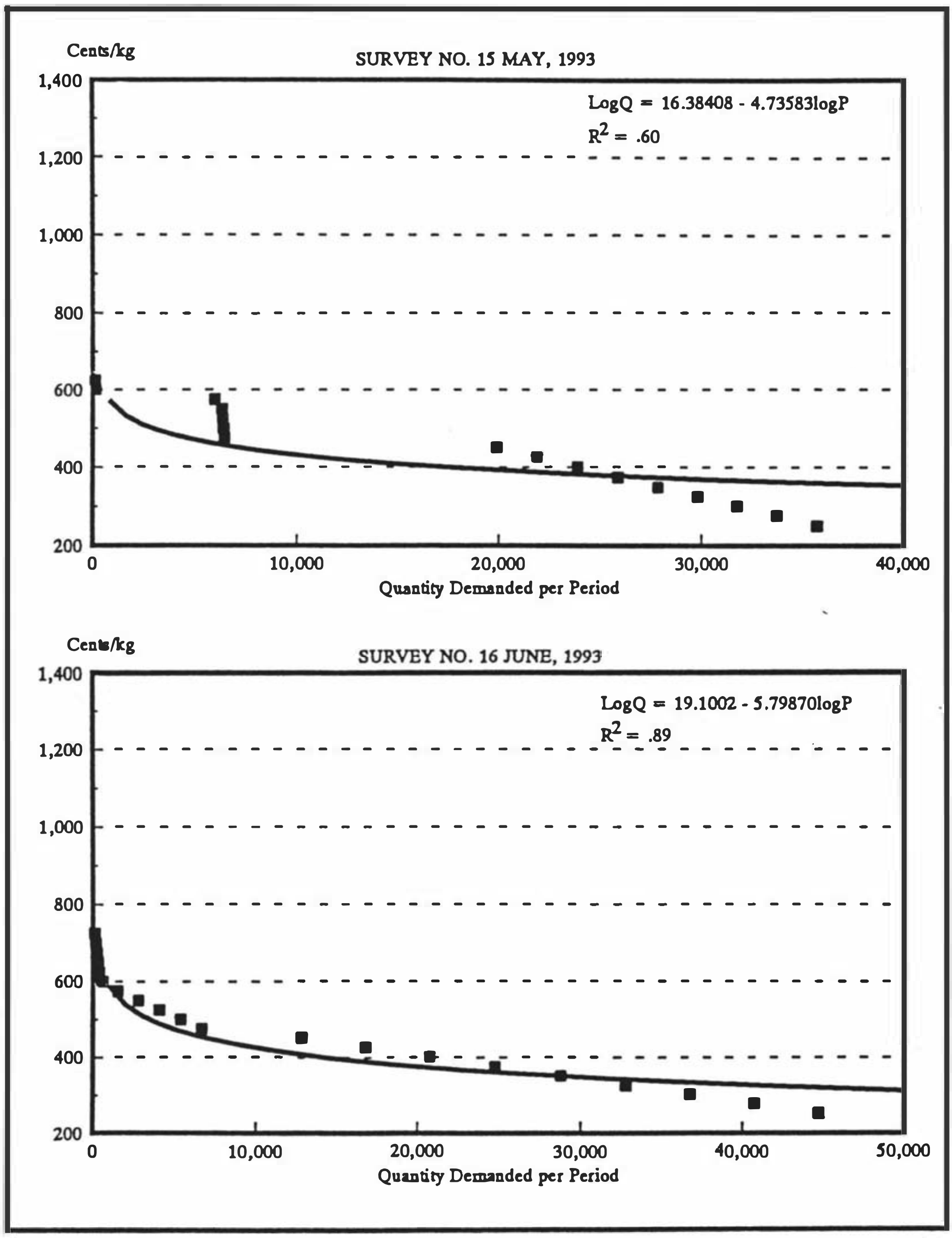


FIGURE 6.13

Aggregate Derived Demand Curves for Survey 15 & 16



6.8 RELIABILITY OF THE EXPECTED PURCHASE LEVELS

6.8.1. Introduction

The data above provide the buyers expectations of wool purchases under some set of assumptions that they may have in response to particular prices. It can also be seen that given these expectations, a series of price-quantity points can be established and formalised through OLS regression. Price elasticity of demand estimates can then be developed given a prevailing price facing the buyer over the period. However, the inevitable question must be asked, how reliable are these expectations? In Appendix N, mention is made of the variability in the macro environment facing the buyers. There appears to be some scope for errors to be made given the uncertainty in the market in terms of quantity and quality of supplies as well as demand. Furthermore, the buyer has available three options from which to purchase wool supplies; the auction system, private buying or through previously acquired stocks (see Chapter Five). The true test of the reliability of these estimates lies in the correlation between the expectations and the realisations. If there are considerable differences, which cannot explained by extraneous factors but instead reflect the inadequacy of the instrument, than the approach being considered in this study needs to be re-evaluated.

To test the ability of this survey based probability approach to accurately capture the wool buyers purchase expectations at auction, a comparison between expected purchases at auction and actual purchases at auction needs to be undertaken. It was a fortunate aspect of this study that the collection of data relating to individual companies' actual auction purchases was able to be achieved without any great difficulty. All purchases of wool made at auction incur a levy which is payable to the Council of Wool Exporters. The New Zealand Wool Board monitor the collection of these levies and thus were able to supply data related to each companies auction purchases and the average clean price paid. The auction data was then aggregated into the respective micron ranges and total purchases calculated for each survey period for each company. Company B however, did not have data available for this procedure. Instead, the companies own records were used to establish purchases over the periods. The prevailing average price for the micron group as used in the estimation of the expected values above (Appendix P) was used as a price variable. This is an acceptable surrogate given that it represents the average market price faced by all buyers at auction.

6.8.2. Aggregate Errors

Figure 6.14 illustrates the expected *vs.* actual wool purchases made by the panel over the two seasons. In 1991-92, the relationship appears relatively close, except for a sharp drop-off in expected purchases in period 4. A combination of factors could explain this discrepancy. First, prices at the beginning of the period were relatively high, with the indicator having risen 16% since period 1. Buyers may have expected prices to fall and adjusted their expectations accordingly. In fact, prices continued to rise (the indicator rose 15% during the period), and buyers may have perceived prices to continue rising and hence, may have brought forward planned purchases to purchase at a high price at that time rather than at a much higher price later. Secondly, demand factors improved substantially over the period with Indian buyers re-entering the market and increased competition amongst local buyers as concerns were raised about future suitable quantities of quality wool.

The 1992-93 relationship also appears close given the volatile movements in the levels of actual purchases. What is apparent however, is that expected purchases were below actual purchases for six of the eight periods, five of which were consecutive.

Figures 6.15 and 6.16 illustrate the expected *vs.*actual purchases for each of the wool groups over the two seasons. In the case of fine wools, there are considerable discrepancies in purchase levels for the first two-three periods, a time when the bulk of the seasons fine wools offerings are traded. This is particularly evident in 1991-92. However, with the smaller volumes traded later in the season, the size of the

FIGURE 6.14

Aggregate Actual *vs.* Expected Purchases for the Panel

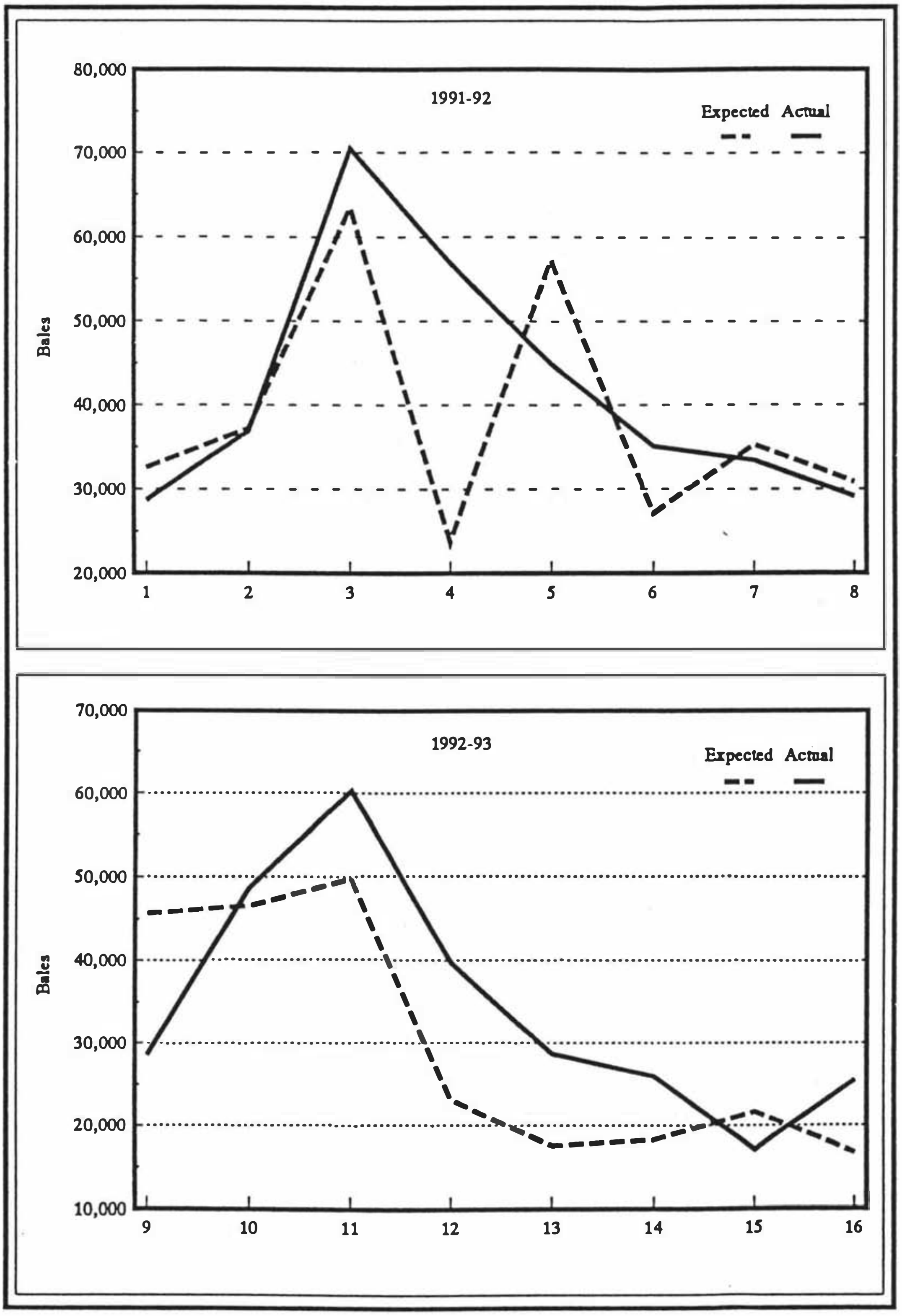


FIGURE 6.15

Actual vs. Expected Purchases by Wool Group - 1991-92

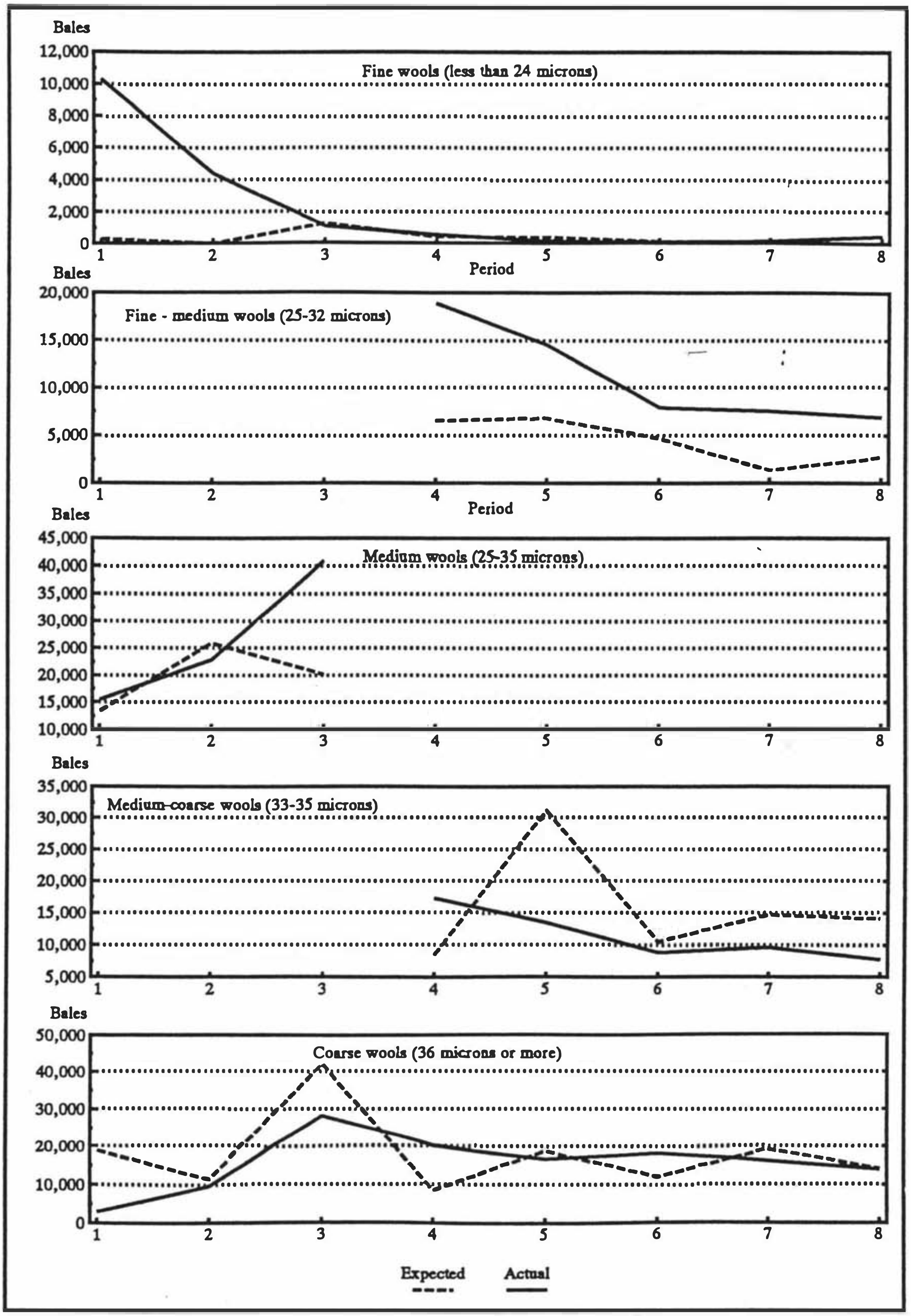
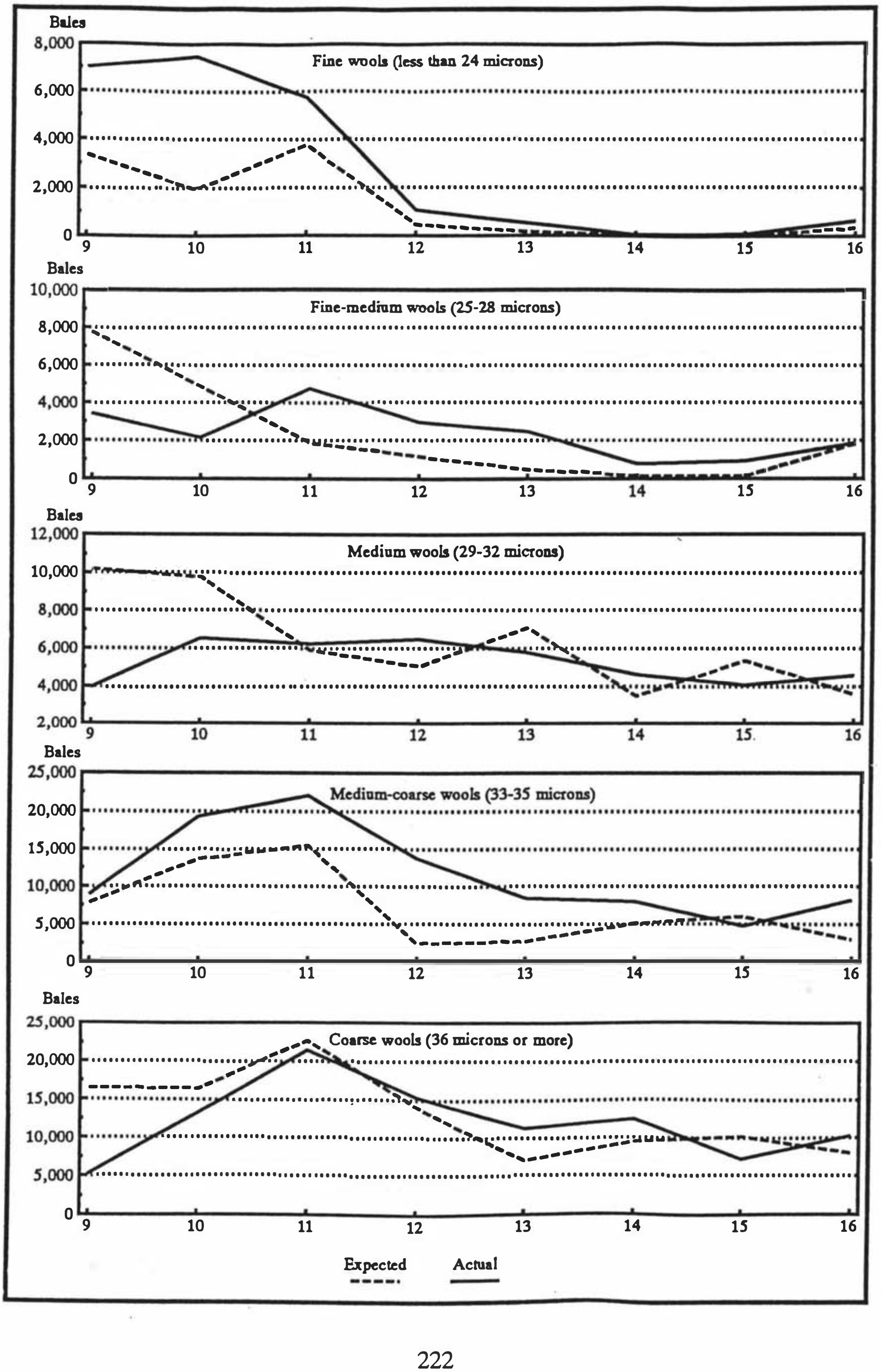


FIGURE 6.16

Actual vs. Expected Purchases by Wool Group - 1992-93



error is somewhat reduced. Substantial errors are also evident in period 4 for fine-medium wools and medium-coarse wools in period 5 while the panel appears to have systematically over-estimated purchases of medium-coarse wools in 1991-92 and 1992-93.

Given expected purchase quantities and actual purchase quantities, it is also possible to measure the numerical extent of any discrepancy in the buyers expectations. In this case, the error is designated as the actual purchase less the 'expected' purchase. This error can also be expressed as a proportion of actual purchases. Table 6.26 summarises the aggregated purchase errors over the two seasons.

TABLE 6.26

Deviations for Aggregated Purchase Data - By season and wool group

	1991 -92		1992 - 93	
	Deviation (bales)	%	Deviation (bales)	%
Fine	+ 14,571	+ 85	+ 12,559	+ 34
Fine-Medium[a]	+ 33,703	+ 60	+ 1,069	+ 6
Medium[b]	+ 19,760	+ 25	- 8,138	- 19
Medium-Coarse[c]	- 21,594	- 38	+ 37,539	+ 40
Coarse	- 18,539	- 15	- 7,690	- 8
TOTAL	+ 27,901	+ 8.3	+ 35,339	+ 12.9

Notes:

a 25-32 microns for survey 4 - 8, 1991-92.
b 25-35 microns for survey 1 - 3, 1991-92.
c 33-35 microns for survey 4 - 8, 1991-92.

Looking firstly at the results in Table 6.26, it is apparent that, on an aggregate basis at least, the panel consistently underestimated purchases (*i.e. actual purchases > expectations*) over the two seasons. A disturbing trend is that this under-estimation increased, rather than decreased as one would have hoped for. The data in the table also shows there was consistent under-estimation of aggregate purchases in the fine and fine-medium wool groups and considerable over-estimation in the coarse wool groups. Also apparent is the fact that every wool group, apart from medium-coarse (*i.e.* 33-35 microns), showed an improvement in both the absolute error and the percentage error between seasons. The ability of the panel to forecast purchases in the medium-coarse group worsened between seasons and is largely responsible for the overall deterioration in aggregate forecasting performance between seasons. In relative terms, only the forecasts for the fine-medium and coarse wool groups showed any promise with forecast errors of 6% and 8% respectively.

Table 6.27, overpage, summarises the deviation errors by survey period. A notable feature of this table is the tendency for the panel to make progressively smaller errors during each season, although for fine and medium-coarse wools there is also an end-of-season upturn in absolute error as well. A possible explanation for this pattern could be the fact that the beginning of the season provides the most uncertainty in terms of future wool supply qualities and quantities for buyers, and hence, some uncertainty of prices. Compounding this, particularly in 1991-92, was the new and unknown experience of a 'free' market. There was also the consideration of a 'new' and unfamiliar instrument for the buyers to use in the purchase expectations experiments. The end-of-season up-turn can also be explained in terms of uncertainty about just what wools are available in such a short time to fulfil any remaining contracts. Why this is apparent in just two wool groups is not clear.

Consideration of just the aggregate figures could provide some degree of encouragement for the endorsement of the purchase probability approach. After all, the aggregate percentage errors tend to be low. Furthermore, this tendency for under-estimation in both periods is consistent with other studies (See Appendix E). However, whether the errors are at 'appropriate' levels is difficult to tell given the unique nature of the product variable in the experiment (*i.e.* a commodity).

TABLE 6.27

A Comparison of Expected *vs.* Actual Purchases at Auction - Total Panel

<table>
<tr><th></th><th colspan="2">Fine</th><th colspan="2">Fine-Medium</th><th colspan="2">Medium</th><th colspan="2">Med-Coarse</th><th colspan="2">Coarse</th></tr>
<tr><th></th><th>Dev'n</th><th>%</th><th>Dev'n</th><th>%</th><th>Dev'n</th><th>%</th><th>Dev'n</th><th>%</th><th>Dev'n</th><th>%</th></tr>
<tr><td colspan="11">1991-92 Season</td></tr>
<tr><td>1</td><td>10,001</td><td>97</td><td colspan="3">2,044</td><td colspan="3">13</td><td>-15,925</td><td>-546</td></tr>
<tr><td>2</td><td>4,404</td><td>100</td><td colspan="3">3,059</td><td colspan="3">-13</td><td>-1,711</td><td>-18</td></tr>
<tr><td>3</td><td>-190</td><td>-18</td><td colspan="3">20,775</td><td colspan="3">51</td><td>-13,605</td><td>-48</td></tr>
<tr><td>4</td><td>131</td><td>25</td><td colspan="2">12,384</td><td colspan="2">65</td><td>8,897</td><td>51</td><td>11,756</td><td>58</td></tr>
<tr><td>5</td><td>-247</td><td>-173</td><td colspan="2">7,739</td><td colspan="2">53</td><td>-17,632</td><td>-131</td><td>-2,181</td><td>-13</td></tr>
<tr><td>6</td><td>-34</td><td>-65</td><td colspan="2">3,232</td><td colspan="2">41</td><td>-1,614</td><td>-18</td><td>6,369</td><td>35</td></tr>
<tr><td>7</td><td>53</td><td>46</td><td colspan="2">6,203</td><td colspan="2">83</td><td>-5,008</td><td>-52</td><td>-3,126</td><td>-19</td></tr>
<tr><td>8</td><td>453</td><td>100</td><td colspan="2">4,145</td><td colspan="2">60</td><td>-6,237</td><td>-80</td><td>-116</td><td>-1</td></tr>
<tr><td colspan="11">1992-93 season</td></tr>
<tr><td>9</td><td>3,650</td><td>52</td><td>-4,373</td><td>-128</td><td>-6,222</td><td>-157</td><td>1,108</td><td>12</td><td>-11,247</td><td>-216</td></tr>
<tr><td>10</td><td>5,540</td><td>74</td><td>-2,723</td><td>-127</td><td>-3,232</td><td>-49</td><td>5,679</td><td>29</td><td>-3,131</td><td>-24</td></tr>
<tr><td>11</td><td>1,998</td><td>35</td><td>2,886</td><td>61</td><td>335</td><td>5</td><td>6,552</td><td>30</td><td>-1,294</td><td>-6</td></tr>
<tr><td>12</td><td>606</td><td>57</td><td>1,815</td><td>61</td><td>1,476</td><td>23</td><td>11,437</td><td>83</td><td>1,314</td><td>9</td></tr>
<tr><td>13</td><td>259</td><td>69</td><td>2,008</td><td>81</td><td>-1,299</td><td>-22</td><td>5,769</td><td>68</td><td>4,347</td><td>38</td></tr>
<tr><td>14</td><td>31</td><td>62</td><td>644</td><td>82</td><td>1,098</td><td>24</td><td>2,963</td><td>37</td><td>3,011</td><td>24</td></tr>
<tr><td>15</td><td>75</td><td>100</td><td>779</td><td>85</td><td>-1,271</td><td>-31</td><td>-1,260</td><td>-27</td><td>-2,964</td><td>-41</td></tr>
<tr><td>16</td><td>300</td><td>47</td><td>33</td><td>2</td><td>977</td><td>21</td><td>5,291</td><td>64</td><td>2,274</td><td>22</td></tr>
</table>

Note:

i) Deviation = Actual number of bales purchased (A_i) - expected number of bales purchased (E_i).

ii) A negative value implies an overestimation of the purchase forecast and *vice versa*. The negative % indicates the direction of the error.

ii) percentage = error/actual

i.e. $\Sigma(A_{ij} - E_{ij})/A_{ij}$ where i = individual buyer & j = period (j = *1..16*)

As evidenced in Table 6.27 above, there exists a considerable degree of variability between the groups. The table reveals an error rate which has a magnitude which is disappointingly high given the objectives of the study. As mentioned, this is particularly evident for fine wools, fine-medium wools and medium-coarse wools.

Figures 6.17 and 6.18 further illustrate the deviation errors by survey period. The extent of the variation in the errors is again quite evident throughout each of the two seasons, particularly at the beginning of each season. In some respects the deviations at the beginning of each period were to be expected given the time required for a learning process. A review of the literature reveals this research to be the only longitudinal study in this area. As such, it is difficult to say how long an 'appropriate' learning period would be. As described in Chapter Five, all the respondents were given a considerable degree of help in understanding the mechanics and process involved in the data collection process. Furthermore, and in line with previous studies, the respondents were allowed a 'dummy run' through a hypothetical experimental situation. Both of these processes were repeated during the second interview. It was not a function of this study to explicitly address this issue of time and learning, but based on the researchers personal experience in conducting the interviews, it was evident that by the third interview **most** respondents could comfortably handle the data collection and experimental process comfortably. Occasionally, during the first season at least, one or two buyers had to be reminded about the survey process. By the second season however, all the buyers could quite comfortably cope with the data instrument without prompting.

Given that a 'learning' period was required, and hence substantial errors more likely, it could be proposed that the first few periods be excluded from the analysis as they may 'bias' the results. Table 6.28 illustrates the revised aggregate 1991-92 season error with the first two periods excluded from the analysis. In the coarse wools group, the improvement in accuracy is quite marked with the aggregate expected and actual purchases more or less equal if the first two periods are excluded. In fact, it is apparent that almost 95% of the total error is accounted for by errors made in the first two periods. This improvement is quite encouraging if future longitudinal studies are to be considered. An improvement in accuracy is also noted for the fine wools group. Some of this improvement however, may be a function of the smaller volumes traded over this period since most fine wool trading occurs in the early parts of the season.

This improvement, unfortunately, does not continue into the second season! As Table 6.27 and Figure 6.18 shows, the error levels, particularly in periods 9 and 10 are quite high for all groups. For example, in periods 11, 12, 13 and 14 there is a

TABLE 6.28

Adjusted Aggregate Errors - 1991-92 season

	1991-92 season		less first two periods	
	Dev'n	%	Dev'n	%
Fine	14,571	+ 85	+ 166	+ 6.7
Fine-Medium	33,703	+ 60	N/A	
Medium-Coarse	-21,594	- 38		
Coarse	-18,539	- 15	-903	- 0.8

Note: Medium wools (25-35 microns) are excluded from the analysis since they cover the first three periods only.

tendency for the buyers to be always under-estimating purchase forecasts. A possible explanation for this behaviour could have been a negative perception of the reduced quantities of 'good' wools being available over the actual situation which prevailed. In period 15 for example, there is a noticeable over-estimation of purchases by the panel. At this point, the market did pick up with the indicator finishing higher than its starting level (for the first time that season). There may have been an expectation of a declining market, and hence cheaper wools. When this did not eventuate, purchases were postponed. In period 16, the pattern reverts back to under-estimations. Again, an explanation for this is a belief by the panel that passings would remain as high as previous levels (*when they did not*) and that quantities of

FIGURE 6.17

Relative Forecasting Errors over time - by Wool Group: 1991-92

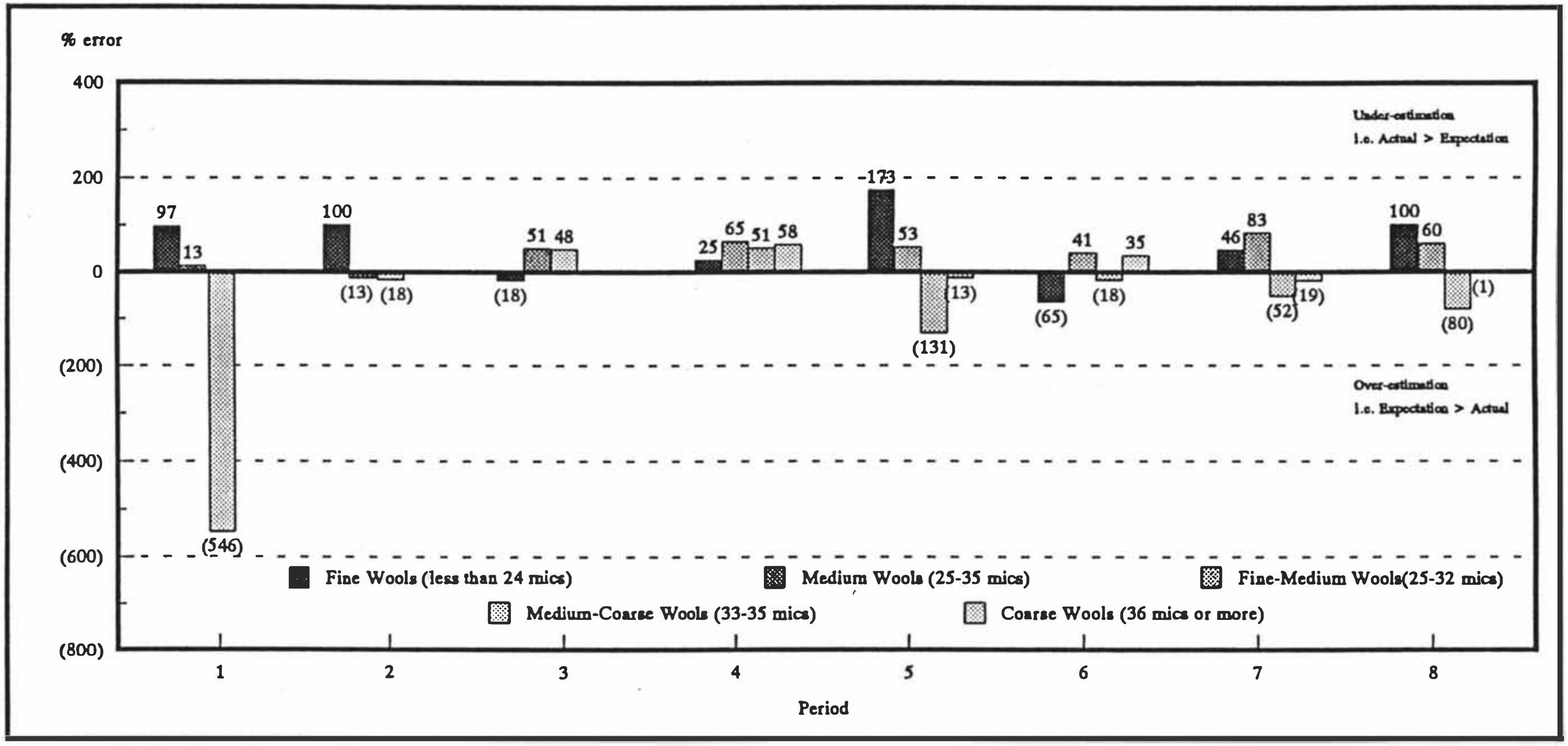
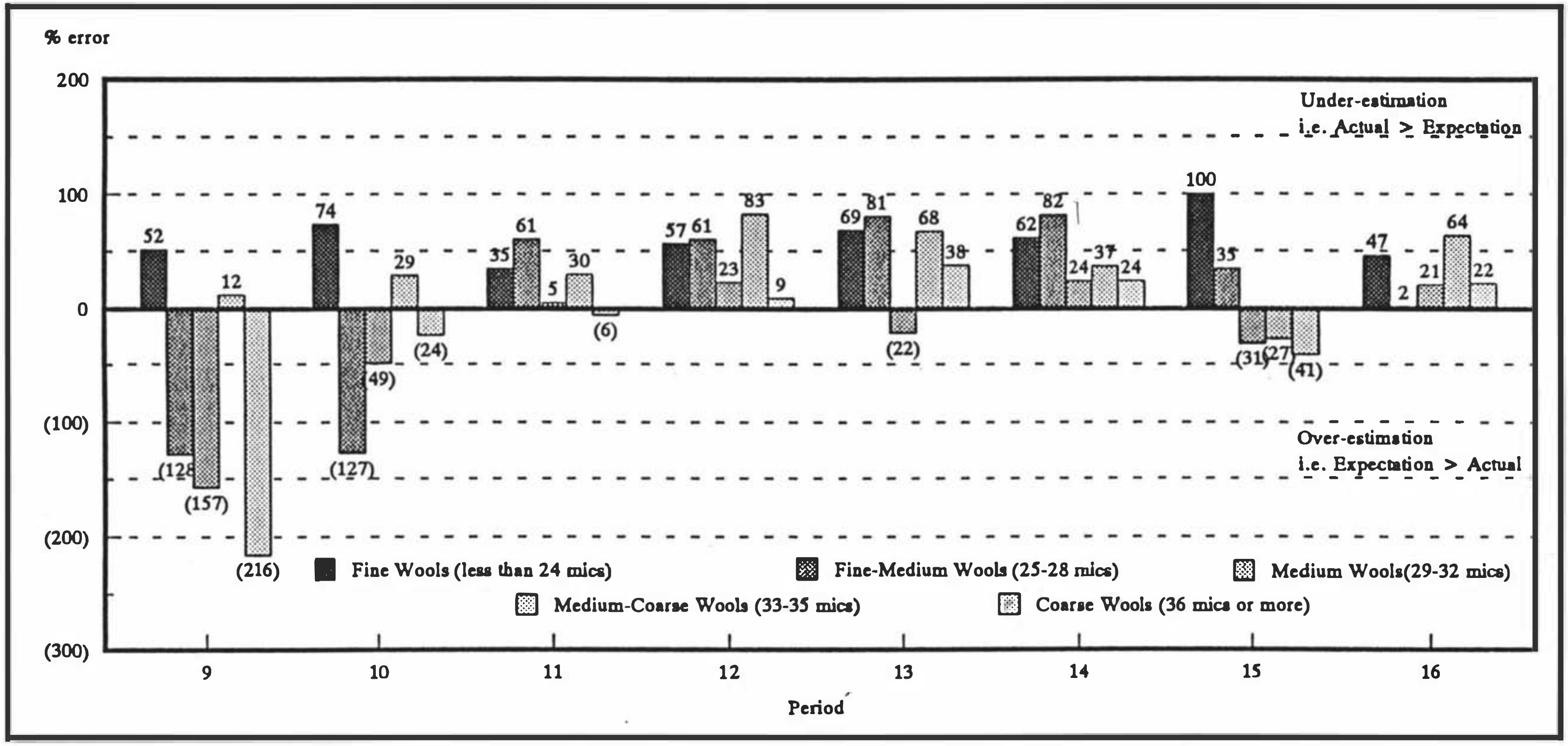


FIGURE 6.18

Relative Forecasting Errors over time - by Wool Group: 1992-93



quality wools would not enter onto the market (*when they did*).

It is also interesting to note that, with the exception of period 15, buyers consistently under-estimated their purchases of medium-coarse wools (*i.e.* 33-35 microns). One could well ask why this is the case. To answer this, it is important to recognise that historically there has always been a premium, or margin, between the wool types. In simple terms, the finer the wool type, the higher the premium. The relative representative prices used in the study through 1991-92 are illustrated in Figure 6.19. While there is some degree of fluctuation of the prices, there appears to be some consistent margin between the wool types (although this does increase over time for fine wools). Figure 6.20 illustrates the traditional seasonal pricing situation, with prices tending to increase markedly throughout the season. Figure 6.21 and 6.22 illustrate the price information for the 1992-93 season. Apart from one sale result (12 November), there still exists some price differential between the fine and medium representative prices. However, between the medium-coarse (*i.e.* 35F3E) and coarse (*i.e.* 37F3D) the early season differential quickly disappears and the two series fluctuate around each other. Compounding this is the overall downward trend in market prices throughout the season, rather than the 'traditional' up-turn. Figure 6.22 illustrates this another way. While the representative price for coarse wools (*i.e.* 37F3D) has minor fluctuations around it's starting price, the relative price for 35F3E falls throughout the season.

In Section 4.3.1 of Chapter Four, the phenomenon of regression towards the mean was discussed. In the context of this study, it could be expected to observe this phenomenon with respect to anticipated purchases. With the exception of indent orders, buyers have a reasonable knowledge of the level of purchases required throughout the season to meet contact orders. There is, in effect, some assumed 'average' purchase requirement required each month in order for this target to be met. Given variability in supply, quality and price, you would expect to see a pattern which would see each periods expected purchases fluctuate around the mean of the season's actual purchases (*i.e.* total error = 0). Figure 6.23 illustrates the desired case.

FIGURE 6.19

Movement of Representative Prices - 1991-92

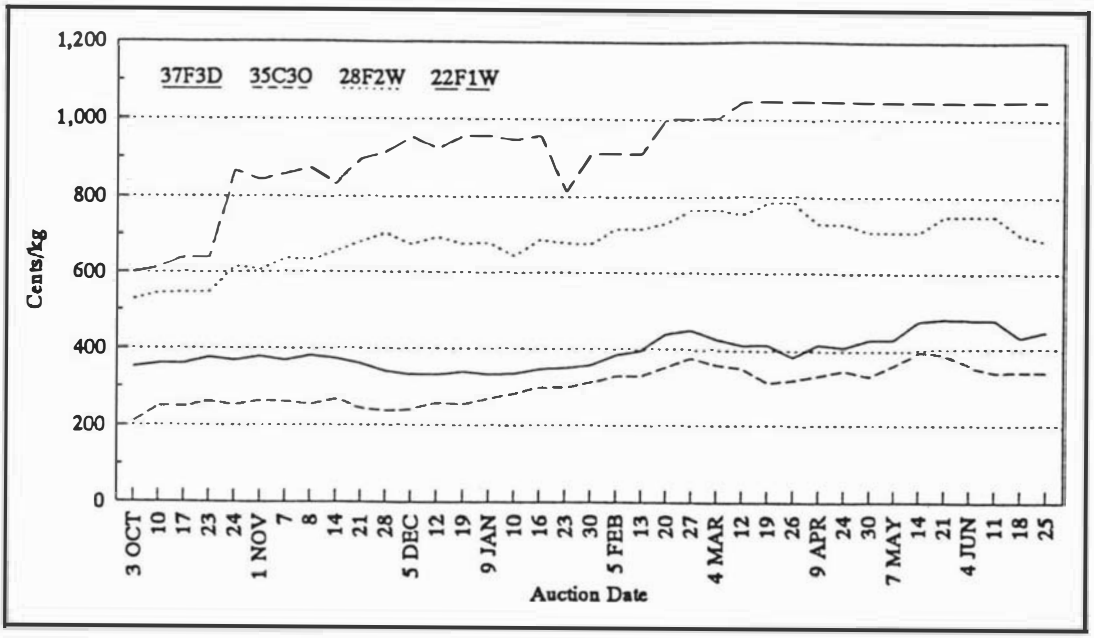


FIGURE 6.20

Index of Representative Price Movements - 1991-92

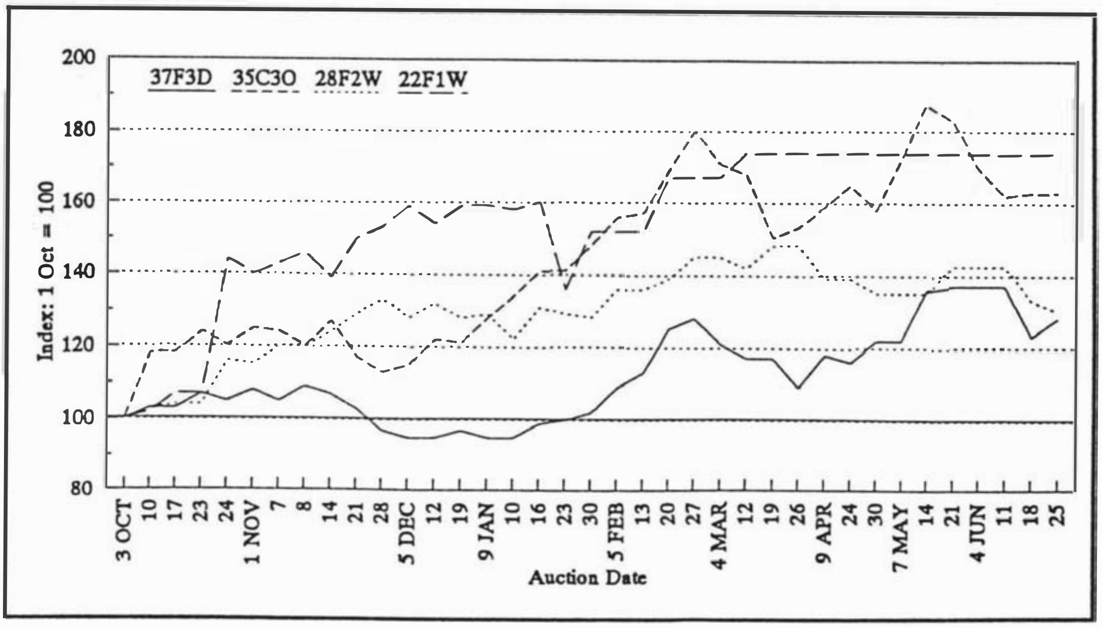


FIGURE 6.21

Movement of Representative Prices - 1992-93

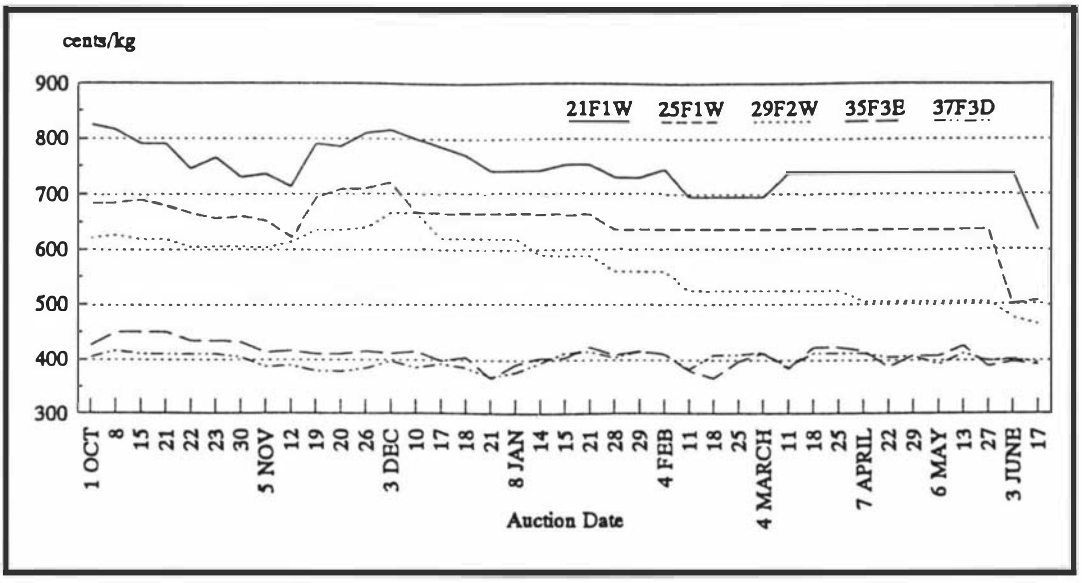


FIGURE 6.22

Index of Representative Price Movements - 1992-93

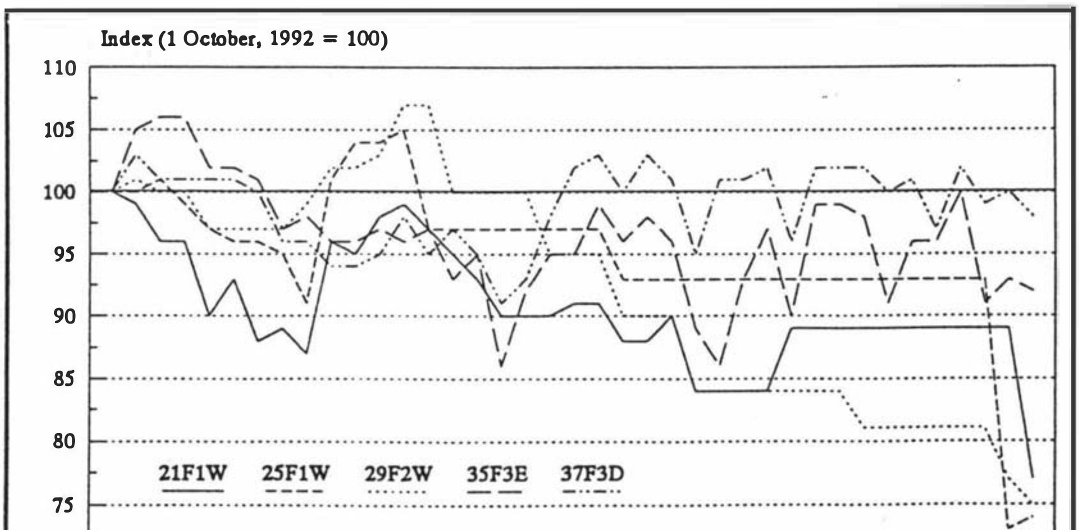
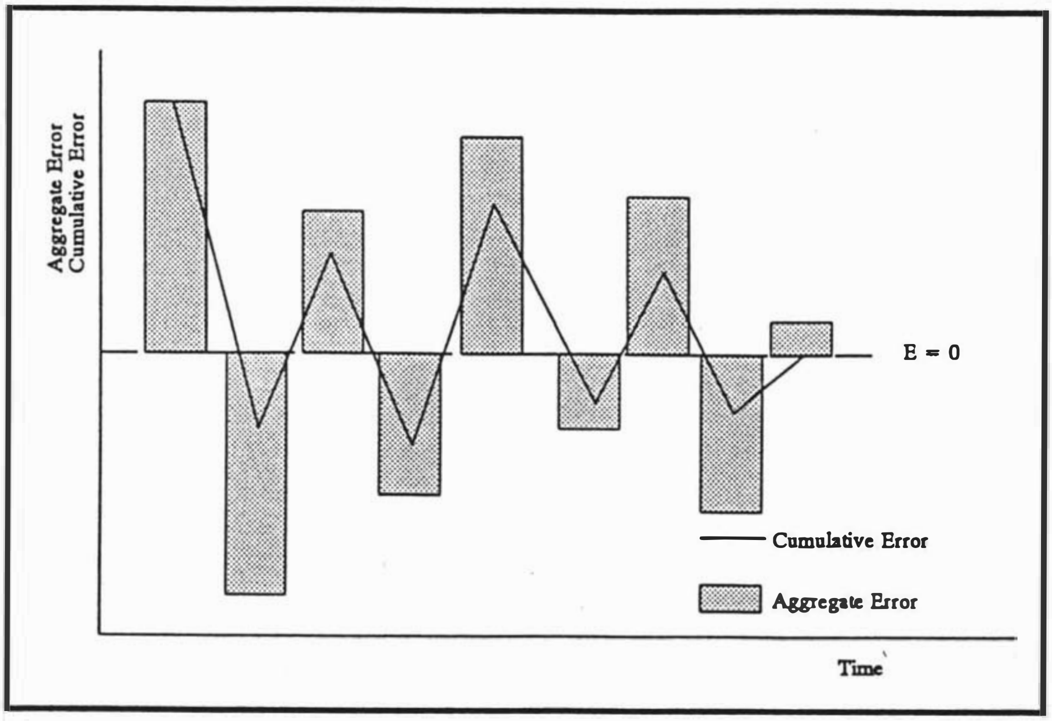


FIGURE 6.23

The Fluctuation of Expected Purchases Around the Seasonal Average



Assuming rational behaviour and basing all decisions on full information, any observed deviation may therefore, be attributed to unanticipated indent orders.

Figure 6.24 illustrates the cumulative error through the two seasons. In both periods the pattern is roughly the same. Initially there is a net cumulative over-estimation of purchases. By the fourth period (*i.e.* January/February) the panel are making a net cumulative under-estimation. There is also the lack of a distinctive 'wave' pattern around the error = 0 mark, as one would have hoped for with negative and positive errors eventually cancelling each other out.

Figures 6.25 and 6.26 illustrate the cumulative errors according to the individual wool groups. As suggested earlier, coarse wools exhibit a consistent over-estimation, while fine wools exhibit a consistent under-estimation. They also both exhibit similar

FIGURE 6.24

Cumulative Aggregate Errors: 1991-92 & 1992-93

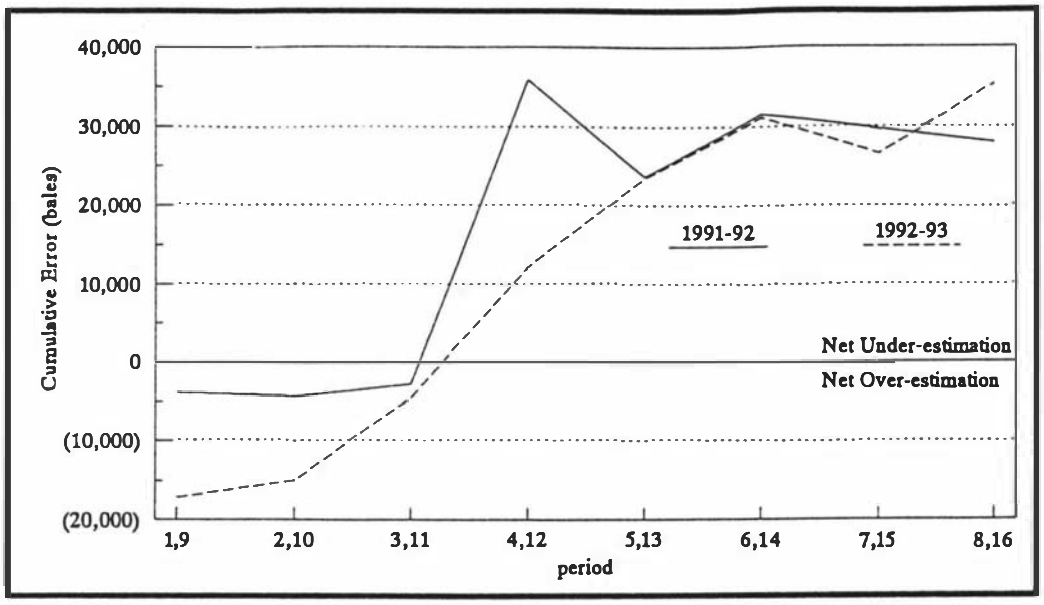


FIGURE 6.25

Cumulative Errors by Wool Group - 1991-92

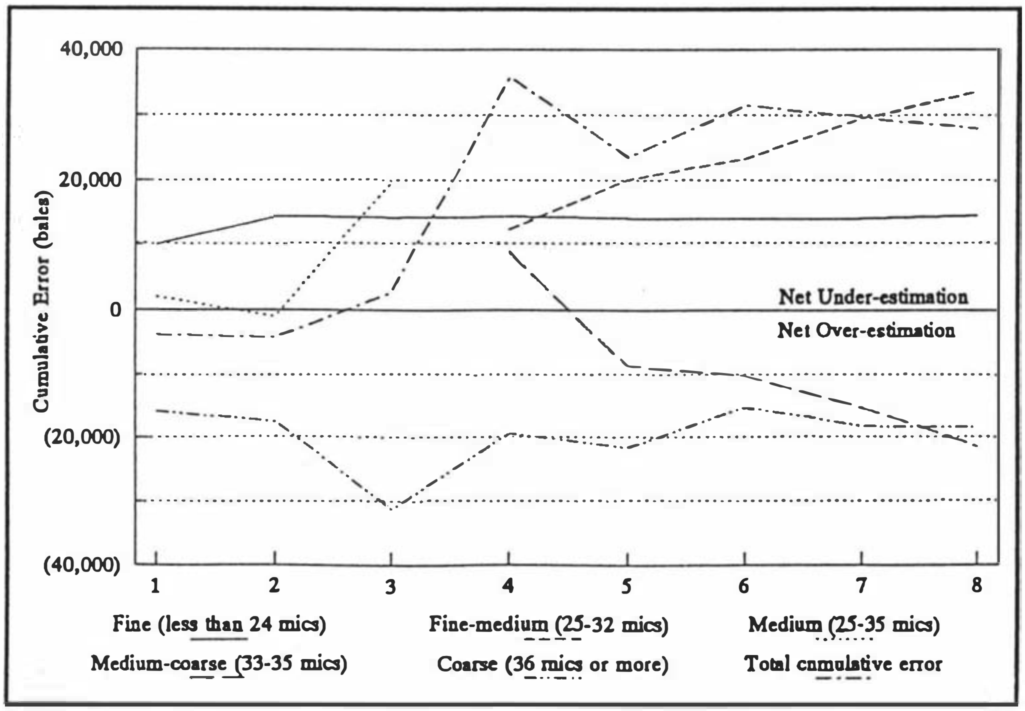
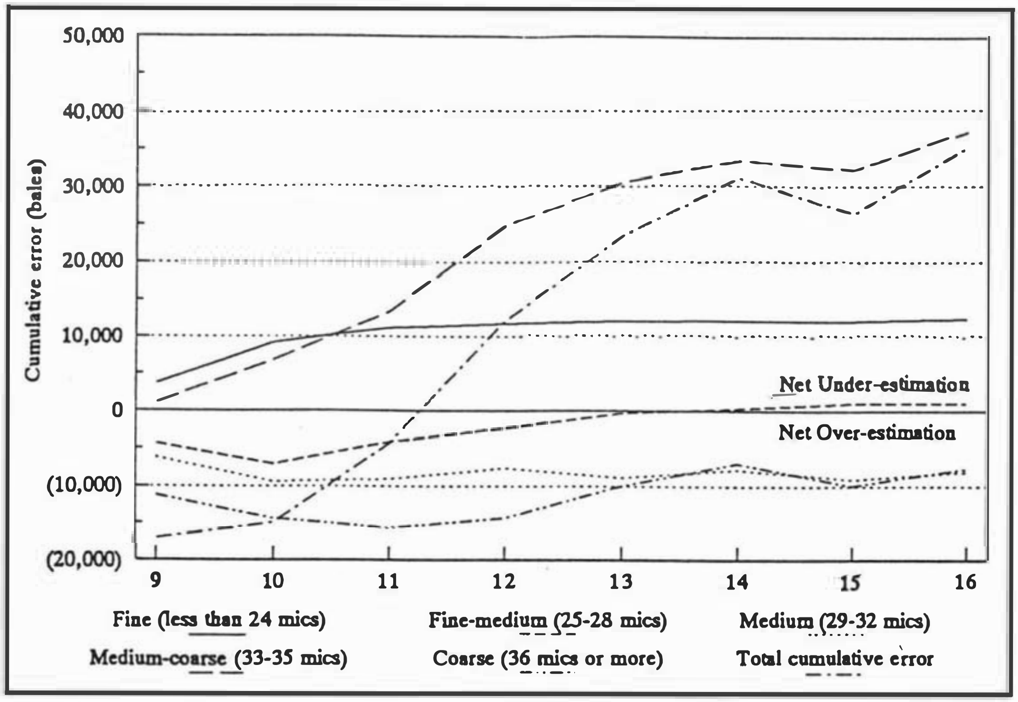


FIGURE 6.26

Cumulative Errors by Wool Group - 1992-93

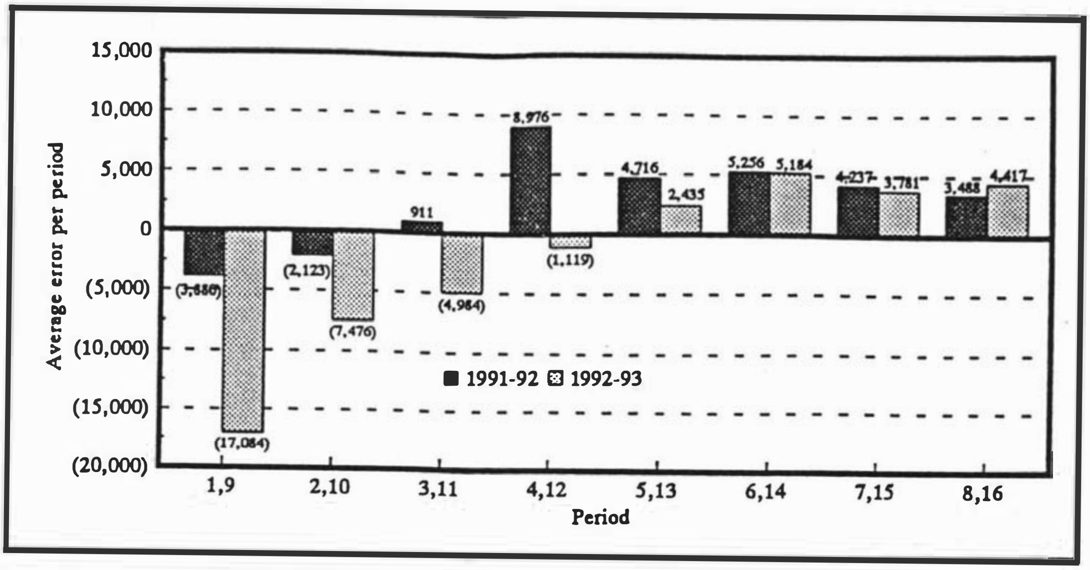


patterns throughout the two seasons. Apart from the fine-medium wools (1992-93), no series approaches the error = 0 mark by the end of the season. In fact, there is a tendency for these other groups cumulative errors to become progressively larger.

An alternative view of the errors can be had by considering the average cumulative error made by the panel (Figure 6.27). As exhibited in the previous figures, the panel, on average, make cumulative over-estimations at the beginning of the season and cumulative under-estimation towards the end of the season. The average cumulative error made does however, show some tendency toward zero over time (although it does not ever reach it!). The smallest average errors occur in period 3 (+ 911 bales) and period 12 (- 1,119 bales), which are both in the middle of the season.

FIGURE 6.27

Average Cumulative Errors Made by the Panel



6.8.3. Predictive Ability Using Theil's U.

To more critically evaluate the panels ability to forecast their purchases, it is possible to apply Theil's Inequality Coefficient[1], U. This statistic measures the *ex post* ability of the panel forecasts. If U = 0, then the actual values and the forecasted values are equal and there is a perfect fit. A value of U = 1 however, shows that the forecasted values are always 0 when the actual values are nonzero and *vice versa* and represents the worst possible forecasting performance. This statistic can also be decomposed into the proportions of inequality, U^m (*i.e.* the bias proportion), U^s (*i.e.* the variance proportion) and U^c (*i.e.* the covariance proportion). U^m provides an indication of systematic error. Ideally it should be less than .20, according to Pindyck and Rubinfeld (1981). U^s essentially shows the extent to which the expectations are related to the outcomes. If the value of U^s is large then it suggests that the expectations are not a good forecaster of actual purchases. The third component, U^c, is what is termed the unsystematic error or the remaining error after deviations from average values and average variabilities have been accounted for (Pindyck and

---

[1] Appendix S provides details of this statistic.

Rubinfeld, 1981). Table 6.29 below, summarises the forecasting performance of the panel over the two seasons.

The encouraging result from the table is that there appears to be some forecasting potential in the aggregate panel data. This was also suggested by a visual analysis of the series earlier (Figure 6.14) This is particularly evidenced by the U statistic and the correlation coefficient. The low value of U^s also suggests that expectations are closely related to actual purchases. The high value of U^m in 1992-93 provides further confirmatory evidence of systematic error (*i.e.* under-estimation).

Tables 6.30 and 6.31 below, summarise the forecast statistics by wool group. With the exception of the fine wools group (1991-92), the values of U would suggest some relationship between the expectation forecasts and the actual values. However, looking at the components of U provides a more revealing picture. Substantial

TABLE 6.29

Statistical Results of Aggregated Forecasts and Actual Purchases

	1991-92	1992-93
U	.057891	.060602
U^m	.070223	.160958
U^s	.001308	.001114
U^c	.928467	.837927
τ	0.56	.72
Mean Error	+ 3478	+ 4,417
R.M.S.	13,161	11,001
R.M.S. %	25	35

systematic errors are confirmed for several of the groups; (*1991-92*) less than 24 microns (under-estimation), 25-35 microns (under-estimation), 33-35 microns (over-estimation); (*1992-93*) less than 24 microns (under-estimation), and 33-35 microns (under-estimation). However, the presence of systematic under-estimation for the 33-35 microns group (1992-93) does not necessarily negate the forecasting ability given the relatively low value of U^s, the variance proportion. For the other groups with systematic errors, this is not the case and the high value of U^s suggests a poor forecasting ability by the panel for these groups.

In both seasons, the coarse wool group exhibits a useful forecast result with low values of U and no substantial evidence of systematic error. This result is significant given that the bulk of the wools traded fall into this category.

TABLE 6.30
Statistical Results of Aggregate Forecasts and Actual Purchases - 1991-92

	Wool Micron Group				
	< 24 mics	25-35 mics[a]	25-32 mics[b]	33-35 mics[b]	> 36 mics
U	.57217	.15215	.21499	.15762	.09280
U^m	.22617	.48731	.81321	.20422	.06766
U^s	.60699	.35467	.12499	.22159	.09859
U^c	.16533	.82468	.06179	.57419	.83374
τ	.060	.325	.819	.072	.518
Mean error	- 1,821	- 3,952	- 6,741	4,319	2,317
R.M.S	3,869	9,435	7,475	9,556	8,909
R.M.S %	91	24	62	77	196

Notes:

a	*Surveys No. 1 to 3 only*
b	*Surveys No. 4 to 8 only*
τ	correlation coefficient
R.M.S.	Root Mean Square

A second statistic to consider in forecasting ability is the mean error. While improvements are apparent across all groups (excluding 33-35 microns) between seasons, it is possible that this result may be due to large positive errors outweighing large negative errors. A more appropriate statistic is the Root Mean Squared (R.M.S.) error. Using this statistic, the previous pattern is confirmed with improvements across all groups between seasons. Moreover, the R.M.S. % errors shows that in the wool groups less than 24 microns, 33-35 microns and 36 microns or more, the R.M.S. % error improved between seasons as one would have hoped.

TABLE 6.31
Statistical Results of Aggregate Forecasts and Actual Purchases - 1992-93

	Wool Micron Group				
	< 24 mics	25-28 mics	29-32 mics	33-35 mics	> 36 mics
U	.21402	.17519	.08149	.11155	.06701
U^m	.40569	.00330	.14546	.63167	.04070
U^s	.43908	.31258	.25982	.02864	.00482
U^c	.15523	.68412	.59472	.33968	.95448
τ	.895	.406	.135	.779	.538
mean error	- 1,569	- 133	1,017	4,692	961
R.M.S	2,465	2,324	2,667	5,904	4,765
R.M.S %	65	87	62	49	80

Notes:

a	*Surveys No. 1 to 3 only*
b	*Surveys No. 4 to 8 only*
τ	correlation coefficient
R.M.S.	Root Mean Square

The final statistic to consider is τ, the correlation coefficient. Despite considerable underestimation there appeared to be a reasonable good fit for wools in the less than 24 microns, 25-32 microns (1991-92), and 33-35 micron groups during 1992-93. Of note is the fact that only coarse wools exhibited any consistent relationship over the two seasons. For the other two groups (*i.e.* less than 24 microns and 33-35 microns), it was a case of a reasonable fit one season, and poor in the other.

6.8.4 Comments on the Results

The data in the previous section revealed that on an aggregate basis, the purchase probability approach as hypothesised in the study could provide a useful instrument to gauge future wool purchase forecasts. Furthermore, it is possible to estimate logical and consistent price elasticity of demand estimates.

However, disaggregating the demand schedule into its component wool groups reveals a mixed picture for the purchase probability approach. Switching between woolgroups was evident as buyers appeared to be substituting cheaper wools across the group margins. Furthermore, the level of error, although falling in the second season, showed considerable variability and some inconsistency.

A closer examination of the data revealed the presence of 'deviations among the deviations'. One hypothesis is that the errors may be symptomatic of the influence of one or two buyers who may not be acting in accordance with the overall 'sentiments' of the market. If this is the case, then this need not obviously be a problem in itself, since speculative activity necessitates the presence of such 'deviant' behaviour to extract returns. If the behaviour is due to other reasons such as market inefficiencies, then adjustments may need to be incorporated into the data collection process. Consideration of the individual buyer forecasts is left until Chapter Seven.

On an aggregate basis, there are two potential reasons as to why the errors that have been discussed could have occurred. The first is an internal matter related to deficiencies in the use of the data instrument. The second relates to uncontrollable external considerations, namely changes in the macro environment and uncertainty in the market (*i.e.* partial information for purchase forecasts).

In some respects the deviations at the beginning of the study were to be expected given the need and time required for a 'learning' process. As discussed previously, the aggregate errors improved with the exclusion of the first two periods data. However, what about the errors over the other periods? Do the differences relate to a deficiency in the survey instrument? Is it really measuring what was intended? Furthermore, is it 'capturing' all the data? If not, then the quantity estimates may not necessarily bear any relationship to actual purchases, causing the observed over- or under-estimations of quantity demanded.

As mentioned earlier, the data contained in Table 6.27 reveal some major inconsistencies in the level of actual purchases and the purchases which are expected to be made at auction. At first glance one could conclude that the survey instrument may not be completely suitable for the purposes being investigated in this study. However, this need not be so. When interviewed at the start of each survey period, the buyer has a reasonably good idea of how much wool they must buy and of what types. They may be committed to buying a specific quantity over the period in order to fulfil some immediate contractual obligation. They probably will also be considering the contractual obligations which will be coming up later in the season. To further complicate the buying decision process, there are indent orders which may be made on the company just prior to a sale. These buying decision requirements need not be completely unpredictable however, since all the buyers in the panel have a reasonable degree of experience in the industry and 'know what to expect'.

In meeting their commitments, the buyers have available a choice of two supply sources, as well as previously acquired stocks. They can obtain the required wool lines from the auction sales, or they can obtain the wool privately (see Section 5.3, Chapter Five). Given that they are operating in a competitive environment, they will, quite rightly, obtain their supplies at the lowest possible cost. The questioning process in this study required the buyer to consider the quantities of wool that they would like to purchase at auction over the next four weeks. Given that they have some 'desired' quantity in mind, it would have been easy for most to have simply transposed this quantity into the anticipated auction purchases. Over the course of the month however, any purchases of wool which were made may have been sourced from a combination of either the auction system and private sources, or solely from private sources.

The potential for purchases to be derived more from the private sources became even more pronounced in 1992-93 when unrealistic reserves were being placed on some of the lots being offered for auction. The passings level at auction was reaching relatively high levels of more than 50% for some sales (see Appendix N). Early in the season, most woolgrowers were simply content to reoffer their wools at later sales at around the same level of reserve price. This behaviour however, had two results. First, some lines of quality wools were not being made available for purchase by exporters. Second, some woolgrowers became desperate for cash and started pushing their wools for sale outside the formal auction system. One buyer made the comment that, at times, there seemed to be little need for the auction to take place! Rather, deals were being done immediately upon the close of the auction between buyers and the woolgrowers on the lines which had just been passed in.

There may also have been some confusion on the part of the respondents to consider **only auction sales**, rather than all purchases (*i.e.* auction + private). To test this hypothesis, buyers were asked to supply information on purchases of wool made during the 1991-92 season. If some buyers were acting as hypothesised and considering purchases from the whole market, then the 'fit' between the expectations data and actual purchases should improve. In other words, the 'company' data, which includes both auction and private sales information, should be closer to the forecast purchase levels made at the beginning of each survey period. Tables 6.32 to 6.36 show the differences between the two forms of purchase data.

An interesting result can be seen in the tables below. As hypothesised there may have been confusion by some of the buyers about the frame of reference to be considered in establishing their purchase expectations. For three of the wool groups, fine, medium-coarse and coarse, the 'fit' between the aggregated company data (*i.e.* auction and/private sales) and expected purchases tends to be better. For the medium and fine-medium wool groups, the picture is a little different. The auction data appears to lead to lower errors of purchases while the 'company' data leads

TABLE 6.32

A Comparison of the Two Sources of 'Actual' Purchases Data: Percentage Deviation from Expected Aggregate Purchases 1991-92

(Fine Wools: 24 microns or less)

Period	'Auction' data	'Company' data	Difference
1	+ 97	+ 97	0
2	+ 100	+100	0
3	- 18	+ 34	52
4	+ 25	+ 68	43
5	- 173	+ 34	207
6	- 65	+ 54	119
7	+ 46	+ 85	39
8	+100	+100	0
Season	+ 85	+ 31	54

TABLE 6.33

A Comparison of the Two Sources of 'Actual' Purchases Data: Percentage Deviation from Expected Aggregate Purchases 1991

(Medium Wools: 25-35 microns)

Period	'Auction' data	'Company' data	Difference
1	+ 13	+ 52	39
2	- 13	+ 85	98
3	+ 51	+ 62	9
Season	+ 25	+ 67	42

TABLE 6.34

A Comparison of the Two Sources of 'Actual' Purchases Data: Percentage Deviation from Expected Aggregate Purchases 1992

(Fine-Medium Wools: 25-32 microns)

Period	'Auction' data	'Company' data	Difference
4	+ 65	+ 74	9
5	+ 53	+ 69	16
6	+ 41	+ 65	24
7	+ 83	+ 86	3
8	+ 60	+ 47	13
Season	+ 60	+ 71	11

TABLE 6.35

A Comparison of the Two Sources of 'Actual' Purchases Data: Percentage Deviation from Expected Aggregate Purchases 1992

(Medium-Coarse Wools: 33-35 microns)

Period	'Auction' data	'Company' data	Difference
4	+ 51	+ 60	9
5	- 131	- 98	33
6	- 18	+ 4	14
7	- 52	- 33	19
8	- 80	- 63	17
Season	- 38	- 17	21

TABLE 6.36

A Comparison of the Two Sources of 'Actual' Purchases Data: Percentage Deviation from Expected Aggregate Purchases 1991-92

(Coarse Wools: 36 microns or more)

Period	'Auction' data	'Company' data	Difference
1	- 546	- 286	260
2	- 18	+ 19	37
3	- 48	- 10	38
4	+ 58	+ 66	8
5	- 13	+ 14	27
6	+ 35	+ 48	13
7	- 19	+ 13	32
8	- 1	+ 9	10
Season	- 15	+ 12	27

to much higher errors. A closer investigation of the data reveals that the differences are possibly being influenced by the behaviours of some of the individual companies in the panel, rather than the panel as a whole. Their error levels with the incorporation of the 'company' data are lower possibly confirming the hypothesis discussed earlier. In other words, they actively use the private market as well as the auction market in sourcing their supplies. This issue will be discussed again in Chapter Seven.

A second reason proffered for the discrepancy between the expected and actual results could be changes in the external environment which impact upon the proposed purchase levels after the forecasts have been made. In recent years the wool market has been significantly depressed as a result of the international recession and political uncertainty in some of New Zealand's major wool trading markets such as China and the C.I.S. nations (see Appendix N for details). This has inevitably led to a reduction in demand. During the 1992-93 season in particular, the level of uncertainty in export orders has been very high. As an example, some buyers were having contracts cancelled by overseas buyers in the face of falling prices. Even when the orders were confirmed there were major concerns about letters of credit being opened. Compounding this has been the impact in recent times of the impact of synthetic fibres. Chapter Two highlighted the fact that empirical evidence on the impact of synthetics remains unclear. However, anecdotal evidence from the buyers would suggest that many Asian mills were quite susceptible to changing to synthetics, especially given that at some points some synthetics were still only half the price of wool.

In addition to unforeseen changes in orders, there was considerable price uncertainty over the two seasons. As discussed in Chapter Two, the 1991-92 season was the first in which the price was 'freely' set by the market. There was no intervention by the New Zealand Wool Board to maintain prices or to ensure some stability in prices as had happened previously. As discussed in Appendix N, the prices throughout both seasons varied quite widely, with prices in 1992-93, in particular, falling quite markedly. The effect of this variability plus the need for buyers to 'learn' about the vagrancies of the free-market considerably increased the level of uncertainty of prices and possibly led to buyers making 'uninformed' purchase forecasts. This was especially evident in those periods where the within-period price change differed markedly from the price level prevailing at the start of the period. A large price increase could, for example, have prompted an increase in actual buying levels in anticipation of future contract commitments. An investigation of the data reveals this to indeed, be the case. For example, in the medium-coarse wools group, prices rose 9.0% over the fourth survey period. The panel expected to purchase 8,409 bales, but went on to actually purchase 17,306 bales, an error rate of 51%. The medium wools indicator at the start of period four of 527 cents was the season's high. The natural reaction would have been an expectation that prices had peaked and that they would soon start to fall. At this price buying levels should be minimal and hence lower quantity expectations were produced. However, prices rose dramatically to finish at 574 cents for the indicator, a rise of 9%. A new benchmark high was thus established, making the price at the start of the period seem relatively low. As such buying levels through the period increased well above the expected levels set earlier. Another interesting phenomenon also became apparent. If buyers had contracts to fulfil within a short time, say two months, then, as prices rose, buying levels increased. Presumably, the buyers had established some subjective forecast which meant that current prices were lower and that it made sense to buy on a rising market rather than later on a much higher expected price!

6.9 COMPARATIVE FORECASTING ABILITY

One measurable outcome of this study is the forecasting ability using the purchase probability approach. However, the inevitable question must be asked, how efficient is this approach compared to other forecasting methods? If we could have obtained a superior 'forecasting performance' using naive methods for example, then the expense and time involved in the proposed approach can not be justified. Unfortunately, a concurrent 'guesstimate' of purchases for comparative purposes was not collected from respondents through the survey period. This additional data may have been useful in allowing a comparison between the two approaches under the same experimental conditions[3].

It is still possible however, to make some comparative analysis using some time-series and regression approaches. A by-product of the validation process for the experimental results was actual purchase data from each auction over the two seasons by the panel. This series also provides enough observations (n=33 in each year) to allow for the use of regression. While the two series are not strictly the same in technical terms (*i.e.* one is monthly, the other weekly), it is still possible to utilise statistics which use the relative errors (*i.e.* $Y_e - Y_a$) as measures of the models forecasting ability. Tables 6.38 to 6.49 summarise the alternative model specifications which are compared. The comparative analysis is divided into two parts: Time-series models and Regression models.

I. TIME SERIES:

(a) Naive

$E_i = A_{t-1}$

The simplest of the time series approaches is the naive method. This model uses the most recent past value as a forecast of sales. In other words, it gives a weight of 1 to the most recent value and assigns a weight of 0 to all other observations.

(b) Two-period Moving Average

$E_i = \Sigma(A_{t-1} + A_t) / 2$

(c) Three- period moving Average

$E_i = \Sigma(A_{t-1} + A_t + A_{t+1}) / 3$

[3] See Dorfman & McIntosh (1990), Tegene (1991) and Dorfman & McIntosh (1991) for a similar type of experimental analysis.

The moving average approach reduces the randomness associated with single value forecasts as happens with the naive approach. This method instead weights the more recent values by 1/N. In the two-period moving average, purchase 'expectations' are taken as the average of the current value and the most recent value. The three-period average also utilises the information contained in the next value (*i.e.* t+ 1) in establishing purchase forecasts.

II. REGRESSION MODELS:

(d) Time Trend

1991-92: $E_i = \alpha + \beta T$, T = 1 (3 Oct),2 (10 Oct),....33)

1992-93: $E_i = \alpha + \beta T$, T = 1 (1 Oct),2 (8 Oct),....33)

This model utilises the idea of a time trend to help 'explain' purchase forecasts. The rationale assumes that there is a consistent pattern of sales according to time of the season, namely that sales increase over time.

(e) Previous Auction Sale

$E_i = \alpha + \beta A_{t-1}$, where A = purchases at last sale

This model assumes that purchases in period t are related in some way to purchases in the most recent period (A_{t-1}). This makes sense if one is attempting to purchase on indents, or to progressively fill an outstanding contract.

(f) Market Indicator (MKT)

$E_i = \alpha + \beta MKT_t$

Purchases in period t are influenced by the market indicator in period t.

(g) Wool T.W.I. (WTWI)

$E_i = \alpha + \beta WTWI_t$

(h) United States Dollar (USD)

$E_i = \alpha + \beta USD_t$

(i) Australian Dollar (ASD)

$E_i = \alpha + \beta ASD_t$

Purchases in period t are influenced by a Trade Weighted Index of foreign currencies according to purchases of New Zealand wool. Given that the bulk of New Zealand wool is exported and that international traders are aware of current rates of exchange, one could assume that the exchange rates play a major part in determining purchases at auction. Additional models are also developed for the Australian dollar and the United States dollar.

(j) Fine Wools Indicator

$E_i = \alpha + \beta FINE_t$

(k) Medium Wools Indicator

$E_i = \alpha + \beta MED_t$

(l) Strong (Coarse) Wools Indicator

$E_i = \alpha + \beta STR_t$

(m) Combination of Wool Indicators

$E_i = \alpha + \beta_1 FINE_t + \beta_2 MED_t + \beta_3 STR_t$

Rather than use an aggregate measure of prices, as indicated by Model (f), it is possible to use three alternative price series, the Fine wools (24 microns or less) indicator, the Medium wools (25-32 microns) indicator and the Strong (Coarse) wools (33 microns or more). A fourth model (m) utilises all three series as explanatory variables. The aim of the model is to predict rather than explain so the risk of multicollinearity associated with this structure is not a major concern. Table 6.37 below summarises the collinearity between the series.

TABLE 6.37

Correlation Between the Price Series - 1991-92 & 1992-93

1991-92			
	Fin	Med	Str
Fin	1.000		
Med	0.781	1.000	
Str	0.538	0.753	1.000

1992-93			
	Fin	Med	Str
Fin	1.000		
Med	0.906	1.000	
Str	0.821	0.807	1.000

(a) Naive $E_i = A_{t-1}$

TABLE 6.38

	1991-92	1992-93
U	.20133	.27048
U^m	.0012	.0002
U^s	.0000	.0000
U^c	.9988	.9998
Mean Error %	15.38	19.98
R.M.S.	5,669	6,299
R.M.S. %	56.80	−78.75
τ	.539	.245

FIGURE 6.28
Naive Forecasts *vs.* Actual Purchases - 1991-92

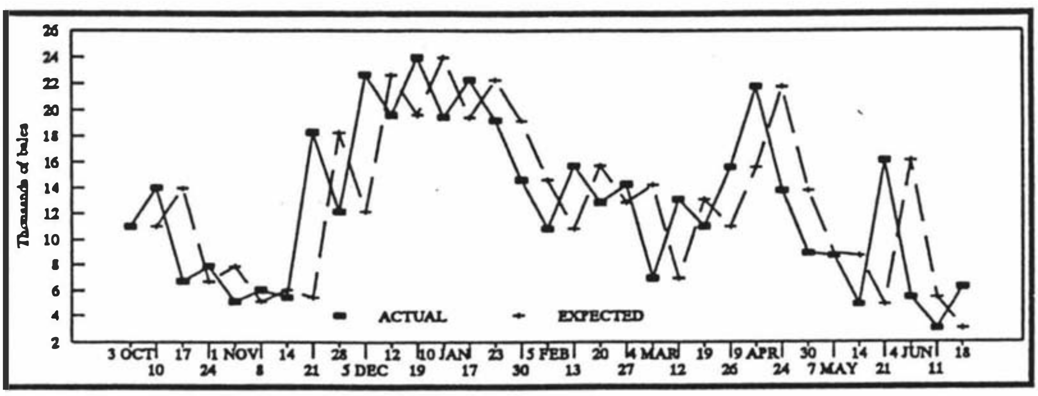
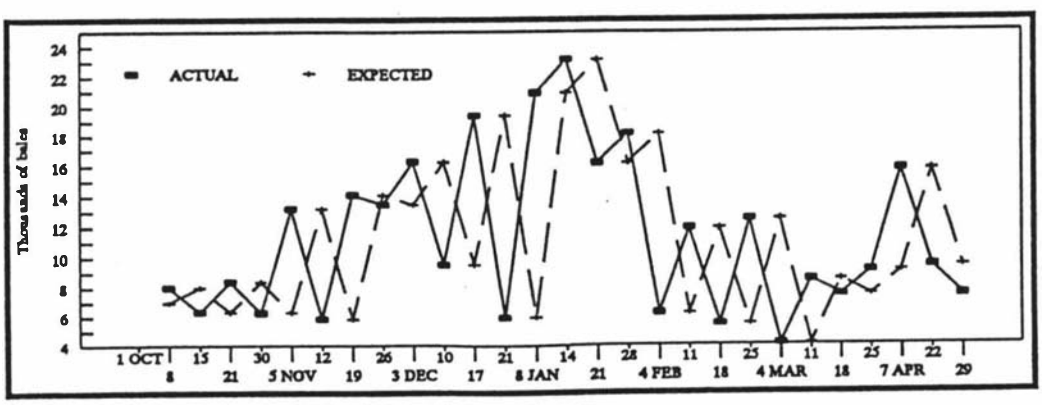


FIGURE 6.29
Naive Forecasts *vs.* Actual Purchases - 1992-93



(b) Two Sale Moving Average $Ei = (A_{t-1} + A_t)2$

TABLE 6.39

	1991-92	1992-93
U	.10198	.13764
U^m	.0000	.0002
U^s	.0640	.1144
U^c	.9360	.8855
Mean Error %	6.62	9.79
R.M.S.	2,833	3,149
R.M.S. %	28.65	39.37
τ	.879	.787

FIGURE 6.30
Two Period Moving Average Forecasts *vs.* Actual Purchases - 1991-92

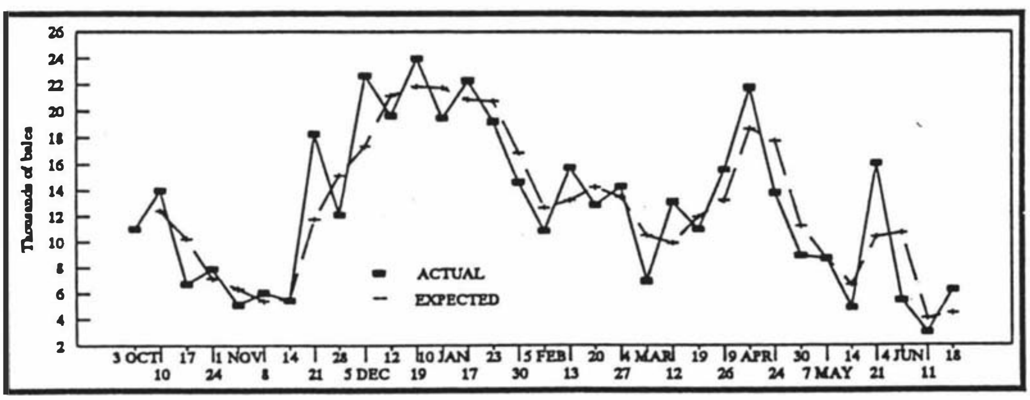
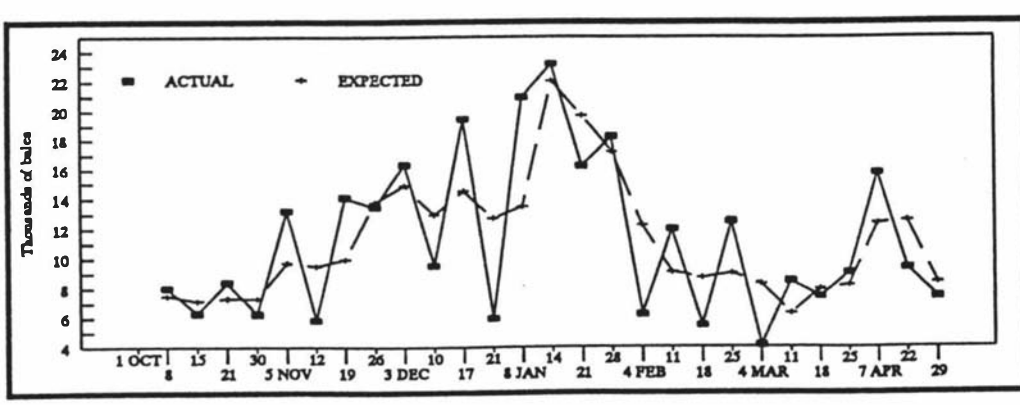


FIGURE 6.31
Two Period Moving Average Forecasts *vs.* Actual Purchases - 1992-93



(c) **Three Sale Moving Average** $Ei = (A_{t-1} + A_t + A_{t+1})3$

TABLE 6.40

	1991-92	1992-93
U	.11691	.16968
U^m	.0000	.0000
U^s	.1104	.1183
U^c	.8896	.8817
Mean Error %	10.29	12.58
R.M.S.	3,275	3,891
R.M.S. %	36.13	49.54
τ	.834	.665

FIGURE 6.32
Three Period Moving Average Forecasts *vs.* Actual Purchases - 1991-92

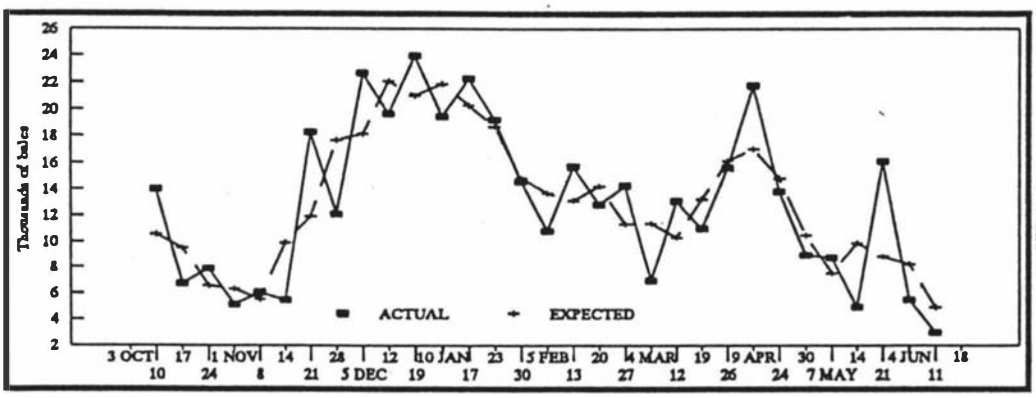
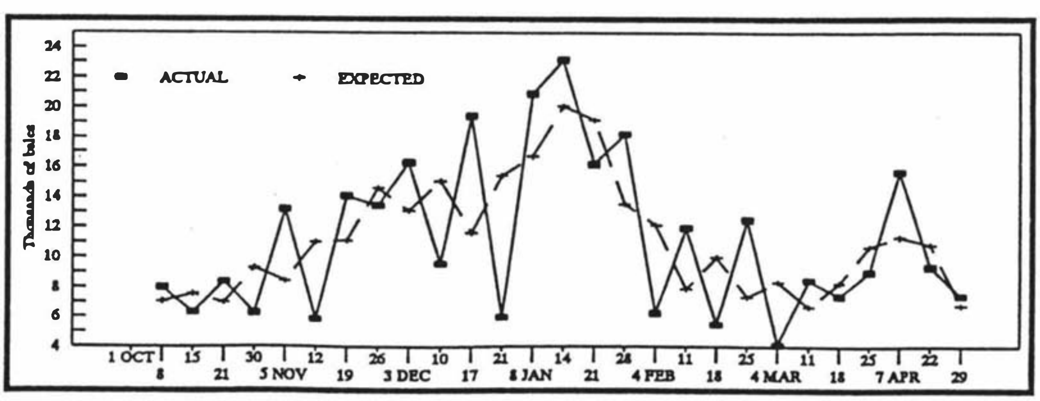


FIGURE 6.33
Three Period Moving Average Forecasts *vs.* Actual Purchases - 1991-92



(d) Time Trend 1991-92: $E_i = \alpha + \beta T$, T = 1 (3 Oct),2 (10 Oct),....33)
1992-93: $E_i = \alpha + \beta T$, T = 1 (1 Oct),2 (8 Oct),....33)

TABLE 6.41

	1991-92	1992-93
U	.2176	.2271
U^m	.0000	.0000
U^s	.7256	.7138
U^c	.2744	.2862
Mean Error %	30.52	15.33
R.M.S.	5,797	4,992
R.M.S. %	81.14	51.13
α	14,321.17 (2.39)*	11,899.38 (2.31)**
β	-98.0638 (-0.987)	-88.8051 (-.943)
R^2	.025	.028

Notes: *** P > 10% ** P > 5% * P > 1%

FIGURE 6.34
Trend Forecasts *vs.* Actual Auction Purchases - 1991-92

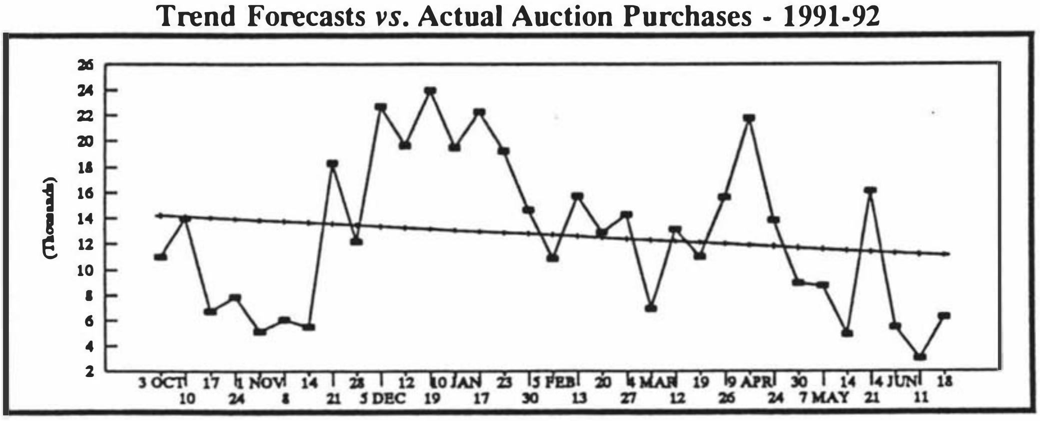
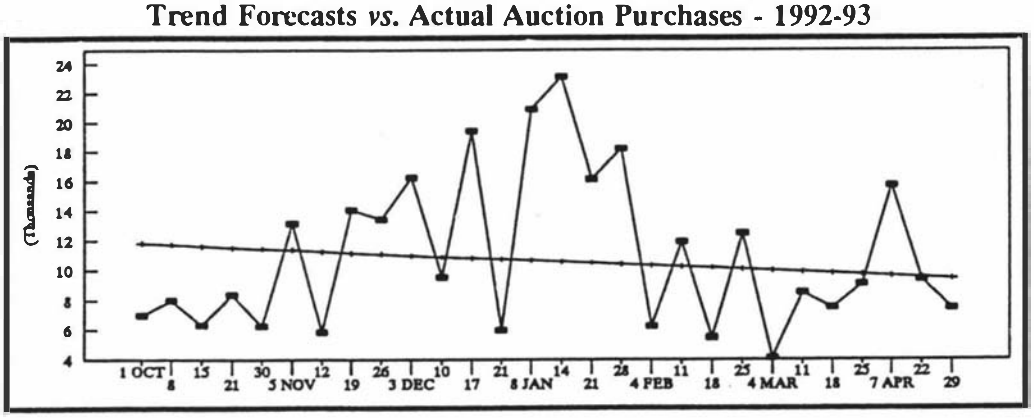


FIGURE 6.35
Trend Forecasts *vs.* Actual Auction Purchases - 1992-93



(e) **Previous Auction Sale** $E_i = \alpha + \beta A_{t-1}$, where A = purchases at last sale

TABLE 6.42

	1991-92	1992-93
U	.18478	.2705
U^m	.0000	.0002
U^s	.2992	.0000
U^c	.7008	.9998
Mean Error %	22.43	19.59
R.M.S.	5,015	6,299
R.M.S. %	63.00	78.75
α	5,649.87 (1.091)	7,971.583 (1.559)
ß	0.5490 (3.508)*	0.242430 (1.379)
R^2	.291	.060

Notes: *** P > 10% ** P > 5% * P > 1%

FIGURE 6.36
Previous Sales Period Forecasts *vs.* Actual Auction Purchases - 1991-92

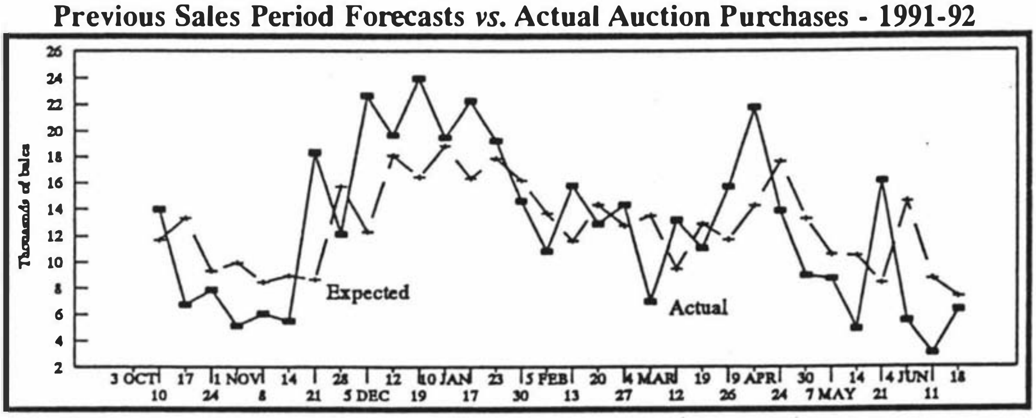
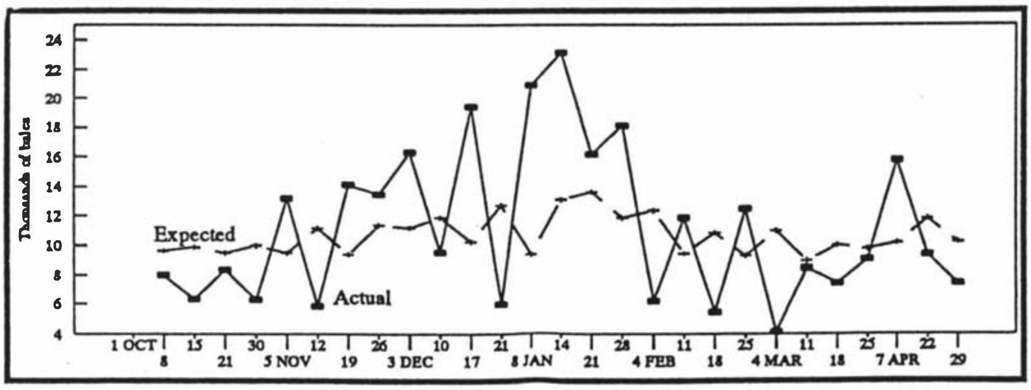


FIGURE 6.37
Previous Sales Period Forecasts *vs.* Actual Auction Purchases - 1992-93



(f) **Market Indicator** $E_i = \alpha + \beta MKT$

TABLE 6.43

	1991-92	1992-93
U	.2105	.2216
U^m	.0000	.0000
U^s	.55.5	.5822
U^c	.4465	.4178
Mean Error %	29.06	16.35
R.M.S.	5,624	4,884
R.M.S. %	79.20	52.47
α	29,408.72 (5.06)*	-9,707.74 (-1.927)**
ß	-37.6022 (-1.671)***	-88.8051 (-.943)
R^2	.083	.028

Notes: *** P > 10% ** P > 5% * P > 1%

FIGURE 6.38
Market Indicator Forecasts *vs.* Actual Auction Purchases - 1991-92

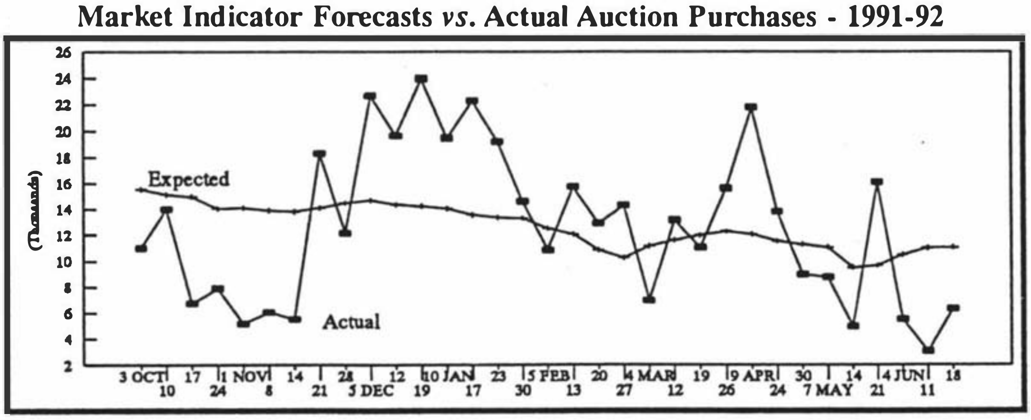
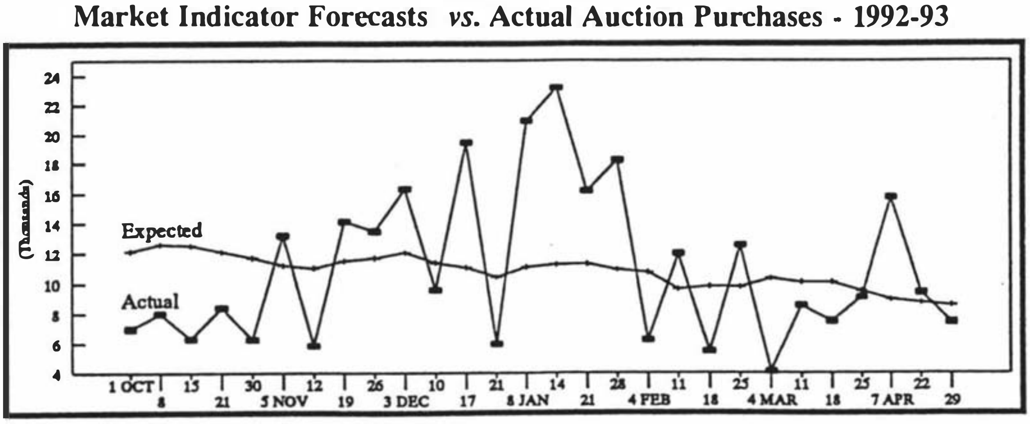


FIGURE 6.39
Market Indicator Forecasts *vs.* Actual Auction Purchases - 1992-93



(g) **Wool T.W.I.** $E_i = \alpha + \beta WTWI$

TABLE 6.44

	1991-92	1992-93
U	.2170	.1993
U^m	.0000	.0000
U^s	.7042	.3478
U^c	.2958	.6522
Mean Error %	31.70	15.56
R.M.S.	5,782	4,431
R.M.S. %	88.95	51.69
α	52,213.06 (8.752)*	142,345.7 (31.134)*
ß	-447.96 (-0.981)	-1,312.63 (-3.078)*
R^2	.030	.234

Notes: *** P > 10% ** P > 5% * P > 1%

FIGURE 6.40
Wool TWI Forecasts *vs.* Actual Auction Purchases - 1991-92

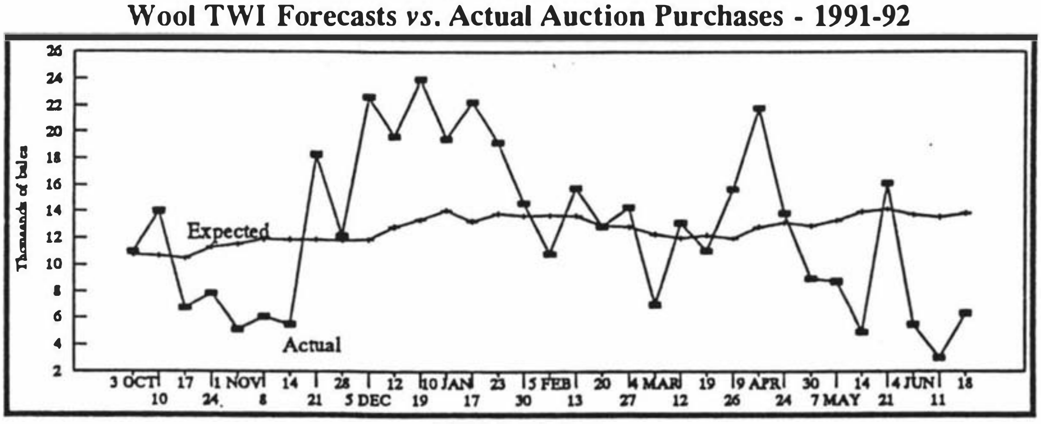
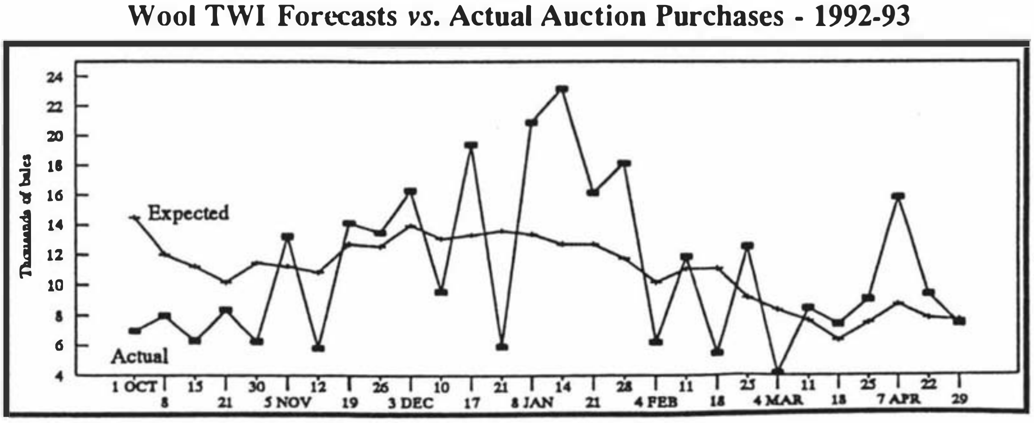


FIGURE 6.41
Wool TWI Forecasts *vs.* Actual Auction Purchases - 1992-93



(h) United States Dollar $E_i = \alpha + \beta USD$

TABLE 6.45

	1991-92	1992-93
U	.2206	.1829
U^m	.0000	.0000
U^s	.9595	.2589
U^c	.0405	.7411
Mean Error %	31.85	15.71
R.M.S.	5,870	4,093
R.M.S. %	86.07	53.82
α	18,691.67 (3.086)*	141,201.4 (33.436)*
β	-11,000.0 (-0.115)	-247,813.5058 (-4.055)*
R^2	.0004	.347

Notes: *** P > 10% ** P > 5% * P > 1%

FIGURE 6.42
United States Dollar Forecasts *vs.* Actual Auction Purchases - 1991-92

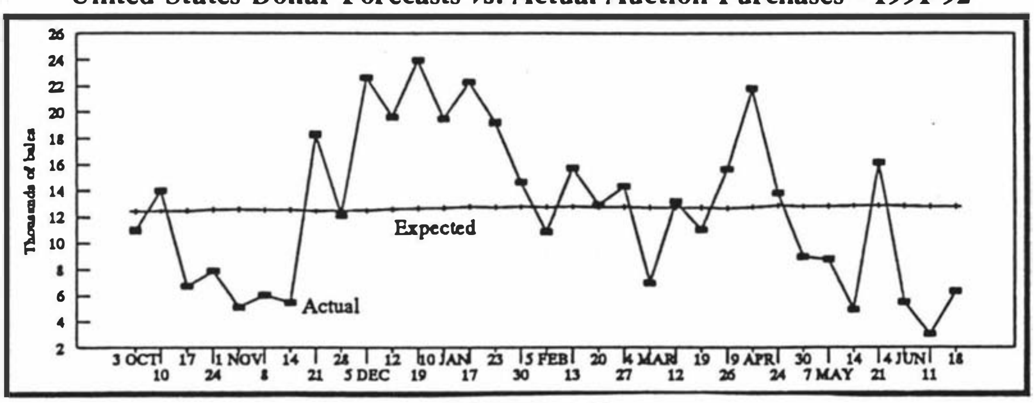
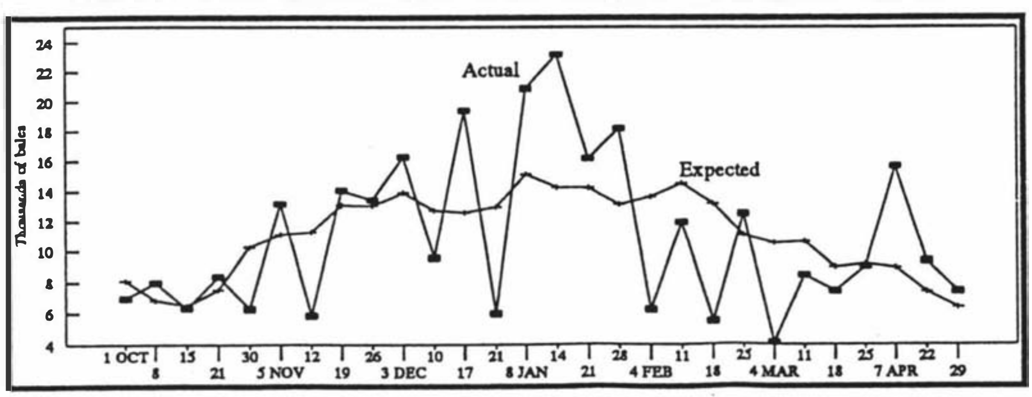


FIGURE 6.43
United States Dollar Forecasts *vs.* Actual Auction Purchases - 1992-93



(i) **Australian Dollar** $E_t = \alpha + \beta ASD$

TABLE 6.46

	1991-92	1992-93
U	.2103	.2294
U^m	.0000	.0000
U^s	.5501	.8151
U^c	.4499	.1849
Mean Error %	28.41	15.20
R.M.S.	5,619	5,037
R.M.S. %	77.54	51.51
α	-17,531.71 (-30.24)*	38,587.6 (7.425)*
β	262,389.632 (-1.689)***	-37,123.6746 (-0.570)
R^2	.084	.010

Notes: *** P > 10% ** P > 5% * P > 1%

FIGURE 6.44
Australian Dollar Forecasts *vs.* Actual Auction Purchases - 1991-92

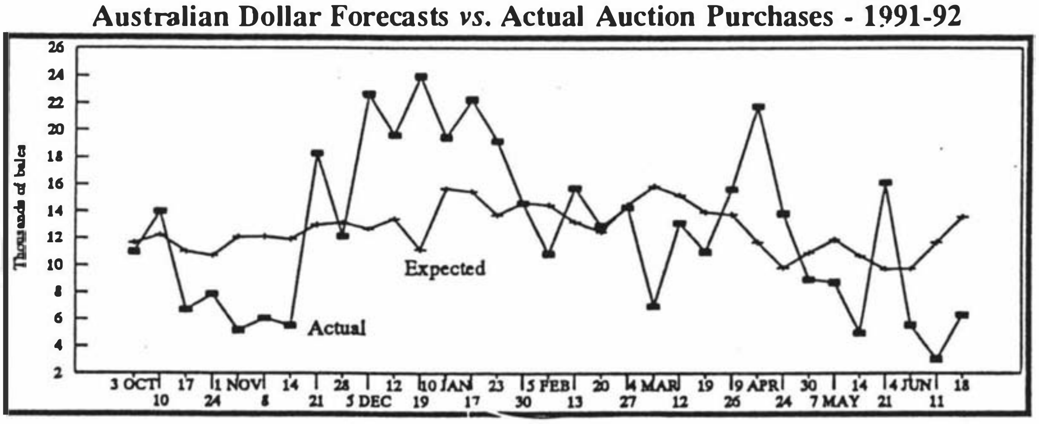
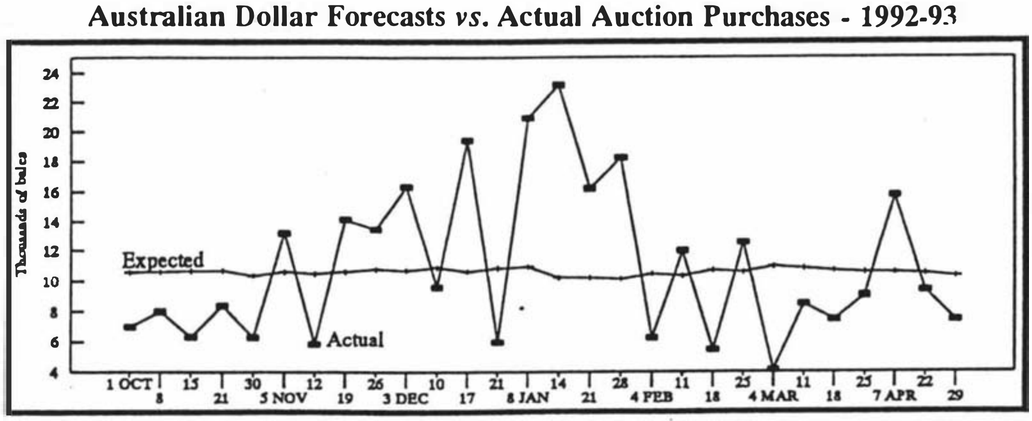


FIGURE 6.45
Australian Dollar Forecasts *vs.* Actual Auction Purchases - 1992-93



(j) **Fine Wools Indicator $E_i = \alpha + ßFINE$**

TABLE 6.47

	1991-92	1992-93
U	.2205	.2251
U^m	.0000	.0000
U^s	.9250	.6544
U^c	.0750	.3456
Mean Error %	31.87	14.91
R.M.S.	5,867	4,983
R.M.S. %	86.33	49.83
α	9,667.96 (1.597)	-1,920.81 (-0.376)
ß	3.2270 (0.217)	17.87272 (1.189)
R^2	.002	.044

Notes: *** P > 10% ** P > 5% * P > 1%

FIGURE 6.46

Fine Wools Indicator Forecasts *vs.* Actual Auction Purchases - 1991-92

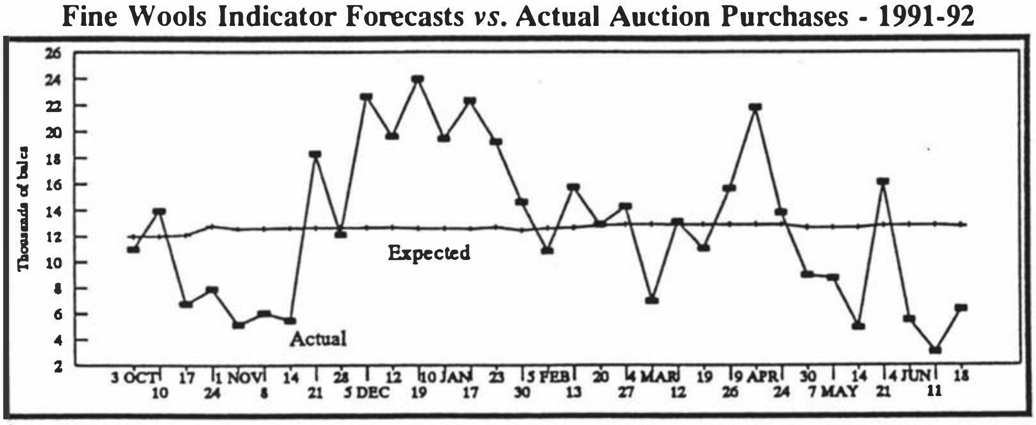
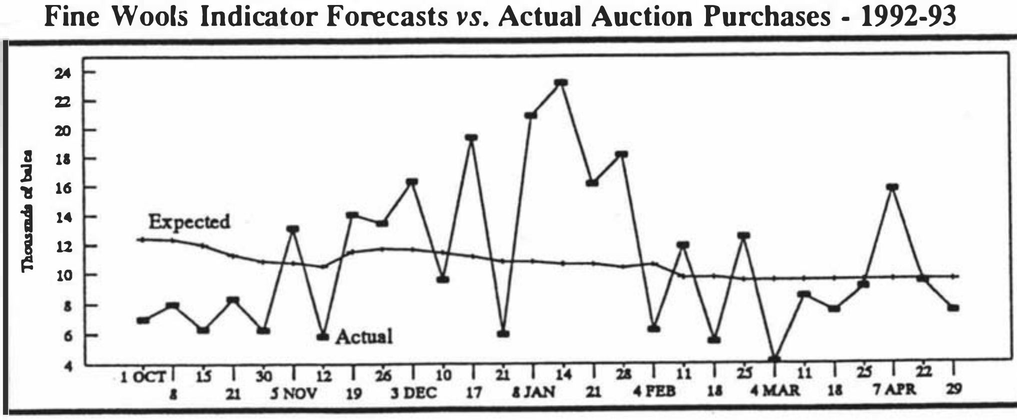


FIGURE 6.47

Fine Wools Indicator Forecasts *vs.* Actual Auction Purchases - 1992-93



(k) **Medium Wools Indicator** $E_i = \alpha + \beta MED$

TABLE 6.48

	1991-92	1992-93
U	.2199	.2293
U^m	.0000	.0000
U^s	.8587	.8146
U^c	.1413	.1854
Mean Error %	31.68	14.67
R.M.S.	5,855	5,037
R.M.S. %	86.12	50.93
α	8,178.06 (1.354)	-2,153.49 (-0.44)
ß	7.9167 (0.424)	26.00523 (2.061)**
R^2	.006	.121

Notes: *** P > 10% ** P > 5% * P > 1%

FIGURE 6.48
Medium Wools Indicator Forecasts *vs.* Actual Auction Purchases - 1991-92

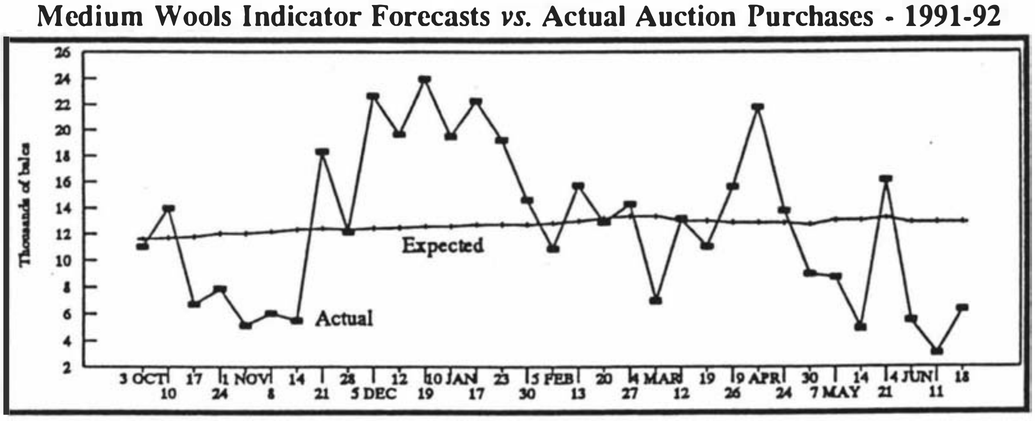
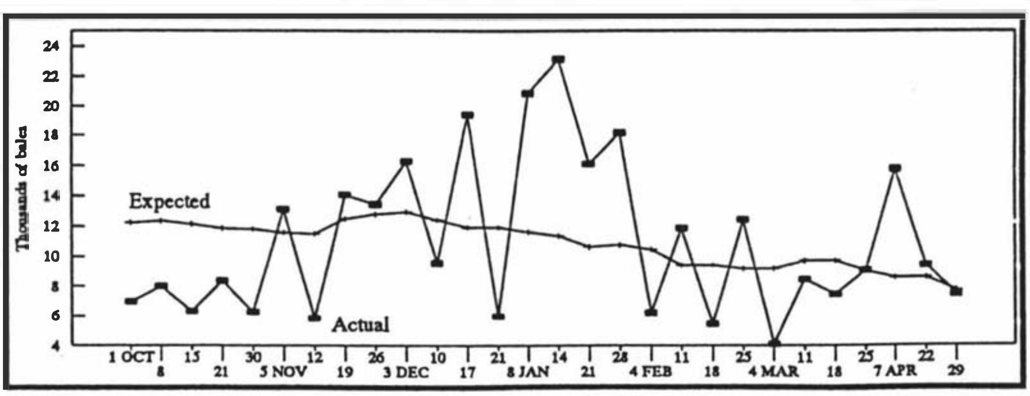


FIGURE 6.49
Medium Wools Indicator Forecasts *vs.* Actual Auction Purchases - 1992-93



(I) **Strong Wools Indicator** $E_i = \alpha + \beta STR$

TABLE 6.49

	1991-92	1992-93
U	.1999	.2293
U^m	.0000	.0000
U^s	.4220	.8146
U^c	.5780	.1854
Mean Error %	26.42	14.67
R.M.S.	5,365	5,037
R.M.S. %	74.06	50.93
α	33,637.52 (6.077)*	145.9043 (0.28)
β	-54.3783 (-2.477)*	26.86095 (0.572)
R^2	.165	.010

Notes: *** P > 10% ** P > 5% * P > 1%

FIGURE 6.50

Strong Wools Indicator Forecasts *vs.* Actual Auction Purchases - 1991-92

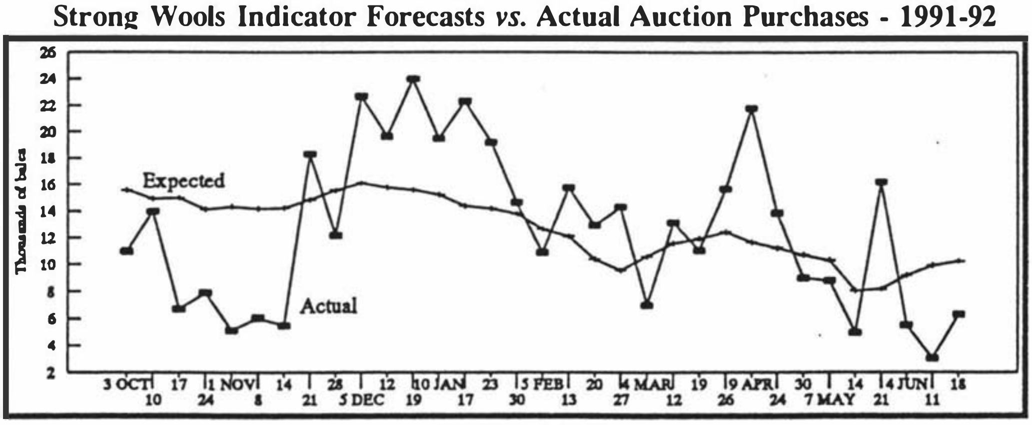
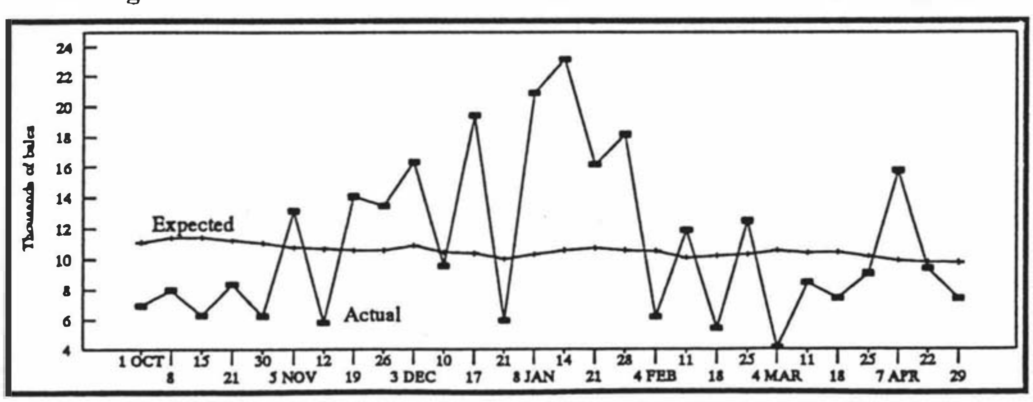


FIGURE 6.51

Strong Wools Indicator Forecasts *vs.* Actual Auction Purchases - 1992-93



(m) Combination of Indicators $E_i = \alpha + \beta_1 FINE + \beta_2 MED + \beta_3 STR$

TABLE 6.50

	1991-92	1992-93
U	.1497	.1993
U^m	.0000	.0000
U^s	.1639	.3478
U^c	.8361	.6522
Mean Error %	15.10	13.48
R.M.S.	4,085	4,431
R.M.S. %	50.31	49.26
α	22,024.14 (5.054)*	37,190.90 (7.867)*
β	β_1 -15.8738 (-0.92) β_2 109.0993 (3.928)* β_3 -146.06945 (-5.523)*	β_1 -32.4279 (-0.923) β_2 76.72651 (2.579)* β_3 -108.74915 (-1.40)
R^2	.516	.010

Notes: *** P > 10% ** P > 5% * P > 1%

FIGURE 6.52

Combined Market Indicator Forecasts *vs.* Actual Auction Purchases - 1991-92

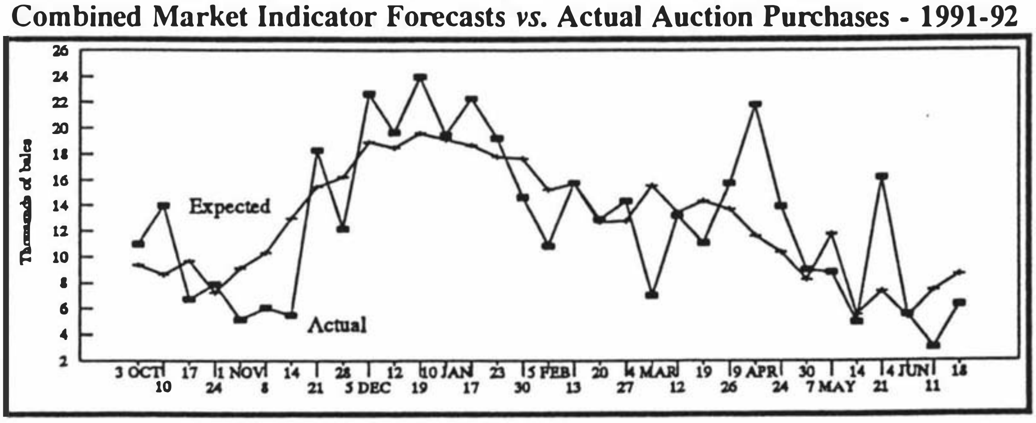


FIGURE 6.53

Combined Market Indicator Forecasts *vs.* Actual Auction Purchases - 1992-93

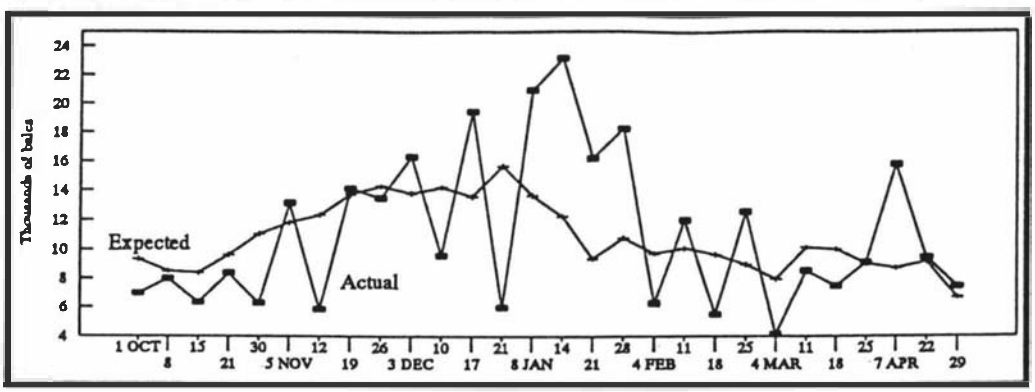


TABLE 6.51
Summary of Alternative Forecasting Models
1991-92 Season

MODEL	U	τ (Correlation)[1]	R.M.S.	R.M.S. %
Purchase Probability	.05789	.560	13,161	25.00
1. TIME SERIES				
Naive	.20133	.539	5,669	56.80
Two sale M.A.	.10198	.879	2,833	28.65
Three sale M.A.	.11691	.834	3,275	36.13
2. REGRESSION				
Trend	.2176	.540	5,797	81.14
Previous sale	.18478	.539	5,015	63.00
Market Indicator	.2105	.288	5,624	79.20
Wool T.W.I.	.2170	.173	5,782	88.95
United States Dollar	.2206	.020	5,870	86.07
Australian Dollar	.2103	.289	5,619	77.54
Fine Wools Indicator	.2205	.044	5,867	86.33
Medium Wools Indicator	.2199	.008	5,855	86.12
Strong Wools Indicator	.1999	.406	5,365	74.06
Combination[2]	.1497	.720	4,085	50.31

NOTES:

1 Correlation between the actual purchases made (Y_a) and the forecasted purchases (Y_e)

2 F = 7.99, P > .01% ($F_{3,33}$ = 5.39)

TABLE 6.52
Summary of Alternative Forecasting Models
1992-93 Season

MODEL	U	τ (Correlation)[1]	R.M.S.	R.M.S. %
Purchase Probability	.060602	.72	11,001	35.00
1. TIME SERIES				
Naive	.27048	.245	6,299	78.75
Two sale M.A.	.13764	.787	3,149	39.37
Three sale M.A.	.16968	.665	3,891	49.54
2. REGRESSION				
Trend	.2271	.167	4,992	51.13
Previous sale	.2705	.245	6,299	78.75
Market Indicator	.2216	.167	4,884	52.47
Wool T.W.I.	.1993	.484	4,431	51.69
United States Dollar	.1829	.581	4,093	53.82
Australian Dollar	.2294	.100	5,037	51.51
Fine Wools Indicator	.2251	.209	4,983	49.83
Medium Wools Indicator	.2293	.348	5,037	50.93
Strong Wools Indicator	.2293	.100	5,037	50.93
Combination[2]	.1993	.100	4,431	49.26

NOTES:

1 Correlation between the actual purchases made (Y_a) and the forecasted purchases (Y_e)

2 $F = .075$, ($F_{3,33} = 2.49$ for $P > .10\%$)

The results shown in Tables 6.51 and 6.52 provide some further encouraging evidence for the use of the purchase probability approach in establishing purchase forecasts. Using the correlation between actual purchases and expected purchases as the first criteria, only the two period moving average (model b) has a forecasting performance which outperforms the aggregate panel forecast. Both the three-period moving average (model b) and the combined indicator model (model m) also have a higher correlation coefficient than the purchase probability approach, but for 1991-92 only. The regression models do not provide any consistency, in terms of correlation, between the forecast and the actual values, between the two seasons. Only five models have coefficients which are both statistically significant, although in four of the five cases, the R^2 remains quite low (see Table 6.53).

TABLE 6.53

Significant Regression Models

MODEL	DEPENDENT VARIABLE	PERIOD	R^2
m	Combination of Indicators	1991-92	.516
h	United States Dollar (USD)	1992-93	.347
g	Wool TWI	1992-93	.234
l	Strong Wools Indicator	1991-92	.165
f	Market Indicator	1991-92	.083

The U statistic provides a second measure to test the comparative forecasting ability of the models. Once again the purchase probability approach has the lowest U statistic in both seasons. The time-series approaches, and in particular, the two-period moving average, have the next best consistent values of U.

The final comparative statistic to consider is the R.M.S. %. Yet again the purchase probability approach has the best statistic with the two-period moving average the next best alternative.

6.10 SUMMARY

In this chapter, the data collected over the two seasons has been analysed in terms of first, constructing aggregate derived demand schedules for raw wool and second, developing aggregate derived demand curves (see Appendix Q). Elasticity estimates were calculated using the average clean auction price for each of the representative wool groups. The estimates showed some consistency in behaviour across the season becoming more elastic in response to changes in supplies of particular lines coming onto the auction market. Aggregate derived demand schedules for the panel were estimated and appropriate logarithmic functions calculated. An average estimate of the price elasticity of demand of -4.5 was developed for the two seasons. This value is higher than those estimated in previous econometric studies, possibly due to generally depressed economic conditions facing the buyers through the period 1991-93, and the 'richer' information contained in the qualitative approach used in this study.

Section 6.8 of this chapter considered the question of the reliability of the expectations data collected. Information on actual purchases made by each of the companies was compared to the 'expected' level of purchases. On a seasonal aggregate basis, the panel under-estimated purchases in both seasons. However, an analysis of the data at the wool group level revealed patterns of consistent over- and under- estimations for particular groups. It was hypothesised that buyers switched between wool groups and substituted wool types on the basis of relative wool prices. The results also showed that there appeared to be some substantial errors, both in absolute and percentage terms in the data. However, over time the correlation between the actual and expected purchase levels appeared to improve. An investigation of the data also reveals some inconsistencies in the behaviour of some individual companies within the panel. Before considering the implications of these aggregate results on the validity of the survey based approach, it is worth considering the data on an individual company basis. This is done in Chapter Seven.

Section 6.9 looked at the question of the comparative forecasting ability of the purchase probability approach against some basic time-series and regression models. The results show that the purchase probability approach has a superior forecasting ability on the basis of correlation between actual and forecast purchases, Theil's U statistic and the R.M.S. % error. The two-period moving average model produced results which were the second best on the basis of the three criteria.

The conclusion can be drawn that the experimental purchase probability approach under investigation in this report can provide an alternative source of demand slope estimation. However, the quantity forecasts associated with the elicitation procedure tended to under-estimate purchases (as per other studies), possibly leading the price elasticity estimates to be more inelastic than the 'true' quantity response.

CHAPTER SEVEN
RESULTS AND DISCUSSION
- INDIVIDUAL BUYERS

CHAPTER SEVEN
RESULTS AND DISCUSSION
- INDIVIDUAL BUYERS

7.1 INTRODUCTION

As noted in Chapter Five, the panel that was selected for this study contained a useful mix of companies with different objectives, ownership structures and purposes. While the sample was in no way meant to be randomly selected, it was hoped that the respondents would represent a cross-section of the industry. In analysing the aggregate results in Chapter Six, mention was made of the 'diversity of the deviations' in the purchase data. These differences in behaviour are to be expected given the random errors which are bound to exist in the subjective assessments. In aggregate we should expect that these random disturbances will 'even out'. The emphasis in Chapter Six therefore, was in examining how these aggregate measurements differed over time.

In this chapter, the analysis will focus on the results of the individual buyers within the panel. The reason for this is not to see '*who was right and who was wrong*'. Rather, it is important in terms of validating the instrument to see if its applicability is widespread or whether refinements are required in the instrument and the surveying procedure for particular circumstances.

Section 7.2 discusses the individual buyer forecasts in terms of the deviation from the actual purchase level. In Section 6.8.4, Chapter Six, it was noted that some companies exhibit large errors for particular wool groups. It was hypothesised that these large deviations may be a function of the respondent's error in considering the whole wool supply market rather than just the auction system. On an aggregate level this appears to be proven with the accuracy of the forecasts tending to be much higher at the beginning of the study. On an individual company level it is suggested that those companies who tend to buy a large proportion of their wool on the private market exhibit an improved 'fit' when total (*i.e.* auction + private) purchases are taken into account. It is suggested that this is due to their ability to source from both sides of the market rather than have a reliance on auction supplies. This characteristic is particularly noticeable in the small specialist buyers who do not deal in large quantities. The larger buyers in the market are somewhat constrained to purchasing often large quantities from the auction system with more uncertainty about size of offerings, types of lines and price levels.

An interesting aspect of this study is the ability of the panel to form consistent, accurate and 'honest' forecasts of purchases. Buyers in the panel were asked to make some prediction of future purchases at various prices while "...*considering all the things that may be likely to affect [their] purchases of wool at these particular prices*" (see Appendix H: Part B, Volume Two). In Section 6.8, Chapter Six, it was evident that buyers were developing forecasts based on possible differences in their perceptions of the environment. If the 'information sets' of the respondents were different, then explanations of different behaviours can be put forward for discussion. Section 7.3 deals with this question covering the ability of the individual buyers to correctly forecast a range of other economic variables within the macro-environment (see Appendix H: Part A, Volume Two). The qualitative data that was collected to help focus the buyer on the forecast period is consequently analysed and compared to outcomes.

7.2 INDIVIDUAL BUYER FORECASTS

Tables 7.1 and 7.2 summarise the deviation scores for the aggregate level of wool purchases over each of the two seasons by respondent. For reasons of confidentiality agreed to at the commencement of the study, the individual companies cannot be identified by name.

As was evident from the discussions developed in Chapter Six, there exists a great

TABLE 7.1

Aggregate Percentage Errors by Company

	1991-92 (%)	1992-93 (%)	DIFFERENCE[1]
A	- 175	+ 76	+ 99
B	+ 45	+ 74	- 29
C	- 18	+ 43	- 25
D	- 340	- 74	+ 266
E	- 13	+ 8	+ 5
F	- 335	- 82	+ 253
G	+ 82	+ 72	+ 10
H	+ 64	+ 22	+ 42
I	- 137	+ 46	+ 91
J	- 19	- 17	+ 2
K	+ 33	- 21	+ 12
TOTAL	+ 8.3	+ 12.9	- 4.6

Note:

A positive value = over-estimation;

A Negative value = under-estimation

1. A positive value in this column indicates an improvement in forecasting between seasons.

i.e. $|1991\text{-}92| - |1992\text{-}93| > 0$

deal of variability in the capacity of some of the buyers to establish accurate forecasts of purchases. In total, the aggregated errors generally balance out. This result, in itself gives some comfort to the approach, since the objective is to establish the 'market' [aggregated] level of demand. However, as alluded to earlier, some of the errors made by some individual buyers tend to be quite large. Is their behaviour reflective of the random nature of the errors, in which case the large errors are 'explained' or are the errors being made on a systematic basis?

In the 1991-92 season for example, the level of error made by four companies was relatively large; D (- 340%), F (- 335%), A (- 175%) and I (- 137%). In terms of bales, the accumulated over-estimation error for these four companies amounted to some 69,309 bales! Only two companies, E and J, stand out with relatively good aggregate forecasting ability over the two seasons. Some consolation can also be derived with the observation that between the two seasons, all but two companies (B & C) improved their forecasting ability as evidenced by a reduction in the percentage error. The largest percentage error in 1992-93 was only - 82% (F) as opposed to - 340% (D) in 1991-92.

Table 7.2 overpage illustrates the aggregate errors in terms of the number of bales. Company G stands out as making consistently large errors through the two seasons. Other firms such as B, D, H, and I made large errors over the two seasons, although they tended to make one large and one small, rather than consistent errors. On the opposite end of the scale, Company E, while only dealing in small volumes, nevertheless revealed a consistent degree of accuracy which was unmatched by others in the panel. The level of absolute error in 1991-92 was 206,127 bales or an average of 18,738 bales for each respondent. In 1992-93 this error was significantly reduced (93,499) with an average absolute error of 8,500 bales. Table 7.2 also shows that companies J, D, and F consistently over-estimated aggregate purchases while companies G, H and B consistently under-estimated their purchases.

Tables 7.3 and 7.4 summarise the deviation scores of the individual buyers for each of the wool groups over the two seasons. The values of zero which appear in the tables refer to situations where the buyer has stated no intention to purchase within that particular wool group and they, in fact, do not make any subsequent purchases. The value of 100% reveals an initial situation of no intention to purchase but then a purchase is subsequently made.

TABLE 7.2

Aggregate Errors by Company (No. of Bales)

	1991-92			1992-93		
	Expected	Actual	error	Expected	Actual	error
A	7,465	2,718	- 4,750	846	3,568	+ 2,722
B	8,082	14,637	+ 6,555	3,530	13,613	+ 10,083
C	31,057	26,368	- 4,989	8,363	14,775	+ 6,412
D	20,409	4,635	- 15,774	14,252	8,211	- 6,041
E	2,396	2,128	- 268	1,470	1,599	+ 129
F	8,204	1,885	- 6,319	2,703	1,487	- 1,216
G	6,401	34,630	+ 28,229	9,209	32,949	+ 23,737
H	42,340	117,064	+ 74,724	45,015	57,655	+ 12,640
I	73,396	30,930	- 42,466	10,394	19,090	+ 8,696
J	92,475	77,628	-14,847	116,035	98,935	- 17,100
K	15,327	22,833	+ 7,506	27,252	22,529	- 4,723
Total	307,555	335,456	+ 27,901	239,069	274,408	+ 35,339

Evidence of switching purchases between wool groups, as suggested in Section 6.8, Chapter Six, is once again apparent for several of the panel members. Company E, for example, is a specialist wool buyer dealing primarily in the coarser type of wools (*i.e* 33-35 and 36 + microns). However, given relative price changes between groups (see Figures 6.20 and 6.22), purchases tend to be over-estimated in the coarser wool groups and under-estimated in the medium micron groups. This is emphasised again with consistent evidence of first, no intention to purchase in the medium wool groups and then, subsequent purchases as relative prices fall during the season.

Another example of switching purchases occurring between woolgroups is shown in the case of Company A, a small, foreign owned company. Most of it's dealings are with one country and with what are termed 'Chinese-Type' or halfbred wools. The expectations data show a consistent level of over-estimation of coarse wools

TABLE 7.3

Individual Companies Percentage Deviation of Forecast *vs.* Actual Purchases over the Season:

1991-92

Company	< 24	25-35[a]	25-32[b]	33-35[b]	> 36	TOTAL
A	0	29	100	-1,363	-13,321	- 175
B	-83	87	81	-37	23	+ 45
C	35	20	100	-94	-37	- 18
D	0	55	99	-844	-443	- 340
E	0	100	100	100	-80	- 13
F	0	81	46	-522	-611	- 335
G	98	69	85	79	82	+ 82
H	99	93	81	65	52	+ 64
I	95	-154	90	-470	-141	- 137
J	72	-27	36	6	-124	- 19
K	41	69	-8	55	-67	+ 33
TOTAL	+ 85	+ 25	+ 60	- 38	- 15	+ 8.3

Notes:

a For the first three surveys only
b From Survey No. Four onwards

(2,550 bales) when only 19 bales were actually purchased (1991-92). The reason for this is again probably one of substitution of cheaper finer wools for the coarser wools loosely specified in the contracts.

Company G tended to consistently under-estimate purchases across every wool group (excluding 25-28 microns for 1992-93) for both seasons.

TABLE 7.4

Individual Companies Percentage Deviation of Forecast *vs.* Actual Purchases over the Season:

1992-93

Company	< 24	25-28	29-32	33-35[b]	>36	TOTAL
A	100	41	82	76	80	+ 76
B	0	76	75	85	59	+ 74
C	53	91	78	9	40	+ 43
D	0	25	83	-67	-151	- 74
E	0	100	100	-18	-29	+ 8
F	0	98	-100	44	-44	+ 82
G	75	-8	15	85	89	+ 72
H	73	75	-78	72	-2	+ 22
I	61	90	69	24	33	+ 46
J	24	-42	-47	22	-44	- 17
K	-17	-131	-72	33	-91	- 21
TOTAL	56	6	-19	40	-8	+ 12.9

In total, the large errors generally balance out. This result in itself gives some comfort to the approach, since the objective is to estimate a 'market' level of demand. However, an interesting observation as alluded to earlier in Chapter Six is that some of the errors made by some companies tend to be quite large. Is this individual behaviour reflective of the random nature of the errors, in which case the errors are 'explained' or are the errors being made on a systematic basis? In other words, what is different about these 'poorer' forecasters?

To determine these characteristics, it is useful to first, isolate those companies which are the poor performers in terms of forecast accuracy. Table 7.5 ranks each company according to a measure of 'accuracy' using the percentage error.

TABLE 7.5

Relative 'Accuracy' Ranking of Panel

	Percentage	Score
1	E	2
2	J	5
3	K	7=
4	C	7=
5	H	10
6	B	13
7	G	14=
8	I	14=
9	D	19=
10	A	19=
11	F	21

The score in Table 7.5 refers to the combined rank position of the respondent firm over the two seasons. If the firm was the most accurate compared to the other panel members, it would be assigned a score of 1. The least accurate would get a score of 11. Adding up the scores over the two seasons gives the total score. If the respondent firm was the most accurate over both seasons, the score would be 2 (*i.e.* 1 + 1). A consistently poor forecaster would get at most a score of 22 (*i.e.* 11 + 11). An = refers to equality of scores.

It is clear that use of this measure establishes a pattern of good or poor performers at the extremes. Companies D, A, and F, for example, perform badly over both seasons, while Companies E, J, K, and C perform relatively well. The question to be considered is what characteristics, if any, distinguish these companies?

In Chapter Six, it was suggested that some companies may have been considering the whole market in the quantity forecasts, rather than their auction purchases. Tables 7.6 and 7.7 describe the aggregate 'auction' data and the 'company' data by respondent firm.

The companies that tend to be poor forecasters under the experimental approach tend to improve with the consideration of 'company' data (*i.e.* auction + private). The worst forecaster, Company F for example, improves markedly from an over-estimation of 335% to an over-estimation of 108%, although this error is still large. Company A, similarly improves from -75% to -25%. Companies that were deemed good forecasters under 'auction data' have considerably inflated auction purchases and hence larger errors (as expected). Company E's error, for example, goes from

TABLE 7.6

Aggregate 'Company' *vs.* 'Auction' Data by Firm

1991-92

Company	Expected (Bales)	'AUCTION' DATA (*i.e. auction sales only*)			'COMPANY' DATA (*i.e. private + auction*)		
		Actual	Error	%	Actual	Error	%
A	7,468	2,718	-4,750	- 175	6,072	-1,515	- 25
B	8,082	14,637	6,555	+ 45	16,212	8,130	+ 50
C	31,057	26,368	-4,689	-18	40,328	9,269	+ 23
D	20,409	4,635	-15,774	- 340	5,188	-15,221	- 293
E	2,396	2,128	-268	- 13	3,591	1,201	+ 33
F	8,204	1,885	-6,319	- 335	3,946	-4,258	- 108
G	6,401	34,630	28,229	+ 82	42,310	37,296	+ 88
H	42,340	117,064	74,721	+ 64	117,332	74,989	+ 63
I	73,396	30,930	-42,466	- 137	66,682	12,729	+ 19
J	92,475	77,628	-14,847	- 19	115,846	23,541	+ 20
K	15,327	22,833	7,506	+ 33	24,069	8,736	+ 36
TOTAL	307,555	335,456	27,901	+ 8.3	441,580	154,897	+ 35

TABLE 7.7

Individual Companies Percentage Deviation of Forecast *vs.* Actual Purchases as Adjusted for 'Company' Data: 1991-92

Company	< 24	25-35[a]	25-32[b]	33-35[b]	> 36
A	0	+ 55	+ 55	- 411	- 13321
B	- 83	0	+ 87	- 37	+ 23
C	+ 82	+ 20	+ 20	- 38	+ 23
D	0	+ 55	+ 55	- 896	- 371
E	0	+ 100	+ 100	+ 100	+ 1
F	0	+ 81	+ 81	- 536	- 94
G	+ 98	+ 78	+ 78	+ 33	+ 87
H	+ 99	+ 93	+ 93	+ 65	+ 53
I	+ 96	- 4	- 4	- 177	- 1
J	+ 4	+ 31	+ 31	+ 18	- 45
K	+ 41	+ 84	+ 84	+ 58	- 17

Notes:

a For the first three surveys only
b From Survey No. Four onwards
* Percentage unable to be calculate, value undefined.

- 13% to + 22%, while J, K and C also exhibit deteriorations, albeit small, in forecasting error.

The difference could also be considered with the following argument; if the buyer purchases mainly from the auction system, then the 'auction' and 'company' data should be roughly the same, and *vice versa*. However, this argument does not stand. Company E, the best forecaster, purchases around 75% privately and thus appears to have been able to distinguish between the two sources of supply in the experiment. Of the group of 'poor' forecasters, only Company A shows any significant improvement (-175% to -25%) with the broader based 'company' data. In the case of the other companies, it would appear that they were 'poor' at forecasting irrespective of the 'market' variable used.

At both a theoretical and operational level it may be useful to distinguish between those 'good' forecasters and those deemed 'poor' forecasters. Several variables which could be used to distinguish between the groups include size of the company ($ turnover), number of buyers, ownership (New Zealand *vs.* foreign owned) and years experience. Table 7.8 below summarises the mean values for these variables for the two groups ; good forecasters (E, J, K, C) and the poor forecasters (D, A, F). A third group of 'average' forecasters (H, B, G, I) is also considered.

TABLE 7.8

Analysis of Group Demographics - Group Average

	$ turnover	No. of buyers	Years exp	Ownership F	Ownership NZ	Prop'n priv. pur	No. Employ
Good	$43m	3	16	3	1	37	8
Average	$72m	4	24	2	2	36	11
Poor	$18m	1	29	2	1	55	4

Given the small numbers involved it is difficult to make a definitive statement about the group differences. However, the 'poor' forecasters tend to be smaller operations. Furthermore, they tend to buy a greater proportion of their purchases privately. This tends to confirm the previous proposition that there may have been some confusion about the purchase definition (*i.e.* auction market only), or that they have more 'opportunity' to purchase smaller quantities through sources other than the auction system.

7.3 ASSESSMENT OF QUALITATIVE DATA ACCURACY

The results above would suggest that some of the respondents were having some degree of difficulty in estimating quantity forecasts for the wool groups, both on an aggregate and individual basis. The question which should be addressed is were these differences a function of the survey process and instrument or are they merely symptomatic of the uncertainty of the macroenvironment in which the buyers operate? To test this proposition it is possible to make a comparative *ex post* assessment of the buyers forecasting ability on other variables.

As part of the lead into the quantitative probability assessments, buyers were asked a number of qualitative questions which helped to focus their attention on the forecast period (See Appendix H: Part A, Volume Two). These questions related to their expectations of wool supplies, wool purchases, the USD/NZD exchange rate and the New Zealand Wool Board's Full Indicator Price. If the buyers were acting with 'full information' then it would seem a reasonable proposition to suggest that their expectations should match the realisation of each variable. Further, if the results of this assessment of the qualitative variables shows the buyers to be correct most of the time, then given the results of the quantity forecasts, it can be argued that the survey instrument is at fault. However, if the buyers are also poor at correctly forecasting these other variables, then it can be suggested that there is a considerable degree of uncertainty in the market and that the results obtained in this study are not necessarily a reflection on the inadequacy of the instrument, but are more a reflection on the volatility of the market.

To test the extent of expectations errors, it is possible to make use of a procedure suggested by Theil (1967; 1958) and reported by Buckle, Assendelft and Jackson (1990; 1988). A comparison of the categorical expectations data allows for the construction of a table cross-classified by expectations and realisations (Table 7.9). The rows and columns represent the nature of the changes (*i.e.* up [+], same [=], down [-]) for expectations and realisations respectively. As such there are 3 X 3 possible outcomes showing the relationship between the expectations and realisations.

TABLE 7.9

Expectations and Realisations Table

Expectation	Realisation			
	Up (+)	Same (=)	Down (-)	Marginal frequencies
Up (+)	$f(+,+)$	$f(+,=)$	$f(+,-)$	$f(+,.)$
Same (=)	$f(=,+)$	$f(=,=)$	$f(=,-)$	$f(=,.)$
Down (-)	$f(-,+)$	$f(-,=)$	$f(-,-)$	$f(-,.)$
Marginal frequencies	$f(.,+)$	$f(.,=)$	$f(.,-)$	$\Sigma^3 f(.,i) = \Sigma^3 f(i,.) = 1$ $i= +,=,-$

Source: Buckle, Assendelft and Jackson, 1990.

It can be seen from Table 7.9 that the diagonal sum of the relative frequencies (*i.e.* $f(+,+) + f(=,=) + f(-,-)$) represents the sum of correct qualitative assessments. The off-diagonal frequencies therefore, represent expectation errors. Note that these forecasts deal with only the prediction of the direction of change rather than the magnitude.

Using the data relationships established in Table 7.9, it is possible to establish other measures of expectation error:

EE = 1 - $[f(+,+) + f(=,=) + f(-,-)]$.

This is the proportion of total expectation error and is essentially the sum of the off-diagonal frequencies. This total error can be broken down into two further components;

OE1 = $[f(+,=) + f(+,-) + f(=,-)]$.

This is the proportion of expectations that over-estimate the level of a variable in a qualitative sense and the expected level is greater than realised.

UE1 = [f(=,+) + f(-,+) + f(-,=)].

This is the proportion of expectations that under-estimate the level in a qualitative sense and the expected level is less than realised.

These over- and under-estimation errors can be further broken down to show the extent of turning point errors, and magnitude of change errors;

TP = [f(+,-) + f(-,+)].

This is the error when the expected change and the realised change have the opposite signs.

OE2 = [f(+,=) + f(-,=)].

This is a measure of the over-estimation of the magnitude of change.

UE2 = [f(=,+) + f(=,-)].

This is a measure of the under-estimation of the magnitude of change.

These measures of over- and under-estimation can be used to develop a measure of the bias in the expectations errors *i.e.* whether there is a tendency to over- or under estimate the change of a variable. These measures are known as B1 and B2:

B1 = [(OE1 - UE1)/(OE1 + UE1)].

This is a measure of the degree of total over-estimation error relative to the total under-estimation error.

B2 = [(OE2 - UE2)/(OE2 + UE2)].

This is a measure of the degree of over-estimation of the magnitude of change relative to under-estimation of the magnitude of change.

B1 and B2 have a range of +1 to -1. They will be +1 if the bias consists of only over-estimation, 0 if the proportions of the over- and under- estimations are the same and -1 if the bias consist only of under-estimation (Buckle *et al*, 1990, p.583).

Table 7.10 summarises the expectations errors for the variables in the study. Also included is the mean proportion of realised expectations (*i.e.* f(+,+) + f(=,=) + f(-,-)) The data for the expectations-realisations matrices are provided in Appendix T.

TABLE 7.10

Mean Frequency of Realised Expectations and Sources of Error

Variable	Source of Error					
	Prop'n. of realised expectations	OE1	UE1	OE2	UE2	TP
Wool Supplies 1[a,c]	.12	.34	.54	.20	.19	.27
Wool Purchased[a]	.16	.55	.29	.14	.20	.18
Exchange Rate[a]	.26	.45	.29	.06	.36	.20
Indicator Price 1[a,d]	.18	.53	.29	.07	.26	.40
Comp. Purchases[b]	.20	.48	.32	.01	.31	.35
Wool Supplies 2[b,e]	.17	.59	.24	.23	.15	.27
Stocks[b]	.11	.66	.23	.13	.20	.28
Indicator Price 2[b,e]	.18	.58	.24	.16	.18	.24

Notes:

a Data covers full study period *i.e.* Survey No. 1 to Survey No. 16.
b Data covers Survey No. 9 to Survey No. 16.
c Wool available to purchase at auction over the next four weeks.
d NZWB Full Indicator Price at the end of the month.
e Comparison of variable at end of month with end of following month.
f Values may not add to 1 due to rounding

The proportion of realised expectations ranges from between a low of .11 (stocks) to a high of .26 (exchange rate at the end of the period). In other words, the panel could only, at best, correctly forecast the direction of change in the USD/NZD exchange rate at the end of the period 3 times out of every ten attempts! Variables which one would have thought buyers had some degree of control over, such as stocks and purchases by the company, had proportions of correct realisations of only

11% and 20% respectively. More importantly for the results outlined in Section 6.8, Chapter Six, is the observation that buyers have little success at correctly forecasting supplies of wool onto the market (12%) and the extent of purchases to be made (16%). Admittedly there was a fair degree of uncertainty in wool supplies, particularly in 1992-93. However, this result alone suggests that a lot of the errors made in forecasting using the purchase probability experiment may be external to the study, rather than internal (*i.e.* the instrument).

In terms of the other variables, some interesting patterns develop. There exists a high degree of over-estimation in stocks at the end of the month (66%), forthcoming wool supplies (59%), wool purchases made by the company (55%) and the Indicator Price at the end of the month (53%). Wools supplies coming onto the market at the end of the period tended to be under-estimated (54%), which is not surprising given the uncertainty over quantities of quality wool expressed by the buyers (see Appendix N).

The turning point errors, as mentioned, reflect a situation where an expected occurrence and the outcome have opposite signs. The results as shown in Table 7.9 indicate a relatively high proportion of times that this result occurred, particularly for the Indicator Price (40%). This could be explained by the ongoing 'optimism' that things could not get worse and that prices would pick up (instead of continuing to fall all season as they did!). Company purchases at the end of the next month, had a very high turning point error (35%), which could possibly be linked in with the uncertainty about supplies.

The OE2 and UE2 statistics essentially show the degree of variability. In the case of OE2, the panel expect a change when, in fact, the variable remains the same. In the case of UE2, the panel expect stability and the variable changes. Uncertainty (OE2) was recorded relatively high in wool supplies in the next period (23%), wool coming onto the market in the current period (20%), and the Market Indicator (16%). Uncertainty, as measured by UE2, was highest for the USD/NZD exchange rate (36%), company purchases in the next period (31%), Indicator Price in the current period (26%), stocks (20%), wool purchases (20%) and wool supplies (19%).

In summary, the OE2 and UE2 statistics suggest that the wool buyers had quite different within-group opinions on market expectations[1], implying their 'information set' were not consistent. This finding was confirmed by Kemp and Willetts (1994) in a further study of Christchurch woolbuyers.

Table 7.11 below summarises the B1 and B2 statistics.

TABLE 7.11

B1 and B2 Statistics

Variable	B1	B2	EE
Wool Supplies 1[a,c]	-.230	+.017	.880
Wool Purchased[a]	+.313	-.170	.840
Exchange Rate[a]	+.206	-.722	.741
Indicator Price 1[a,d]	+.286	-.571	.824
Comp. Purchases[b]	+.200	+.917	.800
Wool Supplies 2[b,e]	+.419	+.214	.827
Stocks[b]	+.474	-.238	.891
Indicator Price 2[b,e]	+.410	+.040	.824

Notes:

- a Data covers full study period *i.e.* Survey No. 1 to Survey No. 16.
- b Data covers Survey No. 9 to Survey No. 16.
- c Wool available to purchase at auction over the next four weeks.
- d NZWB Full Indicator Price at the end of the month.
- e Comparison of variable at end of month with end of following month.

The results confirm the previous findings. The panel tended to over-estimate on all variables with the exception of wool supplies. This bias (B1) is quite apparent in

[1] This, in some respects, is in itself not surprising given the speculative nature of the market.

stocks (+.474), and wool supplies for the next month (+.419). The B2 statistic suggests that uncertainty (*i.e. expectation = same, realisation = change*) is particularly apparent for purchases by the company (*i.e.* over-estimation = +.917) and exchange rates (*i.e.* under-estimation = -.722)

Respondents in the panel were also asked to provide a quantitative forecast of the New Zealand Wool Board's full Market Indicator at the end of each survey period during the 1992-93 season. Table 7.12 summarises the statistical results.

TABLE 7.12

Statistical Analysis of Market Indicator Forecasts

Statistic	Value
U	.01146
U^m	.30850
U^s	.05946
U^c	.63204
p	.256
R.M.S.	20
RMS%	5.0

While the value of U suggests a reasonable fit, it is apparent that there is some systematic error being incorporated into the forecasts (Figure 7.1). With the exception of two periods (*i.e.* 10 & 15), the panel consistently over-estimated the Market Indicator at the end of the month. An investigation of this result shows that when the Market Indicator is rising the forecast expectation is for the rise to continue and *vice versa*. In other words, there appears to be a positive correlation between the Market Indicator direction prior to the interview and the expectation of the Indicator during the survey period (see Figure 7.2). Figures 7.3 to 7.10 show that the distribution of the Indicator forecasts made by the panellists tended to be skewed upwards. Furthermore when the price was rising the range of forecasts was much greater, implying a greater degree of uncertainty.

FIGURE 7.1

Market Indicator *vs.* Expectation at the End of Month

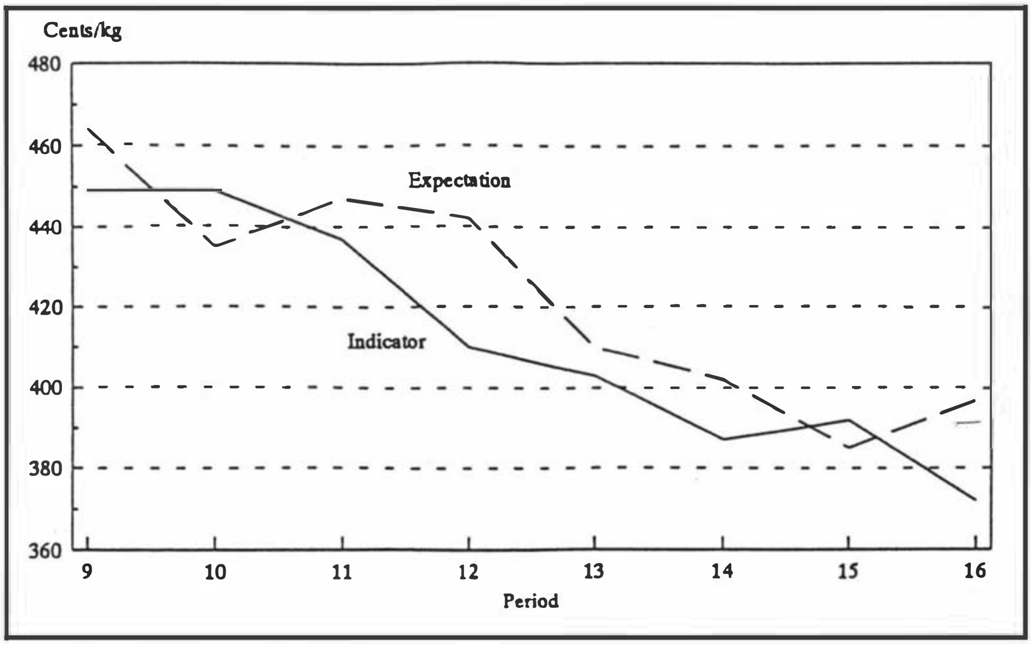


FIGURE 7.2

The Positive Correlation of the Market Indicator Expectation and the Direction of the Market Indicator Prior to the Survey Period

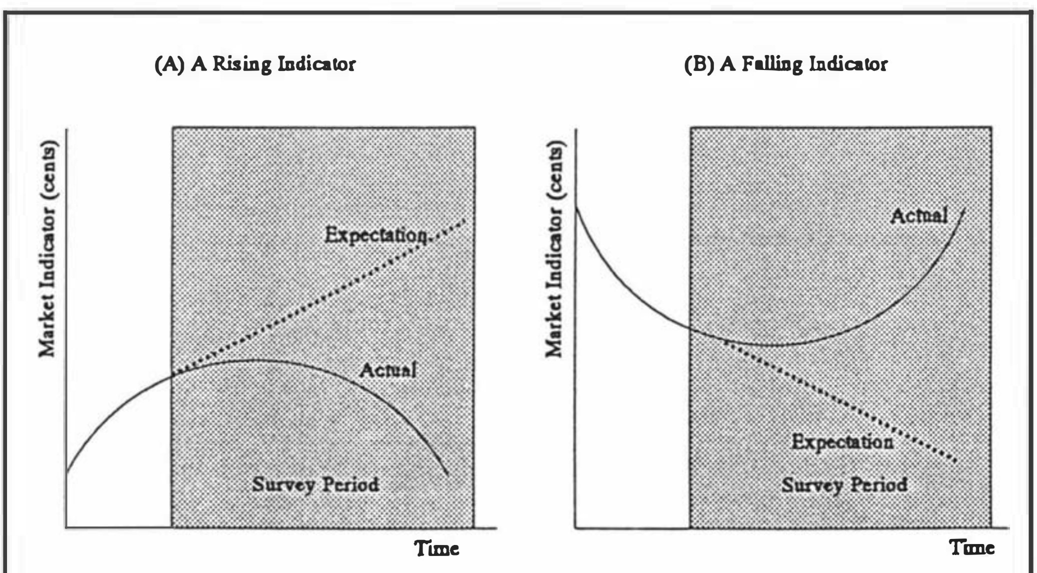


FIGURE 7.3

Market Indicator Forecasts - October 1992

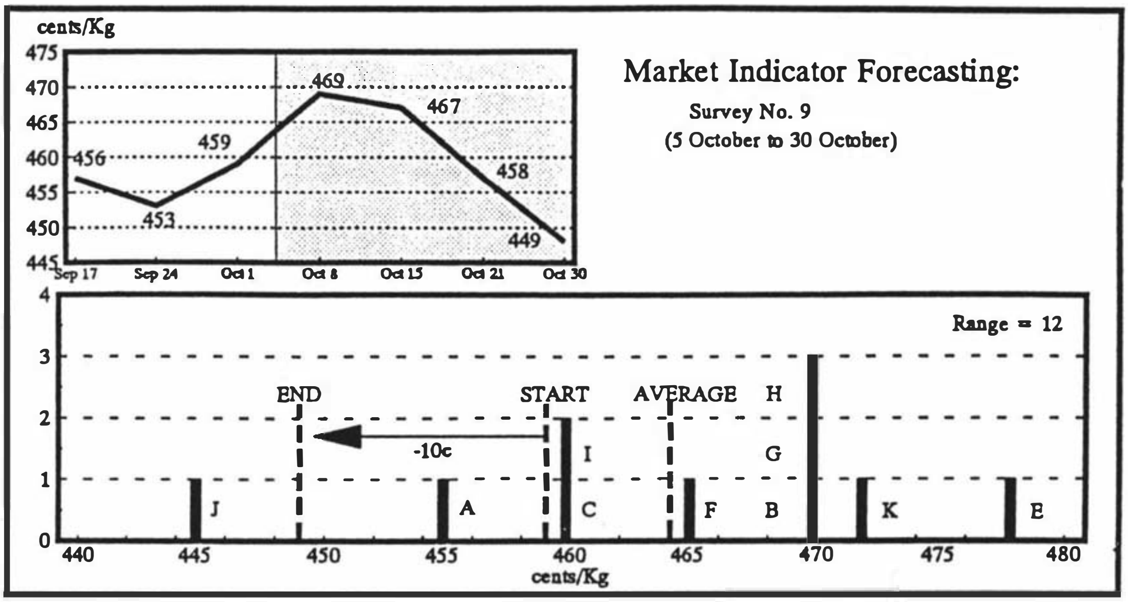


FIGURE 7.4

Market Indicator Forecasts - November 1992

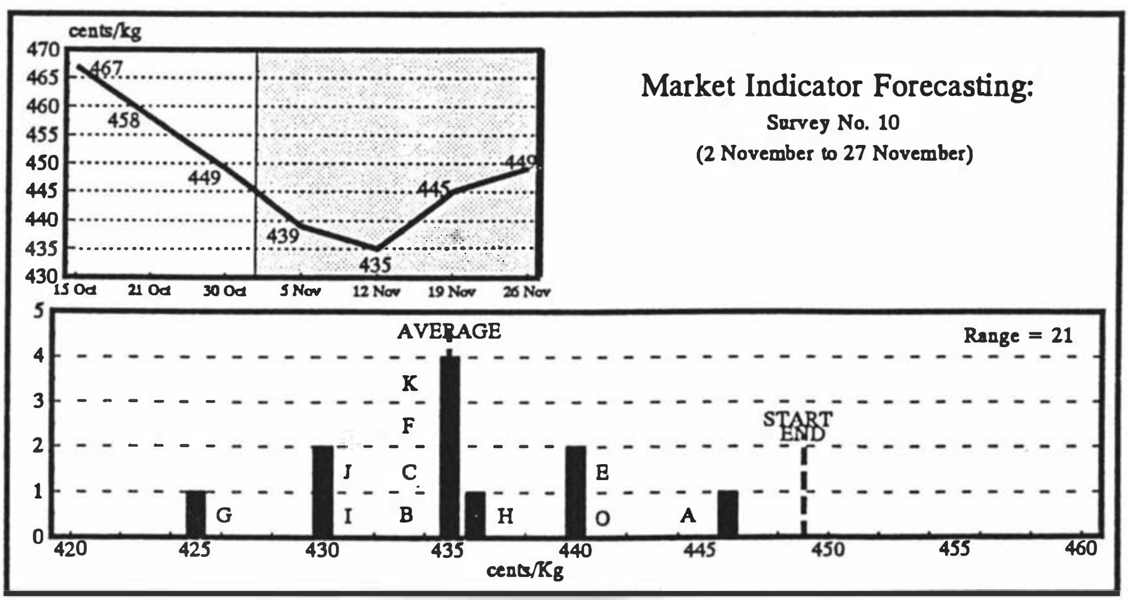


FIGURE 7.5

Market Indicator Forecasts - December 1992

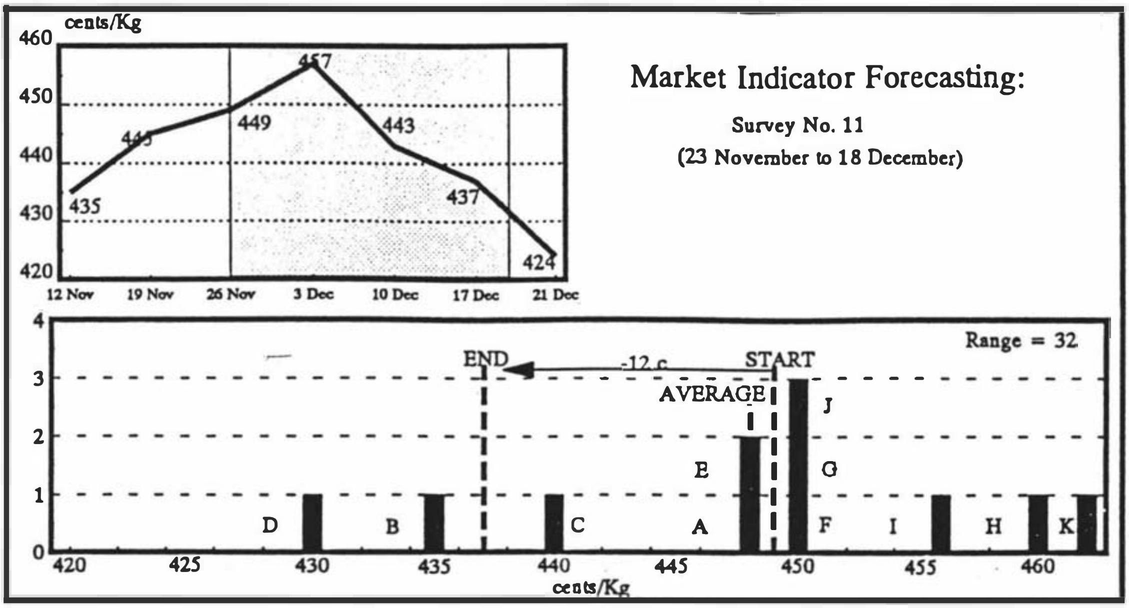


FIGURE 7.6

Market Indicator Forecasts - February 1993

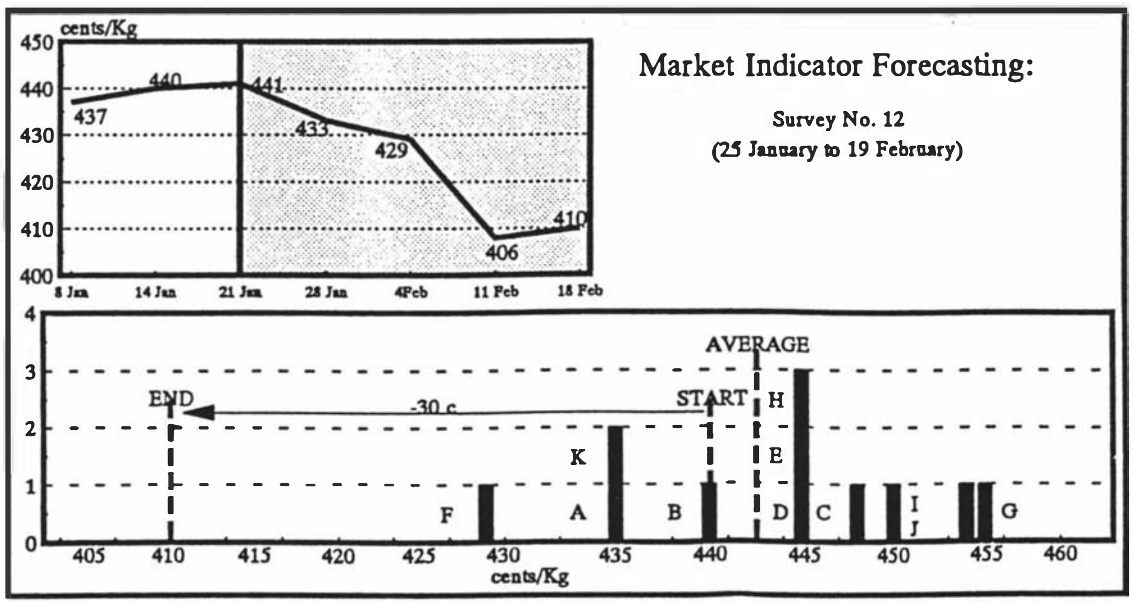


FIGURE 7.7

Market Indicator Forecasts - March 1993

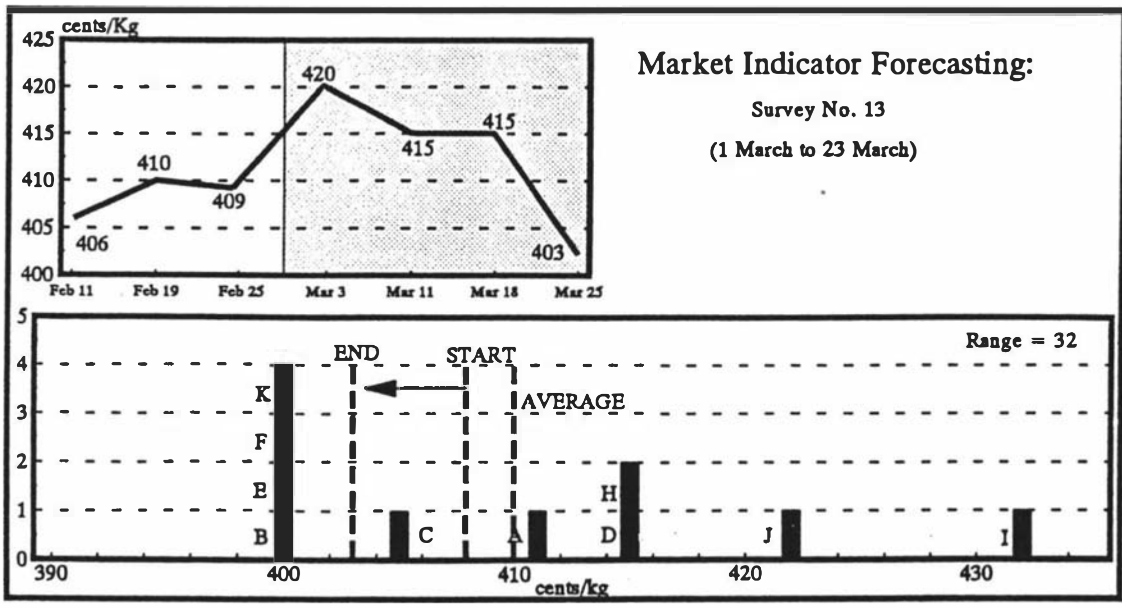


FIGURE 7.8

Market Indicator Forecasts - April 1993

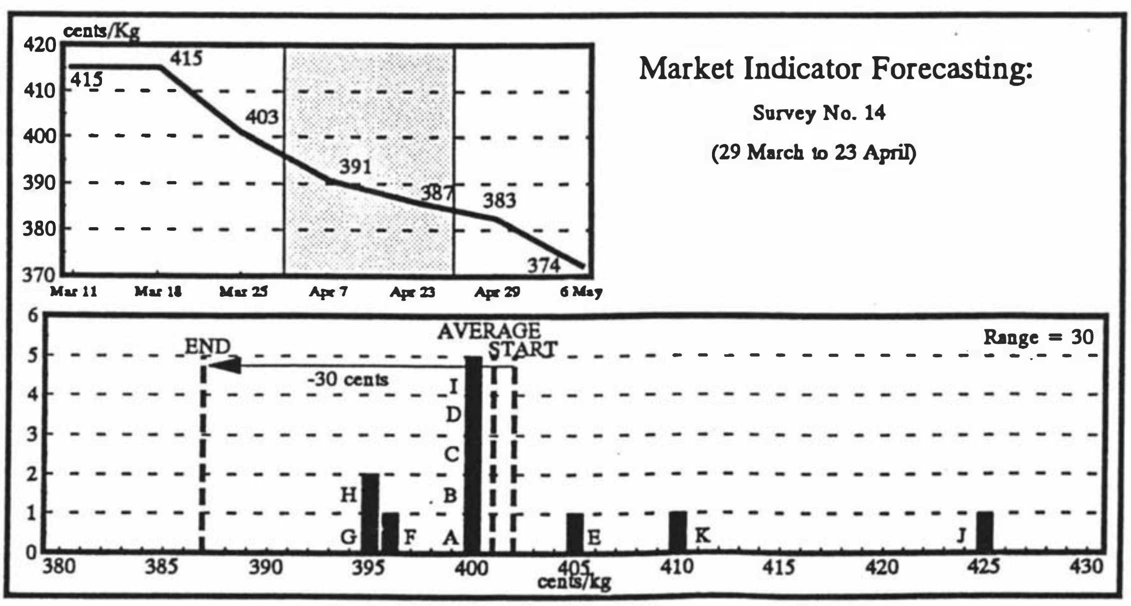


FIGURE 7.9

Market Indicator Forecasts - May 1993

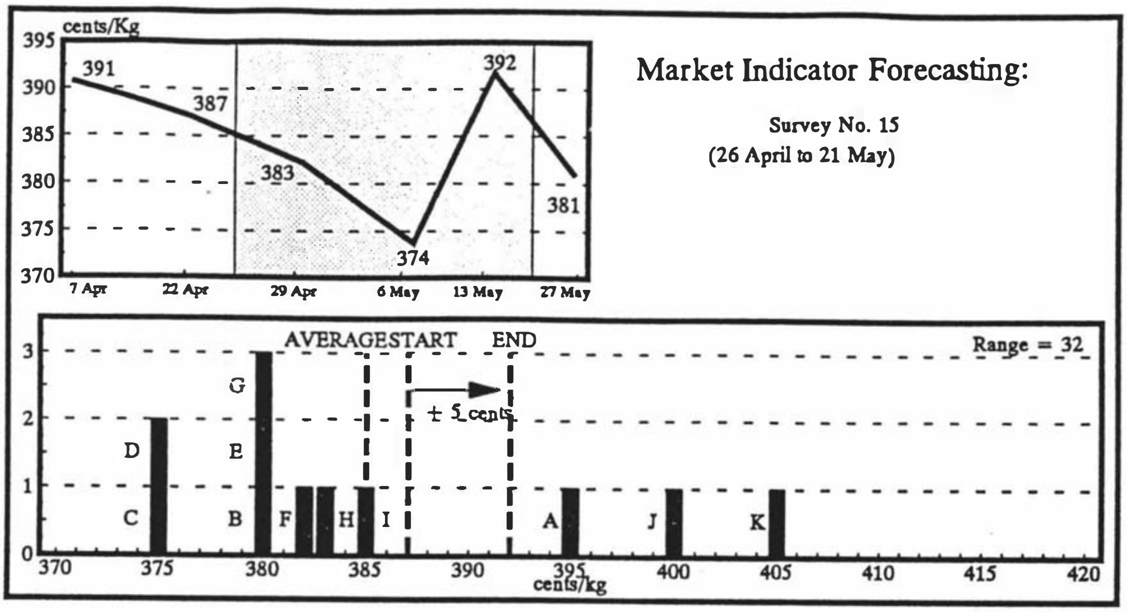
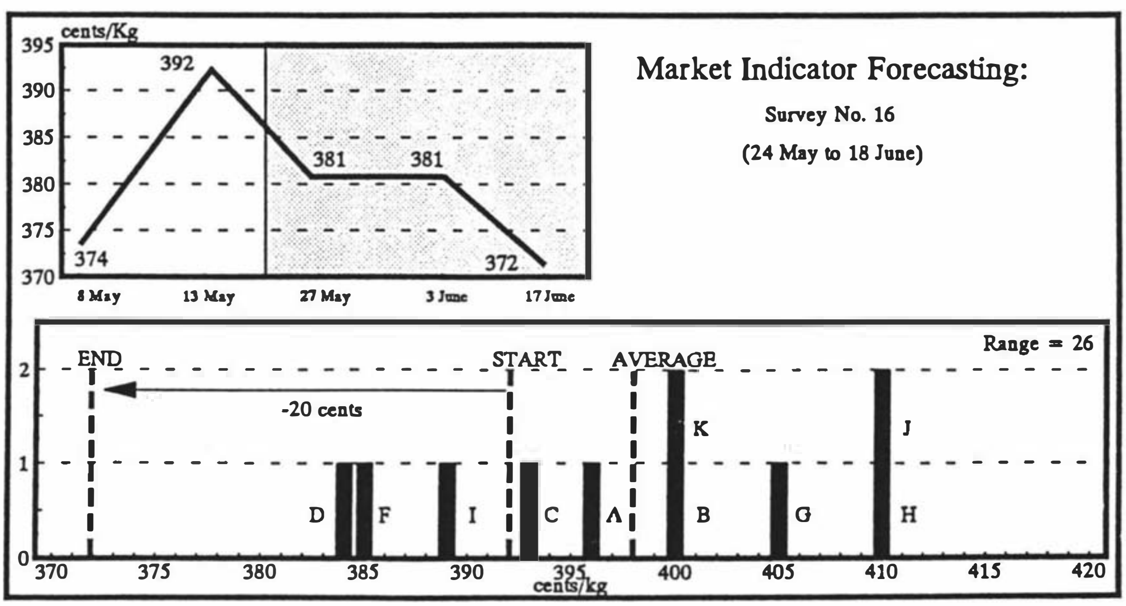


FIGURE 7.10

Market Indicator Forecasts - June 1993



7.4 SUMMARY

In this chapter the results of the aggregate panel data on expectations and actual purchases were analysed from the level of the individual buyers. It was hypothesised that some of the early forecast errors at an aggregate level may have been attributable to a learning period. Some buyers may have been considering the entire wool supply market rather than focusing only on the auction system. Given the influence of the large buyers on the aggregate results, improvements in these particular buyers probability assessments tend to be more noticeable.

As evidenced in Chapter Six earlier, there appears to be a great deal of variability in the capacity of some of the buyers to establish accurate forecasts of purchases. In total, the aggregated errors generally balance out. Four companies were identified as making consistently large errors. This was particularly noticeable in 1991-92 where the combined errors amounted to an over-estimation of some 69,309 bales. Only two of the eleven panel members had a relatively good forecasting ability over the two seasons. Some consolation was derived from the fact that all but two panel members improved their forecasting error between seasons.

Some of the errors identified by particular companies can be attributed to switching of purchases between micron groups. Furthermore, there was some evidence that the 'poor' forecasters were considering a wider definition of the wool market. This was of consequence given that they also tended to purchase, as well as having the flexibility to purchase, more of their wools from private sources.

Section 7.4 focused on the ability of the panellists to forecast the qualitative data. If there was difficulty in doing this as well as the quantitative forecasts, then it could be concluded that the errors were symptomatic of the general uncertainty in the macroenvironment rather than a deficiency in the instrument. This hypothesis tended to be confirmed. The proportion of realised expectations ranged from a low of .11

(stocks) to a high of .26 (exchange rate at the end of the period). Buyers were also having some difficulty in forecasting supplies of wool onto the market, and the extent of purchases to be made. There was a considerable amount of uncertainty recorded in terms of wool supplies, wool coming onto the market and the Market Indicator. Furthermore, there appeared to be a divergence of within-group opinion on these key variables, a finding that was confirmed by a parallel study of Christchurch woolbuyers.

Buyers were also asked to forecast a numerical value of the Market Indicator at the end of the period. When the indicator was rising, the general expectation was for the indicator to keep rising and *vice versa.* In addition, a rising Indicator *prior* to the survey, and hence an expectation of a rising Indicator *through* the survey period, also created a wider divergence of forecast opinion, implying a greater degree of uncertainty.

CHAPTER EIGHT: SUMMARY & CONCLUSIONS

CHAPTER EIGHT:
SUMMARY & CONCLUSIONS

8.1 INTRODUCTION

The prime rationale for this study was on investigating the potential for an experimental survey-based approach to demand slope estimation as an alternative to the traditional econometric approach. Chapter Two highlighted the fact that public debate on a topic such as the merits of the New Zealand Wool Board Market Support at Auction and Minimum Price Scheme's was limited by the lack of any solid empirical analysis of the private and social costs of operating such schemes. This analysis was stifled by the need to use either theoretical or assumed estimates of price elasticities and demand functions in addressing such issues as the redistributive impacts of market intervention apparent from the operation of a buffer stock scheme. Chapter Two summarised the literature in the wool intervention debate through buffer-stocks by outlining the Newbury & Stiglitz welfare approach and the Powell & Campbell 'hidden gains and losses' framework. It was concluded that demand estimates to date, have been indeterminate because many studies have relied upon theoretical/assumed elasticities, the models have incorporated only partial equilibrium effects and statistical/technical issues have necessitated limiting the conclusions to be drawn from the results. This situation had previously been highlighted in the literature by a number of other researchers. The general conclusion has been that only when reliable slope estimates have been established can any progress be made on such economic debates such as that highlighted by the actions of the New Zealand Wool Board and its market support systems.

Chapter Three revealed that, to date, previous research which was largely econometric in nature, had basically failed to provide any uniform estimates of demand elasticities for wool. Data problems, violation of statistical assumptions and misspecification of the underlying model were common difficulties faced by most researchers. A search for an alternative approach was therefore, warranted.

In the marketing literature, it became apparent that demand modelling using a purchase probability scale was having some reasonable degree of success. Chapter Four introduced a scale developed by Juster (1966) which was being successfully applied to a range of consumer items ranging from fast moving consumer goods (FMCG's), frequently purchased items (FPI's) and durables in the estimation of demand schedules. The approach was mechanically simple to implement requiring the elicitation of subjective probabilities for the consumers' forecast of purchase quantities. A number of deficiencies in previous studies were apparent however. Nevertheless, it was decided that, given due consideration to the problems and deficiencies identified, this approach could be a useful alternative in providing demand elasticities for wool. Chapter Four concluded by outlining some of these considerations which needed to be addressed and refinements made in the use of a visual response approach using a purchase probability scale in demand estimation.

Chapter Five provided the background details to the New Zealand wool industry as a precursor to the selection of the appropriate sampling unit. A convenience sample of 11 woolbuyers from a mix of companies was selected to provide purchase expectation data for sixteen four-weekly periods over the 1991-92 and 1992-93 seasons. Details of the survey instrument were outlined before discussion moved to the methodology.

Chapter Six covered the results and discussion of the study with the data from the whole panel. Price elasticity and slope estimates were generated for the four or five wool groups. These derived demand schedules were then aggregated to obtain total wool price elasticity estimates for the panel. However, in Section 6.7 questions were raised about the reliability of the purchase expectations. It was revealed that the errors were substantial for some wool groups and for some buyers, but that these errors tended to reduce over time. Chapter Seven discussed the purchase forecasts from the point of view of the individual buyers. The question which needed to be asked at this stage was, given the errors, is the instrument unsuitable for this type of product (*i.e.* a commodity) in demand estimation? Alternatively, it could well have been that the market in which the buyers were operating contained so much uncertainty that it was extraneous factors, rather than the instrument, which were at 'fault'. An analysis of the qualitative forecasts which preceded the elicitation of the purchase forecasts showed that there was a considerable degree of error in these as well.

The aim of this final chapter is to discuss some of the conclusions which can be taken from the study. While the robustness of the results are important in terms of providing answers to the research problem, the feasibility of this approach is also of prime interest. Section 8.2 provides a summary of the key results. Section 8.3 outlines the feasibility of using the visual response probability method in meeting the studies objectives. Issues concerning cost, validity, and practicality are outlined. Section 8.4 discusses the limitations of this approach and suggests areas of refinement for further research.

8.2 SUMMARY OF KEY RESULTS

Price elasticity and slope estimates were calculated for all five groups of wool, as well as for the aggregated panel. Fine wool price elasticities showed a wide range of variability reflecting, in part, the short season of quality wools. Furthermore, it would appear that price is a comparatively less important factor for this group due to the lack of substitutes (with other natural and synthetic fibres) and the fact that significant premiums can be developed for some particular wooltypes based on the origins of the wool, and style.

The medium wool group price elasticities indicated an elastic demand which is to be expected given the end-uses and relative substitutability with synthetics. It was quite noticeable that a high degree of correlation existed between groups indicating price sensitivity and the potential for switching between micron groups according to price.

The coarse wool group price elasticities were much lower than for the other two groups. This is possibly because there is not as much within-season variability in supply as in the case of, say, fine wools. The value of the elasticity tended to be less elastic at the beginning and end of the season when the quantity of wool on offer is much less and hence, the selection is much narrower.

Aggregate price elasticities of -4.4 and -4.6 were developed for the 1991-92 and 1992-93 seasons respectively. There was much more variability in the estimates for the 1992-93 season, than in 1991-92 possibly due to the depressed market conditions. These elasticity estimates tended to be much higher than those developed from previous econometric studies. This may be due to the fact that the qualitative experimental approach incorporates much more 'information' than the 'snap-shot averaged' econometric approach and that the anticipated quantity levels are under-estimated, thereby implying a more inelastic demand curve.

The true test of the proposed approach is the ability of the forecasts to be related to actual outcomes. On an aggregated basis, the panel consistently under-estimated purchases over the two seasons. The error rates were 8.3% and 12.9% respectively for 1991-92 and 1992-93. There was consistent under-estimation of aggregate purchases in the fine and fine-medium groups and consistent over-estimation of purchase in the coarse groups. The extent of the errors tended to fall both over time and between seasons. Much of the 'blame' for the significant under-estimation errors occurring in the medium group (1992-93), and hence in the aggregate, was due to changes in price relativities against the coarser wools. As such, buyers appeared to be using relatively cheaper finer wools (*i.e.* 33-35 microns) to blend into loosely defined contracts for the coarser wools (*i.e.* 36-37 microns).

On a seasonal basis, the panel of buyers tended to have an initial net cumulative over-estimation of purchases. By the fourth period the panel started to make a net cumulative under-estimation. These findings were confirmed with the application of

Theil's U statistic. In both seasons, the coarse wool groups exhibited a useful forecast result with low values of U and no substantive evidence of systematic error. This result is significant given that the bulk of wools traded fall into this category.

It was hypothesised that some of the 'blame' for poorer forecasting ability may be the responsibility of some members of the panel. In particular, these panel members may have been misinterpreting the market boundary of the experiment and including private purchases as well. This result was confirmed in Chapter Seven, where the forecasting performance of the 'poor' forecasters improved with the incorporation of auction and private purchases. An interesting result was that even with this wider supply definition, the forecasting ability of these panel members was still relatively poor.

To test the comparative forecasting potential of alternative approaches, a number of time-series and regression models were developed. An encouraging result saw the purchase probability approach have the best and consistent forecast response based on a range of criteria. Interestingly, the two-period moving average model also rated relatively highly in second place. All the other models showed temporal inconsistency and insignificant explanatory variables.

Additional qualitative data that was collected as part of the survey introduction allowed for an investigation of the panel's forecasting ability on a range of other variables. It was discovered that the panel had considerable difficulty in correctly forecasting some of the key market variables. This even extended to their own purchases and stocks one month out, an important result in the light of the results developed in Chapter Six. There was considerable over-estimation of stocks, forthcoming wool supplies, purchases made by the company and the Market Indicator Price at the end of the month. Wool supplies coming onto the market tended to be under-estimated. High measures of uncertainty were also recorded in company purchases, the Market Indicator, and the exchange rate (*i.e.* USD/NZD).

8.3 THE USEFULNESS OF THE VISUAL RESPONSE APPROACH IN THE ELICITATION OF SUBJECTIVE PROBABILITIES

The objective of this study was the investigation of the feasibility of using a visual response approach in the elicitation of subjective probabilities for the estimation of a demand schedule. More specifically, the study used a purchase probability instrument known as the Juster scale which previously had been acknowledged as suitable for the estimation of demand schedules for FMCG's, FPI's and durables. Very few of these studies however, explicitly reported the appropriateness of the instrument from the respondents point of view. Intuitively it would seem that unless the respondents were 'comfortable' with the instrument and understood, or at least appreciated the logic behind the procedure, then doubt could be cast on the results obtained. The appropriateness of the visual response approach to demand estimation is considered in this section under buyer participation, the establishment of probability assessments and cost.

8.3.1 Buyer Participation

This study was fortunate in the respect that it dealt with a stable panel of buyers over a prolonged twenty one month research period. Furthermore, considerable effort went into an orientation procedure right from the outset of the study. As such there existed a good degree of familiarity with the procedure by all respondents in the panel. This however, came with time. Even with the use of explanatory procedures, it became apparent that it took, on average, about two interviewing rounds before most of the respondents were able to the use the counters, the probability scale and the quantity grids without prompting or help. In fact, this point was clearly illustrated in Table 6.28 (p. 227), where the error levels improved quite substantially when the first two periods were excluded.

This study was extremely fortunate in that it had excellent cooperation from all members of the panel over the entire survey period of two seasons. There were several occasions when buyers were absent from the country and, for obvious reasons, could not participate in the quantity forecasting component of the survey. On only one occasion did a buyer refuse to participate in all aspects of the research because of work pressures. On all these other occasions however, the respective buyers did complete the qualitative component of the study. During the course of the study, there was one resignation of a buyer. His replacement, however, was able to pick up the interviewing process quite quickly without any serious interpretation or delay.

One of the interesting facets in conducting the fieldwork was the continued enthusiasm for this study by the buyers. In some similar studies, it has been apparent that the use of the counters and showcards could be trivial, monotonous and laborious for respondents. Furthermore, the demands being placed on industry for information are continually increasing with the result that many companies now have a policy of refusing any non-statutory information requests. When questioned as to why this cooperation existed, one buyer suggested that the procedure of having to think about different prices and different quantities was beneficial to him in helping to explicitly focus on contract obligations over the next month. Furthermore, the survey instrument was carefully developed and pre-tested prior to any fieldwork. This meant that the questions asked were efficient in an information gathering sense and easy to answer.

8.3.2 Respondents Probability Assessments

One of the interesting aspects that emerged from conducting the fieldwork was the way respondents went about answering the quantity forecasts. In all cases the buyers had some idea about the 'desired' quantity of wool that they were to purchase over the four week period. This 'desired' quantity was basically a function of impending orders to be filled or of orders which may need to be filled within the next two to three months. In developing probability assessments, the respondents tended to fall into two approaches; those who developed two-tailed probability distributions and those who developed one tail distributions.

The procedure developed by Juster and used in subsequent research implicitly assumes that respondents when presented with a decision alternative such as a price change, are able to make some explicit probability statement in relation to various quantities. In many cases, the respondent in establishing the required probability level would say '*...a good chance...*' or '*...a fair possibility...*' and then use the probability showcard to choose the appropriate number of counters (which bore some relation to the probability scale) to place on the quantity grid. A two-tailed probability distribution around some desired quantity was thus established (Figure 8.1). This distribution around some 'desired' quantity, while not necessarily staying constant, also tended to move down to lower quantities as price increased.

For some buyers though, this explicit reasoning process did not occur. In these instances, the buyers were able to establish with relative ease probability statements for maximum quantities. In other words they could easily state that there was only a 'very slight chance' (*i.e.* 1/10 probability or one counter) for say, 550 bales, and a 'slight chance' (*i.e.* 2/10 probability or two counters) for say, 500 bales. In terms of establishing probability levels for lower quantities however, the buyers simply just put the balance of the counters on the next lower quantity option. The implication from the Juster scale in this case was that there existed, for example, a 'good possibility' (*i.e.* 7/10 probability or 7 counters) of purchasing 450 bales. It is questionable however, whether this probability statement was in fact the 'true' probability attached to this quantity. It became apparent that the 'desired' quantity was fixed throughout the price scenarios and that lower probabilities were simply being attached to it (Figure 8.2).

8.3.3 Cost of Research

This study was always deemed experimental in the way it was conducted. Furthermore, it was fortunate that it had substantial and guaranteed funding during the two seasons. In terms of interviewing cost however, the feasibility of this type of approach remains questionable. There were quite substantial costs involved in travelling, and accommodation in order to conduct the monthly interviews. Over the

FIGURE 8.1

Two-Tailed Distribution of Responses Around Some 'Desired' Purchase Quantity

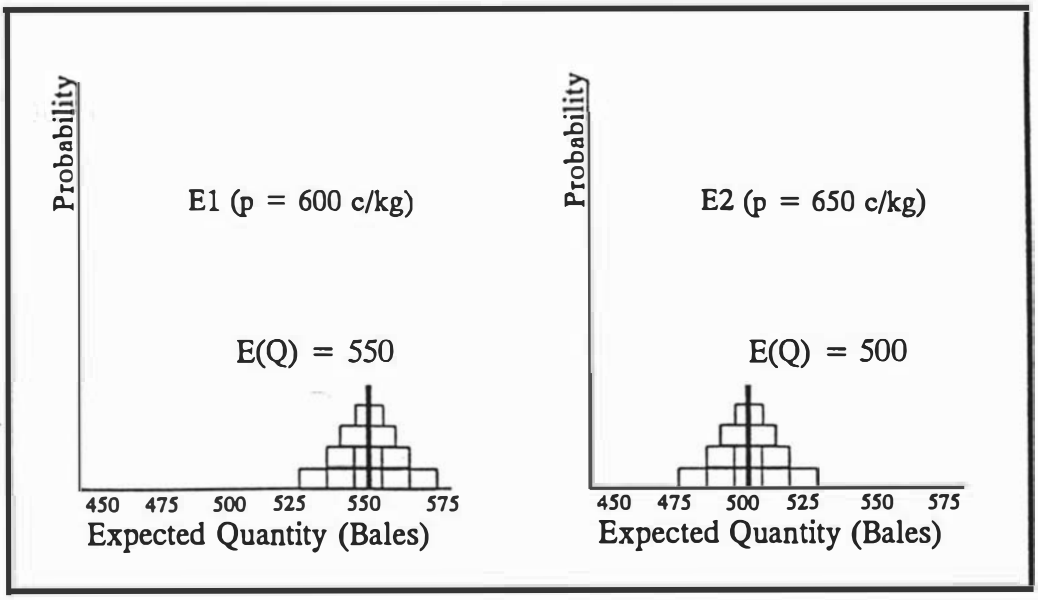
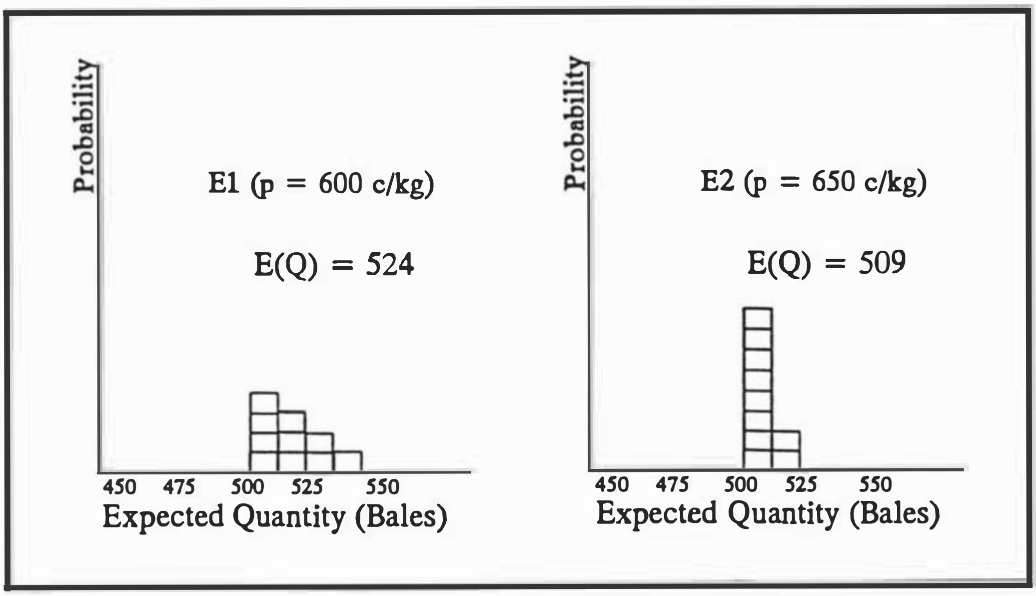


FIGURE 8.2

One-Tailed Distribution of Responses Around Some 'Desired' Purchase Quantity



two seasons the total cost of the study amounted to some $25,000 or $160 per effective interview ($1993). The financial practicality of this face-to-face procedure thus needs to be questioned. Some consideration was given to the possibility of a mail survey to elicit the purchase quantity and qualitative data. However, based on observations from conducting the fieldwork it was apparent that doubts would exist about the validity of the data. While the buyers became progressively familiar with the procedure, it was probably too much to ask that they would all complete the questions under identical conditions and over the same period. The use of face-to-face interviews created a situation where the buyers could concentrate on the questioning procedure and be queried about their particular responses. Furthermore, the personal nature of the interview allowed for the collection of qualitative data, which is one of the strengths in this procedure over alternatives.

8.4 LIMITATIONS AND AREAS OF FURTHER RESEARCH

As with most studies, a number of limitations with the procedure became apparent, even after adjustments were made based on issues raised in the literature. This section outlines some of the areas which caused not so much as concern but interest. Further areas of research are also flagged.

8.4.1 Appropriateness of Classes - Wool Groups

As mentioned previously, there exist over 2000 types of wool. Each wooltype which is presented at auction is assessed and certified on the basis of length, diameter (microns), colour and style (see Appendix M). It is obviously impossible to expect the respondent to go through each of these types in an experimental situation. As a compromise, wooltypes were combined into first, three, then four and finally five wool groups (*i.e.* less than 24 microns, 25-28 microns, 29-32 microns, 33-35 microns and 36 microns or more). These group boundaries were carefully considered in consultation with both the Wool Department of Massey University and the New

Zealand Wool Board[1].

The respondents in the panel were asked to consider purchase forecasts for up to five groups of wool and five price levels. In this case, the experiment to elicit subjective probability distributions was conducted up to 25 times. Generally, the panel expressed satisfaction at the use of these groups which roughly corresponded to discrete end-uses. However, one buyer suggested the following seven groups may have been easier to use:

1. less than 22 microns
2. 23-25 microns
3. 26-29 microns
4. 30-31 microns (*i.e.* Chinese Types)
5. 35-36 microns
6. 37 microns or more
7. Lambswools

Another buyer suggested that groupings based on microns may have been inappropriate and instead, suggested five groups based on style:

1. Full-length fleece
2. Lambswool
3. Hoggetswool
4. Oddments
4. 35-37 Microns

A third buyer expressed difficulty in considering purchases related to the five groups used. He made the useful point that if he purchased for a particular end-use, for example, fill for futons, it did not matter how long or what colour it was. Instead, relative price tended to dictate from which 'group' he purchased.

[1] The New Zealand Wool Board itself uses three categories for wool for statistical and administrative purposes; Fine (less than 25 microns), Halfbred (26-32 microns) and Strong (33 microns or more).

One final comment on the definition of the wool groups was the omission of a separate lambswool category. This 'weakness' was mentioned a number of times by respondents with the prices in the lambswool category (*i.e.* 24 microns or less) often bearing no relation to what the market price for lambswool was.

8.4.2 Appropriateness of Classes - Price Categories

The question of the 'appropriate' price level in this study was a major issue. There was a need for the price change to induce some reaction from the respondent. The price change also had to be within realistic bounds. Once again, as a compromise, price levels were set at the prevailing price at the beginning of the period (1992-93 only), ± 5% and ± 15%. As with the question of the appropriateness of the wool groups, there seemed to be general agreement from the panel that this price range was appropriate and realistic. Some comments which were received suggested that occasionally the price changes seemed too large, particularly for the second half of the 1992-93 season. One suggestion was to use price spreads of ± 10 cents and ± 20 cents of the prevailing price at the start of the period.

It also became apparent that price, for some categories of fine wools was largely irrelevant with significant premiums being obtained, according to the source of supply. For some types of wools, significant discounts, due to colour faults, were also able to be obtained. In both cases, the 'prevailing price' was clearly outside the experimental price range. Complicating matters was the occurrence four times of sharp price rises through the period which pushed the average price above the highest price in the price range.

Finally, the question of pricing is extremely complicated with the same wool type (*i.e.* 37F3D) able to have often large price differences at the same sale. These differences can occur due to timing of particular offerings throughout the sale day, the source of the particular wool and the general sentiment of the sale through the day. It is this final point which invariably opens up the proverbial 'can of worms' in even attempting to offer some logic to buyer behaviour. It is not a function of this study to explicitly consider this factor, suffice to say it is of major consequence.

8.4.3 Appropriateness of Classes - Quantity Measure

Wool at auction is usually offered and purchased by the bale. It seemed logical therefore, to use this as the appropriate quantity measure in the experiment. Generally, the quantity distributions used in the study were satisfactory (see Appendix K). The quantity gaps used were as follows:

E1. 5 bale gap
E2. 10 bale gap
E3. 50 bale gap
E4. 100 bale gap
E5. 500 bale gap
E6. 2,000 bale gap
E7. 5,000 bale gap

The 5 bale gap in showcard E1 (0 to 60 bales) proved useful enough when used. A refinement to 1 bale intervals would have been inefficient. Only occasionally did respondents make use of showcards F6 (0 to 12,000 bales) and F7 (0 to 60,000 bales). However, the gaps were probably too large and could have captured more information if narrowed to 500 bales at least. The predominant showcard used was F3 (0 to 600 bales). However, its upper limit of 600 bales meant that respondents often ended up starting with F4 (0 to 1,200 bales) and moved on to F3 as prices increased. Ideally, it would have been more useful to have had one card with could have combined F3 and F4 and allowed the respondents a quantity range of say, 0 to 1,500 bales in 50 bale intervals. A lot of information was possibly 'lost' in having such large gaps in showcards F4 to F7.

A final point on this issue was the need for some respondents to fill containers, and purchase accordingly, rather than purchase X number of bales. In these cases, the respondent would purchase 350 bales (*i.e.* 1 container) at a range of prices before suddenly dropping to 175 bales (*i.e.* ½ a container) for another range of prices. One suggestion made was to instead consider the following quantity levels:

1. ½ container (~ 175 bales)
2. 1 container (~ 350 bales)
3. 1½ containers (~ 525 bales)
4. 2 containers (~ 700 bales)

8.4.4 Appropriate Time Periods

As with the other variables developed in this study, the question of the time period caused much initial debate. The forecast horizon had to be sufficiently long to incorporate a number of sale opportunities, but not be too long as to be seriously distorted by changes in price and other market considerations. The choice of four weeks appears to have worked reasonably well. The only other potential option would have been a three week period. One week would have been inappropriate, particularly in the second half of the season when sales are held on alternate weeks on a rotating North Island / South Island basis. Similarly, two weeks may have been an insufficient time to allow buyers opportunities to purchase wool.

Forecast periods greater than one month would have allowed considerably more uncertainty in market conditions to impact than already existed in this study. As it was, some of the four week periods saw considerable price changes occurring within them. The difficulty of forecasting purchases in the market over a four week period is typified by Figure 2.4 with potential changes impacting on purchase decisions liable to come from:

1. Weather - drought → poor quality wools
   - wet weather → late shearing and poor quality wools
   - wet weather → stained wools
2. Changes in exchange rates
3. Changes in Australian market conditions

4. Indent orders *i.e.* unplanned orders
5. Speculative elements in the market taking positions
6. Letter of Credit problems
7. Cancelled contracts

It becomes quite clear that changes to any one of these factors is likely to impact upon expected purchases. For both the 1991-92 and the 1992-93 seasons, quite often two, three or even all of these factors were prominent in the market (see Appendix N).

8.4.5 Appropriate Panel Size

While the funding of this project was generous, it quickly became apparent that some constraints needed to be imposed on the logistics of the face-to-face interviewing. As outlined in Chapter Five, three buying centres, Napier, Wellington and Christchurch, were chosen with 3, 2 and 6 respondents in each respective auction centre. The combined purchases of the panel amounted to around 40% of the total auction sales. The panel also represented a useful mix of size of company (in terms of turnover), and type of activity (trader, broker, speculator).

The only major 'fault' of the panel composition was the omission of one of the major buyers who refused to take part in the study. While the sample size was relatively small in number, it probably represented the optimum size for this type of labour-intensive study. Any more, particularly the addition of a further buying centre, would have added considerably to the cost and time. As it was, it took up to two weeks per month for administration and field work.

8.4.5 General Concern over Buyer Interpretation

Based on previous studies, it became apparent that respondents had to be clear on exactly what they were to be assigning probabilities to. In this study, the respondents were substantive experts and hence, had a considerable background knowledge of the market. A considerable proportion of time was spent in the first two surveys in 'educating' the buyers on the survey instrument and the experimental process. Dummy runs were allowed using a hypothetical example.

In Chapter Six, it became apparent that if the first two periods were excluded on the pretext of a learning period, then quite marked improvements were noted in the aggregate errors for the 1991-92 season. However, what is interesting to note is that it took up to three surveys before the majority of respondents were comfortable with the process. By the start of the 1992-93 season, all respondents were comfortable with the experimental procedure and required little prompting or instruction.

Chapter's Six and Seven also revealed another major limitation of the study. Respondents were asked to consider only those purchases at **auction**. This instruction was not followed by some as the results subsequently revealed. It became obvious that some buyers purchased a large proportion on the private market. Given the logic in economic imperatives to purchase from the low-cost source, expected purchases which may have been foreseen for auction were translated into actual private purchases. In other words, the auction purchases were over-estimated. When 'company' data (*i.e.* auction + private) was considered, there was a general improvement in the reliability of the forecasts for some buyers who had previously had high errors with the consideration of auction data only. This would tend to suggest that an easier approach may have been to get the respondent to consider **all** purchases at a particular price, irrespective of whether the purchase originated at auction or from private sales.

Finally, there is some doubt that the respondents were able to understand probability concepts as Juster (1966) would suggest in his paper. It is my opinion that Juster takes a rather large 'leap of faith' in assuming an academic and theoretical situation can be easily translated to the general populace. While cognitive tests were not a feature of this study, it is apparent that some of the respondents used the probability showcard (Appendix L) to **develop** their probabilities, rather than to **guide** them. In other words, the showcard was integral in **establishing** the appropriate number of counters to be placed on the quantity under consideration. As discussed earlier in this chapter, the respondents also placed counters on a particular point and assigned the balance to the next quantity level down. This would appear to be in contrast to Juster's proposition that consumers are able to establish consistent probability statements about some event, and use the probability scale as more of an 'after-thought', or guide.

It also became apparent that the adjectives which were used on the scale had different interpretations according to the individual respondent, and possibly also differed by the same respondent at different times. For example, a respondent may have suggested that there was, in their words, *"...some possibility..."* of purchasing X bales at Y cents/kg. and assigned 6 counters to that point on the showcard (E1 to E7, Appendix K). However, according to the probability scale, **some possibility** equates to 3 counters and 6 counters equals a **good possibility**. The respondent would then remove three counters, possibly leading to a different interpretation than their original intention.

Finally, the numerical descriptions used in the showcard were hardly explicitly used by the respondents, with the probability response being described by the adjectives instead.

8.4.7 Comparative Ability

The question of comparative forecasting ability was covered in some detail in Section 6.9, Chapter Six. Ideally it would have been useful to get the respondents to 'guess' some aggregate quantity of purchases to be made in the period. This would have allowed a comparison against the purchase probability approach. Unfortunately, this was not done. However, as Section 6.9 shows, some comparative time-series and regression models can be estimated using a range of existing data. The purchase probability approach came top of the list on a number of measures for both seasons. The nearest challenge came from the use of a two-sale moving average model.

The purchase probability approach offers superiority in terms of the 'richness' of the data it collects. The elicitation of subjective probabilities incorporates individual buyers assessments of market conditions over the forecast horizons. Furthermore, the use of the qualitative questions allows for these market assessments to be recorded.

The approach, by virtue of both it's cross-sectional and time-series nature, allows for a more thorough investigation of possibly reasons 'why', than is offered by the traditional time-series regression approach (see Chapter Three).

8.5 SUMMARY

The objective of this final chapter was to highlight some of the key findings and take note of the limitations of the approach. On the basis of the results outlined in Chapter's Six and Seven, it would appear that uniform aggregate price elasticity estimates can be calculated using this approach. The errors that occurred within each of the woolgroups are more a function of the uncertain environment, than a weakness of the instrument.

The methodology adopted in this study appears to have been sound from both a practical and a theoretical level. There is however, some possibility of improvements by changes in the price ranges, the wooltypes groupings, the quantity measures and the time horizon. The major constraints in the approach are the high cost, the length of time for interviewing and the uncertain nature of the market, which severely impacted upon buying levels.

REFERENCES

REFERENCES

ACIL Agricultural Marketing Regulation: Reality *vs.* Doctrine. Report prepared for the New Zealand Business Roundtable, October, 1992.

Aaker, D.A. & Day, G.S. Marketing Research. Fourth Edition. New York:Wiley & Sons, 1991.

Adams, F.G. Consumer Attitudes, Buying Plans and Purchase of Durable Goods. Review of Economics and Statistics, 1964, 46, 347-355.

Adams, F.G. & Klein, S.A. (Ed.s) Stabilising World Commodity Markets. Lexington:D.C. Heath & Co. Ltd, 1978

Anderson, J.R., Hazell, P.B.R. & Scandizzo, P.L. Considerations in Designing Stabilisation Schemes. American Journal of Agricultural Economics, December, 1977, 59, 908-911.

Angel, C., Beare, S. & Zwart, A.C. Product Characteristics and Arbitrage in the Australian and New Zealand Wool Markets. Australian Journal of Agricultural Economics, 1990, 34(1), April, 67-79.

Arthur D. Little. A Study of the Raw Wool Marketing System for New Zealand Wool. Final Report, May, 1992.

Axelrod, J.N. Attitude Measures that Predict Purchase. Journal of Advertising Research, 1968, 8(1), 3-17.

Bar-Hillel, M. Studies of Representativeness. *In* Kahneman, D., Slovic, P. & Tversky, A. (Ed.s) Judgement Under Uncertainty: Heuristics and Biases. Cambridge: Cambridge University Press, 1982.

Barry, P.J. (Ed.) Risk Management in Agriculture. Ames:Iowa State University Press, 1984

Beare, S. & Meshios, H. Substitution Between Wools of Different Fibre Diameter. Australian Journal of Agricultural Economics, 1990, 34(1), 56-66.

Becker, B.W. & Greenberg, M.G. Probability Estimates by Respondents: Does Weighting Improve Accuracy? Journal of Marketing Research, 1964, 4, August, 482-486.

Begg, D., Fischer, S. & Dornbusch, R. Economics. Second Edition. London:Mc Graw-Hill. 1987

Bessler, D.A. Aggregated Personalistic Beliefs on Yields of Selected Crops Estimated Using ARIMA Processes. American Journal of Agricultural Economics, 1980, 62(4), 666-674.

Bessler, D.A. Subjective Probability. *In* Risk Management in Agriculture. Barry, P.J. (Ed.), Ames:Iowa State University Press. 1984

Betaque, N.E. & Gorry, A. Automating Judgemental Decision-Making For a Serious Medical Problem. Management Science, 1971, B 17 (April), 421-34.

Bilkey, W.J. A Psychological Approach to Consumer Behaviour Analysis. The Journal of Marketing, 1953, 18, 18-25.

Blau, G. Wool in the World Economy. Journal of the Royal Statistical Society III. 1946, CIX. Boyer, R. Thoughts About a Central Marketing for Wool. *In* Barnard, A. (Ed.), The Simple Fleece: Studies in the Australian Wool Industry. Melbourne: Melbourne University Press, 1962.

Boyer, R. Thoughts About a Central Marketing Authority for Wool. *In* Barnard, A (Ed.), The Simple Fleece: Studies in the Australian Wool Industry. Melbourne: Melbourne University Press, 1962.

Brennan, M.J. & Carroll, T.M. Quantitative Economics & Econometrics. Fourth Edition, Cincinnati:South-Western Publishing Co. 1987.

Buckle, R.A., Assendelft, E.W. & Jackson, L.F. Patterns in Accuracy and Bias of Business Expectations for Several Variables: New Zealand Experience, 1964-87. Working Paper No. 88/19, New Zealand Institute of Economic Research, Wellington, New Zealand, 1988.

Buckle, R.A., Assendelft, E.W. & Jackson, L.F. Manufacturers' Expectations of Prices and Quantities: New Zealand Experience, 1964-87. Applied Economics, 1990, 22 (5), May, 579-598.

Bureau of Agricultural Economics. Analysis of Wool Price Fluctuations. Wool Economic Research Report No. 23, Canberra, 1973.

Bureau of Agricultural Economics. Returns from Wool Promotion in the United States. Occasional Paper 100, 1987.

Büyükkurt, B.K. & Büyükkurt, M.D. An Experimental Study of the Effectiveness of Three Debiasing Techniques. Decision Sciences, 1991, 22, 60-73.

Byrnes, J,C, Consumer Intentions to Buy. Journal of Advertising Research. 1964, 4, September, 49-51.

Campbell, K.O. National Commodity Stabilisation Schemes: Some Reflections Based on the Australian Experience. *In* International Explorations in Agricultural Economics. Dixey, R.N. (Ed.), Ames: Iowa State University Press, 1964.

Campbell, K.O. & Fischer, B.S. Agricultural Marketing and Prices. Second Edition, Melbourne: Longman Chesire, 1986.

Campbell, R. Gardiner, B. & Haszler, H. On the Hidden Revenue Effects of Wool Price Stabilisation in Australia: Initial Results. Australian Journal of Agricultural Economics, 1980, 24, 1-15.

Candler, W. & Yap, C.B. An Aggregative Analysis of Problems of Wool Price Stability. April 1968. Report to the New Zealand Wool Board - Wool Commission Wool Marketing Study Group.

Carlson, G.A. A Decision Theoretic Approach to Crop Disease Prediction and Control. American Journal of Agricultural Economics, 1970, 52(2), 216-223.

Cartwright, R.W. Theoretical Aspects of the Relationship Between International Competitive Performance and the Structure of Land Based Industries and Firms. Paper presented to the Australian Agricultural Economics Association (New Zealand Branch) Conference, July, 1993.

Chapman, R. & Foley, K. A Note on Losses from Price Stabilisation. Australian Journal of Agricultural Economics, 1973, 17(2), 140-43.

Chaio, Y.S. Is the Recent Sharp Drop in Fertiliser Usage a Major Concern for Pastoral Production? Paper presented to the New Zealand Agricultural Economics Society, Blenheim, 1987.

Chambers, R.G. On the Design of Agricultural Policy Mechanisms. American Journal of Agricultural Economics, 1992, 74(3), August, 646-654.

Chesley, G.R. Subjective Probability Elicitation Techniques: a performance comparison. Journal of Accounting Research, 1978, 16(2), 225-241.

Churchill, G.A. Jr. Marketing Research: Methodological Foundations. Fifth edition, Chicago: The Dryden Press, 1991.

Clancy, K.J. & Garsen, R. Why Some Scales Predict Better. Journal of Advertising Research, 1970, 10(5), 33-38.

Clawson, C.J. How Useful Are 90-day Purchase Probabilities? Journal of Marketing, 1971, 35, 43-47.

Conway, P. Wool Price and the Value of the New Zealand Dollar. Paper presented to the Australian Agricultural Economics Society Conference, Lincoln College, 7-9 February, 1989.

Dalton, M.E. Short Term Wool Price Movements - a projection model. Quarterly Review of Agricultural Economics, 1974, XXVII, No.4, 195-209.

Dalton, M.E. and Taylor, E.L. Further Developments in a Model Projecting Short-Term Wool Price Movements. Quarterly Review of Agricultural Economics, 1975, XXVIII, No. 4, 209-222.

Day, D. An Examination of the Accuracy of two Versions of the Juster Scale for Predicting Consumer Purchase Behaviour using Self-Completion Questionnaires. Unpublished Research Report, Marketing Department, Massey University, 1987.

Day, D. Gan,B. Gendall, P. & Esslemont, D. Predicting Purchase Behaviour. Marketing Bulletin, 2, 1991.

deFinneti, F. Does it Make Sense to Speak of a 'Good Probability Assessor'? *In* The Scientist Speculates: An Anthology of Partly-Baked Ideas. New York: Basic Books, 1962.

Dobbs, C. An Application of the Delphi Technique and the Juster Scale as a Means of Forecasting Trends in the Advertising Industry. Unpublished Research Report, Marketing Department, Massey University, 1986.

Donald, J., Lowenstein, F. & Simon, M. The Demand for Textile Fibres in the United States. U.S.D.A. Technical Bulletin, No. 1301, 1963.

Dorfman, J.H. & McIntosh, C.S. Results of a Price Forecasting Competition. American Journal of Agricultural Economics, 1990, 71(3), August, 804-808.

Dorfman, J.H. & McIntosh, C.S. Results of a Price Forecasting Competition: Reply. American Journal of Agricultural Economics, 1991, 72(4), November, 1277-1278.

Dornbusch R. & Fischer, S. Macroeconomics. Fourth Edition, New York: McGraw-Hill International, 1987.

Douglas, E.J. Economics of Marketing. New York: Harper & Row, 1975.

Douglas, E.J. Managerial Economics: Analysis and Strategy. Third Edition, New Jersey: Prentice-Hall International, 1987.

Dudley, G.E. U.S. Textile Fiber Demand: price elasticities in major end-use markets. National Economic Analysis Division, Economic Research Service, 1973.

Duloy, J.H. On the Variance Effects of a Buffer-Stock Scheme : A Simulation Study of a Floor Price Plan For Wool. Australian Economic Papers, 1965, 3, June-Dec., 79-91.

Duloy, J.H. & Parish, R.M. An Appraisal of a Floor-Price Scheme for Wool. New England Marketing Studies No. 1, 1964, Faculty of Agricultural Economics, University of New England.

East, R. Changing Consumer Behaviour. London: Cassell Education, 1990.

Emmery, M.K. The Price Elasticity of Demand for Wool in the United Kingdom: An economic study of demand for a factor. Wool Economic Research Report, No. 11, Bureau of Agricultural Economics, Canberra, Australia, 1967.

Evening Post, "Higher Prices After Wool Market Freed" April, 8, 1991.

F.A.O. An Enquiry into the Problems of Agricultural Price Stabilisation and Support Policies. Rome, 1960.

Fead, M. Cost Components of Manufactured Wool Products. Quarterly Review of Agricultural Economics, 1961, Vol. XIV, No. 1.

Ferber, R. & Piskie, R.A. Subjective Probabilities and Buying Intentions. The Review of Economics and Statistics, 1965, August, 322-325.

Ferguson, C.E. & Polasek, M. The Elasticity of Import Demand for Raw Apparel Wool in the United States. Econometrica, 1962, 33(4), 670-699.

Fischhoff, B. Judgemental Aspects of Forecasting. International Journal of Forecasting 1988, 4, 331-339.

Fisher, B. Rational Expectations in the Australian Wool Industry. Australian Journal of Agricultural Economics, 1983, 27(3), December, 212-220.

Foote, R.F. Analytical Tools for Studying Demand and Price Structures. U.S. Department of Agriculture, Agriculture Handbook No. 146, Washington, D.C.:GPO, 1958

Francisco, E.M. Risk, Uncertainty and Pastoralists' Decisions. 1971, Unpublished M.Econ. thesis, University of New England, Armidale.

Francisco, E.M. & Anderson, J.R. Chance and Choice West of the Darling. Australian Journal of Agricultural Economics, 1972, 16(2), 82-93.

Fraser, R.W. On Evaluating the Producer Benefits from Price Stabilisation. 1989. Agricultural Economics Discussion Paper 3/89. School of Agriculture, The University of Western Australia.

Fraser, R.W. Price-Support Effects on EC Producers. Journal of Agricultural Economics, 1991, 42(1), 1-10.

Gabor, A. & Granger, C.W.J. Ownership and Acquisition of Consumer Durables: Report on the Nottingham Consumer Durables Project. European Journal of Marketing, 1972, 6, 234-248.

Gan, B.C., Esslemont, D.H.B. & Gendall, P.J.A. Test on the Accuracy of the Juster Scale as a Predictor of Purchase Behaviour. Market Research Centre Report No. 45, Massey University, New Zealand, 1985.

Gardiner, B. & Haszler, H. On the Hidden Revenue Effects of Wool Price Stabilisation in Australia: Initial Results. Australian Journal of Agricultural Economics, 1980, 24, 1-15.

Gendall, P. Esslemont, D. & Day, D. A Comparison of Two Versions of the Juster Scale. Journal of the Marketing Research Society, 1991, 33(3), 257-263.

Girào, J.A. Tomek, W.G. & Mount, T.D. The Effect of Income Instability on Farmers Consumption and Income. Review of Economics and Statistics, 1972, 14-19.

Gislason, C. How Much Has the Canadian Wheat Board Cost the Canadian Farmers? Journal of Farm Economics, 1959, 41, 584-599.

Good,I.J. Rational Decisions. Journal of the Royal Statistical Society, Series B, 14, 1952, 107-114.

Grant, R.M. & Shaw, G.K. Current Issues in Economic Policy. Second Edition, Oxford: Phillip Allan, 1980.

Grisley, W. & Kellogg, E.D. Farmers' Subjective Probabilities in Northern Thailand: An Elicitation Analysis. American Journal of Agricultural Economics, 1983, 65(1), 74-82.

Grisley, W. & Kellogg, E.D. Farmers Subjective Probabilities in Northern Thailand: Reply. American Journal Of Agricultural Economics, 1985, 67(1), 149-152.

Gruber, A. Purchase Intent and Purchase Probability. Journal of Advertising, 1970, 10:1, 23-27.

Grubel, H.G. Foreign Exchange Earnings and Price Stabilisation Schemes, The American Economic Review, 1964, 54 (4), June, 378-385.

Gruen, F.H. Some Hidden Gains and Losses of a Wool Reserve Scheme. Australian Journal of Agricultural Economics, 1964, 8(2), 181-188.

Haley, R.I. & Case, P.B. Testing Thirteen Attitude Scales for Agreement and Brand Discrimination. Journal of Marketing, 1979, 43, (Fall), 2-32.

Hamilton-Gibbs, D.J. Predicting the Demand for Frequently Purchased Items. Unpublished Research Report, 1989. Department of Marketing, Massey University.

Hampton, J.M. Moore, P.G. & Thomas, H. Subjective Probability and its Measurement. Journal of the Royal Statistical Society A, 1973, 136(1), 21-42.

Harris, J. The Pre-War Demand for Wool - A Further Comment. Economic Record, 1953, XXVIII, 104-106.

Haszler, H. & Curran, B. On the Hidden Revenue Effects of Wool Price Stabilisation in Australia: Initial Results - A Reply. Australian Journal of Agricultural Economics, 1982, 26(1), 66-71

Heald, B.I. The Relationship of Intentions-to-Buy Consumer Durables with Levels of Purchase. British Journal of Marketing, 1970, 4, 87-97.

Hearth, H.M.G., Hardaker, J.B. & Anderson, J.R. Choice of Varieties by Sri Lanka Rice Farmers: Comparing Alternative Decision Models. American Journal of Agricultural Economics, 1982, 64(1), 87-93.

Helmberger, P. & Weaver, R. Welfare Implications of Commodity Storage Under Uncertainty. American Journal of Agricultural Economics, 1977, 59(4), 639-641.

Heuth, D.L. & Just, R.E. Applied General Equilibrium Analysis: Discussion. American Journal of Agricultural Economics, 1991, 72(4), December, 1517-1519.

Hewlett, J.P., Whipple, G.D. & Menkhaus,D.J. The Demand for U.S. Apparel Wool 1936-1985. SID Research Journal, 5(2), 1989, 20-25.

Hildreth, C. What Do We Know About Agricultural Producers' Behaviour Under Price and Yield Instability?. American Journal of Agricultural Economics, December, 1977, 59, 898-902.

Hincey, M. & Simmons, P. An Optimal-Control Approach to Stabilising Australian Wool Prices. Australian Journal of Agricultural Economics, 1983, 27(1), 44-72.

Hincey, M. & Fisher, B.S. Benefits from Price Stabilisation to Producers and Processors: The Australian Buffer-Stock Scheme for Wool. American Journal of Agricultural Economics, 70(3), 1988, 604-615.

Hogarth, R.M. Cognitive Processes and the Assessment of Subjective Probability Distributions. Journal of the American Statistical Association, 1975, 70 (350), 271-289.

Horner, F.B. The Demand Equation for a Raw Material in Empirical Studies. Economic Record, 1949, 25, 85-91.

Horner, F.B. The Pre-War Demand For Wool. Economic Record, 1952a, XXVII, 15-28.

Horner, F.B. Elasticity of Demand for the Exports of a Single Country. Review of Economics and Statistics, 1952b, 34, 326-342.

Howell, L.D. Does the Consumer Gain from Price Instability? Quarterly Journal of Economics, 1945, February, 287-295.

Howell, L.D. The American Textile Industry, U.S.D.A. Agricultural Economic Report, No. 58. 1965

Hueth,D. & Schmitz, A. International Trade in Intermediate and Finished Goods. Quarterly Journal of Economics, 1972, 86(2), 351-365.

Intrilligator, M.D. Econometric Models, Techniques and Applications. Prentice Hall, New Jersey, 1978.

Isherwood, B.C. & Pickering, J.B. Factors Influencing Individual Purchases of Motor Cars in Great Britain. Oxford Bulletin of Economics and Statistics, 1975, 37, 227-249.

Jarret, F.G. & Dent, W. Fibre Substitution - A Markov Process Analysis. Australian Economic Papers, 1966, 3, 107-131.

Jenkins, E.L. An Assessment of Costs and Capital of a Reserve Price Scheme for Australian Wool, Wool Economic Research Report, No. 7, Bureau of Agricultural Economics, Canberra, Australia, December, 1964.

Jensen, F.A. & Peterson, C.R. Psychological Effects of Proper Scoring Rules. Organisational Behaviour & Human Performance, 1973, April (9), 307-317.

Johnson, D.G. Forward Prices for Agriculture. Chicago: University of Chicago Press, 1947.

Johnson, D.G. World Agriculture, Commodity Policy and Price Variability. American Journal of Agricultural Economics, 1975, 57, 823-828.

Johnston, J. Econometric Methods. 1972, Second Edition, Mc Graw-Hill, New York.

Just, R.E. Theoretical and Empirical Possibilities for Determining the Distribution of Welfare Gains from Stabilization. American Journal of Agricultural Economics, 1977, 59, 912-917.

Just, R.E., Lutz, E, Schmitz, A. & Turnovsky, S. The Distribution of Welfare Gains From International Price Stabilisation Under Distortions. American Journal of Agricultural Economics, 1977, 59, 652-661.

Juster, F.T. Consumer Buying Intentions and Purchase Probability. Occasional Paper 99, National Bureau of Economic Research, Colombia University Press, 1966.

Kabus, I. You Can Bank on Uncertainty. Harvard Business Review, 1976, 54(3), 95-105.

Kahneman, D., Slovic, P., & Tversky, A. (Ed.s). Judgement Under Uncertainty: Heuristics and Biases. New York: Cambridge University Press, 1982.

Kahneman, D. & Tversky, A. Subjective Probabilities: A Judgement of Representativeness. *In* Kahnemann, D., Slovic, P. & Tversky, A. (Ed.s). Judgement Under Uncertainty: Heuristics and Biases. New York: Cambridge University Press, 1982.

Kemp, S. & Willetts, K. Remembering the Price of Wool. Working Paper, Department of Psychology, University of Canterbury, 1994.

Keynes, J.M. The Policy of Government Storage of Foodstuffs and Raw Materials. Economic Journal, 1938, 48, Sept., 449-460.

Keynes, J.M. The International Control of Raw Materials. Journal of International Economics, 1974, 4, 299-315.

Kindleberger, C.P. International Economics. Illinois:Irwin, 1958.

Klein, L.R. & Lansing, J.B. Decisions to Purchase Consumer Durable Goods. Journal of Marketing, 1955, XX (2) October, 109-133.

Knight, T., Johnson, S.R. & Finley, R.M. Farmers' Subjective Probabilities in Northern Thailand: Comment. American Journal of Agricultural Economics, 1985, 67(1), 147-148.

Kramer, R.L., d'Arlin, M.Y. & Root, F.R. International Trade: Theory, Policy & Practice. South-Western Publishing Co. Cincinnati, 1959.

Lapp, J.S. & Smith, V.H. Aggregate Sources of Relative Price Variability among Agricultural Commodities. 1992, 74(1), February, 1-9.

Leftwich, R.H. The Price System and Resource Allocation. Fourth Edition, Holt-Saunders International Edition. Illinois:Dryden Press, 1979

Lewis, A.C. A Note on Hidden Gains and Losses of Buffer Stock Schemes for Wool. Australian Journal of Agricultural Economics, 1972, 16, 72-76.

Lewis, A.C. A Comment on the Role of the Wool Board in Supporting the Wool Price. Marketing Bulletin, 1991a, 2, 75-79.

Lewis, A.C. Comments on the Implications of the Recent Withdrawal of The Wool Board from the Wool Market. Internal Memorandum, Department of Marketing, Massey University, 1991b.

Lewis, K.A. Multimarket Demand Functions in the Presence of Supply Constraints: International Demand Functions for Cotton and Wool. Southern Economic Journal, 38(2), 1971, 210-218.

Lewis, J.N. Floor Prices and Wool Promotion: Some Further Hidden Costs? Review of Marketing and Agricultural Economics, 1979, August, 47(2), 131-139.

Lin, W.G. Decisions Under Uncertainty: an empirical application and test of decision theory in agriculture. Unpublished PhD. Dissertation, 1973, University of California, Davis.

Lin, W.G., Dean, G.W. & Moore, C.V. An Empirical Test of Utility *vs.* Profit Maximisation. American Journal of Agricultural Economics, 1974, 56, 487-508.

Little, I.M.D. A Critique of Welfare Economics. London: Oxford University Press, 1957.

Lipsey, R.G. An Introduction to Positive Economics. Fifth Edition. London: Weidenfeld and Nicholson, 1979.

Lovasy, G. Further Comment. Quarterly Journal of Economics, 1945, February, 296-301.

Ludke, R.L., Strauss, F.F. & Gustafson, D.H. Comparison of Five Methods for Estimating Subjective Probability Distributions. Organisational Behaviour & Human Performance, 1977, 19(1), 162-179.

McDaniel, C. & Gates, R. Contemporary Marketing Research. Second Edition, Minneapolis:West Publishing Co. , 1993.

McKenzie, C.J. Quarterly Models of Price Formation in the Raw Wool Market. Unpublished M.Agr.Sci. thesis, Lincoln College, University of Canterbury, 1966.

McKenzie, C.J., Philpott, B.P. & Woods, M.J. Price Formation in the Raw Wool Market. Economic Record, 1969, September, 386-399.

McKinley, P. Going International: The Role of the Producer Boards. Paper presented to the Agribusiness Seminar, Centre for Agricultural Policy Studies, Massey University, Wellington, December, 1987.

McNicol, D.L. (Ed.) Commodity Agreements and Price Stabilisation. 1977. Lexington:D.C. Heath & Co. Ltd.

Machina, M.J. & Schmeidler, D. A More Robust Definition of Subjective Probability. Econometrica. 1992, 60(4), July, 745-780.

Mansfield, E. Microeconomics: Theory & Applications. Fifth Edition. New York: W.W. Norton & Co. Ltd., 1985.

Marshall, A. Principles of Economics. Nineth Edition, Book V. London: Macmillan and Co. Ltd. 1961.

Massell, B.F. Price Stabilisation and Welfare. Quarterly Journal of Economics, 1969, 83(2), 284-298.

Miller, E. The Perceived Career-Related Education Needs of Agribusiness Employees in New Zealand. Unpublished Research Paper, Marketing Department, Massey University, 1985.

Mishan, E.J. Cost-Benefit Analysis: An Informal Introduction. London: George, Allen & Unwin Ltd. 1972.

Moir, B. & Piggott, R. Combinations of Buffer-Stocks and Buffer-Funds for Wool Price Stabilisation in Australia. Australian Journal of Agricultural Economics, 1991, 35(1), April, 77-89.

Morrison, D.G. Purchase Intentions and Purchase Behaviour. Journal of Marketing, 1979, 43 Spring, 65-74.

Morwitz, V.G., Johnson, E & Schmittlein, D. Does Measuring Intent Change Behaviour? Journal of Consumer Research, 1977, 20, June, 46-61.

Moskowitz, H & Bullers, W.I. Modified PERT versus Fractile Assessment of Subjective Probability Distributions. Organizational Behaviour and Human Performance, 1979, 24(2), 167-194.

Mullen J.D. Alston J.M. & Wohlgenant, M.K. Demand Parameters in the Wool Processing Industry. Paper to the 33rd Annual Conference of the Australian Agricultural Economics Society, Lincoln College, 1989.

Murray, J.A. Canadian Consumer Expectational Data: An Evaluation. Journal of Marketing Research, 1969, VI February, 54-61.

Murphy, A.H. & Winkler, R.L. Scoring Rules: Probability Assessment & Evaluation. Acta Psychologica, 1970, December (34), 273-280.

Musser, W.N. & Musser, L.M. Psychological Perspectives on Risk Analysis. *In* Risk Management in Agriculture. Barry, P.J. (Ed.), Iowa State University Press, Ames: Iowa, 1984.

Muth, J.F. Rational Expectations and the Theory of Price Movements. Econometrica, 1961, 29(3), 315-335.

Myers, R.J., Piggott, R.R. & Tomek, W.G. Estimating Sources of Fluctuations in the Australian Wool Market: An Application of VAR Methods. Australian Journal of Agricultural Economics, 1990, 34(3), Dec., 342-362.

Nelson, A. 1980, As quoted by Musser, W.N. & Musser, L.M. *In* Risk Management in Agriculture. Barry, P.J. (Ed.), Iowa State University Press, Ames:Iowa, 1984.

Nelson, A.G. & Harris, T.D. Designing an Instructional Package: the use of probabilities in farm decision making. American Journal of Agricultural Economics, 1978, 60(5), 933-997.

Neter, J. Measurement Errors in Reports of Consumer Expenditures. Journal of Marketing Research, 1970, VII (February), 11-25.

Newbery, D.M.G. & Stiglitz, J.E. The Theory of Commodity Price Stabilisation: A Study in the Economics of Risk. New York:Oxford University Press, 1981.

New Zealand Council of Wool Exporters. *pers. comm.*, 1991.

New Zealand Wool Board, Important Information on the 1990/91 Minimum Prices from the NZWB, July, 1990.

New Zealand Wool Board, Annual Report, Wellington, 1991-92.

New Zealand Wool Board, Annual Report, Wellington, 1992-93

New Zealand Wool Board, Statistical Handbook, 1989-90, Wellington, 1990.

New Zealand Wool Board, Statistical Handbook, 1990-91, Wellington, 1991.

New Zealand Wool Board, Statistical Handbook, 1991-92, Wellington, 1992.

New Zealand Wool Board, Statistical Handbook, 1992-93, Wellington, 1993.

New Zealand Wool Board, Weekly Wool Market Review, 1991-93, Wellington.

New Zealand Wool Board, *pers. comm.* 1993.

Norris, P.E. & Kramer, R.A., The Elicitation of Subjective Probabilities with Applications in Agricultural Economics. Review of Marketing and Agricultural Economics, 1990, 58 (2, 3), August, 127-147.

Nurkse, R. Trade Fluctuations and Buffer Policies of Low-Income Countries. Kyklos, 1958, 11, 141-154.

Officer, R.R. & Halter, A.N. Utility Analysis in a Practical Setting. American Journal of Agricultural Economics, 1968, 50, 257-277.

Oi, W.Y. The Desirability of Price Instability Under Perfect Competition. Econometrica, 1961, 29, 56-64.

Oi, W.Y. Rejoinder. Econometrica, 1963, 31(1-2), 248.

Pappas, J.L. & Hirschey, M. Managerial Economics. Fifth Edition, Chicago: Dryden Press International, 1987.

Parish,R.M. Revenue Implications of a Buffer-Stock Scheme: Comment. The Economic Record, 1964, September, 465-467.

Peter, J.P. Reliability: A Review of Psychomatic Basics and Recent Marketing. Journal of Marketing Research, 1979, 16 (February), 6-17.

Philpott, B.P. Wool Prices 1870-1950. Unpublished PhD. thesis, Department of Economics, University of Leeds, 1953.

Philpott, B.P. Fluctuations in Wool Prices, 1870-1953. Yorkshire Bulletin of Economic and Social Research, 7, March 1955, 1-28.

Philpott, B.P. Wool in the New Zealand Economy. Economic Record, 1957, XXXIII, 216-233.

Philpott, B.P. Economic Implications of Increased Wool Production. Agricultural Economics Research Unit Publication No. 8, Lincoln College, 1965a.

Philpott, B.P. Fluctuations in Wool Prices 1870-1963. Agricultural Economics Research Unit Publication No. 13, Lincoln College, 1965b.

Philpott, B.P. The Contribution to Stabilisation by the New Zealand Wool Commission and Lessons for the Present. New Zealand Economic Papers, 1975, 9, 33-57.

Pickering, J.F. Verbal Explanations of Consumer Durable Purchase Decisions. Journal of the Market Research Society, 1975, 17(2), 107-113.

Pickering, J.F. & Greatorex, M. Evaluations of Individual Consumer Durables: Differences between Owners & Non-Owners and Buyers & Non-Buyers. Journal of the Market Research Society, 1980, 22(2), 97-141.

Pickering, J.F. & Isherwood, B.C. Purchase Probabilities and Consumer Durable Buying Behaviour. Journal of the Market Research Society, 1974, 16:3, 203-226.

Pindyck R.S. & Rubinfeld, D.L. Econometric Models and Economic Forecasts. Second Edition, McGraw-Hill International, 1981.

Polasek, M. & Powell, A. Wool versus Synthetics: An International Review of Innovation in the Fibre Market. Australian Economic Papers, 1964, June-Dec. 49-65.

Porter, R.S. Buffer Stocks and Economic Stability. Oxford Economic Papers,1950, 2, January, 95-118.

Powell, A. Export Receipts and Expansion in the Wool Industry. The Australian Journal of Agricultural Economics, 1959, 3(2), December, 67-74.

Powell, A. and Campbell, K.O. Revenue Implications of a Buffer-Stock Scheme with an Uncertain Demand Schedule. Economic Record, 1962, 38(83), September, 373-385.

Powell, A., Polasek, M. & Burley, H.T. Synthetic Fibres in the Wool Textile Industry. Australian Journal of Agricultural Economics, 1963, December, 107-120.

Powell, A. & Campbell, K.O. Revenue Implications of a Buffer-Stock Scheme: A Further Comment. Economic Record, 1964, 40, December, 596-597.

Ptacek, C.H. & Ross, I. Propensity to Buy Ratings. Journal of Advertising Research, 1979, 19(6), 43-47.

Quiggin, J. & Fisher, B. Generalised Utility Theories: Implications for Stabilisation Policy. Paper Presented to the 33rd Annual Conference of the Australian Agricultural Economics Society, Lincoln College, 7-9 February, 1989.

Ravinder, H.V. Bias in Aggregations of Subjective Probability and Utility. Journal of the Operational Research Society, 1992, 43 (6), 621-627.

Reserve Bank of New Zealand. Monetary Policy and the New Zealand Financial System. Deane, R.S. & Nicholl, P.W.E (Eds.), Wellington: Reserve Bank of New Zealand, 1979.

Reutlinger, S. A Simulation Model for Evaluating Worldwide Buffer Stocks of Wheat. American Journal of Agricultural Economics, 1976, 58, 1-12.

Richardson, B. On the Hidden Revenue Effects of Wool Price Stabilisation in Australia: Initial Results - A Comment. Australian Journal of Agricultural Economics, 1982, 26, 63-65.

Riefler, W.W. A Proposal for an International Buffer-Stock Agency. Journal of Political Economy, 1946, 48, December, 538-546.

Ritson, C. Agricultural Economics: Principles and Policy. Student Edition, London: Granada, 1977.

Roshwalb, I. A Consideration of Probability Estimates Provided by Respondents. Journal of Marketing Research, 1975, XII, February, 100-103.

Ross, B.J. Fluctuating Export Prices and Economic Instability: Problems and Policies in New Zealand. Journal of Agricultural Economics, 1976, XXVII(i), 77-95.

Rural News, Wool Board pays more than $11 million in annual store fees. April 19, 1993.

Salant, S.W. The Vulnerability of Price Stabilization Schemes to Speculative Attack. Journal of Political Economy, 1983, 91(1), 1-38.

Samuelson, P., Hancock, K. & Wallace, R. Economics. Second Edition, Sydney: McGraw-Hill, 1975.

Sandrey, R. & Reynolds, R. (Ed.s) Farming without Subsidies: New Zealand's Recent Experience. Wellington: MAF-Government Print, 1990.

Sanford, S. Factors Influencing Total Fiber Consumption and Domestic Mill Demand for Cotton and Wool. Cotton and Wool Situation, U.S.D.A. March 15, 1988, 24-28.

Sarris, A.H. & Taylor, L. Cereal Stocks, Food Aid and Food Security for the Poor. World Development, 1976, 4(12) 967-976.

Sarris, A.H. & Taylor, L. Buffer-Stock Analysis for Agricultural Products: Theoretical Murk or Empirical Resolution? *In* Adams F.G & Klein, S.A. (Ed.s) Stabilising World Commodity Markets Lexington:D.C. Heath & Co., 1978.

Sawyer, A.G. Worthing, P.M. & Sendak, P.E. The Role of Laboratory Experiments to Test Marketing Strategies. Journal of Marketing, 1979, 43, Summer, 60-67.

Scandizzo, P.L., Hazell, P.B.R. & Anderson, J.R. Producers' Price Expectations and the Size of the Welfare Gains from Price Stabilisation. Review of Marketing and Agricultural Economics, 1983, 51(2), August. 93-107.

Schlaifer, R. Analysis of Decisions Under Uncertainty. New York: Mc Graw-Hill, 1969

Scobie, G. The Price Elasticity of Demand for New Zealand Exports: theory and estimation. New Zealand Economic Papers, 7,1973, 1-24.

Seaver, D.A., von Winterfeldt, D. & Edwards, W. Eliciting Subjective Probability Distributions on Continuous Variables. Organizational Behaviour and Human Performance. 1978, 21(3), 379-391.

Shapiro, E. Macro-Economic Analysis. Fourth Edition, New York: Harcourt Brace Jovanovich, 1978.

Simmons, P. A Theoretical Discussion of the Economic Effects of Buffer Stocks and Buffer Funds. 31st Annual Conference of the Australian Agricultural Economics Society, University of Adelaide, 10-12 February, 1987.

Simmons, P. A Theoretical Discussion of the Economic Effects of Buffer Stocks and Buffer Funds. Australian Journal of Agricultural Economics, 1988, 129-143.

Smallhorn, P.J. Demand Elasticities for Raw Wool in Japan. Quarterly Review of Agricultural Economics, 26(4), 1973, 253-262.

Södersten, B. International Economics. Second Edition, London:MacMillan, 1980.

Spetzler, C.S. & Stael von Holstein, C.A.S. Probability Encoding in Decision Analysis. Management Science, 1975, 22(3), 340-358.

Sri Ramaratnam, S. Texas Coastal Bend Grain Sorghum Producers' Fertilizer Decisions Under Uncertainty., Ph.D. Dissertation, Texas A & M University, College Station, 1985.

Sri Ramaratnam, S. *pers. comm.* 1992.

Stein, J.P. & Smith, R.T. The Economics of United States Grain Stockpiling. Report for Council International. Economic Policy, no. R-1861-CIEP, RAND Corp., March, 1977.

Sturgess, I.M. The Wool Board's Second Report on Marketing: A Review Article. Australian Journal of Agricultural Economics, 1968, December, 16-33.

Stael von Helstein, C.A.S. Assessment and Evaluation of Subjective Probability Distributions. The Economic Research Institute at the Stockholm School of Economics, Stockholm, 1972.

Stapel, J. Predictive Attitudes, *In* Attitude Research on the Rocks. Adler, L & Crespi, I (Eds.) American Marketing Association, 96-115, 1968.

Stone, R. The Analysis of Market Demand. Journal of the Royal Statistical Society, 1945, parts III-IV, 148, 287-391.

Subotnik, A. & Houck, J.P. Welfare Implications of Stabilising Consumption and Production. American Journal of Agricultural Economics, 1976, 58(1), 13-20.

Swinnen, J. & van der Zee, F.A. The Political Economy of Agricultural Policies: a survey. European Review of Agricultural Economics, 1993, 20, 261-290.

Tegene, A. Results of a Price Forecasting Competition: Comment. American Journal of Agricultural Economics, 1991, 72(4), November, 1274-1276.

Theil. H. Economic Forecasts and Policy. Amsterdam: North-Holland, 1958.

Theil, H. Economics and Information Theory. Amsterdam: North-Holland, 1967.

Theil, H. & Kosobud, R.F. How Informative Are Consumer Buying Intentions Surveys? Review of Economics and Statistics, 1968, 50, 50-59.

Thurmann, W.N. Applied General Equilibrium Welfare Analysis. American Journal of Agricultural Economics, 1991, 72(4), December, 1504-1516.

Tier, T.J. & Kidman, P.R. Price Movements in Between the Wool, Wool tops and Worsted Yarn Spot and Futures Markets. Quarterly Review of Agricultural Economics, 1971, XXIV (2), 63-81.

Tisdell, C. Uncertainty, Instability, Expected Profit. Econometrica, 1963, 31(1-2), 243-247.

Tisdell, C. Some Circumstances in Which Price Stabilization by the Wool Commission Reduces Incomes. Australian Journal of Agricultural Economics, 1972, 16(2), 94-101.

Tisdell, C. A Comment on Losses From Stabilisation. Australian Journal of Agricultural Economics, 1973, 17(2), 144-151.

Tobin, J. On the Predictive Value of Consumer Intentions and Attitudes. Review of Economics and Statistics, 1959, XLI (1), February, 1-27.

Tomek, W.G. Stability for Primary Products: Means to What Ends? Cornell University Department of Agricultural Economics, USAID Prices Research Project. Occasional Paper No. 28, September, 1969.

Tomek W.G. & Robinson, K.L. Agricultural Product Prices. 2nd Edition. Ithaca: Cornell University Press, 1981.

Townsend, R.M. The Eventual Failure of Price Fixing Schemes. Journal of Economic Theory, 1977, 14, 190-199.

The New Zealand Treasury, Economic Management. Wellington, 1984.

Turnovsky, S.J. Price Expectations and the Welfare Gains from Price Stabilisation. American Journal of Agricultural Economics, 1974, 56(4), 706-716.

Turnovsky, S.J. The Distribution of Welfare Gains from Price Stabilization: The Case of Multiplicative Disturbances. International Economic Review, 1976, 17(1), February, 133-148.

Turnovsky, S.J. The Distribution of Welfare Gains from Price Stabilisation: a survey of some theoretical issues. *In* Adams, F.G. & Klein, S.A. (Eds.), Stabilizing World Commodity Markets. Toronto:Lexington, 1978.

Tversky, A. & Kahneman, D. Belief in the Law of Small Numbers. Psychological Bulletin, 1971, 76(2), 105-110.

Tversky, A. & Kahneman, D. A Heuristic for Judging Frequency and Probability. Cognitive Psychology, 1973, 5, 207-232.

Tversky, A. & Kahneman, D. Judgement under Uncertainty: Heuristics and Biases. Science, 1974, 185, 1124-1131.

Tversky, A. & Kahneman, D. Judgements of and by Representativeness. *In* Kahneman, D. Slovic, P. & Tversky, A. (Ed.s). Judgement under Uncertainty: Heuristics and Biases. New York:Cambridge University Press, 1982.

U, C. Predicting the Demand for Branded Food Products Using The Juster Scale - An Experiment. Department of Marketing, Massey University, 1991.

USDA. Cotton and Wool Situation. Economic Research Service, March 15, 1988.

Veeman, M. Marketing Boards in New Zealand: An Economic Analysis and Appraisal. Unpublished PhD. thesis, University of Berkeley, 1972.

Ward, L.F. An Evaluation of the Reserve Price Scheme for Wool. Paper presented to the Victorian Branch of the Australian Agricultural Economics Society, Melbourne, 1978.

Wallstein, T.S. & Budescu, D.V. Encoding Subjective Probabilities: A Psychological and Psychomatic Review. Management Science, 1983, 29(2), 151-173.

Watson, A.S,. Wool in 1980. Australian Journal of Agricultural Economics, 1980, 24, August, 79-93.

Watson, A.S. Unravelling Intervention in the Wool Industry. The Centre for Independent Studies. 1990.

Waugh, F. Does the Consumer Benefit from Price Instability? Quarterly Journal of Economics, 1944, 58, August, 602-614.

Waugh, F. Consumer Aspects of Price Instability. Econometrica, 1966, 34, 504-508.

Wegge, L.L., Sosnick, S.H., & George, P.S. The Effect of Price Stabilization on Consumers' Welfare. Western Economic Journal, 1971, 9, 289-298.

Wheelwright, S. & Makridakis, F. Forecasts Based on Subjective Estimates. *In* Forecasting Methods for Management. Second Edition, New York:Wiley, 1977.

Winkler, R.L. The Assessment of Prior Distributions in Bayesian Analysis. Journal of the American Statistical Association, 1967a, 62, 776-800.

Winkler, R.L. Quantification of Judgement: Some Methodological Suggestions. Journal of the American Statistical Association, 1967b, 62, December, 1105-1120.

Winkler, R.L. & Murphy, A.H. Good Probability Assessors. Journal of Applied Meteorology, 1968, 7 (5), 751-758.

Winter, F.W. Laboratory Measurement of Responses to Consumer Information. Journal of Marketing Research, 1975, XII, November, 390-401.

Woods, N.R. The Role of Producer Boards. Economic Development Commission, Wellington, 1988.

Wool Marketing Group Study. Final Report. Prepared for the New Zealand Wool Board and New Zealand Wool Commission, November, 1967

Wonnacott, R.J. & Wonnacott, T.H. Econometrics. Second Edition, New York: Wiley, 1979.

Worcester, R.M. & Burns, T.R. A Statistical Examination of the Relative Precision of Verbal Scales. Journal of the Market Research Society, 17, July, 1975. 181-197.

Working, E.J. What Do Statistical Demand Curves Show? Quarterly Journal of Economics, 41, 1927, 212-235.

Wright, B.D. The Effects of Ideal Production Stabilization: A Welfare Analysis Under Rational Behaviour. Journal of Political Economy, 1979, 87(5), 1011-1033.

Wright, B.D. & Williams, J.C. The Welfare Effects of the Introduction of Storage. The Quarterly Journal of Economics, 1984, 99(1), 169-182.

Young, D.L. A Practical Procedure for Eliciting Subjective Probability Distributions. Paper Presented For Annual American Economics Association Meeting, 1983.

Young, A. An Examination of the Accuracy of the Juster Scale for Predicting the Proportion of New Product Purchasers. Unpublished Research Report, Marketing Department, Massey University, 1990.

Zentler, A.P. The Pre-War Demand for Wool : A Comment. Economic Record, 1953, XXVIII, 101-103.

Zikmund, W.G. Exploring Market Research. Fourth Edition, Chicago:Dryden Press, 1991.

Zwart, A.C. Controlling Exports: The Role of Marketing Boards. Paper presented at the Conference of the New Zealand Branch of the Australian Agricultural Economics Society, Blenheim, 1988.

Zucker, A. On the Desirability of Price Instability. Econometrica, 1965, 33(2), 437-441.