THE WORLD SHEEPMEAT MARKET:

AN ECONOMETRIC MODEL

by

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## CONTENTS

| LIST OF TABLES                  | (iii) |
| LIST OF FIGURES                | (iii) |
| PREFACE                        | (v)  |
| ACKNOWLEDGEMENTS               | (vii) |
| SUMMARY                        | (ix)  |
| **CHAPTER**                   |       |
| 1. THE WORLD SHEEPMEAT MARKET  |       |
| 1.1 Introduction               | 1     |
| 1.2 The World Sheepmeat Market | 2     |
| 1.3 The Need for a Model       | 6     |
| 1.4 Organisation of the Report | 7     |
| 2. THE THEORETICAL MODEL       |       |
| 2.1 The General Structure      | 9     |
| 2.2 Deriving an Estimating Form from the Theoretical Model | 11 |
| 2.2.1 Commodity Specification  | 11 |
| 2.2.2 Temporal Aggregation     | 13 |
| 2.2.3 Regional Coverage        | 16 |
| 2.2.4 International Price Linkages | 16 |
| 2.2.5 Derived Demand and Supply Relationships | 17 |
| 2.3 Prices in the Model        | 20 |
| 2.4 Specification of the Supply Equations | 21 |
| 2.4.1 Theoretical Considerations | 21 |
| 2.4.2 Implications of the Reduced Form Functions | 23 |
| 2.4.3 The Data                 | 25 |
| 2.4.4 The Estimating Form      | 27 |
| 2.5 Specification of the Demand Equations | 27 |
| 2.5.1 Theoretical Considerations | 27 |
| 2.5.2 Discussion of Variables  | 30 |
| 2.5.3 The Derived Demand Functions | 32 |
| 2.6 Trade in the Model         | 32 |
| 2.7 The Estimating Form        | 32 |
| 2.8 Method of Estimation       | 34 |
LIST OF TABLES

TABLE
1. Main Features of the World Sheepmeat Market in 1980 4
2. Estimates of Price Transmission Elasticities 18
3. Supply Responses in the Model 52
4. Demand Responses in the Model 53
5. Projections of Sheepmeat Production, Consumption and Trade to 1985 and 1990 63
6. Comparison of EEC Trade Barriers 69
7. Simulation of an Increase in Supply from NZ 75
8. Simulation of Cessation of Trade With Iran 78
9. Summary of Other Studies of Sheepmeat Demand and Supply 109
10. Summary of Goodness-of-Fit Statistics for Each Endogenous Variable 1960-80; Dynamic Simulation 119

LIST OF FIGURES

FIGURE
1. Major Sheepmeat Trade Flows: 1960 3
3. World Sheepmeat Price Trends 5
5. Australian Wholesale Price for Mutton and Lamb 14
6. NZ Schedule Price for Mutton and Lamb 15
7. Actual and Predicted Values of World Trade 60
8. Actual and Predicted Values of UK Imports 60
9. Actual and Predicted Values of NZ Exports 61
10. Actual and Predicted Values of World Sheepmeat Prices 61

(iii)
Sheepmeat accounted for 55.5 per cent of New Zealand meat exports in 1982 and 13.6 per cent of total exports by value in the same year. Considerable geographical diversification of export markets has occurred away from the United Kingdom in recent years. Events in the world sheepmeat market are now more complex than when the United Kingdom was practically the sole market for New Zealand sheepmeat. In addition, increasing uncertainties associated with access to traditional markets, and instability of sheepmeat imports by new markets, add to this complexity.

It is appropriate therefore that attempts are made in New Zealand to understand the implications for New Zealand policies of events that affect the world sheepmeat market. One way of gaining such insight is by the construction of a mathematical model of the market. An attempt to do just this has been made by the author of the present Report.

Nicola Blyth has been employed as a graduate fellow in the Unit for the past three years. The project was undertaken while the author was studying for a doctorate degree in the Department of Agricultural Economics and Marketing at the College under the supervision of senior lecturer, Dr. A.C. Zwart. This Research Report provides an abridged version of the thesis work.

Some financial support was given to this project in its third year by the Ministry of Agriculture and Fisheries. This assistance is gratefully acknowledged by the Unit.

P.D. Chudleigh
Director
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Personal support and encouragement from Professor J.B. Dent, Professor B.J. Ross and Dr P.D. Chudleigh is also gratefully acknowledged.
SUMMARY

This paper reports the development of an econometric model of the world sheepmeat market.

Sheepmeats are only of minor importance in the world meat trade, but New Zealand plays a major role within this market. Since the 1960's the pattern of trade has changed markedly, with a decline in the main importing market, the UK, and a diversification of exports to several new markets such as Japan, North America and the Middle East.

A dynamic, non-spatial price equilibrium model was constructed in order to quantify factors causing these changes and to determine the structural relationships in the new markets. By having global coverage, account can be taken of the interactions among the markets and world prices.

At the same time the model provides a simulation instrument which is used for predicting the level of trade and prices through the 1980's. The effects of various policies and market changes are assessed against a Base simulation. Three specific aspects were considered: (i) the effect of the closure of the Middle East market; (ii) an increase of 10% in N.Z.'s sheepmeat production, and (iii) the effects of various types of trade barriers which could be imposed by the EEC, such as 0%, 10% or 20% Ad Valorem tariffs; Variable Levies, restrictive Voluntary Restraint Agreements (VRA's) or quotas.

Conclusions are drawn about the sheepmeat market for countries such as New Zealand.
CHAPTER 1

THE WORLD SHEEPMEAT MARKET

1.1 Introduction

The availability of quantitative analyses of the determinants of demand, supply and price in the world sheepmeat market are quite limited. There is little understanding, moreover, of the relationships between the various markets, and the producers and consumers in each market on a global scale. In order to resolve some of the issues currently facing the New Zealand industry, a better understanding is desirable.

That there are few previous studies of this commodity market, especially at the international level, is perhaps because of the past stability and relative unimportance of the trade, and its limitation to a handful of countries. Previous work has been descriptive (e.g. Brabyn, 1978; NZMPB, 1978; Regan, 1980) or has been devoted to sheepmeat supply or demand in a single market (e.g. Edwards, 1970; Kelly, 1978; Sheppard, 1980) or to trade of all meat (Regier, 1978), of which sheepmeat forms only a small part.

Little quantitative analysis of any market has been carried out, except the UK, and there has been no analysis of the determination of world sheepmeat prices. The EMABA model (Reynolds, 1981) goes some way to rectifying this, by incorporating export demand sub-models of three regions into a national sheep industry model. But, as in other studies, the world price is treated as exogenous.

This study presents a non-spatial, price equilibrium model in which prices are endogenised. The model gives some understanding of the structure and parameters of the behavioural relationships underlying the international market. The study analyses and quantifies the determinants of production, consumption and trade in sheepmeat. It is intended to give a wider appreciation of why the market has developed in the way it has, and how the various market forces might be expected to affect the course of future developments. At the same time the model provides a simulation instrument which is used for analyzing market properties, for forecasting and for assessing various policies. Several hypotheses are tested regarding possible structural and policy changes, and their effects on the market evaluated.

However, since this is a first generation model of the entire market, more emphasis is placed on determining the mechanisms of trade, than on making policy recommendations for trading countries. But whilst the study maintains an international impartiality, it does provide the basis on which an effective export policy for NZ's trade in sheepmeat could be framed. The model is highly aggregated, and cannot, of course, yield a detailed picture, but it does capture the essentials of the mechanisms of the sheepmeat market. With the aim of providing coverage
of these mechanisms, it was intended to explore whether a relatively simple model could explain the changes which have taken place recently in the market.

A brief description of the market in Section 1.2 gives the background for the model developed in subsequent chapters. A more detailed review of the market can be found in Hlyth (1981).

1.2 The World Sheepmeat Market

There are a number of aspects of international trade in sheepmeat that make it an interesting subject for analysis.

Sheep are kept in most temperate regions of the world, but the largest excess production is in the Southern hemisphere, whilst the main excess demand is in the Northern hemisphere. Around 12% of world production enters trade, being shipped from the south to the north. Since the late 1880's when the first shipments were made, traditional patterns of trade developed, with the market being dominated by exports from NZ to the UK (accounting for 75% of world sheepmeat trade in 1962). Other traders were Australia and Argentina on the export side, and Japan and North America on the import side, but on a small scale. (Figure 1).

Since the 1960's trade patterns have changed considerably, with Australia and NZ still dominating exports, but with new import markets being developed in place of the UK. The latter is still the world's largest importer though other EEC countries (including Greece), Japan, Canada, the USA, the USSR, and more recently, the Middle East countries have expanded imports rapidly (Figure 2). The current features of the main importing and exporting markets are summarised in Table 1.

The diversification of markets was partly a conscious policy by exporters to reduce their reliance on the British market. They foresaw that the market would decline, and would be detrimentally affected initially by EEC membership and later by the introduction of a common sheepmeat regime with excess supply causing falling prices. It was also a response to market forces brought about by increasingly affluent societies in certain regions, who had a preference for eating sheepmeat, or needed a cheap, plentiful source of protein.

As a consequence, trade became less concentrated, though the British market continues to exert a strong influence on world sheepmeat prices, and international prices follow closely those determined at Smithfield (the UK wholesale market).
FIGURE 1
Major Sheepmeat Trade Flows: 1960

FIGURE 2
Major Sheepmeat Trade Flows: 1980
Table 1
Main Features of the World Sheepmeat Market in 1980 (Kt)

<table>
<thead>
<tr>
<th>Net Importers</th>
<th>Production</th>
<th>Consumption</th>
<th>Imports</th>
</tr>
</thead>
<tbody>
<tr>
<td>USSR</td>
<td>844</td>
<td>1,004</td>
<td>160</td>
</tr>
<tr>
<td>EEC (9)</td>
<td>628</td>
<td>842</td>
<td>293</td>
</tr>
<tr>
<td>Iran</td>
<td>350(^a)</td>
<td>415(^a)</td>
<td>65(^a)</td>
</tr>
<tr>
<td>Japan</td>
<td>0</td>
<td>176</td>
<td>170</td>
</tr>
<tr>
<td>USA</td>
<td>144</td>
<td>159</td>
<td>15</td>
</tr>
<tr>
<td>Western Europe (non EEC)</td>
<td>311</td>
<td>330</td>
<td>18</td>
</tr>
<tr>
<td>Asia (other)</td>
<td>1,057</td>
<td>665</td>
<td>0</td>
</tr>
<tr>
<td>Africa</td>
<td>222</td>
<td>223</td>
<td>1</td>
</tr>
<tr>
<td>Other</td>
<td>-</td>
<td>-</td>
<td>144</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Net Exporters</th>
<th>Exports</th>
</tr>
</thead>
<tbody>
<tr>
<td>New Zealand</td>
<td>450</td>
</tr>
<tr>
<td>Australia</td>
<td>247</td>
</tr>
<tr>
<td>Argentina</td>
<td>18</td>
</tr>
<tr>
<td>Eastern Europe</td>
<td>27</td>
</tr>
<tr>
<td>Other</td>
<td>124</td>
</tr>
<tr>
<td>World</td>
<td>866(^a)</td>
</tr>
</tbody>
</table>

\(^a\) Preliminary Source: USDA, 1981
During the 1970's, sheepmeat prices quadrupled, from around $500/tonne, to $2,606/tonne in 1980. However, in real terms prices have changed very little (Figure 3), and have shown far more stability than most primary commodities (OECD, 1979).

**FIGURE 3**

*World Sheepmeat Price Trends*

US$/Tonne

<table>
<thead>
<tr>
<th>Year</th>
<th>Nominal</th>
<th>Real</th>
</tr>
</thead>
<tbody>
<tr>
<td>1960</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1965</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1970</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1975</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1980</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year</th>
<th>Nominal</th>
<th>Real</th>
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<tr>
<td>1960</td>
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<td>1970</td>
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<td></td>
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<tr>
<td>1975</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1980</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Corresponding to the dramatic changes in direction and value of trade, has been a large growth in the volume entering the world market. Apart from an abrupt fall in trade in 1973-74 (associated with the increase in many commodity prices following the 'oil shock', and the general world food crisis), quantities exported expanded overall some 75% between 1960 and 1980. Total world trade amounted to 866Kt (866,000 tonnes) in 1980, which was around 18% of production in the main trading countries.

Government influence or participation in sheepmeat production and marketing occurs to varying degrees in the regions involved, but to a far lesser extent than in other commodity markets (NZMPB, 1978). The main interventions are bilateral deals and Government purchasing (as in Iran and the USSR); production subsidies and export incentives in certain exporting regions, and, since 1980, the EEC common sheepmeat regime. Thus the market has relatively few direct forms of price protection but an increasing number of non-tariff barriers (the competitive nature of market prices is discussed in Section 2.2.4).

The market tends to be relatively stable (OECD 1979), though it is becoming less so, with the irregular entrances of Japan, Iran and the USSR. At no time has a world price-stabilization scheme been necessary, such as the International Commodity Agreements for coffee, tea, cocoa and tin. Nor do stocks play a major role, as in these other markets, apart from short-term stocks (weekly or monthly) resulting from events such as dock-strikes and excess shipments.

The market is therefore an appropriate one for the application of a competitive equilibrium modelling approach.

1.3 The Need for a Model

NZ has an increasing excess supply and a high degree of dependence on exports. Generally there has been no 'global strategy' for marketing NZ exports, though recently there has been increasing discussion of the need for one (Gullwick, 1980; NZMPB, 1980) because of changes taking place in the market. For instance, NZ's major market (the UK) is a declining market, but the EEC and other countries are putting up more trade barriers, in order to raise self-sufficiency levels. This, and increased contractual purchasing, reduce the size of the 'free market' where NZ can market its increasing excess supply. Excess supply from other exporters is also increasing, which poses greater competition for existing exporters, as does the competition from lower priced pork and poultry meat.

New markets are developing, but there has been little assessment of them, or of the potential which exists for further development. There is increasing dependence on one of these new markets, the Middle East, because of its fortuitous expansion at a time of difficulties in the rest of the international market. The Middle East is an extremely fragile market however, and despite its high demand for sheepmeat, it may not therefore be reliable as a long term importer.
Because of these issues currently facing the industry, and the importance of the sheepmeat trade to NZ, it was felt that there was a need for a detailed study of the whole market.

The objectives which this study attempts to achieve are;

- to describe how the market behaves, and to determine why it has changed over the past 20 years,

- to determine the linkages in the market, and the international market clearing mechanism,

- to determine and analyse the response parameters in both import and export markets which have not previously been considered,

- to provide a forecasting tool which can be used to assess the outlook for sheepmeat in the international market over the next ten years, and

- to provide a framework within which the impact of various alternative combinations of assumptions can be evaluated. Specifically, the effects of changes in three areas are analysed. The first involves increasing NZ's excess supply to a higher level than it would otherwise be; the second involves a disturbance in the Middle East which has the effect of closing the Iranian market to sheepmeat imports entirely. The third area of change considered is the level and type of protection in the EEC; the international ramifications are measured of the imposition of either higher Ad Valorem Tariffs, Variable Levies, import quotas, or negotiation of restrictive Voluntary Restraint Agreements.

On the basis of these forecasts and policy evaluations exporters should be in a better position to determine their future export strategy.

1.4 Organization of the Report

In Chapter 2 a theoretical model is developed of the world sheepmeat market. Some of the general issues such as derived relationships, the price linkages, the data used and the estimation method are discussed.

In Chapter 3 the results of supply and demand equations which have been estimated for each individual region are presented and discussed.

In Chapter 4 the complete model is brought together with a series of price-linkage equations, identities, and the market clearing mechanism based on a representative world price. Elasticities of derived supply and demand are calculated as well as approximate estimates of actual elasticities, for making comparisons among countries.

A historical simulation provides validation of the model over the estimation period, and is outlined in Chapter 5. Also in Chapter 5, a forecast of trends in the sheepmeat market from 1981-90 is provided.
In Chapter 6 the estimated model is applied in various ways. A series of simulation experiments is performed and the results of the analysis are evaluated against the Base simulation determined in Chapter 5.

The concluding remarks in Chapter 7 summarize the results, draw together the implications of the study, point out its limitations, and indicate areas of possible future research.
CHAPTER 2

THE THEORETICAL MODEL

2.1 The General Structure

In this chapter a theoretical model of the world sheepmeat trade is developed. The type of model specified is determined by the constraint of data availability and the objectives of constructing the model. Although more sophisticated approaches have been taken elsewhere (see Labys, 1973, for a bibliography) a relatively simple approach was taken here. This uses a non-spatial, price equilibrium model to describe multi-region trade in a single commodity.

The market can be represented by a set of equations with the following general structure, where supply and demand for sheepmeats in each region is a function of price and other exogenous factors. Trade is determined as a residual of domestic production and consumption.

\[
\begin{align*}
(2.1) \quad & D_i = f(P_i, PR_i, Y_i, ZD_i) \\
(2.2) \quad & Q_i = g(P_i, PS_i, ZI_i) \\
(2.3) \quad & Q_i - D_i = X_i \\
(2.4) \quad & \sum X_i = 0
\end{align*}
\]

where
- \( D \) = Quantity demanded within one period
- \( Q \) = Quantity produced within one period
- \( P \) = Commodity price
- \( PS \) and \( PR \) = Vectors of prices of substitutes
- \( Y \) = Income
- \( X \) = Net trade
- \( i \) = region (\( i = 1, \ldots, n \))

and
- \( ZD \), \( ZH \) = other explanatory variables.

Figure 4 portrays a flow diagram of the model format.

In the above set of equations there are no inventory relationships specified, since world sheepmeat stocks are minimal. Various other issues need to be covered in order for the parameters in the system to be estimated. The following sections deal with the way in which the estimating equations in Section 2.7 are derived from the theoretical model above.
FIGURE 4

Flow-Diagram of the World Sheepmeat Model

D = Demand
S = Supply
P = World Price in Real National Currency
A, B = Exogenous Variables
X, M = Exports, Imports
2.2 Deriving an Estimating Form from the Theoretical Model

2.2.1 Commodity specification.

In a study such as this, concentrating specifically on one commodity, it is necessary to deal with that commodity in a partial equilibrium framework. Behind the partial analysis lies the assumption of separability, where all prices other than that of sheepmeat, are taken as exogenous. In reality, if the price of one commodity changes then the prices of substitutes are likely to change as well. Elasticities of total demand and supply response (Buse, 1958) incorporate these inter-relationships among commodities. The ceteris paribus demand and supply curves are more elastic than the total response curves, so the partial elasticities provide an upper bound to the true response.

The commodity "sheepmeat" is far from homogeneous with trade of various countries differing not only in composition (i.e. mutton and lamb flows), but also in seasonality (see Blyth, 1982, for a description of the markets). Therefore, production and consumption patterns for each product are determined by somewhat different processes. For example, separate demand functions for mutton and lamb in Australia have been estimated (Gruen, 1967; Main, 1976). They showed a decline in mutton, but an increase in lamb consumption over time, and that demand for mutton was less elastic with respect to both income and sheepmeat prices than lamb.

In such models separate equations of the following form are specified;

\[(2.5a) \quad PC_m = f(P_m, P_l, Z)\]
\[(2.5b) \quad PC_l = g(P_l, P_m, H)\]

where \(PC_m\) and \(PC_l\) are per capita demand for mutton and lamb respectively, \(P_l\) and \(P_m\) are lamb and mutton prices, and \(Z\) and \(H\) represent other factors affecting demand. Similar specifications can be made for production of mutton and lamb (Reynolds and Gardiner, 1980; Laing, 1982) which also account for the timing of substitution between animal categories.

Data for this level of disaggregation are not available on an international scale, so a single function for mutton and lamb is derived which can be estimated. To derive the demand function for "sheepmeat" Equations 2.5a and 2.5b are summed to give;

\[(2.5c) \quad PC(1+m) = f(P_m, P_l, Z) + g(P_l, P_m, H)\]

Letting \((1+m) = s\), then,

\[(2.5d) \quad PCs = f'(P_m, P_l, Z, H)\]
Differentiating this gives;

\[
(2.5e) \frac{\partial \text{dPCs}}{\partial \text{Pm}} \cdot \frac{\partial \text{dPl}}{\partial \text{I}} = \frac{\partial \text{f}}{\partial \text{Pm}} \cdot \frac{\partial \text{g}}{\partial \text{Pl}}
\]

and dividing throughout by \(dPl\)

\[
(2.5f) \frac{\partial \text{PCs}}{\partial \text{Pl}} = \frac{\partial \text{f}}{\partial \text{Pm}} \cdot \frac{\partial \text{Pl}}{\partial \text{Pl}} + \frac{\partial \text{f}}{\partial \text{Pl}} + \frac{\partial \text{g}}{\partial \text{Pl}} \cdot \frac{\partial \text{Pl}}{\partial \text{Pl}} + \frac{\partial \text{g}}{\partial \text{Pl}}
\]

By making the assumption that the prices of mutton and lamb are related;

\[
(2.6a) \text{Pm} = h(\text{Pl})
\]

then,

\[
(2.6b) \frac{\partial \text{Pm}}{\partial \text{Pl}} = h \quad \text{where } h > 0.
\]

Thus,

\[
(2.6c) \frac{\partial \text{PCs}}{\partial \text{Pl}} = \frac{\partial \text{f}}{\partial \text{Pm}} \cdot h + \frac{\partial \text{f}}{\partial \text{Pl}} + \frac{\partial \text{g}}{\partial \text{Pm}} \cdot h + \frac{\partial \text{g}}{\partial \text{Pl}}
\]

Sheepmeat consumption therefore is affected by both the cross- and direct-price effects of changes in lamb prices. The cross-price effect on mutton demand \((\partial f/\partial \text{Pm})\) could be expected to be positive, but is likely to be outweighed by the direct effect on lamb demand \((\partial g/\partial \text{Pl})\). Hence the coefficient will still be negative.\(^1\) The negative term will be supported by the (expected negative) own price response of mutton demand \([(\partial f/\partial \text{Pm}) \cdot h]\). Partially offsetting this effect is the positive cross price response of lamb demand with respect to mutton prices \([(\partial g/\partial \text{Pm}) \cdot h]\), but both responses will be reduced by the size of the coefficient 'h'.

By substitution of Equation 2.6a into 2.5d;

\[
(2.7a) \text{PCs} = f'(h(\text{Pl}), \text{Pl}, Z, H)
\]

which can be simplified to Equation 2.7b;

\[
(2.7b) \text{PCs} = f''(\text{Pl}, Z, H)
\]

Equation 2.7b is an aggregate demand function for mutton plus lamb, derived from the true separate relationships. An equivalent

---

\(^1\) Own price elasticities of -1.55 and -1.89 for lamb in Australia were estimated by Gruen (1967) and Main (1976) respectively. They also estimated elasticities of demand for mutton with respect to lamb prices of +0.24 and +0.48.
aggregate supply function can be derived, where sheepmeat production is a function of lamb prices.

The assumption of a relationship between mutton and lamb prices is not unreasonable, especially in the longer term. Although their prices differ by a margin to account for quality differences, and mutton prices tend to be less stable than lamb prices (OECD, 1979) the prices appear to be linked (Figures 5 and 6). This is confirmed by the estimated forms of Equation 2.6a for Australia and NZ (reported in Blyth, 1982) and the correlation coefficients of 0.83 and 0.63 respectively.

Moreover, the two products are highly substitutable at the consumer level, and differences in "market prices are constrained by the high cross price elasticities of consumer demand between categories". This "limits relative price variation ... (and) allows the use of a single price as the price variable for all types of (sheepmeat) in an econometric model, without great loss of accuracy. This is helpful because it is difficult to identify the consumer demand for each type of animal" (Jarvis, 1974).

A growing proportion of exports from the sheep industry is sold in carcase form rather than as live animals and this accounts for some of the apparent increase in the total volume of sheepmeat traded, especially from Eastern Europe. Trade in live sheep has also increased rapidly from countries such as Australia, in response to growing demand in the Middle East for fresh meat. However, no explicit attempt is made to explain trade in live sheep, but it is incorporated implicitly on a carcase weight basis.

2.2.2 Temporal aggregation.

The model is estimated on an annual basis: this permits the examination of the important supply, demand and trade relationships which are essentially of a long-run nature. By using annual data, shorter-run movements in the market, such as seasonal variation in production and consumption and other factors such as strikes and wars are effectively filtered out. Also, the complementary, seasonal nature of production in the Northern and Southern hemispheres, which results in distinct trading patterns (see Chapter 1) is obscured by annual data. However, production of sheepmeat is mainly an annual process, for ewes lamb once a year, and although slaughter can take place throughout the year or be spread between years, in most countries it follows a regular annual pattern. Thus for many producing countries there often exists only annual data on supply. Similarly, by developing an 'annual' model consumption can be analysed for many countries for which no monthly or quarterly data exist. The markets of these countries can then be included as endogenous sectors of the world model.
FIGURE 5

Australian Wholesale Price for Mutton and Lamb

US$/t

1200
1000
800
600
400
200

Lamb

Mutton

1960 2 4 6 8 1970 2 4 6 8 1980
FIGURE 6
N.Z. Schedule Price for Mutton and Lamb

US$/t
1500
1250
1000
750
500
250

1960 1970 1980
15.
2.2.3 Regional coverage.

The study covers production and consumption of sheepmeat in the main trading countries. These are Australia, New Zealand, Argentina, the EEC (10), the USA, Canada, Japan, Iran, Eastern Europe and the USSR. The remainder of the trading countries have been aggregated together as two 'Rest-of-World' import and export sectors, since trade is often irregular or consists of sales of less than 1,000 tonnes per annum.

As the main concern is 'trade', countries which may be important in terms of production or consumption but do not trade to any extent (China, India, and South Africa, for example) are not included explicitly.

In 1980 the trading countries covered accounted for about 72% of the world's sheepmeat production and consumption.

2.2.4 International price linkages.

There are three sub-classes of non-spatial price equilibrium model, which differ in the way prices are incorporated into the model (Thompson, 1980).

The first class assumes that a single price clears the global market for a commodity (Adams, 1976; Labys, 1973; Withrill, 1968), and uses this price directly to estimate derived regional supply and demand equations. This approach abstracts from the spatial pattern of prices associated with transfer costs, but does not preclude the introduction of both tariff and quantitative trade barriers into the model. Moreover, the approach is useful where domestic price series are not available. An alternative to this simplified type of model is the approach taken by Fisher (1972), Lattimore (1978) and Tyers (1980) among others, whereby prices in each region are linked through transfer costs to a world market price. This allows relevant policy distortions, exchange rates and transport costs to be incorporated in more detail, but requires information on domestic prices in every region.

The third sub-class of model attempts to link prices in only those countries which actually trade with one another. Prices are linked bilaterally between trading partners through transport costs, which requires considerable data on both these and prices.

Because of inadequate domestic data the first approach is used here, whereby price is determined by the interaction between supply and demand in a competitive market. The values of the world market clearing price are obtained from the solution of the final model. This provides a measure of the reaction of each region to changes in international prices. While the estimation of each region's supply and demand relationships in terms of a world price may appear to be restrictive, the estimated relationships have considerable relevance, given the objectives of the study. Although this does not show domestic price changes, it does show the changes in domestic supply and demand levels that would result from a change in world market conditions.
For regions which have wholesale price data available, the linkage between domestic and world market prices can be made. Thus an estimate of the domestic function, rather than the derived function, can be determined and can provide information on the actual response to changes in domestic price. The relationship between the world price and domestic prices can be written in the general form:

\[(2.8) \quad P_i = f(P_w)\]

where \(P_i\) is the domestic wholesale price in country \(i\), and \(P_w\) is the world price, both measured in national currencies. The prices are distinguished by transport costs, meat quality differences (especially where trade unit values are the dependent variable), exchange rates and barriers to trade.

The estimated forms of Equation 2.8 are given in Blyth (1982) for several regions in the study; these are not however, included in the final model, for reasons given there.

The relationship between prices at producer, retail and wholesale levels in domestic markets (i.e. marketing margins) is not measured here. Little of the necessary data on such prices is available globally, but details on individual countries can be found elsewhere (Naughtin, 1979; Griffith, 1974; Tambi, 1975; Houston, 1962).

In a perfectly competitive market a single price would pertain at each level of the market, differentiated only by the amount of transfer costs. Thus the price transmission elasticity (that is, \(E_{pi,pw}\), the percentage change in domestic price in response to a one percent change in the world price) would be approximately one, were there no barriers to trade.

Several studies (e.g. Bredhal, 1979; Tyers, 1980) suggest that the price transmission elasticity is likely to be less than one. For countries or commodities where governments insulate internal producer and consumer prices from world market price trends this would be expected to be the case. Further discussion of this point is found in Blyth (1982).

The price transmission elasticities for sheepmeat from Equation 2.8 are given in Table 2. These range from 0.56 to 1.24, which suggests that there is a relatively high degree of price responsiveness and that a single representative world price can be used in the model. However, not all factors which restrict trade are included in such a relationship, so the elasticities given provide an upper limit to the actual responsiveness of domestic to world prices. (Again, further discussion of this point is included in Blyth (1982)).

2.2.5 **Derived demand and supply relationships.**

The relationships estimated using the world price instead of the domestic price can be considered as derived demand and supply curves. They are similar to those used by Foote (1958) to explain the relationship between wholesale prices and producer behaviour, and later
TABLE 2

Estimates of Price Transmission Elasticities a

<table>
<thead>
<tr>
<th>Country</th>
<th>Price Transmission Elasticity b</th>
</tr>
</thead>
<tbody>
<tr>
<td>Argentina</td>
<td>0.95</td>
</tr>
<tr>
<td>Australia</td>
<td>0.95</td>
</tr>
<tr>
<td>Canada</td>
<td>1.00</td>
</tr>
<tr>
<td>East Europe</td>
<td>0.86</td>
</tr>
<tr>
<td>EEC(9)</td>
<td>0.94</td>
</tr>
<tr>
<td>Greece</td>
<td>0.70</td>
</tr>
<tr>
<td>Iran c</td>
<td>0.56</td>
</tr>
<tr>
<td>Japan d</td>
<td>0.64</td>
</tr>
<tr>
<td>NZ</td>
<td>0.86</td>
</tr>
<tr>
<td>USA</td>
<td>0.81</td>
</tr>
<tr>
<td>USSR</td>
<td>1.24</td>
</tr>
<tr>
<td>World Exports</td>
<td>0.97</td>
</tr>
<tr>
<td>World Imports</td>
<td>0.99</td>
</tr>
</tbody>
</table>

a  Full details are given in Blyth (1982).
b  Response of wholesale price to changes in World price. Border prices used where domestic prices not available. Adjusted for exchange rates.
c  13 observations only.
d  10 observations only.
by George and King (1971) in the relationship between wholesale prices and consumers.

The relationships can be derived mathematically by substituting the price expression determined in the previous section into the domestic supply and demand equations. Repeating, for example, the general domestic demand and price functions;

\[(2.1) \quad D_i = f(P_i, P_R, Y_i, ZD_i)\]
\[(2.8) \quad P_i = g(P_w)\]

and substituting Equation 2.8 into 2.1 gives the general form of the derived demand function;

\[(2.9) \quad D_i = f(g(P_w), P_R, Y_i, ZD_i)\]
\[(2.10) \quad Q_i = g'(P_w, P_S, ZH_i)\]

The derived demand function, which has an equivalent derived supply function (Equation 2.10) shows the general form of functions estimated in the sheepmeat model. The relationships summarize the impact and interaction between each individual region and the world price.

Implicit in the derived functions are the assumptions that transport costs do not differ widely between regions, that quality differences remain constant, that any trade barriers remain constant, and that even if the margins between world and domestic prices differ, the response of trading countries to changes in world price is consistent over time.

Equations 2.9 and 2.10 could be estimated by determining independently the domestic demand, supply and price relationships. Lack of information though, on domestic prices at retail and farm level in each region, especially in aggregated regions, means that only the derived relationship can be estimated.

The theory developed by Foote (1958) and used by George and King (1971) related specifically to the derivation of elasticities at farm-level from those at retail-level, using retail-producer price transmission elasticities. By extending this concept to the price transmission elasticity of domestic to world prices (\(E_{pi.pw}\)) the actual elasticities of supply and demand (\(E_{cpi}, E_{spi}\)) can be calculated from the derived responses (\(E_{cpw}, E_{spw}\)) using the relationships;

\[E_{cpw} / E_{pi.pw} = E_{cpi}\]
\[E_{spw} / E_{pi.pw} = E_{spi}\]

In Chapter 4 the derived elasticities are estimated and used in these relationships to determine the actual supply and demand elasticities. Because the price transmission elasticities will
generally be less than one, the derived responses place a lower bound on the approximated actual responses.

2.3 **Prices in the Model**

The world price used in the model is taken to be the wholesale market price at Smithfield (UK) for PM grade, imported, New Zealand lamb. This price is based on the largest import grade of sheepmeat in the UK. There were several reasons for this choice of price series as a proxy world price. The predominance of the UK market was indicated in Chapter 1, and "while the UK market has been diminishing in importance for NZ lamb exports, the prices achieved in that market are widely used as indicators for the world market situation", (Ross et al, 1982). To provide support for this statement it is demonstrated in Blyth (1982) that the Smithfield price is representative of prices in other countries. Admittedly, the volume of product passing through Smithfield is becoming smaller, relative to total UK sales. Thus, overall market transparency has been reduced and Smithfield as the residual market is the only one whose prices are generally publicly available and published internationally. Other available series are the NZ schedule price, the UN mutton price index and various Australian series. Reasons for not using these and further discussion on the choice of the Smithfield price series is provided in Blyth (1982).

As was stated in the previous section, the world price is used in the derived relationships. It is converted to real, national currencies for each region, using the formula:

\[ P_i = \frac{P_w \times E_{Ri}}{CPI_i} \]

where \( E_{Ri} \) and \( CPI_i \) are the exchange rate and Consumer Price Index in region \( i \).

All other prices and incomes in the model are converted to national currencies and deflated by the respective price indices (base 1970 = 100).

It is necessary to deflate prices and incomes to real terms because of the high rate of inflation during the 1970's. The rapid increase in actual market prices but stability of real prices for sheepmeat, was demonstrated in Figure 3.²

² Prices are highly sensitive to exchange rates and deflators. Under such transformations the model's world price, for example, declined 43% in real terms in Japan, but increased 51% in the EEC, over the 1960-80 period.
2.4 Specification of the Supply Equations

2.4.1 Theoretical considerations.

The relationship used here to explain sheepmeat supply is derived from producer supply theory. That theory explains supply based on the maximization of profits for a producing unit, subject to the production function constraint (Klein, 1962). Defined in terms of the underlying cost relationships, the supply curve of an industry represents the summation of the portion of the marginal cost curve lying above the average variable cost curve for individual producers.

Supply functions can be formulated in various ways, depending on the availability of data and the objectives of the modelling exercise. A common procedure in modelling livestock supply applies the theory of sheep flocks as a capital investment and the farmer as portfolio manager, developed by Jarvis (1974), and outlined below. Separate equations for the number of animals and for the slaughter rate are specified, and total supply is determined by an identity. These models (summarised by Laing, 1982) show varying degrees of sophistication. For example, Lavercombe (1978) developed a life-cycle model of the UK sheep industry which determines the supply response to price via the interaction of lamb and ewe numbers, and turn-off rates from both hill and lowland (i.e. breeding and fattening) flocks.

A more aggregate supply response model has been developed by Reynolds and Gardiner (1980) which endogenises inventory changes, turn-off rates and per unit production in the Australian sheep sector.

These more complex approaches are not justified here, given the level of aggregation of the data and the objective of a simple model structure. The supply response specification for the world model requires a direct relationship between quantity and price, which can be determined for all the regions in the study. Thus a reduced form of the inventory response models is developed, leading to a derived supply function of the form of Equation 2.21.

The theory behind the models is based on the availability of livestock at any time for current slaughter or for retention as breeding stock. However, an essential dynamic aspect of sheepmeat production is that sheep numbers cannot change immediately in response to new conditions, to reach the desired level of production planned for that period. To increase output from the flock a period of adjustment is necessary, unless breeding ewe numbers are diminished, or marginal adjustments are made by altering time of slaughter or feed levels, to increase or decrease unit slaughter weights.

A method was developed by Nerlove (1956) for building a dynamic aspect into his studies of agricultural supply functions. He showed that producers anticipate what they expect to be the planned long-run, or equilibrium flock size, so the principal determinants of desired sheep numbers can be represented by the function;
(2.11) \( S^*_t = f(P^*_t, P^t) \)

where \( S^*_t \) is the planned number of sheep,
\( P^*_t \) is the expected live sheep price,
\( P^t \) are the expected prices of substitutes,
and \( t \) is the time period.

It is emphasised that these are 'planned' not 'actual' sheep numbers, and decisions are based on 'expected' not 'known' prices. Little is known about the way in which farmers form these expectations, but some assumptions can be made about the process. Equation 2.12 is a general version of the process by which it is assumed actual sheep numbers \( (S_t) \) adjust to planned sheep numbers \( (S^*_t) \) in year \( t \).

(2.12) \( S_t - S_{t-1} = d(S^*_t - S_{t-1}) \)

In Equation 2.12 the actual change in numbers of sheep in year \( t \) is specified to be equal to a fraction, \( d \) (the coefficient of adjustment), of the desired or equilibrium change in numbers. The fraction \( d \) lies between zero and one, and is a measure of the speed with which actual sheep numbers adjust in response to factors determining the planned flock size. It is determined by the biological production lag and a number of institutional, technological and behavioural rigidities in the industry.

In Equation 2.11, \( P^*_t \) is the expected normal price of sheepmeat for year \( t \), and \( P^t \) represents the expected prices of substitutes, these expectations being formed over previous seasons. The formation of price expectations is affected by many factors, which to simplify the model are summarized in actual past prices. By making a further simplifying assumption of naive expectations it can be stated that the most relevant past price affecting decisions is the actual price in the period in which the expectations are formed. This is where;

\[ P^*_t = P_{t-1} \text{ and } P^t = P_{t-1} \]

The assumption may of course be violated, and presents a particular problem at times of speculative price change, as in 1972-74. It would be interesting to consider other more complex specifications of the formation of price expectations but the available number of observations and the degree of aggregation limits the choice of alternatives. (The most common of these are the adaptive method of Cagan; the rational model of Muth; Solow's Pascal lag scheme, and Jorgenson's Rational distributed lag model: see Koyck (1954), or Nerlove (1956) for a theoretical exposition of the methods).

Thus the following may be written;

(2.13) \( S^*_t = f(P_{t-1}, P_{t-1}) \)

Combining Equations 2.12 and 2.13 and lagging one period, yields an equation in which the variables are represented only in terms of their actual, observable quantities;

(2.14) \( S_{t-1} = d f(P_{t-2}, P_{t-2}) + (1-d)S_{t-2} \)
So far the relationships have been determining sheep numbers. The total amount of sheepmeat supplied from the flock each year (Qt, which is the rate of slaughter times carcase weights) comprises the supply of mutton (QMt) and lamb (QLt).

Mutton supply is determined by closing inventory numbers (St-1) since mutton is obtained from older ewes being culled from this portion of the flock, and other factors (ZHt) affecting current turn-off decisions. Lamb production, on the other hand, is dependent on the numbers of breeding ewes available in the previous season, which are also approximated by closing inventory numbers.

It was shown in Section 2.2.1 that it is possible to derive an aggregate sheepmeat response function. Using this assumption again, the derived relationship for mutton and lamb supply (Qt) can be written as;

\[ Qt = g(St-1, ZHt) \]  

Substitution of Equation 2.14 into Equation 2.15 gives the determinants of total sheepmeat production;

\[ Qt = g[(d*f(Pt-2, PSt-2) + (1-d)St-2), ZHt] \]

In order that this relationship can be expressed only in terms of production variables, the simple and direct relationship between sheep numbers and production (Equation 2.15) can be utilised.

Lagging Equation 2.15 one period gives;

\[ Qt-1 = g(St-2, ZHt-1) \]

Then Equation 2.17 can be inverted in such a manner that,

\[ St-1 = g'(Qt-1, ZHt-1) \]

which, when substituted into Equation 2.16 gives Equation 2.19;

\[ Qt = g\{(d*f(Pt-2, PSt-2) + (1-d)g'(Qt-1, ZHt-1)), ZHt\} \]

This is a general form of the estimating equation used in the model.

### 2.4.2 Implications of the reduced form functions.

Equation 2.19 includes a lagged dependent quantity variable as an explanatory variable, the conventional justification for which is the partial adjustment mechanism. Smith (1976) gives an alternative justification "based on the pragmatic grounds that farmers do consider the previous year's plans in making their current production decisions." These two alternative justifications cannot be easily distinguished from the empirical results except for the fact that the partial adjustment model requires that the coefficient of the lagged dependent variable be significantly less than one. However, the alternative justification has no such requirement.
The same is true of Equation 2.19 since the coefficient of adjustment, \( d \), is related to some function \( g' \) of \( q_{t-1} \), and not directly to it. (It can be shown that since the function \( g' \) is the inverse of \( g \), the coefficient would in fact reduce to \((1-d)\) if Equation 2.15 were a simple linear relationship based on the partial adjustment mechanism).

In the general case the coefficient of \( q_{t-1} \) in Equation 2.18 will be positive, and could be greater (though will generally be less) than one. Thus the same will be true of the coefficient of \( q_{t-1} \) in Equation 2.19.

In this case the lagged dependent quantity variable simply indicates that farmers are guided in their production decisions by flock size and supply in previous periods.

It is difficult to postulate \textit{a priori} the signs of the coefficients in Equation 2.19, because of the dual role of sheep in production (i.e. for slaughter, or for flock-building). In general, positive responses to sheepmeat price changes would be expected in the long run, but these could be negative in the short run. The latter is complicated where reduced forms of the livestock inventory model are being estimated (Tryfos, 1974). A negative price coefficient could result from either aggregation error (which occurs where the components of supply (ewes, hoggets, lambs) are not examined separately) or from a dominant short run flock building response. In the short run this apparently perverse supply response can be justified as "a necessary, logical and distinctive feature" (Reynolds and Gardiner, 1980). The rational producer reduces current supply and increases current breeding ewe numbers in response to price rises, in order to expand future production.

Where responses are positive in the short run, producers may be 'cashing in' on higher prices. If their expectations are that current price levels are more favourable than future levels (i.e. if the naive expectations assumption is invalid), they could be slaughtering at higher than optimal levels, and reducing the size of the breeding flock.

Short run responses will differ among countries therefore, depending on producers' attitudes towards price changes. In the long run all responses are expected to become positive. The difficulty lies in identifying the 'short run', but it could be expected to be periods of less than one year. Although the time stream for the change is indeterminate, in the medium term (which includes the two year lag period used in the model) a negative supply response is improbable. Moreover, it is not consistent with the theoretical reduced form model developed, which implies that the coefficient of the price variable should be positive.

The sheep model is complicated by being part of a multi-product decision environment. Sheep can produce several complementary goods such as wool and milk, as well as meat. In addition there are a number of enterprises which can be substituted for sheep production such as beef cattle, or cropping. The variable \( P_S \) in Equation 2.19 represents factors which affect the current sheepmeat supply decision. For
example, PS might be the past price of wool, included because producers have the option of selling lambs if the price is low so discouraging wool production, or of retaining sheep for breeding to increase wool production in future years if prices are high. Other variables included could be beef, wheat and dairy-product prices.

The response to changes in wool prices could be either positive or negative, depending on the relative importance of wool and meat as outputs from the industry. With a two year lag it would be expected that in regions where meat supply predominates, an increase in wool prices would lead to higher numbers of breeding ewes and hence lambs for slaughter. Where wool is the main product, ewes would be retained for increasing wool production. The number of cull ewes (the main source of mutton) being slaughtered and hence meat output, would decline. In the long run all responses should become positive.

The response to changes in beef prices and other substitutes is more likely to be positive in the short run (as producers slaughter at a higher rate, to replace sheep with cattle), and become negative in the long run (as output capacity from the reduced breeding flock declines). The medium term response is expected to be positive, but the time path for the change is again indeterminate (Reynolds and Gardiner, 1980).

Two problems result from the medium term supply response and the reduced form of the model. Firstly, since the coefficient of the lagged dependent variable is not the simple coefficient of adjustment, it cannot be used to determine long-run elasticities. Secondly, any negative medium term coefficients would lead to negative long-run elasticities, which would not be particularly meaningful. Long-run responses are therefore not calculated.

2.4.3 The data.

(1) Production

Data on production of sheepmeat in each country or region was taken from USDA (FAC-LM, 1980) and covers mutton, lamb and goatmeat. It is recorded on an annual rather than a seasonal basis and is measured in thousands of tonnes, dressed carcase weight.

Whilst the aggregate data also covers goatmeat, which is outside the scope of the study, it is not thought to be a real problem. Goatmeat production cannot readily be separated from sheepmeat production, but data from various sources suggest that it is stable, and contributes only a small part of production in most of the countries included in the model. In countries where it forms a larger part of production (eg. Iran) it rarely becomes a marketed commodity, but is consumed by the local producers.
(ii) Prices

A farmer's supply of goods should depend on the expected profitability of the various commodities he produces. Output levels and product mixes are adjusted according to variations in the absolute and relative levels of net returns from the farm products. However, as disaggregated cost data are rarely available, profit series cannot be calculated, and price movements are used instead as explanatory variables in the supply equations.

For the sheepmeat price in each region the world price is used, as explained in Section 2.3.

For beef prices, where no domestic series are available, an international price series is used, converted to the domestic currency and deflated as with other prices. This price series is the world average annual trade unit value (FAO Production Yearbook).

Where wool prices are included and no domestic series are readily available, a proxy for a world price is used. This is taken as the Australian wholesale price (FAO Production Yearbook) which is an average across all qualities of wool on a greasy basis. The level of this series may be above the average wholesale price in some countries, due to a preponderance of fine wool. However, it has been demonstrated elsewhere (Witherell, 1968) that quoted prices are a good indication of movements in the whole spectrum of world wool prices.

Using world series instead of farm-gate prices implies that the estimated responses are derived rather than actual ones.

(iii) Other trends

The functions estimated here are intended to be supply functions rather than production functions, so the principal emphasis is on measuring economic, not technological variables. Nevertheless, in the sheepmeat industry technology and inputs are important factors in increasing productivity and supply. Technological improvements in both the quality and the quantity of inputs used affect not only immediate livestock yields, but also the agricultural resource base. Obvious examples of the first effect are specific breeds for meat, and of the secondary effect are the impact of irrigation and fertilisers on pasture improvement.

Such relationships are difficult to measure accurately, and are too complex to include explicitly in the equations estimated here. However, the relationships were included in a simplified form, using a time trend as a proxy for technological change.

(iv) Weather

Weather conditions affect sheepmeat supplies indirectly through the amount and quality of pasture forage available. Producers base part of their decision to invest or disinvest in capital stock (ie. breeding
ewe numbers) on the weather in the current period; moreover, pasture availability determines the age and weight at which sheep are slaughtered within a period.

Measures used to account for weather conditions reflect the amount of rainfall (or lack of it) in the principal sheep regions, and are discussed further in the relevant sections of Chapter 3. It should be noted that the general form of supply function given by Equation 2.19 incorporates the effect of weather conditions in previous as well as current periods. Omission of the lagged effects could lead to bias in the estimated equations, thus the variables used are weighted accordingly, to account for weather conditions in the previous season.

2.4.4 The estimating form.

The actual estimating form of the supply equations derived from the above specifications can be stated as;

\[
Q_{it} = a + bQ_{i(t-1)} + cP_{i(t-2)} + dPW_{i(t-2)} + ePB_{i(t-2)} + fW_{it} + gT_{it}
\]

where \( Q \) is the quantity produced, 
\( p \) is the world price of sheepmeat, 
\( PW \) is the price of wool, 
\( PB \) is the price of beef, 
\( W \) represents climatic factors, 
\( T \) represents trend factors, 
t is the time period, 
\( i \) is the country or region
and \( a-g \) are estimated coefficients.

Production trends in individual regions and equations estimated for each are discussed in more detail in Chapter 3. More general conclusions are left to the discussion of the overall model in Chapter 4.

2.5 Specification of the Demand Equations

2.5.1 Theoretical considerations.

Specification and estimation of commodity demand relationships has received much attention elsewhere (see Labys, 1973, for a bibliography).

There are several techniques for analysing meat demand (Colman, 1976). These use either complete systems of demand for all commodities at once, or take a partial approach, which relates demand for a single commodity to a subset of factors which affect total demand. Both are based on the analysis of either cross-sectional or time-series data.
The relationship usually used to explain demand derives from consumer demand theory. The theory explains demand based on the maximisation of consumer utility, subject to an appropriate budget constraint. Solution of the maximisation problem through differentiation leads to a set of individual’s demand equations similar to the form of Equation 2.1 (Equation 2.22);

\[(2.22) \text{PC}_{it} = f(\text{P}_{it}, \text{PR}_{it}, \text{Y}_{it}, \text{ZDi})\]

which relates per capita consumption of the commodity (PCi) to its price (Pi), the prices of other commodities (PRi), per capita income (Yi) and other exogenous factors (ZDi) in the same time period (t).

There are a number of important aspects of Equation 2.22 to consider in deriving an estimating form of the generalised equation.

Underlying the complete demand system of which Equation 2.22 is a member, is a set of restrictions based on rational consumer behaviour, which the demand functions satisfy. These are known as the homogeneity condition, the Engel aggregation condition, the Cournot condition, the symmetry condition and the Slutsky condition.

Discussion of complete demand systems and the underlying conditions can be found elsewhere (eg. George and King, 1971).

Since sheepmeat is being treated in a partial framework it is sufficient here to say that the conditions provide the properties which are generally associated with a system of demand equations.

The homogeneity condition however, is useful in partial analysis for obtaining an estimate of the response to price changes of competing goods when only limited data are available. The condition implies that if prices and incomes are changed by the same proportion, the quantity demanded remains the same. With homogeneity of degree zero the direct- and cross-price elasticities plus the income elasticity sum to zero. If estimates of the own price and income elasticities can be made, then it is possible to derive the sum of the cross-price elasticities.

The parameter estimates for the model are obtained using time-series rather than cross-sectional analysis. In cross-section household demand analysis all prices are typically omitted from consideration, so this method is not appropriate, a major objective of the study being to determine price relationships. Moreover, such data are not readily available, as household consumption surveys have not been undertaken in many of the countries involved here.

Another consideration with regard to Equation 2.22 is that it is designed to explain individual consumer behaviour. In the complete model the per capita consumption estimates are aggregated to obtain market demand functions for each country. However, as individual taste and consumption patterns differ, aggregation is only valid if it is assumed that income distribution is constant over time, or, if redistribution takes place, the individuals do not alter their demand for the commodity. It is also assumed that consumers in any particular country react in the same manner to price changes. Thus, aggregating
individual responses into a market demand function assumes homogeneity of degree zero in prices and income.

One possible solution would be to estimate an elasticity of demand with respect to population, by determining total consumption as a function of population. This entails estimating an aggregate, not a per capita consumption function however, which would reduce the degree of detail.

The relationship specified in Equation 2.22 is static in that it makes no distinction between differences in demand response in the short run and the long run, and takes no account of the influence of past levels of demand. For these reasons a dynamic relationship was also considered.

When prices or incomes change, consumers respond to the changes over a period of time, the length of which varies between commodities and consumers. The time taken for the adjustment of actual consumption to desired or equilibrium consumption depends on institutional and technological rigidities and the strength of habit persistence. The longer the adjustment period considered, the less important the constraints become, but in the short run, demand for a non-durable commodity such as sheepmeat, tends to be inelastic.

The theories proposed to explain such behaviour are similar to those explaining lags in production responses, developed by Koyck (1954) and Nerlove (1956).

Koyck assumed that a direct form of distributed lag exists between the dependent variable and one or more of the explanatory variables. (For example the lag weights might decline geometrically - the 'Koyck lag', or in a polynomial form - the 'Almon lag').

A simpler dynamic theory was developed by Nerlove, and was outlined in the previous chapter. Similarly a dynamic equation suitable for estimation can be obtained by introducing an adjustment coefficient, \( d \) (the speed at which consumers adjust actual towards desired consumption; \( d \) is determined by the strength of habit persistence etc.). By substitution, Equation 2.22 becomes, (see Labys, 1973, for a proof);

\[
(2.23) \quad PCi = f(PCi1, Yi, Pi, Pri, ZDi)
\]

where variables are as defined in Equation 2.22. The inclusion of \( PCi1 \), the lagged dependent variable, implies that current consumption is a function of past desired or equilibrium consumption, as well as other current factors.

If it is assumed that habit persistence lasts for only one year, and that the annual response is the same as the long-run response, then Equation 2.23 reduces to Equation 2.22. This implies that adjustment is rapid, and is completed in a period of less than one year. There are few rigidities to slow change in the meat marketing system, since manufacturing and further processing are not widespread, and refrigeration facilities, promotion and retail outlets are quite flexible. For periods less than one year (i.e. weekly or monthly) there
may be some delay in adjustment, because of domestic purchasing patterns (Baron, 1976) which are not a constraint over longer periods.

A survey of meat demand studies (Colman, 1976) concluded that none of the studies had established a significant difference between long- and short-run parameters. Moreover, little additional understanding of the market is obtained by including the lagged dependent variable, even though the 'fit' is improved and $R^2$ approaches unity if it is. Therefore, the estimated equations are of the form of Equation 2.22.

2.5.2 Discussion of variables.

It was stated previously that demand for sheepmeat is determined by the price of sheepmeat, prices of closely competing or complementary products, the level of income, taste and other special factors where relevant. The inclusion of these variables in the general equation (2.22) is discussed here in order to arrive at an estimating equation.

(i) The Dependent Variable

Consumption figures used in the study are constructed by USDA (FAC-LM, 1980) and cover total mutton, lamb and goatmeat consumption, in thousands of metric tonnes. The same limitations apply as were discussed in Section 2.4.3.

Total consumption figures ($C_{it}$) are converted to kilograms per capita ($PC_{it}$) by dividing by the population of the respective country in year $t$ ($N_{it}$). Population data were obtained from IMF (Statistical Yearbook).

(ii) Prices

The sheepmeat price variable used in the demand equations was described in Section 2.3. It is emphasised that since these are not the actual retail level prices which face consumers, the estimated equations are derived demand functions.

The main substitutes for sheepmeat are beef, pork and poultry meat. Retail prices of these commodities are included in the functions as explanatory variables. The prices are taken from various national sources.

It is expected that the estimated coefficients of sheepmeat prices will be negative, but that the coefficients of other meat prices will generally be positive.
(iii) Income

Income is a key variable in explaining trends in sheepmeat demand, but few studies have attempted to study income responses in a co-ordinated way.

FAO (1976) conducted cross-section studies using household food surveys to build a set of estimated income elasticities for many countries, as a basis for their commodity projection work. The USDA GOL model (Regier, 1978) determined a set of income elasticities for a limited number of countries, though these were synthesised from available information, not estimated directly. Greenfield (1974) estimated price and income elasticities for eleven countries on a uniform basis. A summary of these and other studies is given in Appendix 3.

In general, at low levels of income, food consumption is expected to increase substantially with increases in income, but as income continues to rise the food consumption response weakens. At high levels of income, the added income expended for some food groups may taper off, or even become negative. A similar pattern is expected for sheepmeat, except in those countries where tastes prevent increasing consumption, regardless of income, so income coefficients could take either a positive or a negative sign.

Per capita incomes were taken from Gross National Expenditure data, as quoted by IMF (Financial Yearbook), divided by the population of the country. All incomes are in real (1970) national currencies.

For the EEC an average income figure for the eight countries was used. For the Rest-of-World region incomes were taken to be the average per capita Net Disposable Income for all market economies.

(iv) Other trends

Changes in taste have also played an important role, with increased demand for protein foods, a shift from mutton to lamb and, more recently, a reduction in meat consumption possibly for dietary reasons.

Other factors which have had an important effect on consumption have been the increased ownership of deep freezers, and the trend towards eating convenience foods and meals away from home (Baron, 1976; Brabyn, 1978; Sheppard, 1980).

Since it is not possible to quantify the effects of these trends, they were included in the model using a time trend as a proxy variable. The coefficient could be either positive or negative, depending on the particular factors causing the changes in consumption patterns.
2.5.3 The derived demand functions.

Inclusion of these variables in the general equation (2.22) leads to the estimating form of the derived demand equations:

\[(2.24) \quad PCit = a + bPit + cYit + dPBit + ePPit + fPCHit + gTt\]

where \(PCi\) is per capita consumption of sheepmeat, 
\(Pi\) is the price of sheepmeat, 
\(PBi, PPi, PCHi\) are prices of substitute meats (i.e. beef, pork or chicken),  
\(Yi\) is per capita income, 
\(T\) is a time trend,  
\(i\) is the region,  
\(t\) is the time period
and \(a-g\) are estimated coefficients.

2.6 Trade in the Model

For most regions, import demand or export supply can be calculated as a residual of domestic production and consumption, using Equation 2.3.

In certain cases, where there are insufficient data to estimate both supply and demand equations, a behavioural, net trade equation can be specified instead. The excess function is the reduced form of the other two functions (see Leamer, 1970, for a proof). A single equation regression can therefore be run, for quantity of sheepmeat traded on prices, past trade levels and time, of the general form:

\[(2.25) \quad Xi = f(Xli, Pi, T)\]

where \(Xi\) = net trade in region \(i\),  
\(Pi\) = world price, in real, national currency  
and \(T\) = time (a proxy for incomes, taste factors, market development and changes in government policy).

Excess functions are estimated for Eastern Europe, the USSR and two net importing and exporting Rest-of-World regions. Little data is available on these regions, and virtually nothing is known about the relationship between market prices and trade levels. The formation of a simple net trade equation therefore yields useful information on price elasticities of excess supply and demand. Clearly though, the estimated parameters are of a very tentative nature because of the simplified form of the explanatory function and the level of aggregation of the data.

2.7 The Estimating Form

By making a series of conditions and assumptions in Sections 2.2–2.6, a form of the theoretical model developed in Section 2.1 has been derived which can be estimated.
The derived model has the following general structure:

\[(2.26) \quad PCI = f( Pi, Yi, PRI, ZDI) \]
\[(2.27) \quad Qi = g( Oli, Pi, PSI, ZHi) \]
\[(2.28) \quad (PCI*Ni) - Qi = Mi \]
or \[(2.29) \quad Qi - (PCI*Ni) = Xi \]
or \[(2.30) \quad Xi = h( Xli, Pi, T) \]
\[(2.31) \quad Pi = (Pw * ERi)! CPIi \]
\[(2.32) \quad \Sigma Xi = \Sigma Mi \]

where variables are as defined in Section 2.1 and;

- (2.26) is a derived demand function for per capita consumption,
- (2.27) is a derived supply function for total production,
- (2.28) is a net import identity,
- (2.29) is a net export identity,
- (2.30) is the reduced form of Equations 2.26 and 2.27 and gives the excess demand and supply for certain net trading regions,
- (2.31) converts the equilibrium world price to real, national currencies, and
- (2.32) is the market equilibrating and solution mechanism,

for \( i = \) Argentina, Australia, Canada, EEC (8), Eastern Europe, Greece, Iran, Japan, NZ, the UK, the USA, the USSR, and two Rest-of-World import and export regions.

More specifically, the model consists of;

(i) 9 behavioural equations explaining production of sheepmeat in the major trading countries (not Japan),

(ii) 10 behavioural equations explaining net per capita consumption in the major trading countries,

(iii) 10 identities explaining net trade — that is, the difference between consumption and production in each country,

(iv) 4 behavioural equations explaining net trade in the USSR, Eastern Europe, and two Rest-of-World importing and exporting regions,

(v) 1 market clearing identity and
(vi) 11 identities converting the world price to real national currencies for each region.

A series of price linkage equations, of the form of Equation 2.8, relating the world price to domestic wholesale prices and border prices where appropriate, is additional, but not essential to the model.

The model therefore consists of 23 behavioural equations, 22 identities and 45 endogenous variables, plus the additional series of price linkage equations. In Chapter 3 the estimated relationships are given for the major trading regions.

2.8 Method of Estimation

Ordinary Least Squares (OLS) was used to derive the final estimates of the equations, though the structural form of the model was examined to determine whether a systems estimation technique (such as 2SLS, 3SLS, or Joint Generalised Least Squares (JGLS)) should be applied.

JGLS is used for systems of equations where the error terms are correlated, to improve the asymptotic efficiency of estimates, though OLS will also give consistent and unbiased parameter estimates. The gain in efficiency is greater, the higher the degree of correlation. To test the relationship among the error terms the correlation matrix of the residuals of the equations was constructed. The coefficients were tested, using the Fisher \( Z \) statistic (Hayslett, 1978), to determine whether significant correlation existed. Some correlation was found among the error terms of the consumption equations, though there was less on the supply side. Within country correlations were also high and so the model was re-estimated using JGLS. Under the estimating procedure's default value the disturbances of each equation proved to be unrelated. (Thus \( \Omega \), the variance-covariance matrix of the reduced form errors is normally distributed, and \( \Omega = \delta^2 I \)). In this case the method reduced to that of OLS.

The matrix of coefficients of the endogenous variables was also examined, with the system ordered into blocks of supply and demand equations. The former produced a triangular matrix of coefficients, indicating the recursive nature of the supply side. The coefficients of the consumption equations were not triangular, appearing above and below the diagonal, thus confirming the interdependency of the system. However, the particular form of the model implies that to use two stage estimation would require a single reduced form equation, with price as the dependent variable and a large number of exogenous variables. This in turn necessitates using a Principal Components routine, which generally produces results only marginally different from OLS (Klein, 1962) because of the small sample size. Klein also proposes that for international trade models, where a country's exports or imports are small relative to total world trade, OLS is an adequate estimating procedure.
One of the assumptions of OLS is that there is zero autocorrelation of the disturbance terms. This assumption may be violated in certain cases (as determined by the Durbin-Watson, or the 'h' statistic \(^3\) in the presence of lagged dependent variables) so the resulting estimates, though unbiased, have large variances.

In these cases the equations can be re-estimated with a first order autoregressive scheme to account for the relationship of the error terms. The Cochrane-Orcutt method gives consistent and efficient results, though the estimates may be biased due to the small sample size and the presence of lagged dependent variables (Johnson, 1972). Values of the Durbin-Watson or 'h' statistics and the adjusted results are given in the relevant sections of Chapter 3 as well as the original equations.

The simulation technique used however, involves retrieving the coefficients from the estimated equations and subsequently reforming the functions. Since this method ignores the contribution of the serial correlation term it was not possible to retain the corrections in the final model for simulation.

\[^3\] The formula for the 'h' statistic is:

\[
d = \frac{n}{1 - \frac{1}{2} \frac{\sqrt{n \cdot \text{vb}_1}}{1 - n \cdot \text{vb}_1}}
\]

where \(d=\text{DW}\) and \(\text{vb}_1\) is the variance of the coefficient of the lagged dependent variable, from the OLS estimate. Values of \(h > 1.645\) indicate autocorrelation among the error terms. The test is strictly only applicable to large samples (\(n > 30\)), as nothing is known about its small sample properties (Johnston, 1972). Since here \(n\) is generally 20, the test is not exact.
CHAPTER 3

ESTIMATED RELATIONSHIPS FOR MAJOR TRADING REGIONS

In this chapter, production and consumption in the main regions are discussed and analysed formally using the methodology outlined in the previous chapter. Estimated equations for all regions are given in Appendix 1, and further discussion of the whole model is given in Chapter 4. Figures in brackets beneath the coefficients of estimated equations are t-values, and an asterisk indicates non-significance at the 5% level.

3.1 The Supply Equations

3.1.1 Australia.

Australia is the second largest sheep rearing country in the world, with 136 million sheep in 1980, though numbers have declined 24% during the 1970's. The decline is the result of a tendency to develop mixed farming and cattle at the expense of sheep rearing. A number of severe droughts have also affected sheepmeat production, which is now around 500Kt per annum, compared with 908Kt in 1970.

Aggregation problems are faced in explaining Australian supply, because of distinct mutton and lamb production patterns. Wool is the industry's major product and mutton is a by-product. However, a large crop of lambs is also produced specially for meat, and more emphasis is now being placed on improving carcase quality. According to other studies (eg. Freebairn, 1973) flock size is determined in the long run by relative wool, beef and wheat prices, whilst mutton and lamb prices determine short-run changes in flock composition.

Various forms of equation were tested to explain supply in Australia, yielding quite similar results, with the signs of coefficients generally conforming to a priori assumptions. The following is the final form used in the model, where Australian sheepmeat supply (SAU) is determined by beef prices (PBAU2), sheepmeat prices (PAU2), wool prices (PWLAU2), rainfall (RAU) and time (T).

\[
SAU = 531.44 + 0.46SAU_1 - 0.89E-01PAU_2 + 1.47PBAU_2 - 0.98PWLAU - 1.55RAU - 4.69T
\]

\[
(0.90)^* (1.35) (0.19)^* (0.65)^* (0.86)^*
\]

\[
R^2=0.57 \quad DW=1.49 \quad S=93.94 \quad F(6,12)=2.64
\]
The equation only explained 57% of variation in supply, and whilst all but one of the coefficients were consistent with a priori expectations, the coefficients were generally not significant. The lagged dependent variable had most of the explanatory power; its coefficient of 0.46 indicates that producers adjust towards desired output relatively quickly.

Sheepmeat prices were not significant (which could be a result of the opposite effects on production of mutton and lamb prices), and had a negative coefficient. This problem has been encountered by other researchers estimating Australian supply functions (Smith, 1976) and is possibly caused by the dominant short-run stock withholding effects. The price elasticity of supply was -0.10.

Wool prices have the principal impact on breeding ewe numbers (BAE, 1979), so price with a 2 year lag was included in the equation, to show the effect on current production. This yielded a cross price elasticity of -0.23 indicating that sheepmeat production is more responsive to wool prices in Australia than in other countries in the study (see Chapter 4). Although the coefficient was not significant it had the expected negative sign. Thus if wool prices rise, in the medium term, ewes are retained for breeding and later wool production. Conversely, if wool prices fall higher numbers are culled and meat supply increases.

Beef prices were not significant either, in explaining production of sheepmeat in Australia, although substitution between beef cattle and sheep occurs within the grazing industry. Again, the equation gave a high cross price elasticity of 0.30 which is higher than other sheepmeat exporting countries (see Chapter 4). As expected the beef price variable had a positive sign, so an increase in world beef prices would give a subsequent increase in sheepmeat supply as producers shift into beef production.

Wool prices were thought to have an effect on sheepmeat supply, but no significant relationship between these variables could be found. This could be because only part of the flock is held in the wheat-sheep zone, or that the wheat price data series available were not the most relevant ones. Few researchers have obtained significant results, so the variable was omitted.

Year to year variations in Australian supply depend in a complex way on the weather. A specification for weather is difficult to make on a national basis, since weather may have different effects on production in the various producing areas. Yet rainfall is important, and droughts are cited as the most frequent cause of variation in Australian supply (BAE, 1979). The BAE constructs an annual index of rainfall on a seasonal basis in which the rainfall indices for each state are weighted by the proportion of total sheep in that state. Because production (especially of lamb) depends on ewe-matings during the autumn of the previous July-June year, allowance is made in the index for rainfall in that period. In the equation the rainfall index had the expected negative sign, but its coefficient was not significant. This implies that high rainfall gives better pasture growth and allows stock to be carried to heavier weights or kept for future production instead of
being slaughtered. Conversely, drought conditions lead to higher turn-off rates in the same period.

Although major technological advances have been made in the Australian sheep industry since World War II (in particular through the use of superphosphate fertilizers on pastures, and the control of rabbits with poison and myxomatosis), the time trend (T) had a negative coefficient. Though the coefficient was not significant, it suggests that at the aggregate level, social and institutional factors have outweighed technological change and would have caused a long term decline in the industry.

3.1.2 New Zealand.

Although NZ and Australia exhibit some similarities in their sheep production systems, there are a number of features that differentiate them. The climate, industry structure, and alternative enterprises, also differ, and so in the equations estimated different responses are expected. NZ is one of the world’s major producers, and by far the leading exporter, but relies more heavily on trade in sheepmeat for its export earnings than does Australia. Supply in NZ has increased 20% over the period, with several fluctuations, to reach 560Kt in 1980.

NZ supply (SNZ) was explained by previous levels of supply (SNZ1), sheepmeat prices (PNZ), wool prices (PWLNZ), beef prices (PBNZ) and weather conditions (SMD).

\[
SNZ = -20.70 + 1.03SNZ1 + 0.46E-03PNZ2 - 0.21PBNZ2 + 0.41PWLNZ2 - \\
(0.81)^* (2.77) (0.01)^* (0.22)^* (0.68)^* \\
0.58SMD \\
(0.92)^*
\]

\[R^2=0.65 \quad DW=1.92 \quad S=25.50 \quad F(5,13)=4.91\]

The results were not very satisfactory, as only the coefficient of the lagged dependent variable was significant and only 65% of the variation in supply was explained. This could be due to the omission of a variable to explain technological change, but there was little improvement in the results when a time trend was included (as a proxy for technological change), so it was dropped from the final equation.

The climate in NZ is comparatively wet, so annual sheepmeat production does not experience fluctuations to the same degree as does that of Australia or Argentina. However, weather conditions do still play a part in determining SNZ; a useful measure of this is the number of days of Soil Moisture Deficit (SMD), weighted by the number of sheep in each region. (NZ Meteorological Society, Pers. Comm.). This was included in the model, and gave a negative coefficient, as production falls during the drier years, and increases during wetter years when lambs can be carried to heavier carcase weights. The result differs from that observed in Australia, where mainly wool and mutton is
produced, as NZ produces a greater proportion of lamb and relies on seasonal pasture growth for fattening.

NZ is the third largest producer of apparel wool in the world, thus prices for wool are an important factor in the NZ sheep industry. NZ wool producers have been protected from the more extreme fluctuations in world wool prices by a reserve price scheme, so this was the appropriate price series to use (Witherell, 1968). NZ is also important for its specialised fat-lamb production, and the two are complementary products in most areas. Wool prices had a positive coefficient therefore, and a cross price elasticity of 0.06 was calculated, (unlike Australia, where sheepmeat is generally a by-product of the wool industry and gave a negative coefficient).

Beef prices were included to represent the main alternative activity to sheep in NZ. The NZ schedule price for prime beef was used; its coefficient had a negative sign but was not significant. A cross price elasticity of -0.02 was calculated, which as expected, suggests that as beef prices become less favourable producers move into lamb production.

Other alternative enterprises, such as dairying and crops, are analysed by Rowe (1956); Court (1967); Rayner (1968); Woodford and Woods (1978); Rich (1978); Laing and Zwart (1981), but were not included here, as the equation estimated here is satisfactory for the purpose of the model.

As NZ exports 85% of its sheepmeat, the industry is geared to the export market. Thus overseas prices largely determine domestic sheep prices through the schedule price system (Blyth, 1982). As expected, a positive coefficient was obtained for prices, but the coefficient was extremely small and not significant. The price elasticity was approximately zero. Whilst this may be a problem of the model rather than a characteristic of NZ supply, it does indicate that the response to price changes is small. This is confirmed by the results of other researchers (Appendix 3).

Moreover, the coefficient on the lagged endogenous variable was greater than one, indicating that supply is slow to change to desired levels. Coupled with the normal cross price elasticities and the low own-price responses, this suggests that NZ farmers base sheepmeat production decisions on relative returns and previous levels of supply rather than on sheepmeat prices.

3.1.3 Eastern Europe.

The main producing countries of Eastern Europe are Bulgaria, Romania, and Yugoslavia, though the analysis also covers the minor producing countries, East Germany, Poland, Hungary and Czechoslovakia. The southern countries have much larger sheep numbers than the northern countries but production systems are similar.

Sheep farming is a marginal enterprise, pursued in mountain regions and in the extensive areas of poor quality grass. Grazing
seasons are short because of the climate, and the extreme variability of
the weather often adversely affects production.

There has been a shift of emphasis from wool to meat production,
and Government plans in all States encourage further expansion. A
figure of 65-75% of production is consumed domestically, but whilst the
East Europeans do not dislike sheepmeat, they prefer pork, and so per
capita consumption is generally low. To a large extent the level of
consumption is determined politically, as is production. Whilst
consumption has been static over the period, production has been
encouraged to allow some surplus for export. Exports, which were
negligible during the 1960's, grew rapidly during the late 1970's to
reach 28Kt in 1980.

Difficulties were found with estimating both supply and demand
equations, so an excess supply function was determined instead, since
it is exports from the region with which the study is primarily
concerned. The following equation was estimated, with export supply
(XEE) as a function of real world prices (DPW) and a time trend (T):

\[
XEE = -16.00 + 0.17E-01DPW + 1.20T \\
\text{(1.49)} \quad \text{(1.08)}^* \\
\text{(5.77)}
\]

\[
R^2 = 0.79 \quad DW = 0.56 \quad S = 4.46 \quad F(2,18) = 35.54
\]

The equation was satisfactory, with the signs and coefficients as
expected though the value of the Durbin Watson statistic indicated the
presence of autocorrelation among the residuals. A price elasticity of
1.27 was calculated, though it was not significant. Thus exports appear
to be highly elastic with respect to world price which suggests that
Eastern Europe's exports are responsive to world market forces.

The strong positive time trend reflects the Governments' need to
increase export earnings by expanding supply, and maintaining domestic
consumption at low levels. It also reflects the reduction in live sheep
exports which have been replaced by carcase meat sales.

3.1.4 Argentina.

A rapid deterioration has been seen in Argentina's sheep
industry, with a 60% fall in sheep numbers caused partly by declining
and unstable prices but also by the uncertain political climate.
Production has correspondingly declined from 209Kt in 1968 to 118Kt in
1980.

The industry is based on extensive grazing, and whereas sheep
production has stagnated, beef production has increased. The flocks
which remain are mainly kept for domestic purposes, though a few
larger, commercial enterprises still exist. In the commercial flocks
sheep are dual purpose animals, with wool being the most valuable
Weather has an effect on production (Johns, 1978), but it was not possible to incorporate this into the model, even using a dummy variable. Apart from data limitations, there are wide climatic differences between regions and conditions vary from flooding to extreme drought. The equation estimated here was as follows:

\[
SAR = 18.55 + 0.85SAR_1 - 0.46E^{-07}PAR_2 - 0.46E^{-02}PBAR_2 + (0.40)^* (4.44) (0.01)^* (0.65)^*
\]

\[
0.40E^{-01}PWLAR_2 - 0.23T
\]

\[
(0.77)^* (0.15)^*
\]

\[
R^2=0.77 \quad DW=1.65 \quad S=17.49 \quad F(5,13)=8.91
\]

Seventy six per cent of the variation in supply in Argentina was explained by previous levels of supply (SAR1), sheepmeat prices (PAR2), beef prices (PBAR2), wool prices (PWLaR2) and a time trend (T). Calculation of the 'h' statistic (1.54) indicated that autocorrelation was not a problem.

Only one coefficient (that of the lagged dependent variable) was significant; this could be the result of not having captured producer responses correctly in periods of extreme inflation. It should also be noted that many sheep flocks in Argentina are not kept for commercial purposes and do not therefore respond to economic pressures strongly. This was confirmed by the size of the coefficient of the lagged dependent variable, which reflects the traditionalism inherent in the industry.

A positive response was determined for wool prices, suggesting that producers increase breeding ewes and subsequently output, in response to rising prices. The elasticity with respect to wool prices was low, at 0.13, but was not significant.

Beef appeared as a competitive enterprise to sheepmeat production, with a cross price elasticity of -0.17. The own price coefficient was negative but had little effect on sheepmeat supplies, and neither beef nor sheepmeat prices were significant.

To determine whether the revolution in 1974 had any effect on supply, a dummy variable was tested, since production fell 24Kt in that year. The results were no better than the original equation, so the dummy variable was omitted. Similarly, wheat prices were tested in the equation, to represent another alternative enterprise to sheep farming, but there was no significant effect on supply of sheepmeat.

The proxy variable 'T' had a negative sign, even though technological change would be expected to increase output. The long term decline suggests that social and institutional factors have outweighed any increases in efficiency.
3.1.5 The United Kingdom.

The UK has the largest sheep industry in the EEC, with a flock of some 20 million head. Production systems differ from most other countries, being based on the interdependence of hill and lowland flocks (Lavercombe, 1978).

A 'Fat Sheep Guarantee Scheme' was used by the Government for many years to support farm incomes, and this in turn stabilised both sheep numbers and production of sheepmeat. UK production varies annually around 250Kt, but has shown no distinct trend. Wool is an important secondary product from the industry, and wool prices are also guaranteed by the Government.

Production (SUK) was estimated to be a function of the prices of sheepmeat (PUK), beef (PWBUK) and wool (PWLUK) and a dummy variable (DUK) to account for accession to the EEC.

\[
SUK = 35.33 + 0.39SUK1 - 0.98E-01PUK2 + 0.18PWBUK2 + 0.30* (1.08)* (0.34)* (0.71)* 135.28PWLUK2 + 20.85DUK \\
(1.09)* (0.83)* 23.76DUK
\]

\[
R^2 = 0.26 \quad DW = 1.39 \quad S = 18.27 \quad F(5,13) = 0.94
\]

Though the signs of the coefficients were as expected, the value of $R^2$ was poor, and none of the coefficients was significant. It was thought that this could have been the result of using an inappropriate price series, so another equation was estimated, using the Guaranteed price for sheepmeat.

\[
SUK = 173.97 + 0.13SUK1 - 151.36PUK2 + 153.55PWLUK2 + 0.62PWBUK2 + 1.17* (.37)* (.82)* (1.51)* (.53)* 23.76DUK \\
(.94)*
\]

\[
R^2 = 0.40 \quad DW = 1.49 \quad S = 14.55 \quad F(5,13) = 1.75
\]

While the equation shows that much of the stability in British supply is due to stable prices, it performed little better than the previous one. Therefore, since the objective was to determine the supply response to changes in the world price, the initial equation was retained.

The equation implies a relatively high coefficient of adjustment, which is probably much lower, in reality. The response to sheepmeat prices is, though, as expected, extremely low (at -0.003). The elasticities with respect to beef and wool prices were 0.18 and 0.226 respectively. The dummy variable indicates that supply in the UK increased as a result of joining the Common Market.
3.2 The Demand Equations

3.2.1 The EEC (10).

Sheepmeat consumption in most states in the EEC is relatively unimportant, and is only 3.4% of all meat eaten, at 3kg per capita. Total sheepmeat consumption has varied around 800Kt per annum, but this masks trends within the Community, as consumption has fallen in Ireland and the UK but risen in France, Italy and West Germany.

The EEC was divided into 3 regions; the EEC(8), the UK and Greece.

(i) The EEC (8)

The following equation was estimated for the EEC (8), where per capita consumption (PCEC) is determined by sheepmeat prices (PEC), per capita incomes (YEC), the price of beef (PBEc) and a time trend (T). The resulting equation was generally satisfactory, though only the intercept term and one of the coefficients was significant.

\[ PCEC = 0.94 - 0.76 \times 10^{-4} PEC + 0.17 \times 10^{-4} YEC - 0.62 \times 10^{-4} PBEc + 0.40 E^{-01} T \]

\[ (7.08) \quad (0.64) \quad (0.20) \quad (0.50) \quad (7.58) \]

\[ R^2 = 0.93 \quad DW = 1.13 \quad S = 0.73 \quad F(4, 16) = 57.08 \]

The price response was as expected, yielding a negative elasticity of -0.12, and similarly, the income elasticity was negative (-0.19). The response to beef price changes was positive, with an elasticity of 0.15.

To see if the formation and enlargement of the EEC had had any effect on consumption, dummy variables were tested. There appeared to be no significant change, so they were omitted from the final equation.

The time trend had a small positive effect on consumption, and was highly significant. This implies that tastes and changing consumption patterns cause, ceteris paribus, small annual increases in market demand. In the EEC, these changes are mainly the result of increasing migrant workers and other ethnic groups, and the desire for more variety in the diet.

(ii) The United Kingdom

Meat consumption in Britain is high, with a per capita consumption of 75kg, but the market is dominated by beef and an increasing amount of pork and poultry meat. From 1960-80 per capita consumption of sheepmeat declined by 36%, from 11.2kg to 7kg. Total consumption fell likewise from 604Kt to 410Kt.
The main factors affecting demand are income (YUK), sheepmeat prices (PUK), prices of substitutes, such as beef (PRBUK), pork (PRPUK) and poultry (PRCUK), and other factors which affect demand that are accounted for implicitly in a time trend.

\[
PCUK = 12.09 - 0.43E-02PUK + 0.10E-01YUK - 0.74E-01PRBUK + 0.44E-01PRPUK - 0.17PRCUK - 0.50T
\]

\[
(2.55) \quad (1.48) \quad (1.23)^* \quad (1.20)^* \quad (2.99) \quad (3.47)
\]

\[R^2=0.97 \quad DW=2.43 \quad S=0.31 \quad F(6,14)=92.77\]

The equation has an extremely good fit, explaining 97% of the variation in UK consumption. Three of the coefficients were not significant though, and two were not of the expected sign.

The price and income elasticities were -0.14 and 0.95 respectively, which were consistent with those from other studies (Appendix 3).

The substitution effects between sheepmeat and other meats were not distinctive in the equation. The results reaffirm the difficulties encountered by other researchers in obtaining consistent coefficients (Colman, 1976). Only pork prices had a positive coefficient, which denotes a competitive good, but the coefficient was not significant. Beef and poultry prices both had negative signs, which is usually indicative of a complementary product. Both meats are considered to compete with sheepmeats, though the coefficient of the chicken price variable was significant. The elasticities for all three were quite low, with -0.25 for beef, 0.13 for pork and -0.35 for poultry meat. No attempt was made to include other substitutes, such as fish or bacon, but the above results suggest a total cross price elasticity for these goods of about -0.34.

The time trend, a proxy for taste and institutional change, gave a negative, highly significant coefficient, which follows the long term decline in sheepmeat consumption in the UK.

(iii) Greece

Sheepmeat consumption (which also includes goatmeat consumption) is higher in Greece than most European countries at 14kg per capita. The preference is for small, young lambs or kids, bought fresh. Frozen, imported meat is heavily discounted, but only accounts for 10% of domestic consumption and is mainly mutton. There appear to be no direct substitutes for sheepmeat, so the following equation was estimated, where consumption (PCG) is determined by prices (PG), incomes (YG), trend factors (T), and a dummy variable (DG) to account for the change in Government in 1974.
PCG = 12.10 - 0.92E-04PG + 0.85E-04YG - 3.90DG + 0.24T

(6.60) (0.96)* (0.51)* (4.45) (0.76)*

R^2=0.75  DW=1.09  S=0.89  F(4,16)=12.11

A reasonable amount of variation in consumption was explained but the stability of consumption was reflected by the large, highly significant constant term, around which consumption has varied little.

Demand was not highly responsive to prices; this is partly because sheepmeat is a staple food in the Greek diet, but also because the Government fixed domestic prices for several years, so changes in demand were in response to factors other than world prices. Hence the price elasticity was relatively low at -0.16 and the coefficient was not significant.

The dummy variable explained the drop in per capita consumption in 1974 of around 4kg. Against this was a tendency for consumption to increase as incomes increased and over time as tastes and consumption patterns changed. The response to income changes was small though and not significant and Greece has an income elasticity of only 0.19.

3.2.2 North America.

North American was treated as two separate regions; Canada and the USA. Per capita consumption of all meat in the USA is amongst the highest in the world, at 118kg per annum. Of this, less than 1kg is mutton or lamb, and whilst other meats have shown distinct increasing trends, consumption of sheepmeats declined by more than two-thirds over the period.

However, the large population of 221 million, with even a low per capita consumption, ensures a sizeable total consumption of 159Kt (419Kt in 1960).

The factors affecting quantities of sheepmeat consumed (PCUS) are prices of sheepmeat (PUS) and other meats (PBUS), income levels (YUS) and taste factors (T), as in the following equation:

PCUS= 1.77 - 0.27E-03PUS + 0.27E-04YUS + 0.64E-03PBUS - 
(5.86) (1.47) (0.49)* (3.11)
0.82E-01T
(12.34)

R^2=0.98  DW=1.79  S=0.08  F(4,16)=222.10

All the signs were as expected, and all the coefficients are significant, except for income. Both the value of the R^2 and the DW were satisfactory.
Income was found to have little effect on consumption. However, it was included in the final equation, as it allows the income elasticity of demand to be calculated. This proved to be +0.08, although the coefficient was not significant.

The response of consumption to changes in sheepmeat prices was significant at the 10% level, and this yields a derived elasticity of only -0.16. (Other studies' estimates of actual elasticities are larger, for reasons given in Chapter 4. They are in the range of -1.6 to -2.6, as summarised in Appendix 3).

Demand for sheepmeat is strongly affected by the price of substitutes, and the equation showed that beef prices are highly significant. No other prices were included here, as 98% of the variation was explained by the given equation. The cross price elasticity calculated for beef was 0.48, and application of the homogeneity condition to the equation suggests that the cross price elasticity for all other substitutes is 0.40.

Finally, the time trend was also highly significant, and reflected the long term decline in sheepmeat consumption in the USA.

A separate equation was estimated for Canada, though its meat market resembles that in the USA and is therefore not discussed here in detail. The following equation was estimated, where per capita consumption (PCC) is a function of prices (PC), incomes (YC), beef prices (PBC) and trend factors (T).

\[
PCC = 2.71 - 0.17E-02PC + 1.11E-02YC + 0.25E-02PBC - 0.13T
\]

\[
(0.87) \quad (2.07) \quad (1.63) \quad (2.35) \quad (1.66)
\]

\[
R^2 = 0.60 \quad DW = 2.04 \quad S = 0.32 \quad F(4,16) = 6.12
\]

The equation only explained 60% of variation in Canadian consumption though the equation was generally good, and most variables had coefficients which were significant (except for the intercept term) and had the expected sign.

Income had a positive coefficient, since lamb (the main type of sheepmeat now eaten) is considered a luxury item in Canada. This gave an income elasticity of 2.79, which is close to those reported in Appendix 3, but higher than for most countries.

Price had the expected negative sign, and the coefficient yielded an elasticity of -0.99 which again, is relatively high.

Beef prices were also significant in explaining sheepmeat demand and gave a high cross price elasticity of 1.87. The inclusion of pork and chicken prices could have improved the results but application of the homogeneity condition indicates that a total cross price elasticity of around -3 could be expected for such meats.
Inclusion of a trend variable (T) reflects the long term decline in consumption, similar to that in the USA, caused largely by a shift from mutton to lamb consumption.

3.2.3 Iran.

Of the Middle East countries, Iran has the largest population, with 35 million people, and also the largest total demand for sheepmeat. Until recently consumption was restricted by low income levels. Following the oil-price rise in 1974-77 total consumption grew 45%, though it fell slightly towards the end of the decade, reflecting the problems caused by the political situation. Even at its highest levels of 12kg per capita, it was far below consumption levels in other Middle East states (eg. Qatar, at 29.1kg).

Consumption in Iran (PCI) was estimated to be a function of prices (PI), incomes (YI) and a dummy variable to show the effects of the revolution in 1978.

\[
PCI = 7.61 - 0.42 \times 10^{-4} PI + 0.75 \times 10^{-4} YI - 2.61 DI \\
(3.98) \hspace{1cm} (1.17) \ast \hspace{1cm} (8.73) \hspace{1cm} (2.81)
\]

\[ R^2 = 0.86 \hspace{1cm} DW = 1.79 \hspace{1cm} S = 0.91 \hspace{1cm} F(3,17) = 34.82 \]

A large proportion of consumption was explained by the equation and there was no significant autocorrelation. The variables had coefficients of the expected sign and size. In the past prices have been set by Governments, and thus, as was expected, the analysis showed that demand was not highly responsive to international price changes, with a price elasticity of -0.28.

There has been little substitution between meats in the past, so no other prices were included in the equation. An increasing amount of poultry meat is being eaten in the Middle East though, which is likely to pose increasing competition in future.

Incomes were, predictably, the most significant factor determining consumption, and an income elasticity of 0.41 was calculated.

The dummy variable was significant, and indicated that per capita consumption fell by about 2.5kg as a result of the revolution in Iran.

3.2.4 Japan.

Meat consumption in Japan rose 330% from 1960 to 1980, but by western standards the meat diet is still rather frugal. Sheepmeat consumption was only 7% of all meat eaten in 1980, at around 1kg per capita, though this is twice the 1960 level. Total sheepmeat consumption has therefore risen fivefold, given the high population growth rate, from 24Kt in 1960 to 253Kt in 1975, though it had fallen back to 176Kt by 1980.
Only 36% of the sheepmeat is consumed directly, due to the Japanese dislike of the taste and smell, and a preference for fish and other meats. The remaining 74%, which is mainly mutton, is used as an additional source of protein in processed hams and sausages, and in the fast-food industry. The annual usage for manufacture is greatly affected by moves in the cost of pork and pork based products, and by mutton prices.

The following equation was estimated, where per capita consumption in Japan (PCJ) is a function of prices (PJ), incomes (YJ), and the prices of beef (PBJ) and pork (PPJ):

\[
PCJ = -0.56 - 0.31E-05PJ + 0.15E-02YJ + 0.25E-02PPJ + 0.24E-03PBJ
\]

\[
(0.68) \quad (2.01) \quad (2.57) \quad (2.98) \quad (0.55)
\]

\[
R^2=0.77 \quad DW=1.30 \quad S=0.20 \quad F(4,16)=13.69
\]

The signs in the equation were as expected, and the coefficients significant, except for the beef price and the intercept term.

Pork appeared as the main substitute, and had a high cross price elasticity of 1.18. A cross price elasticity of 0.36 showed that demand was also responsive to changes in beef prices.

By applying the homogeneity condition to the equation, the total cross price elasticity with respect to all other goods (such as whale, horsemeat and fish) would be around -1.10. Increasing incomes were shown to have encouraged meat consumption, and therefore there was a high income elasticity of demand with respect to sheepmeat of 1.02.

Because of its use in manufacturing, and its use as a non-traditional, non-staple food, a relatively high own price elasticity was calculated from the equation, of -0.94. Demand is responsive to international price changes since there is no domestic production and little market protection.

3.2.5 The USSR.

The USSR has the world's largest number of sheep and annual output of sheepmeat. Though productivity is lower than in many countries, domestic production has always provided at least 95% of domestic consumption.

Sheepmeat consumption is fairly stable, at around 4kg per capita or 800Kt–1,000Kt. Russian people generally have no prohibitions or inhibitions about eating sheepmeat but consumption is restricted by low incomes and political forces which control product availability.

To maintain availability in times of shortfalls in domestic production, imports have been permitted. For some time during the late 1960's the USSR was something of a bargain-basement hunter, purchasing...
bulk meats to fill the protein gap. Recent purchases of mutton at higher prices suggest the recognition of both a need to compete in the world market, and the need to satisfy consumer demand.

To obtain some information on the order of magnitude of the price elasticity of demand in the USSR for other countries' sheepmeat, a single regression equation for quantity of imports (MR) was run on world sheepmeat prices (DPW) and time (T), a proxy for income, taste, population growth, market development and government policy.

\[
\begin{align*}
MR &= 30.51 - 0.087DPW + 6.34T \\
(0.43) &*(0.82)* (4.66)
\end{align*}
\]

\[R^2 = 0.62 \quad DW = 1.20 \quad S = 29.14 \quad F(2,18) = 14.69\]

The equation explained the sporadic imports reasonably well, though the \(R^2\) value was only 0.62. This could be because the decision to import is in reality more complex, including for example, political decisions, which are not known and cannot be included. The strong time trend however, indicated the improvement in living standards, and the effect of population growth (1.2% per annum) on demand for imports.

Clearly, the estimated parameters are of a very tentative nature, but even so the estimates suggest that import demand for sheepmeat is price responsive. From the equation a price elasticity of -1.83 was calculated, though the coefficient was not significant.
CHAPTER 4

DISCUSSION OF THE ESTIMATED MODEL

4.1 Derived Demand and Supply Responses

This chapter summarises the estimated model of the international sheepmeat trade, and examines various aspects of responses in the market.

The derived price and income elasticities for sheepmeat supply and demand that were estimated in the model are given in Tables 3 and 4.

Caution must be taken in interpreting the estimated elasticities. Firstly, all elasticities of supply and demand with respect to prices are calculated at the respective means. As such they are point elasticities and may vary considerably if determined at different points. A further consideration is that the elasticities measure the derived supply and demand response to changes in world market prices, not domestic producer or consumer prices, as was discussed in Chapter 2. This means that the elasticities are often lower than in other studies, since derived demand and supply elasticities are generally smaller than actual (farm level) supply and (retail level) demand elasticities (Foote, 1958). Moreover, the derived responses here relate to changes in real prices, whereas several studies work with nominal values. It may be that failure to account for inflation would result in over-estimates of the size of responses.

Another reason for estimates being smaller than in other studies is that elasticities calculated here are short- and medium-run measures of response, which are generally lower than long-run responses. The derived elasticity therefore provides a lower bound to the estimated value of the actual elasticity.

Finally, it may be that the price series used is differentiated from the price to which local producers or consumers respond. This could be the case where, for example, consumer preference is for fresh, locally produced sheepmeat, and there is only a small demand for frozen, imported product. Similarly, prices paid to farmers for live sheep at auction markets or slaughter-houses could be quite different from those prevailing in wholesale markets. In both cases, where the price transmission between trading and local prices is low, it would not be surprising if there was little or no response to world market prices.

Unfortunately, because of lack of information on retail and farm level prices it was not possible to determine the actual producer and consumer responses. Thus the actual elasticities can be approximated from the derived estimates in Chapter 3 and information on price
### TABLE 3

**Supply Responses in the Model**

<table>
<thead>
<tr>
<th>Country</th>
<th>Elasticity With Respect to Price of: ( b )</th>
<th>Coefficient of: Lagged Dependent Variable</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sheepmeat</td>
<td>Wool</td>
<td>Beef</td>
</tr>
<tr>
<td>Argentina</td>
<td>0.01&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.13&lt;sup&gt;a&lt;/sup&gt;</td>
<td>-0.17&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Australia</td>
<td>-0.10&lt;sup&gt;a&lt;/sup&gt;</td>
<td>-0.23&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.30&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Canada</td>
<td>-0.29&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.12</td>
<td></td>
</tr>
<tr>
<td>EEC (8)</td>
<td>-0.009&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>East Europe</td>
<td>1.27&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Greece</td>
<td>0.16</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Iran</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>New Zealand</td>
<td>0.01&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.06&lt;sup&gt;a&lt;/sup&gt;</td>
<td>-0.02&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>UK</td>
<td>-0.13&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.27&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.29&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>USA</td>
<td>-0.005&lt;sup&gt;a&lt;/sup&gt;</td>
<td>-0.07&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>Rest-of-World</td>
<td>0.54</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup> Coefficient not significant at 10% level.

<sup>b</sup> Lag of two years.
### TABLE 4
Demand Responses in the Model

<table>
<thead>
<tr>
<th>Country</th>
<th>Elasticity With Respect To:</th>
<th>Coefficient of Time Trend&lt;sup&gt;c&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Own-Price</td>
<td>Income</td>
</tr>
<tr>
<td>Argentina</td>
<td>-0.18</td>
<td>-0.21&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Australia</td>
<td>-0.54</td>
<td>+0.27&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Canada</td>
<td>-0.99</td>
<td>2.79&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>EEC (8)</td>
<td>-0.12&lt;sup&gt;a&lt;/sup&gt;</td>
<td>-0.19</td>
</tr>
<tr>
<td>Greece</td>
<td>-0.16&lt;sup&gt;a&lt;/sup&gt;</td>
<td>+0.19&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Iran</td>
<td>-0.28&lt;sup&gt;a&lt;/sup&gt;</td>
<td>+0.41</td>
</tr>
<tr>
<td>Japan</td>
<td>-0.94</td>
<td>1.02&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>New Zealand</td>
<td>-0.15&lt;sup&gt;a&lt;/sup&gt;</td>
<td>-0.94&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>UK</td>
<td>-0.14</td>
<td>+0.95&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>USA</td>
<td>-0.16</td>
<td>+0.08&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>USSR</td>
<td>-1.83&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>Rest-of-World</td>
<td>-0.40&lt;sup&gt;a&lt;/sup&gt;</td>
<td>+0.89</td>
</tr>
</tbody>
</table>

<sup>a</sup> Coefficient not significant at 10% level.
<sup>b</sup> Calculated from homogeneity condition.
<sup>c</sup> Brackets denote coefficient obtained from other (i.e. not final) equations.
transmission between world prices and wholesale prices (see Table 2 and Blyth, 1982).

In comparison to the elasticities given in Tables 3 and 4 there was little difference between the actual and derived estimates, as the transmission elasticities used were close to unity. However, since not all factors which restrict trade are included in the price transmission elasticities (such as meat quality differences and health regulations), they could be lower than those used. Therefore, as the derived elasticities provide a lower bound to actual elasticities, the actual elasticities could be significantly larger, in reality.

4.2 Responses in the Model

(i) Supply Responses

On the supply side in general, the diversity of responses reflects differences in production techniques and farming structures between countries. The main determinants of sheepmeat supply were found to be prices of sheepmeat, wool and beef, previous levels of supply, weather conditions and trend factors such as technological improvements.

The results in Table 3 show that production responsiveness to economic factors is small, and in many cases the coefficients do not have the expected sign and are not statistically significant. It is difficult therefore to make inter-regional comparisons and to draw general conclusions. The elasticities have a number of interesting features, nevertheless.

Responses to changes in sheepmeat prices varied widely, from approximately zero in Argentina, to 0.16 in Greece. Producers in traditional exporting countries (NZ, Argentina and Australia) showed little response to world price changes. Price responses were larger in the non-traditional exporting regions, Eastern Europe and the Rest-of-World sector, as these are excess supply elasticities.

In five cases the own-price elasticities were negative, which is hard to justify in this form of model, as was discussed in Chapter 2. Unless an alternative reason can be given for why responses should actually be negative after two years, causes of the perverse responses must be looked for in the modelling process itself. It was suggested in Chapter 2 that producers react to relative, not absolute price changes. In certain cases this was shown to be true, but the responses still had negative coefficients. Another reason could be that the price deflators used are inappropriate, in that they fail to account for either the timing of, or the size of producers' responses to actual price changes.

4 To account for apparent inconsistencies, some of the equations were re-estimated and an alternative forecast made (see Section 5.3 and Appendix 6).
However, insufficient is known about producer behaviour in times of inflation to treat it differently. Similarly, it should be recalled that these are derived responses to world, not farm-gate prices and the degree of transmission between the price series used could be very low. This would also account for the lack of significance among the coefficients as well as the negative price responses.

Wool generally appeared as a complementary enterprise to sheepmeat production. Responses were similar in NZ and Argentina where sheepmeat is the main product from the industry. In Australia, where wool is the main product, the response to changes in wool prices was greater and negative, for reasons given in Chapter 2.

In virtually all cases the elasticities with respect to beef prices were not significant. Some were positive in the medium term, indicating that producers were reducing sheep numbers to replace them with cattle.

Thus, in the majority of equations economic factors were not important in explaining production levels. The lagged dependent variable and the time-trend coefficients were the most significant and the two variables had most of the explanatory power.

Production in current periods is affected by the relationship between production and sheep numbers in previous periods. Unless this is a linear relationship the coefficients of the lagged dependent quantity variable cannot be justified with a simple partial adjustment approach (see Section 2.4). Estimates of the functions were not made, for reasons given previously; consequently the alternative justification advanced in Section 2.4 is accepted. In this case the lagged dependent variable indicates the extent to which farmers are guided in their production decisions by supply in the previous period.

The coefficients of the lagged dependent variables ranged from 0.39 to 1.03. A common feature was that large coefficients were associated with low responses to sheepmeat price changes. This could imply that producers who are slow to adjust are bound by traditional and physical constraints. They are not able to respond rapidly to changes in relative price levels, because of the difficulty of shifting factors in and out of sheepmeat production. For example, much of the world's sheep farming takes place on marginal land which has few alternative uses. Alternatively, if in reality producers respond to some price series other than the one used, the lagged dependent quantity variable is likely to be highly significant as it will compensate for the lack of economic explanation in the equations.

The response to time shows the underlying secular trend around which the price responses occur. In virtually all cases there was an increasing trend (the coefficient of 'T' being positive), since it was a proxy for such things as technology and heavier average carcase weights. In two cases (Argentina and Australia) the technological effects were outweighed by overall long term trends and produced a negative coefficient.
(ii) **Demand Responses**

On the demand side there are differences in the base levels of consumption and therefore, as is shown in Table 4, different responses were observed. The main determinants of demand were found to be prices of sheepmeat and other meats, income levels, tastes and other trend factors.

The price responses showed more similarity than on the supply side and tended to be more significant and greater than the medium term supply elasticities.

Sheepmeat price changes generally gave less than proportionate changes in consumption, as in all cases the elasticities lay between zero and minus one. Aggregation of individual price elasticities, weighted by average market share, gives an approximation of the world average derived demand elasticity for sheepmeat. This has a value of -0.28.

In cases where it was possible to include prices of other meats explicitly the responses were found, as expected, to be mainly positive and less than unity. The main substitutes were identified as beef, pork and poultry meat. Because of difficulties in determining responses for all substitutes, estimates of cross price elasticities were obtained from the homogeneity condition. This gave a wide range of values, which frequently showed that some goods would be complements to sheepmeat, depending on taste and relative price factors within the country concerned. The small size of the cross price elasticity in cases such as Iran, indicated that there are few substitutes. Where large values were obtained (e.g. NZ) there are many other meats eaten.

The income elasticities of demand showed that in a minority of cases sheepmeat is an inferior good, with consumption falling as incomes rise. In the majority of countries sheepmeat consumption rises as incomes rise, and these countries exhibited an average elasticity of 0.75.

For many agricultural commodities the rate of increase of income largely determines the level, pattern and variation in per capita consumption. This is especially so in developing countries. However, for sheepmeat the effect was not so pronounced (except for the Middle East countries) and it tended to be taste factors which determined the quantity of sheepmeat eaten.

The estimated secular trends (indicated by the coefficient of 'T') showed that almost all the significantly non-zero trends were negative in the traditional, high level consumption countries, reflecting the shift away from sheepmeat consumption. The shift in consumption shares away from the traditional countries to new markets is associated primarily with these negative trends. In the growing import markets, such as the EEC(8), Greece, Iran, the USSR and the Rest-of-World sector the trends were evidence of increasing consumption levels.
Dummy variables were included in three cases in the demand functions. They represented the effects of political disturbances in Iran, Greece and Argentina, and there was a surprising similarity in the results. In all three cases consumption fell immediately by between 1.7 and 2.7kg per capita. Only in Argentina was there any evidence of the disturbances affecting supply to any extent; in both Greece and Iran the fall in consumption corresponded to reductions in trade.

In general both supply and demand responses confirmed estimates for individual countries calculated by others. The value of having recalculated them was obtaining estimates for countries and regions which were not available previously. Recalculation also ensures that responses were calculated on a uniform basis, and would be appropriate therefore for comparison and for further use later in the study.

(iii) International Trade and Prices

The system is completed with a set of relationships representing trade flows. These trade flows are determined as the residual of domestic supply and demand. For example, the demand for imports in the UK has declined; this was caused by a fall in consumption as a result of relative price and taste changes, and increasing self-sufficiency levels as supply has remained stable. Similarly in the Middle East, rapidly growing incomes and population have increased total demand for sheepmeat at a greater rate than production. These different growth rates were reflected in the outward shift in the excess demand curve during the 1970's.

The world market-clearing price is determined by the simultaneous interaction of supply and demand of each of the main trading countries or regions. As was shown in the previous section, the derived elasticity of demand with respect to prices tended to be greater than that of supply, though responses on both sides were low. A dynamic model where the supply curve is steeper than the demand curve is likely to have convergent properties. Following a change in output in one period, the oscillations in price and quantity become smaller in successive time-periods until equilibrium is eventually established.

Moreover, because of the low degree of market protection, fluctuations in any one market are more readily transmitted to, and hence absorbed by, other markets. (Unlike, for instance, the wheat market, where the degree of protection has led to a small and highly unstable residual market (Zwart and Meilke, 1979)).

Sheepmeat prices have shown some instability, especially in the short term, which is partly a result of the very low responses of both supply and demand. This is particularly so in the mutton market, as the elasticity of demand and supply tend to be much smaller for mutton than for lamb (OECD, 1979). It was not possible though to investigate the latter because of the aggregation of mutton and lamb in the model.
CHAPTER 5

MODEL SIMULATION

5.1 Introduction

Simulation analysis (i.e. the mathematical solution of a simultaneous set of equations) can be carried out for many purposes. These include "model testing and evaluation, historical policy analysis, and forecasting. Usually the time horizon over which the simulation is performed will depend on the objective of the simulation" (Pindyck, 1976). In this chapter both ex post and ex ante simulations are carried out. The objective of performing a historical ex post simulation over the period 1960-80 was to validate the model. The objective of performing an ex ante simulation over the 1981-90 period was to provide forecasts and a base simulation for comparison in the following chapter.

5.2 Validation of the Model

Some emphasis was placed on validation as this is a first generation model of the market. Rigorous testing was therefore required for want of alternative studies with which to make comparison.

The model was validated by comparing variables predicted from the solution of the estimated structural relationships with actual market behaviour.

A satisfactory model implies one in which the estimated equations have captured a significant amount of the systematic, non-random structure of the market. That is, the endogenous variables in the model approach closely their equilibrium values, given the values of the exogenous variables (Kost, 1979). Thus, an ex post dynamic simulation of the model was performed (using Newton's method) and the usual criteria applied to test the system's performance over the period.

Results of the tests of the dynamic simulations are reported in Appendix 4. The dynamic simulation exhibits an average Root Mean Square Error of 8.8%, and an R² of 0.72. The other results indicate that the model's performance is generally satisfactory, and explains a major

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5 The criteria used for determining the validity of the model's output were: the correlation coefficient, Mean Absolute Relative Errors, Root Mean Square Errors and Theil's Inequality Coefficient. Graphical examination of actual and simulated values provided information on turning points.
FIGURE 7

Actual and Predicted Values of World Trade

FIGURE 8

Actual and Predicted Values of U.K. Imports
FIGURE 9
Actual and Predicted Values of N.Z. Exports

FIGURE 10
Actual and Predicted Values of World Sheepmeat Prices
(UK £, 1970)
proportion of actual variation throughout the historical period of fit. The time paths of actual and predicted values of four key variables are presented in Figures 7-10.

The world market price in the model is determined by the simultaneous interaction of supply and demand, such that there is global equilibrium. The most stringent test of the model's performance is therefore its ability to predict prices. As can be seen in Figure 10, the simulation path of the world price generally reflected the moves in market prices. Not all the turning points were predicted in the early years but the model predicts quite closely the level of prices in the 1960's. The rapid increase in real price in 1973 is simulated and the extent of that increase (over 70%), is largely captured. Since this is the key variable in the system its performance increases confidence in the model.

5.3 Forecasting with the Model

An ex ante simulation of the model was performed from 1981-1990, the decade following the estimation period. The objectives in doing so were to examine the forecasts of the time-paths of the main variables, to assess the outlook for sheepmeat in the international markets over the ten year period, and to provide a Base forecast for comparison in the policy analysis.

Various assumptions were made about the level of exogenous variables. Real per capita incomes and population levels were extrapolated to 1990, using geometric growth rates given by FAO (1979). Other exogenous variables were maintained at their most recent levels for the entire period. Initial values of the lagged endogenous variables were taken to be the actual 1980 estimates. The system's sensitivity to, and the implications of assuming such levels are discussed later in this section.

The projections for 1985 and 1990 are summarised in Table 5. FAO forecasts are also given in the table for comparison and a summary of other projection studies is given in Appendix 5.

Most other studies are based on trend extrapolation, rather than formal analysis of the structure of supply and demand. In general the trends in results are similar, even though in some cases the magnitude of the changes differ.

The main divergencies were under-prediction by the model of NZ and Australian supply, and of North American and Australian consumption. On the trade side the results were also similar, but with under-prediction of exports from Argentina, Eastern Europe, NZ and the Rest-of-World sector, and of imports by North America and the Rest-of-World import sector.

Most of the divergencies which did occur were to be expected. The more conservative estimates of activity in the market predicted by the model were made taking into account certain events which occurred
TABLE 5

Projection of Sheepmeat Production, Consumption and Trade to 1985 and 1990

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Actual</td>
<td>Model f</td>
<td>FAO a</td>
</tr>
<tr>
<td>Production</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Argentina</td>
<td>118</td>
<td>80.0</td>
<td>158-194 b</td>
</tr>
<tr>
<td>Australia</td>
<td>551</td>
<td>582.7</td>
<td>774-788</td>
</tr>
<tr>
<td>Canada</td>
<td>5</td>
<td>10.0</td>
<td>5-7</td>
</tr>
<tr>
<td>EEC (8)</td>
<td>311</td>
<td>333.5</td>
<td>291-319</td>
</tr>
<tr>
<td>Greece</td>
<td>120</td>
<td>140.3</td>
<td>110-120</td>
</tr>
<tr>
<td>Iran</td>
<td>350</td>
<td>298.6</td>
<td>276-324</td>
</tr>
<tr>
<td>New Zealand</td>
<td>568</td>
<td>494.6</td>
<td>642-656</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>278</td>
<td>236.4</td>
<td>270-279</td>
</tr>
<tr>
<td>USA</td>
<td>144</td>
<td>77.3</td>
<td>97-85</td>
</tr>
</tbody>
</table>

Per Capita Consumption (kg)

<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>Model f</td>
<td>FAO a</td>
</tr>
<tr>
<td>Argentina</td>
<td>3.8</td>
<td>3.6</td>
<td>3.4</td>
</tr>
<tr>
<td>Australia</td>
<td>21.9</td>
<td>9.5</td>
<td>17.8-16.9</td>
</tr>
<tr>
<td>Canada</td>
<td>0.8</td>
<td>0.8</td>
<td>1.8</td>
</tr>
<tr>
<td>EEC (8)</td>
<td>1.9</td>
<td>2.0</td>
<td>1.8-1.9</td>
</tr>
<tr>
<td>Greece</td>
<td>13.5</td>
<td>16.1</td>
<td>14.2-14.4</td>
</tr>
<tr>
<td>Iran</td>
<td>11.1</td>
<td>11.9</td>
<td>13.2-14.3</td>
</tr>
<tr>
<td>Japan</td>
<td>0.7</td>
<td>1.2</td>
<td>1.4-1.5</td>
</tr>
<tr>
<td>New Zealand</td>
<td>32.7</td>
<td>34.6</td>
<td>31.3-30.3</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>7.7</td>
<td>6.2</td>
<td>6.6</td>
</tr>
<tr>
<td>USA</td>
<td>0.7</td>
<td>0.2</td>
<td>1.0</td>
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</table>

Exports

<table>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Model f</td>
<td>FAO a</td>
</tr>
<tr>
<td>Argentina</td>
<td>14.0</td>
<td>-24.2</td>
<td>58-94</td>
</tr>
<tr>
<td>Australia</td>
<td>247.0</td>
<td>434.3</td>
<td>490-520</td>
</tr>
<tr>
<td>East Europe</td>
<td>26.0</td>
<td>32.7</td>
<td>110-120</td>
</tr>
<tr>
<td>New Zealand</td>
<td>450.0</td>
<td>387.3</td>
<td>530-550</td>
</tr>
<tr>
<td>Rest-of-World</td>
<td>129.0</td>
<td>164.2</td>
<td>(242)-(326)c</td>
</tr>
</tbody>
</table>

Imports

<table>
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</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Model f</td>
<td>FAO a</td>
</tr>
<tr>
<td>Canada</td>
<td>14.0</td>
<td>10.1</td>
<td>50-40</td>
</tr>
<tr>
<td>EEC (8)</td>
<td>59.0</td>
<td>87.8</td>
<td>80-70</td>
</tr>
<tr>
<td>Greece</td>
<td>8.0</td>
<td>14.4</td>
<td>20-10</td>
</tr>
<tr>
<td>Iran</td>
<td>65.0</td>
<td>185.4</td>
<td>320-320</td>
</tr>
<tr>
<td>Japan</td>
<td>79.0</td>
<td>144.1</td>
<td>180-190</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>154.0</td>
<td>113.0</td>
<td>110-100</td>
</tr>
<tr>
<td>USA</td>
<td>15.0</td>
<td>-26.8</td>
<td>130-150</td>
</tr>
<tr>
<td>USSR</td>
<td>160.0</td>
<td>107.9</td>
<td>10.0</td>
</tr>
<tr>
<td>Rest-of-World</td>
<td>372.0</td>
<td>358.4</td>
<td>(530)-(820)c</td>
</tr>
</tbody>
</table>

World Trade

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Model f</td>
<td>FAO a</td>
</tr>
<tr>
<td>World Trade</td>
<td>866.0</td>
<td>994.4</td>
<td>1430-1610d</td>
</tr>
</tbody>
</table>

World Price $2,606.00 $3,128.91 $3,999.64

Source: FAO Agricultural Commodity Projections 1975-85 (1979)

Range based on Basic and Supplementary forecasts

Encompasses wider area than model's Rest-of-World region

Includes intra-EEe trade

1980 SUS/tonne

One of a series of forecasts only: an alternative forecast is presented in Appendix 6.
after the FAO forecasts were made. For example, the long term decline in production in the US, which would have led to the high import demand indicated by FAO and GOL, appears to have reached a turning point in 1980, so imports should remain stable or may actually decline further.

Another example is that of Australia where several seasons of low rainfall and relatively strong beef prices have reduced sheepmeat production considerably. It is unlikely therefore that the high growth rate projected above could be achieved from the low 1980 base levels.

However, some of the model predictions such as Australian consumption levels and North American trade, are not entirely satisfactory, nor consistent with a priori expectations.

The outlook for the market is for declining per capita consumption in the traditional sheepmeat consuming countries, but with increasing consumption in the EEC, Canada, Greece, the Middle East and Japan. Supply is forecast to decline in the main producing countries, with small increases elsewhere. Trade is forecast by the model to increase 14.8% overall by 1985, and 26.5% by 1990. On the export side, growth is likely to come from Australia, Eastern Europe and the Rest-of-World sector. There is likely to be a continuing decline in imports into North America and Britain.

As forecast changes in demand are largely a function of changes in income and population, equilibrium is determined by changes in price. Prices in the model are forecast (in 1980 US dollar terms) to increase from $2606 in 1980, reaching US$3219/tonne in 1985 and $3999/tonne in 1990.

Certain qualifications about these projections are in order. Firstly, the forecasts were made under a specific set of assumptions. Changes in the levels of the exogenous variables could result in significantly different values for the projected endogenous variables. For example, although income elasticities with respect to sheepmeat are positive, the effect of income on overall demand depends on the assumptions made about future levels of real incomes. In view of the world recession in 1980 these could be lower than forecast, which would restrict purchases of goods like sheepmeat.

It will be recalled from Chapter 4 that not all of the parameters in the supply equations were consistent with a priori expectations. To test the effect of these parameters on the forecast, the supply equations were re-estimated, with negative price coefficients suppressed, and the forecast performed utilising the adjusted equations. The re-estimated equations and the forecast are reported in Appendix 6. Comparing Table 5 and Appendix Table A6.1, it can be seen that there are small differences in the magnitude of the Base forecast values (for

6 Alternative scenarios of constant or increasing supply in New Zealand are evaluated in Section 6.3
example, the world price is 2.1% lower on average over the period in the alternative Base simulation and World trade is 0.7% higher), but in general the forecasts are not greatly different from those presented here.

Secondly, the analysis was done in a partial equilibrium framework; no account was taken of the simultaneous relationships with other meats. There is likely to be greater substitution with other meats if prices do rise substantially (according to the 'total elasticity' concept), and beef, pork and poultry prices would also be likely to rise as increasing substitution occurred.

However, pork and chicken could continue to decline in price relative to sheepmeat (FAO, 1979; Ojala, 1982) possibly faster than assumed in the forecasts. They would pose increasing competition as substitute meats, especially in regions such as the Middle East. Many countries are looking to this region as an outlet for their growing (and frequently subsidised) exports of beef and poultry meat.

The forecast takes no account of feed-grain costs, but "the evolution of the world energy situation could improve the comparative advantage of the pasture system of livestock production" (Ojala, 1982). If feed costs, and hence relative beef prices, were to rise substantially, sheepmeat could become more attractive to consumers. World grain harvests and prices are likely to continue to be particularly significant in affecting USSR import policy.

Many other factors could come into play to alter the forecasts. Some are unpredictable (such as wars, revolutions or droughts), others are more predictable (such as intra-EEC trade effects or NZ's export selling strategy) and could be built into the model to give a range of possible forecast outcomes.
CHAPTER 6

POLICY ANALYSIS WITH THE MODEL

6.1 Introduction

During the 1970's some of the most important issues faced by the NZ sheepmeat industry were the accession of the UK to the EEC, implementation of the NZ Diversification scheme, and development of new markets, especially in North America and Japan.

Moving into the 1980's the emphasis shifted to concern over the continuing decline of the UK market, the introduction of the EEC sheepmeat regime, and the growth and subsequent instability in the Middle East market. The ability of the industry to expand NZ's overseas exchange earnings has also become crucial, as terms of trade decline (Lloyd, 1980).

Over the next decade the problems could become more pressing depending on the outcome of the EEC re-negotiations in 1984, the effect of Supplementary Minimum Prices on NZ production, and the state of the Middle East market. Using the model developed previously some of these issues can be simulated, providing a sounder basis for export policy-making.

The applications of the model and the theory behind them are discussed in the sections below. They relate to the evaluation of various EEC import policies, an increase in NZ's excess supply, and cessation of trade with one of the main Middle East markets, Iran.

The results of the ex ante simulations are subsequently evaluated with respect to changes in the endogenous variables relative to the values in the Base simulation of Chapter 5. It is this difference between the Base level and the policy inclusive level of each variable which is primarily of interest when making projections.

6.2 Import Restrictions in the EEC

6.2.1 Introduction.

Since the formation of the EEC, in accordance with the Common Agricultural Policy various measures have been applied to restrain imports of sheepmeat. These were outlined in Blyth (1980).

Past studies have shown the effects on the internal EEC market of various forms of regime which could have been applied (Kelly, 1978; Boutonnet, 1981) and on the effects on the UK of various forms of external protection (Brabyn, 1978). However, no research has been done
on the effects of the external protection on the EEC as a whole, nor on the effects on trade in the rest of the world. The model developed in previous chapters can be used to quantify some of these effects.

Specifically, the effects are shown on the world market over the 1981-90 period of;

- imposing no restrictions to trade,
- imposing an Ad Valorem tariff of 10%,
- imposing an Ad Valorem tariff of 20%,
- applying a Variable Levy, at the level of the (proposed) EEC Basic price levels,
- imposing a Quota equal in its trade restricting effects to (b).
- imposing a VRA at similar levels, and
- imposing a more restrictive VRA, at only half the levels permitted in (b).

The theoretical background and implications of the various policies are analysed in Blyth (1982).

In the rest of this section the effect of various restrictions are measured in terms of the level of production, consumption and trade in each of the main trading regions, and the level of the world price prevailing under each over the period 1981-90. For each of the policy simulations the mean absolute percentage differences between the variables in the simulation and in the Base run are given in Table 6.

6.2.2 Results.

(i) Ad Valorem Tariffs

The first policy considered involved two simulations. In the first an Ad Valorem tariff of 10% was imposed on EEC imports during the projection period. In the second the tariff was raised to the level prevailing during the 1970's, of 20%.

Under the first policy the world price is depressed 1.8%, as imports into the EEC fall 7.4% on average over the 1981-90 period. This represents a $62/t decline over the mean Base simulation world price, or a $61/t decline in 1985, and a greater $83/t decline in 1990, as imports are considerably lower in the later period. The lower world price stimulates demand for imports in other countries, partially offsetting
### TABLE 6
Comparison of EEC Trade Barriers

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean Base Level (1981-90)</th>
<th>Mean Percentage Change Over Base Run</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>10% Tariff</td>
</tr>
<tr>
<td>PW</td>
<td>$2,825.94</td>
<td>-1.8</td>
</tr>
<tr>
<td>MEC (10)</td>
<td>236.8 Kt</td>
<td>-7.4</td>
</tr>
<tr>
<td>MW</td>
<td>938.2 Kt</td>
<td>-1.0</td>
</tr>
<tr>
<td>XNZ</td>
<td>377.1 Kt</td>
<td>-0.5</td>
</tr>
<tr>
<td>SEC (10)</td>
<td>707.2 Kt</td>
<td>+0.9</td>
</tr>
<tr>
<td>CEC (10)</td>
<td>944.0 Kt</td>
<td>-1.1</td>
</tr>
<tr>
<td>EEC Price</td>
<td>$2,825.94</td>
<td>+8.0</td>
</tr>
<tr>
<td>Total Revenue N.Z.</td>
<td>$1,065.06 m</td>
<td>-2.3</td>
</tr>
<tr>
<td>FEOGA Revenue (Average: US$ mill.)</td>
<td>0</td>
<td>$68.3</td>
</tr>
</tbody>
</table>

*a For variable definitions, see Appendix 2.*
the reduction in sales to the EEC, so total world imports fall only 1%, or 11Kt below the Base level.

NZ exports therefore fall only 0.5%, or a mean 2Kt below the Base level, as most of the impact of the fall in world demand is felt in Australia and in the marginal exporting countries.

However, NZ revenue from sheepmeat exports suffers, falling 2.3% below the Base level, as prices obtained in world markets are reduced, as total exports decline, and as exporters are unable to benefit from higher prices in the Community.

Similar trends are seen under the second situation, where the tariff rate is 20%. EEC(10) consumption falls 2.2%, and EEC(10) supply rises 1.8%, therefore EEC imports are 15.3% below the Base level. The world price is depressed by a mean $121/t, and NZ revenue falls 4.3%.

The average change over the Base level in the price prevailing in the EEC, under the Ad Valorem tariff, is not the full percentage change of the tariff. The dynamics of the market cause the world price to fall as well. Thus imposing a 20% tariff in the EEC gives only a 15.8% increase in EEC market prices over prices which prevailed in the rest of the world in the Base run. With a 10% tariff the EEC price is 8% higher than in the Base simulation.

Under the first regime of a 10% tariff, the European Guarantee and Guidance fund, FEOGA, gains $68.76m in revenue in 1985, and $60.28m in 1990. Under a 20% tariff the revenues are $62.66m and $49.68m respectively. The fall in revenue over time is caused by the steep decline in imports, despite the rising world price. Comparing the different tariff levels, most revenue is gained for FEOGA with the tariff of only 10%, as imports are higher than with a 20% tariff.

(ii) The Variable Levy

The EEC has opted for an agricultural policy which results in high domestic food prices. One way of maintaining internal prices in the face of low world prices is by the use of a sliding scale tariff or Variable Levy.

In this simulation therefore, a Variable Levy was applied to EEC imports, at the level of the (proposed) EEC Guide price levels. Volans (1981) calculates that in the UK the Guide price will increase over the transition period to 1984 and be harmonised with the Basic price thereafter.

---

7 The relative distribution of changes in imports in other world markets is similar under each policy considered, although the absolute volumes differ. Details are only given therefore, in Sections 6.3 and 6.4.
Applying these rates results in a 48.8% decline in EEC imports over the Base projection for 1981-90. This represents levels 123Kt and 85Kt below the Base projections in 1985 and 1990 respectively. In these years world imports are only 991Kt and 1232Kt, which is an average of 5.3% below the Base simulation.

Under this type of regime NZ exporters suffer more than they did in the previous case, where the domestic market was protected by an Ad Valorem tariff. With a Variable Levy there would be a 3.4% (or 11Kt) fall in trade below the Base level. Moreover, as a result of the fall in the world price, NZ revenue would be $170m or 12.8% lower than it would otherwise be.

Thus a Variable Levy set at the proposed level would be more restrictive than a continuation of the actual, or even of the previous Ad Valorem tariff rate. It would result in a higher level of internal EEC prices, with the 1980/81 Basic price being set at approximately double the world price.

Internal prices at this high level would increase the supply in the EEC(10) by 29Kt on average, or 4.1% above the Base level. Consumption, being more responsive to price, would fall 76Kt, or 8.2% below what it would otherwise be.

However, under this system FEOGA gains the maximum revenue, and would collect an average annual sum of around $290m. Thus, if the EEC wants to maintain its internal price by reducing imports, and to maximise Government revenue, it could apply a system of Variable Levies. Correspondingly, exporters would sustain the greatest loss in revenue under this system. Moreover, it is well known that Variable Levies cause price instability on the world market to be amplified, to the detriment of exporters.

(iii) A Quota

Under this policy two sets of results were determined for limiting exports into the EEC using quotas. The first determines the level of quota required to have an effect on imports similar to the current regime. The second determines the effects of imposing a quota at 50% of the level of imports in the Base simulation.

An import quota of a mean of 220Kt (7.4% below the EEC Base level imports) would have the same effect as the 10% tariff in (i), except for the ownership of the levy proceeds.

World prices are $62/t lower than without the quota but EEC prices are forced up by $281/t. Consumption in the EEC(10) falls, but by less than the full amount of the quota, as EEC(10) supplies increase under the higher price incentive.

NZ's total exports decline marginally with a quota, but NZ export earnings fall 2.3% below the Base level.
The second set of policy results shows that in terms of quantitative restrictions, a quota at 50% of the Base level permits a similar volume of imports into the EEC as the Variable Levy system.

The world price would fall 12.6% below the Base level, and EEC prices would be around 70% higher than the world price. Note that this result differs slightly from the change in world prices predicted under the Variable Levy, where the objective was to maintain a fixed EEC price. Under the quota system a fixed volume of imports is maintained. EEC prices will also be higher, but the extra revenue accrues to importing agents and not to FEOGA. NZ revenue is reduced 16.1% below the Base run, as a result of lower world prices and smaller exports. In addition, imposition of a quota by the EEC could amplify any instability in the world market price.

(iv) **Voluntary Restraint Agreements**

Continuation of the VRA at 1980 levels would not result in them being binding on exporters, given the import demand levels projected for the EEC in the Base simulation.

If the VRA's were to be re-negotiated they would have to be set at least 37.5% below current levels to become binding. Moreover, given the projected long-run decline in EEC imports, they would have to be negotiated on an annual, diminishing scale.

Presuming that the VRA's were to be reduced, two policy scenarios can be simulated, similar to case (iii), where quotas were imposed. Under the first, imports are voluntarily restrained to an average of 220Kt. This could be, for example, in exchange for a removal of tariff barriers, in order to maintain the level of EEC prices.

In this case the results would be identical to the case where a 10% tariff was imposed, except that exporters' revenue may be increased by part of the amount that was formerly removed by FEOGA, through obtaining higher prices for sales within the EEC. Whilst it is not possible to calculate the exact change in NZ revenue, an estimate can be made on the basis of certain assumptions. If approximately 30% of NZ exports over the simulation period are sold in the EEC at the higher EEC price, with the remainder being sold at the world price, then NZ revenue could actually increase 1.1% above the Base level. (This approximation takes no account of the simultaneous and dynamic effects of increased revenue).

Under the second policy scenario the VRA's are assumed to be re-negotiated to diminishing quantities at only 50% of the projected Base levels. The results are the same as those reported in (iii), except for the export revenue effect. As with the previous case, making the same assumptions, then NZ revenue falls only 5.3% below the Base level, not 16.1% as with a quota.
6.2.3 Summary and implications of EEC policy analysis.

Under normal market conditions EEC import barriers of any form depress the demand for deliveries to the EEC, and hence the world price. The simulation analysis showed that, in quantity terms, the most restrictive barriers are the quota or VRA at 50% of the base. They are also the policies which depress the world price most. The Variable Levy is similar in its effects, and all three have implications for market stability. Whilst it was not possible to quantify these, it has been shown (Blyth, 1982) that all three policies ensure that shocks affect only the world, and not the domestic market.

In all the cases discussed the overall level of world trade falls, as the decline in EEC imports is not fully offset by increases in imports in other countries. World trade is, however, relatively responsive and the maximum decline is only 6.6%, or 72Kt, even under the most restrictive assumptions.

The reduced imports, and hence availability on the EEC market, forces up the EEC price, even though some extra supply is encouraged. Again, EEC prices are highest under the quota or Variable Levy, and EEC consumption is lowest. The Ad Valorem incidence of the Variable Levy system is approximately 70%, thus FEOGA revenue is greater than under other policies. The Ad Valorem tariff also provides some revenue for FEOGA, and the amount is greater with a tariff of 10% rather than 20%.

NZ exports fall under all the forms of protection. As a result of both declining exports and world prices, total revenue also falls. Again, exports and revenue are lowest under the restrictive quota and Variable Levy systems.

The most favorable options for protection therefore appear to be the 10% Ad Valorem tariff or the equivalent VRA, if any restriction is to be applied. Allowing for the stability effects though, the former measure has the least harmful effect on exporters, but the VRA allows exporters to minimise revenue losses.

If the existing system of protection were removed (ie. if the tariff rate were zero, and VRA's were not binding), exporters would gain extra revenue from increased sales and a rise in the world price of an average 1.8% or $62/t, as the increase in EEC imports would more than offset the decline in other markets.

So far the VRA's have not been binding due to the high levels negotiated and the fortuitous rise in the Middle East market. The VRA therefore presents more of a psychological barrier to exporters, knowing that they cannot 'dump' on the UK market, and that they now require a more co-ordinated marketing policy in the EEC to avoid problems.

Nevertheless, it has been shown that if the VRA were to be reduced and to become binding (at approximately half the level of 'normal' imports) or if a Variable Levy system were introduced, then the effects on the rest of the world market could be major.
Whilst it is interesting to note these effects, it has been shown elsewhere (Blyth, 1982) that the current level and type of tariff protection is, in fact, approaching the optimum level. It gives the greatest welfare gain to the EEC as a whole, so it is unlikely that increased protection measures would be implemented, even if they were permissible under GATT.

6.3 Growth in Production in NZ

NZ's livestock sector is considered to be capable of expansion, and hence of increasing export earnings (McLean, 1978; Laing, 1982). Expansion of sheepmeat production could be the result of higher lambing percentages in a season of favorable weather conditions. Alternatively, increased efficiency and hence higher stocking and turn-off rates could result from Government production-incentive schemes.

Taylor (1980) postulated that a 5% increase in the current lambing-rate, from the existing ewe flock, would result in an increase in lamb exports of 30Kt (i.e. approximately 6% of sheepmeat production). Silcock and Sheppard (1981) showed that this could represent an f.o.b. value 6-7% higher, of approximately NZ$37m. Such a figure should be treated as indicative of a general trend only, since it takes no account of the dynamic effects nor the changes in world prices which would occur. Thus, it provide an upper bound to the likely increase in export earnings.

Using the model the dynamic effects and price responses can be incorporated, to produce a better estimate of the net gain in export returns. It was postulated that supply should increase by 10% in the initial year, in order to observe the changes in key variables in subsequent years during the 1981-90 period. It was assumed that the production increase would be sustainable, and was not achieved by increased slaughter of breeding stock. In the short-run producers would have either to hold back sheep from slaughter, causing an initial decline in output of sheepmeat, or to achieve higher than normal production per breeding ewe.

The model showed that the subsequent increase in sheepmeat production would lead to corresponding increases of around 10% (or 50Kt) above the Base simulation level in each of the following years, because of the dynamic effects of the system.

Similarly, NZ exports increased by a corresponding amount (as the change in domestic off-take was negligible), compared to the Base simulation (Table 7) but still showed a decline overall, falling to 441Kt in 1985, and 400Kt in 1990. Thus trade was around 13.0% higher on average, than it would otherwise have been.
### TABLE 7

**Simulation of an Increase in Supply from New Zealand**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean Value of Simulated Variable 1981-90</th>
<th>Mean % Change Over Base Run</th>
</tr>
</thead>
<tbody>
<tr>
<td>SNZ</td>
<td>534.6 Kt</td>
<td>+10</td>
</tr>
<tr>
<td>PW</td>
<td>$3,087.46/t</td>
<td>-4.4</td>
</tr>
<tr>
<td>XNZ</td>
<td>425.4 Kt</td>
<td>+13.0</td>
</tr>
<tr>
<td>MW</td>
<td>1,044.1 Kt</td>
<td>+4.2</td>
</tr>
<tr>
<td>MUK</td>
<td>112.9 Kt</td>
<td>+1.5</td>
</tr>
<tr>
<td>Total Revenue N.Z.</td>
<td>$1,318.05 m</td>
<td>+7.7</td>
</tr>
</tbody>
</table>
Because of the increased production in NZ the world price was $142/t (or 4.4%) lower than in the Base simulation. Overall the level of world trade only increased by 40Kt, or 4.2% over the Base level, as exports from other countries declined in the face of reduced market prices. NZ supply would have increased by a greater amount had this decline in prices not occurred.

Imports increased in most countries by varying amounts above the Base level, with the largest increases in the Middle East and the Rest-of-World sector, followed by the USSR, Greece and Japan. The EEC and the UK expanded imports marginally, but overall EEC(10) imports were still within the VRA 1980/81 quota.

The average decline in prices on the world market of 4.4%, in response to the one-off increase in supply from NZ of 10%, implies a flexibility of 0.44 and a demand elasticity of -2.27.

The size of the elasticity indicates that NZ exports do in fact have some influence on world prices, and that NZ is not necessarily a 'price taker' on the world market. Thus, the suggestion that NZ is a 'small country', in terms of its position on the world sheepmeat market may not be appropriate; nor can world sheepmeat prices be taken as being exogenous to NZ supply, as is frequently stated (eg. Laing and Zwart, 1981; Tweedie and Spencer, 1981).

Because of the change in prices prevailing on the world market, NZ's total revenue from sheepmeat exports was $1249m in 1985, and $1553m in 1990, with the increase in supply, as opposed to $1212m and $1345m respectively projected in the Base simulation. Thus a 10% increase in NZ supply in the early 1980's, would lead to a mean level of total revenue 7.7% above what it would otherwise be, in the late 1980's.

Comparing this to the estimate for overseas earnings expansion by Silcock and Sheppard (1981), the absolute value is obviously much larger, since the figure here includes mutton receipts. However, their estimates required a 6% expansion of production, to give a 7% increase in export revenue. When world demand, supply and price responses are taken into account, it requires an expansion in production of 10% to yield that increase in revenue. The interesting point to note is that an increase in exports does not lead to the same proportionate expansion in revenue. An assessment of the domestic costs of achieving such an expansion in supply must take this factor into account.

In the predictions made so far, New Zealand supply has been forecast to decline overall during the 1981-90 period. Moreover, it has been shown that certain supply equations used in the world model to make these predictions had inconsistent price response coefficients. To give a view of the market which may be more realistic two further policy simulations were run. These assess the effects of firstly, the assumption of constant supply in New Zealand, and secondly, a small annual increase in New Zealand supply. In addition, to give an indication of the long run position, the alternative model specification (as given in Appendix 6, with negative price coefficients suppressed) was utilised, both in the Base forecast for comparison and in the simulations. The results are summarised in Appendix 6.
The first policy simulation, where New Zealand supply is maintained at a constant level, has an average world price level 6.2% below the Base simulation level (Table A6.2). This is due largely to an increase in New Zealand exports and a subsequent increase in world trade, on average 2.6% above the Base level.

In the second policy scenario New Zealand supply is forecast to increase at an annual rate of 2%, putting the mean production level 23.7% above the mean Base simulation level (Table A6.3). World prices fall 11.4% below the Base level and hence New Zealand revenue is only 14.8% above that mean Base level.

A comparison can be made of the forecast revenue effects under the two different assumptions about production in New Zealand. Average New Zealand revenue is forecast to be 5.4% higher over the 1981-90 period, under the assumption of an annual growth-rate of 2%, than it is under the assumption of no growth in production.

Therefore, these policy simulations indicate that making different assumptions about the level of production in New Zealand can result in different scenarios of the world market during the 1980's, because of the importance of New Zealand sheepmeat exports in world trade, and the relatively inelastic import demand curve facing New Zealand.

6.4 Simulation of No Trade with Iran

In Chapter 2 the fortuitous expansion of the Middle East market at a time of stagnation and decline in the other major markets was outlined. Despite the growth in imports, trade proved difficult in the late 1970's and early 1980's, particularly with Iran, following the revolution. Trade remains uncertain because of the risk of inter- and intra-regional warfare, the suggestions of placing an embargo on trade, inability to make payments, and delays in negotiating contracts (Gullwick, 1980; NZMPB Annual Report, 1981).

Despite the instability the market is still viewed as one with considerable potential (Taylor, 1980). It is likely though that a combination of factors will affect the Iranian trade detrimentally for some time to come. The worst possible situation would be a complete closure of the market, rather than just reductions in trade with individual exporters. Thus an ex ante simulation was run to show the effects on the world market of a complete closure of the Iranian market.

In this case demand in Iran is satisfied purely by domestic supply, which is limited by physical constraints. Supply in Iran in this forecast is the same as in the Base simulation reported in Chapter 5; it remains stable at around 350Kt. Because there are no imports however, and population in Iran is forecast to increase by 1.2% per annum, per capita consumption would decline from the current level of over 11kg, to
under 7kg. On average over the period, per capita consumption is likely to be 38.7% lower than it would be if imports were to continue (Table 8).

In the Base simulation imports into Iran were projected to be 196Kt in 1985, and 236Kt in 1990. In this simulation though, reducing imports to zero does not cause a fall of the same magnitude in world trade. Total world imports are forecast to be below the Base forecast levels by only 115Kt in 1985, and 122Kt in 1990 (or 11.5% on average), as lower prices encourage an increase in imports into other regions. Imports would have to rise by around 15Kt in each of the other regions, above the Base forecast levels, to absorb the surplus. The largest expansion is forecast to be in Japan, Greece, North America, the UK, and the USSR, where demand is relatively price elastic. Production, however, would also be discouraged by depressed prices in these importing countries in the longer term, so consumption would only increase moderately.

Even though imports into the EEC(10) are forecast to be 14.1% higher than in the Base simulation, at a mean of 243Kt, they are within the VRA quotas set in 1980/81 of around 320Kt.

TABLE 8
Simulation of Cessation of Trade with Iran

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean Simulated Level 1981-90</th>
<th>Mean % Change Over Base Run</th>
</tr>
</thead>
<tbody>
<tr>
<td>MI</td>
<td>Zero</td>
<td></td>
</tr>
<tr>
<td>PW</td>
<td>$2,374.0</td>
<td>-26.5</td>
</tr>
<tr>
<td>MW</td>
<td>887.5 Kt</td>
<td>-11.5</td>
</tr>
<tr>
<td>MUK</td>
<td>128.2 Kt</td>
<td>+15.2</td>
</tr>
<tr>
<td>MEC(10)</td>
<td>242.9 Kt</td>
<td>+14.2</td>
</tr>
<tr>
<td>XNZ</td>
<td>377.8 Kt</td>
<td>-0.8</td>
</tr>
<tr>
<td>XAU</td>
<td>360.2 Kt</td>
<td>-18.3</td>
</tr>
<tr>
<td>Total Revenue N.Z.</td>
<td>$896,897 mill US</td>
<td>-27.3</td>
</tr>
<tr>
<td>PCI</td>
<td>7.4 Kg</td>
<td>-38.7</td>
</tr>
</tbody>
</table>
Correspondingly, exports are forecast to be below the Base forecast level in all exporting regions, with large reductions in Australian exports, and lesser but significant reductions in exports from the Rest-of-World region. NZ exports are forecast to decline slightly, and to be an average 0.8% below the average Base level. The response in NZ, resulting from falling prices, could be somewhat larger than forecast; (it should be recalled that the estimated price elasticity of supply for NZ was extremely small, and provides a lower bound to changes).

Thus, in itself, the cessation of imports into Iran would have only a small effect on NZ exports, as NZ would not have had the capacity to supply a large proportion of the original expansion which was projected (and which would have been supplied mainly by Australian and the Rest-of-World exporters). The more significant effect, which would be detrimental to NZ, would be the indirect depression of world price levels.

The effect of a closure of the market would be spread over a number of years. World prices are forecast to decline 11.3% in the first year, to remain below current levels up to 1987, and to increase only slightly thereafter. Prices of $2242/t and $2925/t are forecast for 1985 and 1990. This is, on average, 26.5% below the mean projected price when imports are not restricted, and leads to the reduction in exports and expansion in imports outlined above.

Finally, total revenue in NZ, which under the Base forecast was projected to be $1,212m in 1985, and $1,345m in 1990, would only be $850m and $951m in those years (or a mean 27.3% lower), if Iranian imports were reduced to zero.

Some qualification of these results is in order. This scenario portrays, of course, the worst possible situation. If trade were put in jeopardy as a result of an attempted embargo, the results would be less severe, as some imports may continue from other sources. The possibility of collusion amongst all exporters is remote, especially in view of the drastic effects on the world price.

Offsetting this though, other markets are unlikely to be as 'absorbent' as forecast. Each market prefers a different quality of meat, so may not be willing to purchase the type being diverted away from Iran, in the short term. For example, much of the meat purchased by Iran from NZ is lamb, but the markets which are predicted to absorb excess supplies, such as the USSR and Japan, prefer to purchase mutton as a form of bulk protein. On the other hand, a large proportion of Australian exports to the Middle East is mutton, which would not be readily sold in the other main markets, of Europe and North America.

Moreover, if the Iranian market were to close as a result of war or closure of ports, other markets, such as Iraq, could be affected. This would reduce trade with the model's Rest-of-World region, which includes other Middle East countries. The effect therefore would be worsened, so the results given here are possibly a good indication of the overall situation.
In this chapter a number of issues currently facing the sheepmeat industry have been analysed in some depth, using the model developed in previous chapters. The scenarios simulated here provide a basis for the discussion in the following chapter of the particular implications for NZ. An indication is given of possible areas of future research.
CHAPTER 7

CONCLUSION

7.1 Summary

The aim of the study was to examine the dynamic structure of the world sheepmeat market, and from a better understanding of the relationships existing among the various regions to draw some implications for policy.

The approach followed was firstly (Chapter 1), to review international trade over the 1960-80 period, in order to identify important features and changes in the market, and the factors causing them. Secondly (Chapter 2), a non-spatial price equilibrium model was developed over the same period, incorporating the essential features of the market. Several assumptions and simplifications were made in order to derive an estimating form of the model. The next chapter (Chapter 3) dealt with the 23 estimated derived supply and demand functions. The complete model was brought together in Chapter 4, with a set of identities determining net trade in each region, and a market-clearing, price-determining mechanism.

The model was validated (Chapter 5) using a dynamic ex post simulation, and comparing the predicted with the actual values. An ante simulation was run over the 1981-90 period, to provide market forecasts and a basis for comparison in the following chapter.

The model was then used in Chapter 6 to analyse in more depth a number of issues currently facing the industry. These included determining the ability of the world market to absorb an increase in NZ's exports, and a closer examination of the problems in the Iranian market. The effects of current EEC protection and alternative methods of protection were also examined. The simultaneous, dynamic properties of the model meant that these issues could be evaluated in terms of their effects on other countries over a number of years.

Based on the results and conclusions described in previous sections, a number of implications for policy making can be drawn about the sheepmeat market.

7.2 Implications for NZ

NZ has a comparative advantage in pastoral livestock production and relies heavily on exports from this sector. The main output from the sheep industry is meat, but both the mutton and lamb export trade have faced a number of difficulties in recent years.
The problems facing NZ result from the traditional reliance on one major market and the decline of this market at a time of increasing exports from NZ. Despite moves to diversify into new areas, some of the importers (such as the USSR, Japan and the Middle East) have proved to be irregular purchasers. Trade is increasingly subject to access barriers, or purchasing by Central Authorities. There has also been increasing competition from beef (which often benefits from subsidised grain production or from export restitutions) and white meats, and from both traditional and new exporters whose excess supplies, like NZ's, have also increased.

The forecasts imply that these trends are likely to continue through the 1980's, though NZ export levels should stabilize. Overall NZ revenue could increase marginally, even if exports do not grow, as a result of rising prices on the world market. It is likely though, that NZ will continue to be faced with the problem of finding markets which offer attractive prices for its sheepmeat.

Two strategies are available to NZ if the objective is for the sheep industry to earn higher and more stable returns. These could be either to improve returns from the existing export volume, or to expand the volume exported. A few of the issues and constraints related to each are discussed here, as they affect NZ policy making.

The analysis showed that if NZ were to increase revenue by encouraging an increase in its exports, world prices would be depressed because it is already such an important participant in the world market. The cost of achieving such an expansion therefore requires careful assessment.

Moreover, it was shown with the estimated equation that NZ producers' response to economic factors is small in the short and medium term which should be recognised when designing policies to expand output. Also, little is known about NZ farmers' marginal propensity to invest. It may be that higher returns from guaranteed prices are treated as a 'windfall' gain, and spent on extra consumption rather than invested to expand future production. Policies based on the price mechanism may not therefore be an effective method of encouraging expansion. It would perhaps be more effective to help producers to adjust more rapidly, by increasing their supply response to changing world market conditions.

Some of the constraints on expansion on the export side were identified with the simulations. The new markets into which NZ is diversifying (eg. Japan, the USSR, the US and Canada) are not projected to expand greatly. They are more likely to require imports at about the current levels in the long term. The market which NZ exporters feel offers the greatest potential - the Middle East - was indeed shown in the Base forecast to become a major importer in the 1980's. The area however, offers little security for a long term stable market because of the political situation. Further analysis showed the effect on NZ of a closure of the Iranian market, and the sharp decline in NZ revenue as a result.
The simulated scenarios all painted a pessimistic outlook for the possibility of increasing NZ revenue in future. NZ may therefore be justified in its concern over the state of the industry (Qullwick, 1980) and needs to devise both pricing and allocation policies to avoid the type of issues dealt with.

NZ needs to continue its diversification into other markets, such as the EEC(8) and the Rest-of-World sector (eg. North Africa, Western Europe) or to try to stabilise trade with irregular purchasers such as Japan and the USSR. Spreading trade over a number of markets should reduce fluctuations by pooling risk amongst them. Market diversification in itself does not necessarily imply an increase in stability though, (eg. if all countries are in recession simultaneously) and it may be more appropriate to trade with a few stable economies, rather than diversify trade over many unstable countries.

It has been suggested (NZMPB Annual Report, 1981) that an appropriate balance for exports would be one-third to the EEC, one-third to the Middle East and the remainder going to other markets. To achieve this, in future "new opportunities will involve a major emphasis on market development in specific countries rather than continued diversification of sales. This will require an integrated approach to the role of different markets, the different levels of profitability, and the need to balance sales returns with market or economic risk" (Qullwick, 1980).

It is therefore important for NZ to attempt to maintain supplies to the EEC(10). This should be done by diversifying into the Continental EEC states, in view of the fragility of the UK market. If the UK market price were to be depressed there is a danger that the EEC might attempt to introduce a more stringent pricing policy to support internal market prices (for instance, a Variable Levy system).

On the other hand, NZ needs to maintain supplies to the region to prevent a reduction in the VRA being negotiated (the analysis in Chapter 6 showed the damage that a more restrictive VRA could do). Moreover, NZ needs the EEC as a long term, stable market, in view of the riskiness and slow growth of alternative markets.

In the 1984/85 re-negotiations, assuming that the EEC continues to impose some form of trade barrier, NZ would minimise its revenue losses by agreeing to voluntarily restrain exports at the current favourable levels. A further reduction in the tariff (preferably to zero, or at least to a lower level) could be requested. This would also ensure welfare maximisation within the EEC, consistent with the continuing forecast decline in imports.

NZ authorities have little direct control over production, and although it is possible to control allocation of supply to the various
markets, the extent to which monopoly power can be exercised through such control is limited. Whilst NZ exports form a large part of world trade and face a relatively low world export demand elasticity, self-sufficiency levels are high in most countries and there is growing competition from other exporters, which reduces NZ’s ability to manipulate individual markets. Moreover, NZ sheepmeats have always been in a highly competitive situation with other meats. Because of this, the status of sheepmeat relative to other meats (i.e. whether it is a ‘preferred’ meat, or whether price levels are more important, and whether tastes are changing) in the specific country in question needs to be taken into account in pricing and promotion policies.

The size of the derived supply and demand responses determined in the study give an indication of which import markets are most ‘absorbent’, and which exporters pose the greatest potential competition. Export policies should be designed which account for the size of market responses and which are also consistent with the continuing forecast decline in traditional markets, and the expansion of many small, new markets.

The rapidly changing markets and the degree of competition point to the necessity of maintaining a flexible and adaptable trading system, within which enterprising exporters are able to look for, and take advantage of new opportunities. Encouragement of sound marketing strategies among these exporters is perhaps more important than attempting to regulate world markets. Some control may be necessary though, to enable exporters to operate efficiently in individual markets and develop new ones (Hilgendorf, 1980).

In terms of export market development, returns could probably be improved by exploiting the full potential of large, stable markets, as well as new so-called ‘development’ markets. This requires a coordinated approach, using promotion and advertising (Cullwick, 1980).

Similarly, product development would allow meat to be provided in forms for which markets are prepared to pay a premium. An example is the air-freighting of chilled meat to the Middle East.

Although the carcase meat trade is likely to continue for many years, higher returns could be achieved from further processing (Silcock and Sheppard, 1980). Linked with this, selling more meat on contract would stabilise returns and be a move towards ‘product marketing’, rather than the traditional ‘commodity trading’ approach (Hilgendorf, 1980). Other means of improving and stabilising returns have been suggested by Ross et. al. (1982). They propose that introducing a greater degree of competition among exporters within NZ would increase market transparency. Hence "a publicly determined price would be set in

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8 This research was undertaken prior to the 1982/83 season, when the NZMPB took control of lamb exports. By doing so the Board intended to improve product prices and returns to the producer, but their actions do not negate the results in this report.
NZ, reflecting the demands from all markets around the world. Smithfield would therefore lose its pre-eminence in the setting of the price, and instability in the UK market would not therefore be transmitted to the prices received for product to be sold in other markets”.

Whilst the model is useful in terms of general international market analysis, there are a number of issues which a detailed market strategy for NZ’s sheep industry should also incorporate. These generally lie in the area of improving efficiency and revenue within the existing structure and as most lie outside the scope of the model, are not discussed here (see Blyth, 1982).

In order for NZ to design a ‘global strategy’ for its sheep industry detailed information is needed on individual market requirements, on the characteristics of each market (eg. single buyer; new market) and on the most effective methods of selling in each (eg. single seller or licensed traders). By linking this qualitative information with the quantitative information provided by the model, future marketing directions can be defined, in terms of which markets to develop and how to develop them.

In turn this would enable farmers, as well as freezing, transport and export companies to plan their own directions for the future.

7.3 Areas for Further Research

The model used in this study could be refined further, were data available or if certain heroic assumptions were made, in the following areas.

The study suggests that the concept of an integrated world sheepmeat market with one product and one world price is a useful simplification for analysis of the long-run structure and functioning of the market. But it is probably too great a simplification for the analysis of the short-run aspects of the market. For instance, the temporal aggregation made in Chapter 2 introduces certain errors into the model. The bulk of sheepmeat production is six months out of phase in the Northern and Southern hemispheres. Nevertheless, for the sake of simplicity and because of available data, an annual model must necessarily force events in different trading regions to occur contemporaneously, when in fact they do not. This will introduce some distortion into the price relationships estimated here, and the predictions will be biased.

The development of a quarterly or monthly model, which looks at the generation of short-run moves in stocks, trade flows, and seasonal patterns could therefore be useful.

To account for distinct trade patterns between regions, a trade flow model of the Armington type (Labys, 1973; Thompson, 1980) could be developed. Even if flow data were not available, development could proceed by making some rough assumptions about market shares. Transport costs and regional prices could also be built in.
The scope of this study could be broadened to cover smaller participants in international trade, especially the individual countries of the EEC, the Middle East and East Europe. This would be rewarding in view of the development projects being undertaken, and the apparent potential for trade in these regions.

The breakdown of the aggregate 'sheepmeat' to mutton, lamb and live sheep would account for the distinct response patterns of each. This would reduce any bias in the forecasts and ensure that results are also feasible in the short run. Again, as no separate data are available, assumptions could be made about the proportions of each product traded. Similarly, if more detailed sheep numbers and slaughter data were available, both livestock inventory and turn-off equations could be estimated, instead of the reduced form functions in Chapter 2.

It should be noted though, that most of the above refinements require a trade-off between greater detail or realism, and lower accuracy of data, given the data currently available.

A general assumption made was that all trading countries behave competitively. This was shown to be true by calculating the responsiveness of domestic to world prices. Distortions to trade could occur, however, that were not reflected in prices. These would include health and veterinary regulations, licensing by governments or Marketing Authorities, or trade being in the hands of one or a limited number of traders. It may be possible to incorporate some of these factors into the model. Alternatively, if reliable domestic price series were available, actual rather than derived functions could be estimated.

Further work could be done to account for the nature of competition between meats on both the supply and demand side. This would naturally evolve towards a model of the entire world meat market. Since such models exist (with little detail of sheepmeat trade at present) it would be feasible to link one of them to this model.

Similarly, it would be possible to replace the equations for a particular country with a more detailed model of that country's agricultural sector or domestic meat market. This enables world market prices to be endogenised within a national model.

Finally, the simulation analyses could be extended to cover a wide range of issues of current concern to the industry. From this, and other existing studies, it would be possible to develop a 'global policy' on sheepmeat exports.


FAO Annual. Production Yearbook.

FAO Annual. Trade Yearbook.


USDA Monthly. Foreign Agriculture Circular; Livestock and Meat.


APPENDIX 1

Estimated Equations for the Complete Model
APPENDIX 1
ESTIMATED EQUATIONS FOR THE COMPLETE MODEL

Values in brackets beneath the estimated coefficients are 't' tests. Asterisks indicate coefficients which are not significant at the 5% level. Variable definitions are given in Appendix 2.

**Demand Equations**

\[
\text{PCAR} = 7.03 - 0.27E-05 \text{PAR} - 0.25E-03 \text{YAR} + 0.21E-03 \text{PBAR} - 1.85\text{DAR}
\]

(6.14) (2.03) (0.79)* (1.54) (5.17)

\[R^2 = 0.92 \quad DW = 1.75 \quad S = 0.36 \quad F(4,16) = 47.24\]

\[
\text{PCAU} = 35.74 - 0.25E-01 \text{PAU} + 0.38E-02 \text{YAU} + 0.18 \text{PBAU} - 1.48\text{T}
\]

(1.85) (2.38) (0.54)* (2.44) (2.43)

\[R^2 = 0.89 \quad DW = 1.78 \quad S = 3.39 \quad F(4,16) = 32.76\]

\[
\text{PCC} = 2.71 - 0.17E-02 \text{PC} + 1.11E-02 \text{YC} + 0.25E-02 \text{PBC} - 0.13\text{T}
\]

(0.87)*(2.07) (1.63) (2.35) (1.66)

\[R^2 = 0.60 \quad DW = 2.04 \quad S = 0.32 \quad F(4,16) = 6.12\]

\[
\text{PCEC} = 0.94 - 0.76E-04 \text{PEC} + 0.17E-04 \text{YEC} - 0.62E-04 \text{PBEC} + 0.40E-01\text{T}
\]

(7.08) (0.64)* (0.20)* (0.50)* (7.58)

\[R^2 = 0.93 \quad DW = 1.13 \quad S = 0.73 \quad F(4,16) = 57.08\]

\[
\text{PCG} = 12.10 - 0.92E-04 \text{PG} + 0.85E-04 \text{YG} - 3.90\text{DG} + 0.24\text{T}
\]

(6.60) (0.96)* (0.51)* (4.45) (0.76)*

\[R^2 = 0.75 \quad DW = 1.09 \quad S = 0.89 \quad F(4,16) = 12.11\]

\[
\text{PCI} = 7.62 - 0.42E-04 \text{PI} + 0.75E-04 \text{YI} - 2.61\text{DI}
\]

(3.98) (1.17)* (8.73) (2.81)

\[R^2 = 0.86 \quad DW = 1.79 \quad S = 0.91 \quad F(3,17) = 34.82\]
PCJ = \(-0.56 - 0.31E-05PJ + 0.15E-02YJ + 0.25E-02PPJ + 0.24E-03PBJ\) 
\((0.68) \ (2.01) \ (2.57) \ (2.98) \ (0.55)\)

\(R^2=0.77 \quad DW=1.30 \quad S=0.20 \quad F(4,16)=13.69\)

\(PCNZ = 75.83 - 0.97E-02PNZ - 0.21E-01YNZ + 0.15PRBNZ\) 
\((4.32) \ (0.34) \ (1.97) \ (0.93)\)

\(R^2=0.50 \quad DW=1.20 \quad S=6.47 \quad F(3,17)=5.60\)

PCUK = \(12.09 - 0.43E-02PUK + 0.10E-01YUK - 0.74E-01PRBUK + \)
\((2.55) \ (1.48) \ (1.23) \ (1.20)\)

\(0.44E-01PRPUK - 0.17PRCUK - 0.50T\) 
\((0.42) \ (2.99) \ (3.47)\)

\(R^2=0.97 \quad DW=2.43 \quad S=0.31 \quad F(6,14)=92.77\)

PCUS = \(1.77 - 0.27E-03PUS + 0.27E-04YUS + 0.64E-03PBUS - \)
\((5.86) \ (1.47) \ (0.49) \ (3.11)\)

\(0.82E-01T\) 
\((12.34)\)

\(R^2=0.98 \quad DW=1.79 \quad S=0.08 \quad F(4,16)=222.10\)

**Trade Equations**

\(MR = 30.51 - 0.87E-01DPW + 6.34T\) 
\((0.43) \ (0.82) \ (4.66)\)

\(R^2=0.62 \quad DW=1.20 \quad S=29.14 \quad F(2,18)=14.70\)

\(XEE = -16.00 + 0.17E-01DPW + 1.20T\) 
\((1.49) \ (1.08) \ (5.77)\)

\(R^2=0.79 \quad DW=0.56 \quad S=4.46 \quad F(2,18)=35.54\)

\(MRW = 78.87 + 0.588MRW1 + 0.89E-01DPW - 0.87E-01WPB + \)
\((0.73) \ (2.55) \ (0.59) \ (1.47)\)

\(0.14WRNY + 3.88T\) 
\((1.13) \ (0.94)\)

\(R^2=0.87 \quad DW=2.01 \quad S=36.79 \quad F(5,14)=19.30\)

\(XRW = -27.62 + 0.45XRW1 + 0.53E-01DPW + 2.65T\) 
\((1.04) \ (2.15) \ (1.27) \ (2.24)\)

\(R^2=0.93 \quad DW=1.61 \quad S=10.36 \quad F(3,16)=68.44\)
Supply Equations

\[
\text{SAR} = 18.55 + 0.85 \text{SAR1} - 0.46 \times 10^{-6} \text{PAR2} - 0.46 \times 10^{-2} \text{PBAR2} + (0.40) \times (4.44) + (0.01) \times (0.65) \\
- 0.40 \times 10^{-4} \text{PWLR2} - 0.23 \text{T} \\
(0.77) \\
\]

\[R^2=0.77 \quad DW=1.65 \quad S=17.49 \quad F(5,13)=8.91\]

\[
\text{SAU} = 531.44 + 0.46 \text{SAU1} - 0.89 \times 10^{-1} \text{PAU2} + 1.47 \text{PBAU2} - 0.98 \text{PWL2} - (0.90) \times (1.35) - (0.19) \times (0.65) - (0.86) \\
+ 1.55 \text{RAU} - 4.69 \text{T} \\
(0.97) \\
\]

\[R^2=0.57 \quad DW=1.49 \quad S=93.94 \quad F(6,12)=2.64\]

\[
\text{SC} = -5.99 + 0.66 \text{SC1} - 0.29 \times 10^{-6} \text{PC2} + 0.85 \times 10^{-2} \text{PBC2} + 0.18 \times 10^{-1} \text{PBRLY} \\
(1.67) \times (6.39) - (1.28) \times (2.81) - (1.45) \\
\]

\[R^2=0.91 \quad DW=2.22 \quad S=1.05 \quad F(4,14)=36.47\]

\[
\text{SEC} = 74.42 + 0.63 \text{SEC1} - 0.13 \times 10^{-2} \text{PEC1} + 2.09 \text{T} \\
(1.71) \times (2.69) - (1.11) \times (1.68) \\
\]

\[R^2=0.96 \quad DW=1.86 \quad S=6.30 \quad F(3,15)=138.62\]

\[
\text{SG} = 2.86 + 0.77 \text{SG1} + 0.67 \times 10^{-6} \text{PG1} + 0.45 \text{T} \\
(0.31) \times (6.36) - (1.98) \times (1.52) \\
\]

\[R^2=0.95 \quad DW=1.05 \quad S=3.78 \quad F(3,16)=107.68\]

\[
\text{SI} = 15.22 + 0.77 \text{SI1} + 4.27 \text{T} - 57.30 \text{DI} \\
(0.88) \times (5.23) - (2.02) \times (2.13) \\
\]

\[R^2=0.94 \quad DW=1.50 \quad S=23.52 \quad F(3,16)=84.54\]

\[
\text{SNZ} = -20.70 + 1.03 \text{SNZ1} + 0.46 \times 10^{-3} \text{PNZ2} - 0.21 \text{PNZ2} + 0.41 \text{PWLNZ2} - (0.81) \times (2.77) - (0.01) \times (0.22) - (0.68) \\
+ 0.58 \text{SMD} \\
(0.92) \\
\]

\[R^2=0.65 \quad DW=1.92 \quad S=25.50 \quad F(5,13)=4.91\]

\[
\text{SUK} = 35.33 + 0.39 \text{SUK1} - 0.98 \times 10^{-6} \text{PUK2} + 0.18 \text{PWBUK2} + (0.30) \times (1.08) - (0.34) \times (0.71) \\
+ 135.28 \text{PWLUK2} + 20.85 \text{DUK} \\
(1.09) - (0.83) \\
\]

\[R^2=0.26 \quad DW=1.39 \quad S=18.27 \quad F(5,13)=0.94\]

\[
\text{SUS} = 14.12 + 0.97 \text{SUS1} - 0.15 \times 10^{-6} \text{PUS2} - 0.15 \times 10^{-6} \text{PBUS2} \\
(0.35) \times (15.07) - (0.08) \times (0.43) \\
\]

\[R^2=0.98 \quad DW=1.46 \quad S=11.76 \quad F(3,15)=215.69\]
APPENDIX 2

Variable Definitions for the Model
APPENDIX 2

VARIABLE DEFINITIONS FOR THE MODEL

<table>
<thead>
<tr>
<th>Variable name</th>
<th>Definition and source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pw</td>
<td>World price of sheepmeat; Smithfield (UK) price for imported, PM grade, NZ lamb; US$/t (NZMPB, Annual Report).</td>
</tr>
<tr>
<td>Pi</td>
<td>Pw converted to real national currency, in region i.</td>
</tr>
<tr>
<td>Si</td>
<td>Quantity of sheepmeat produced in region i, thousand tonnes carcase weight per annum. (Foreign Agricultural Circular, Livestock and Meat, USDA-FAS).</td>
</tr>
<tr>
<td>Ci</td>
<td>Quantity of sheepmeat consumed in region i, thousand tonnes carcase weight per annum. (as above).</td>
</tr>
<tr>
<td>PCi</td>
<td>Per capita consumption in region i, calculated from Ci/Ni.</td>
</tr>
<tr>
<td>Xi</td>
<td>Quantity of sheepmeat exported from region i, thousand tonnes carcase weight equivalent basis. (Source as above).</td>
</tr>
<tr>
<td>Mi</td>
<td>Quantity of sheepmeat imported by region i, thousand tonnes per annum. (Source as above).</td>
</tr>
<tr>
<td>Ni</td>
<td>Population in region i, millions at mid-year. (Demographic Yearbook, UN, 1980).</td>
</tr>
<tr>
<td>ERi</td>
<td>Exchange rate in region i; domestic currency/US$. (IMF).</td>
</tr>
<tr>
<td>T</td>
<td>Time variable. (1960 = 1, 1980 = 21).</td>
</tr>
<tr>
<td>DPW</td>
<td>Pw/CPIW</td>
</tr>
<tr>
<td>DUK</td>
<td>UK supply and demand; the dummy variable reflects the UK's accession to the EEC. (1960-73 = 0, 1974-80 = 1).</td>
</tr>
<tr>
<td>DI</td>
<td>Iranian supply and demand; the dummy variable incorporates the effect of the revolution. (1960-78 = 0, 1979-80 = 1).</td>
</tr>
<tr>
<td>DAR</td>
<td>Argentina; the dummy variable represents the military takeover of Government. (1960-71 = 0, 1972-80 = 1).</td>
</tr>
</tbody>
</table>
DG Greece; the dummy variable represents the change to civilian Government. (1960-73 = 0, 1974-80 = 1).

PWL World wool price; Australian greasy at wholesale, US$/100kg. (Production Yearbook, FAO).

PB World beef price; average export unit value, US$/tonne. (Production Yearbook, FAO).

WPB PB/CPIW

PBAR (PB*ERAR)/CPIAR

PWLAR (PWL*ERAR)/CPIAR

RAU Australian Weather index; a seasonal index measuring rainfall and sheep performance factors, as a percentage of the normal. (BAE, Pers. Comm.).

PBAU Australian beef price, real Auc/kg, retail. (BAE, Situation and Outlook).

PBRLYC Canadian Barley price; Feed No. 1, in store, Thunder Bay, real c$/tonne. (Production Yearbook, FAO).

PBC Canadian beef price, calculated from PBUS converted to real c$.

PBEUC EEC beef price, calculated from PBUK converted to real ECU.

PBJ Japanese beef price, medium quality, at wholesale, Tokyo, real yen/kg. (Japanese Statistical Yearbook).

PPJ Japanese pork price, medium quality, at wholesale, Tokyo, real yen/kg. (Japanese Statistical Yearbook).

PWLNZ NZ wool price; average auction price for greasy wool, real NZc/kg. (Production Yearbook, FAO).

PBNZ NZ beef price; average mid-month schedule for P.1 Steer, real NZc/kg. (NZMPB, Annual Report).

SMD NZ weather index; the Relative Soil Moisture Deficit Index of the number of days of no grass growth per year. (NZ Meteorological Service, Wellington).

PRBNZ NZ retail beef price, real NZc/kg. (NZ Department of Statistics, 'Prices, Wages and Labour').

PRPUK UK retail pork price, annual national average, real p/lb. (National Food Survey, MAFF; UK Market Survey, MLC).

PRBUK UK retail beef price, annual national average, real p/lb. (Source as above).
PRCUK  UK retail poultry price, annual national average, uncooked broiler, real p/lb. (Source as above).

PBUK  UK wholesale beef price; Smithfield, top quotation for English longsides, £/tonne. (Production Yearbook, FAO).

PWBUK  PBUK/CPIUK

PWLUK  UK wool price; Guaranteed price to producer, real p/lb. (British Wool Marketing Board, Annual Report).

PBUS  US beef price; wholesale steer beef carcases, 500 600lb, Chicago, real US$/100lbs. (Production Yearbook, FAO).


t  Time period.

i  The following regions: Argentina = AR, Australia = AU, Canada = C, East Europe = EE, EEC(8) = EC, Greece = G, Iran = I, Japan = j, NZ = NZ, UK = UK, USA = USA, USSR = R, Rest-of-World = RW, Total World = W.
APPENDIX 3

Summary of Other Studies of Sheepmeat Demand and Supply
### TABLE 9

<table>
<thead>
<tr>
<th>Researcher</th>
<th>Year</th>
<th>Dependent Variable</th>
<th>Demand Elasticity with Respect to</th>
<th>Data Period</th>
</tr>
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<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Own-Price</td>
<td>Lamb</td>
</tr>
<tr>
<td>Taylor</td>
<td>1963</td>
<td>L</td>
<td>-1.8</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>M</td>
<td>-1.2</td>
<td></td>
</tr>
<tr>
<td>Taplin</td>
<td>1965</td>
<td>L</td>
<td>-1.5</td>
<td></td>
</tr>
<tr>
<td>Marceau</td>
<td>1967</td>
<td>L</td>
<td>-2.07</td>
<td>0.79</td>
</tr>
<tr>
<td></td>
<td></td>
<td>M</td>
<td>-1.09</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>Q</td>
<td>0.14</td>
<td></td>
</tr>
<tr>
<td>Gruen et al.</td>
<td>1967</td>
<td>L</td>
<td>-1.55</td>
<td>0.28</td>
</tr>
<tr>
<td></td>
<td></td>
<td>M</td>
<td>-1.38</td>
<td></td>
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<tr>
<td>BAE</td>
<td>1967</td>
<td>S</td>
<td>0.51</td>
<td></td>
</tr>
<tr>
<td>Papadopoulos</td>
<td>1971</td>
<td>L</td>
<td>-1.3</td>
<td>1.29</td>
</tr>
<tr>
<td></td>
<td></td>
<td>M</td>
<td>-2.13</td>
<td></td>
</tr>
<tr>
<td>Greenfield</td>
<td>1974</td>
<td>S</td>
<td>-0.61</td>
<td></td>
</tr>
<tr>
<td>Main et al.</td>
<td>1976</td>
<td>L</td>
<td>-1.89</td>
<td>0.91</td>
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<tr>
<td></td>
<td></td>
<td>M</td>
<td>-2.02</td>
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<tr>
<td></td>
<td></td>
<td>S</td>
<td>-1.24</td>
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</table>

*a* Price elasticity implied by flexibilities reported.

S = Mutton/Lamb
L = Lamb
M = Mutton
A = Annual
Q = Quarterly
W = Weekly
### TABLE 9 (contd.)

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<tr>
<th>Researcher</th>
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<th>Demand Elasticity with Respect to:</th>
<th>Data Period</th>
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<td>Own-Price Beef Pork Income</td>
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<tr>
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<td>S</td>
<td>-2.110 1.74 -0.93 -1.67</td>
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<tr>
<td>Laloux</td>
<td>1968</td>
<td>S</td>
<td>1.35</td>
<td>1966</td>
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<td>Fouquet</td>
<td>1973</td>
<td>S</td>
<td>-0.876 +0.1</td>
<td>1949-67</td>
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<td>1974</td>
<td>S</td>
<td>-0.576</td>
<td>1955-72</td>
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<td>Kelly</td>
<td>1970</td>
<td>S</td>
<td>-0.17</td>
<td>1966-73</td>
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<td>Ireland</td>
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<td>Murphy</td>
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<tr>
<td>Sakellis</td>
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<td>Researcher</td>
<td>Year</td>
<td>Dependent Variable</td>
<td>Demand Elasticity with Respect to:</td>
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<td>Own Price</td>
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<td>Matheson &amp; Philpott</td>
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<tr>
<td>Chetwin</td>
<td>1968</td>
<td>Quantity</td>
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<td>Edwards &amp; Philpott</td>
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<td>Quantity</td>
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<td>1974</td>
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<td>Maclaren</td>
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<td>NZMPB</td>
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### TABLE 9 (contd.)

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<tr>
<th>Researcher</th>
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<th>Dependent Variable</th>
<th>Demand Elasticity with Respect to:</th>
<th>Data Period</th>
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<td>Own-Price Beef Pork Chicken Income</td>
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<td>Brandow</td>
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<td>S</td>
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<td>Tryfos</td>
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<td>-2.91 1954-70 A</td>
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<td>Kulshreshtha</td>
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<td>Min. of Ag.</td>
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<td>0 1950-65 Q</td>
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**CANADA**

**JAPAN**

**NEW ZEALAND**
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*a Cross Sectional Data.

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*a* As defined in Appendix 2.

*b* RMSE = Root Mean Square Error

*c* MARE = Mean Absolute Relative Error
APPENDIX 5

Alternative Projections of Sheepmeat Market Trends
### APPENDIX 5

**Alternative Projections of Sheepmeat Market Trends**

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<td>1985</td>
<td>P</td>
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<td>M</td>
<td>15</td>
</tr>
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<td>World Bank</td>
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<td>Iran</td>
<td>1985</td>
<td>P</td>
<td>344</td>
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<td>960</td>
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<td></td>
<td>M</td>
<td>666</td>
</tr>
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<td>World</td>
<td>1985</td>
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<td>GOL</td>
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<td>World</td>
<td>1985</td>
<td>Price$^e$</td>
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</tbody>
</table>

---

*a P = Production C = Consumption X = Exports M = Imports

*Includes live sheep exports at approx. 110 Kt.

*c 17.7Kg per capita.

*d Not available: by deduction of C from P, X = 381 Kt.

*e Price (equivalent definition to DPW) in real 1970 terms.
APPENDIX 6

Alternative Forecasts
APPENDIX 6

ALTERNATIVE FORECASTS

In this appendix the alternative forecasts discussed in Sections 5.3 and 6.3 are reported. The re-estimated supply equations used in these forecasts are given below. (Where price responses derived from the original equations in Chapter 3 had negative coefficients, the equations were re-estimated after setting the coefficients to zero).

Values in brackets beneath the estimated coefficients are 't' tests. Asterisks indicate coefficients which are not significant at the 5% level. Variable definitions are given in Appendix I.

\[
SAU = 430.84 + 0.49SAU_1 + 1.56PBAU2 - 0.94PWL2 - 1.56RAu - 4.79T
\]
\[
\begin{align*}
(1.62) & \quad (1.89) & \quad (0.73)^* & \quad (0.87)^* & \quad (1.01)^* & \quad (0.99)^* \\
R^2 & = 0.56 & \quad DW & = 1.44 & \quad S & = 90.30 & \quad F(5,13) & = 3.42
\end{align*}
\]

\[
SC = -8.24 + 0.72SC1 + 0.77E-02PBC2 + 0.19E-01PBRLYC
\]
\[
\begin{align*}
(2.58) & \quad (7.77) & \quad (2.56) & \quad (1.45)^* \\
R^2 & = 0.90 & \quad DW & = 2.08 & \quad S & = 1.07 & \quad F(3,15) & = 46.07
\end{align*}
\]

\[
SEC = 94.72 + 0.50SEC1 + 2.80T
\]
\[
\begin{align*}
(2.38) & \quad (2.43) & \quad (2.60) \\
R^2 & = 0.96 & \quad DW & = 1.94 & \quad S & = 6.35 & \quad F(2,16) & = 204.30
\end{align*}
\]

\[
SUK = 57.36 + 0.32SUK1 + 0.10PWBUK2 + 120.97PWLUK2 + 15.89DUK
\]
\[
\begin{align*}
(0.61)^* & \quad (1.12)^* & \quad (0.83)^* & \quad (1.06)^* & \quad (0.80)^* \\
R^2 & = 0.26 & \quad DW & = 1.44 & \quad S & = 17.68 & \quad F(4,14) & = 1.23
\end{align*}
\]

\[
SUS = 12.83 + 0.97SUS1 - 0.16E-01PBUS2
\]
\[
\begin{align*}
(0.40)^* & \quad (20.99) & \quad (0.47)^* \\
R^2 & = 0.98 & \quad DW & = 1.46 & \quad S & = 11.38 & \quad F(2,16) & = 345.02
\end{align*}
\]

In Table A6.1 the results of a Base forecast are given. This Base forecast uses similar assumptions to those in Chapter 5, except for the substitution of the above set of non-price responsive equations on the supply side.

Summarised in Tables A6.2 and A6.3 are the results of the two simulations discussed in Section 6.3. In both cases the simulations were performed using the equations presented above and evaluated against the alternative Base forecast detailed earlier in this appendix.

The simulations assess the effects of firstly, a constant level of production in New Zealand and secondly, an annual growth of 2% in New Zealand production over the period 1981-90.
TABLE A6.1

<table>
<thead>
<tr>
<th>Country</th>
<th>1985</th>
<th>1990</th>
<th>Average 1981-90</th>
</tr>
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<tbody>
<tr>
<td><strong>Production</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Argentina</td>
<td>79.9</td>
<td>57.2</td>
<td>79.8</td>
</tr>
<tr>
<td>Australia</td>
<td>603.0</td>
<td>558.3</td>
<td>593.6</td>
</tr>
<tr>
<td>Canada</td>
<td>12.1</td>
<td>13.6</td>
<td>11.6</td>
</tr>
<tr>
<td>EEC (8)</td>
<td>329.5</td>
<td>357.4</td>
<td>332.6</td>
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<td>Greece</td>
<td>140.5</td>
<td>168.4</td>
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<td>Iran</td>
<td>298.6</td>
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<td>318.9</td>
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<td>426.8</td>
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<td>226.2</td>
<td>228.3</td>
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<td>USA</td>
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<td>37.0</td>
<td>74.9</td>
</tr>
<tr>
<td><strong>Per Capita</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Consumption</strong></td>
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<td></td>
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<tr>
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<td>3.3</td>
<td>3.5</td>
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<tr>
<td>Canada</td>
<td>0.8</td>
<td>0.7</td>
<td>0.8</td>
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<tr>
<td>EEC (8)</td>
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<td>2.1</td>
</tr>
<tr>
<td>Greece</td>
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<td>17.4</td>
<td>16.3</td>
</tr>
<tr>
<td>Iran</td>
<td>12.0</td>
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<td>12.1</td>
</tr>
<tr>
<td>Japan</td>
<td>1.1</td>
<td>1.3</td>
<td>1.2</td>
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<td>New Zealand</td>
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<td>28.0</td>
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<td>Australia</td>
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<td>575.1</td>
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<td>42.3</td>
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<td>Rest-of-World</td>
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<td><strong>Imports</strong></td>
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<td>Iran</td>
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<td>297.7</td>
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<td>1115.8</td>
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<tr>
<td><strong>World Price</strong></td>
<td>$3099.25</td>
<td>$3776.98</td>
<td>$3161$^a</td>
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^a 1980 US dollars
TABLE A6.2
Ex Ante Simulation of a Constant Level of Production in New Zealand

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean Value of Simulated Variable 1981-90</th>
<th>Mean % Change Over Base Run</th>
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<tbody>
<tr>
<td>SNZ</td>
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<td>PW</td>
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<td>XNZ</td>
<td>441.7 Kt</td>
<td>+16.3</td>
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<tr>
<td>MW</td>
<td>1045.2 Kt</td>
<td>+2.6</td>
</tr>
<tr>
<td>MUK</td>
<td>125.1 Kt</td>
<td>+4.6</td>
</tr>
<tr>
<td>Total New Zealand Revenue</td>
<td>$1,308.3m</td>
<td>+8.8</td>
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TABLE A6.3
Ex Ante Simulation With an Annual Growth Rate of 2% in Production in New Zealand

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean Value of Simulated Variable 1981-90</th>
<th>Mean % Change Over Base Run</th>
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</thead>
<tbody>
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<tr>
<td>Total New Zealand Revenue</td>
<td>$1,379.7m</td>
<td>+14.8</td>
</tr>
</tbody>
</table>

a As defined in Appendix I.