QUANTITATIVE ANALYSIS OF THE IMPACT OF IMPORTS ON THE DOMESTIC PIG AND PIGMEAT INDUSTRIES

A report prepared for the

Productivity Commission

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by the

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EXECUTIVE SUMMARY

The Productivity Commission has commissioned the Institute for Research into International Competitiveness and the Muresk Institute of Agriculture, both located at Curtin University of Technology to undertake an econometric investigation into the impact of Canadian pigmeat imports on domestic pig and pigmeat industries.

This report represents the consultants' response to the following Terms of Reference for this project. The research team was asked to examine the impact of imports of frozen, uncooked pigmeat on prices received by, and output of Australian pigmeat producers. Furthermore, the research team was asked to analyse the impact of other factors affecting the domestic pigmeat market which might include, for example, changes in beef prices, consumer preferences or feed costs.

The following six chapters of this Report outline the research team's findings with regard to this project. Chapter 1 is an Introduction to the issues relating to this problem, and provides a motivation and context for the Report.

Chapter 2 provides an Industry Overview. Several key issues are identified:

1) There does not appear to be an oversupply of domestic produce compared with past 5-6 years;
2) Australia has been a net exporter of pigmeat over most of the period under examination, with the exception of 1996/97 (prior to the current price slump);
3) Canadian imports comprise a relatively small fraction of the overall market, with the most significant impact on the industry being felt in the ham and smallgoods market;
4) Given stable consumption patterns for pork, it appears likely that substitute prices have had a large effect on pork prices. For instance, slumps in beef prices due to

the Asian economic crisis and lower lamb prices due to European food scares may explain the general decline in meat prices;

5) The lags between the issuing of contracts and the arrival of imported products may explain at least part of the decline in prices over the past year; and
6) Lower domestic prices and a falling Australian dollar will tend to reduce incentives for continued importation of Canadian pigmeat.

Chapter 3 presents a review of the previous literature in this area. In particular, the research team focuses on submissions to a previous Commission study (Industry Commission, 1995), ABARE's 1998 work in this area and a recent report to the Department of Primary Industries in Queensland (Purcell and Harrison, 1998).

Generally speaking, the analyses provided to the Commission in 1995 and ABARE's 1998 report use standard econometric causality tests to determine if there exists a relationship between Canadian pigmeat imports and Australian pigmeat prices. These reports find no evidence for reaching a conclusion that there exists any direct causal link between the two. Purcell and Harrison (1998) undertake a fairly extensive econometric analysis and find that there exists strong evidence for the hypothesis that there are negative effects associated with trade liberalisation in the Australian pigmeat industries. That is, they find evidence that imports of Canadian pigmeat have reduced the overall price of the product in the domestic market.

The research team views Purcell and Harrison (1998) acceptable in overall approach, but disagree with several aspects of their methodology on technical grounds. Notably, this disagreement is in relation to the tests for stationarity undertaken, the transformation of the several variables and model specification. These concerns are discussed in Chapter 3.

Chapter 4 outlines the data issues associated with this project and the issues involved in testing the time series properties of the quarterly data collected. The data set used in this analysis is for a set of variables over the period 1984:1 to 1998:2. The consultants have collected data on a number of variables: saleyard prices for pork and its substitutes; retail prices for pork products; pigmeat production; volumes, value and prices for Canadian pigmeat imports; and volumes and values for Australian imports and exports of pigmeat. A series of unit root tests with adjustments for trends and seasonality are conducted. Most variables are found to have non-seasonal (zero frequency) unit roots, while the Canadian import price series is found to have a semi-annual unit root. The unit value of pigmeat exports series is found to have both zero frequency and semi-annual roots. The implications from these findings are that the majority of variables can be modelled in a standard cointegrating framework.

Chapter 5 presents the methodology and actual modelling undertaken, which includes tests for cointegration in a vector autoregression using the Johansen method. It is found that there exists a cointegrating vector between four domestic variables:

1. Pork saleyard price;
2. Beef saleyard prices;
3. Pigmeat production; and
4. The retail price of pork.

Hence, there exists a long-term relationship between these four variables. The issue in question here is whether this relationship has remained stable over the period during which Canadian imports were allowed into the country.

Our analysis indicates that there is no role for import volumes in this relationship. In fact the only variable that has major impacts upon the dynamics of the pig saleyard price is domestic pigmeat production. Hence, over the period of examination there is no clear evidence to suggest that pigmeat imports are a direct and important cause of the volatility and decline seen in the pig saleyard price in recent quarters.

The conclusion (Chapter 6) provides a summary of our methodology and findings.

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CHAPTER 1

INTRODUCTION

With the relaxing of the quarantine restrictions in July 1990, the Australian domestic pigmeat market was opened to the competition of imported uncooked frozen pigmeat, predominantly from Canada.

More recently, over the past few months, the saleyard price of pigmeat has failed to follow the normal seasonal patterns and has fallen to a historically low level. Australian pig producers have claimed that the low prices for domestic pigmeat were largely attributable to the imports of pigmeat from overseas. This is as the argument goes, due to a further lifting of quarantine restrictions to allow the imports of cooked pigemeat from Canada and frozen uncooked pigmeat from Denmark in November 1997. Concern for the future of Australian pig industry has led to an inquiry by the Productivity Commission to determine:

1) whether some form of safeguard action is needed against imports of frozen pigmeat; and
2) the factors affecting the competitiveness and profitability of the domestic pig and pigmeat industries.

This report is prepared for the Productivity Commission to assist in an investigation into the impact of imports on domestic pig and pigmeat industries in Australia. The objectives of this report are to examine:

1) the impact of imports of frozen, uncooked pigmeat on prices received by, and output of Australian pigmeat producers; and
2) the impact of other factors which might include, for examples, changes in beef prices, consumer preferences or feed costs.

This study is conducted jointly by a team of economists from the Institute for Research into International Competitiveness and the Muresk Institute of Agriculture at the Curtin University of Technology. The plan of this report is as follows: Chapter 2 examines the main issues of the pig and pigmeat industries in Australia. It provides a descriptive analysis of the three sectors of Australian pigmeat industry, namely the farm sector, the slaughter and processing sectors, and the final marketing sector, which includes the imports and exports of pigmeat. Chapter 3 presents a review of recent studies on the Australian pig and pigmeat industries, particularly the reports submitted to the Industry Commission and the Queensland Department of Primary Industries. A summary of their results and weaknesses would facilitate the quantitative analysis on the impacts of pigmeat imports on domestic markets. One of the limitations of time series modelling is the availability of relevant data over extended periods. Chapter 4 will examine the time series properties of the data. It focuses on the issues such as data sources, the price behaviour and data stationarity. Chapter 5 provides an empirical modelling of the pigmeat prices in a multivariate framework. A vector autoregressive (VAR) model is set up to testing for the existence of a linear long-run relationship among the variables and the impact of imports. The stability of the VAR model and the causal links between the variables are examined with the inclusion of the import variable. The summary and concluding remarks are presented in Chapter 6.

CHAPTER 2
INDUSTRY OVERVIEW: WHAT ARE THE ISSUES?

Introduction

In recent months Australian pig producers have maintained that the prices received for their pigs during the latter half of 1997 and throughout 1998 have (i) been abnormally low and (ii) failed to follow normal seasonal patterns. These unusual circumstances are causing serious damage to the industry.

For many years Australia had a near complete ban on the imports of pigmeat and pigmeat products for phytosanitary reasons. The exceptions were some pigmeat from the south island of New Zealand and canned pigmeat. From July 1990, imports of frozen, boned, uncooked pigmeat from Canada was permitted for processing on arrival in Australia. In November 1997, a decision by the Federal government allowed the imports of processed products from Canada and fresh or frozen boned meat from Denmark for processing in Australia.

Australian producers have repeatedly claimed that reductions in farm-gate prices are largely attributable to these imports. Claims of unfair trade due to dumping or subsidised production in Canada have not been sustained. Under the WTO agreement, safeguard measures may only be applied by the Australian government if the government can demonstrate that (i) imports have increased substantially and (ii) the increase has caused or threatens to cause a serious injury to the industry.

To sustain an argument for safeguard remedies, there is therefore, a need to prove that the imports, rather than other factors, have been responsible for price reductions and that these price reductions have injured or threaten to injury the industry.

This report provides a critical review of previous studies that have addressed the causal link between imports and domestic farm-gate and retail prices. In the light of this review, a further attempt is made to estimate the effect of imports on domestic prices. Within the time constraints of this study, this empirical analysis incorporates further data sets, different model specification and analytical techniques.

The remainder of this chapter is devoted to a discussion of the pigmeat industry within Australia. This description provides a background rationale to the review of other studies and the model specification within this study. This description of the industry also helps, in a purely qualitative way, to postulate whether or not price reductions have injured the industry.

The description is divided into three sections which examine, in turn, the farm sector, the slaughter and processing sectors and the final marketing sector (which is almost exclusively retailing). In practice the industry is not so clearly segmented and there are a number of instances of vertical integration. Probably the most prevalent integration is at the farm level involving feed growing, feed compounding and pig production. The more substantial examples involve feed compounding, pig production and processing.

2.2 Pig production sector – size and structure

The Australian pig production sector is small by international standards. As Table 2.1 shows, Australian production represents about 0.5 per cent of world production (75 million tonnes) and is a quarter of the production in Canada and a fifth of Danish production.

In common with many other agricultural activities both in Australia and overseas, the pig production sector has experienced substantial structural change over recent decades (Table 2.2). In the last thirty years, national sow numbers have remained mostly between 300,000 and 350,000. However, over the same period the number of producers has declined from 40,000 to just over 3,000 and the average herd size has increased tenfold from 8 sows to 90 sows per producer.

Table 2.1
International Pigmeat Production (1996/7)

Country	Production (000 tonnes)
China	42,500
EU	17,755
USA	7,835
Denmark	1,625
Canada	1,255
Australia	326

Source: PigStats 97

Table 2.2
Australian Sow and Producer Numbers (1970-97)

Year	Sows ('000)	Producers (no)	Average herd size (no)
1970	338	39,498	8.6
1980	352	19,279	18.3
1990	331	6,847	48.3
1997	299	3,337	89.5

Source: PigStats 97

Although the current average herd size of 90 sows is considered large enough to fully employ one person, there are still a very large number of producers with 50 sows or less for whom pig production can only be a complementary or supplementary activity. Roughly two-thirds of production is concentrated in less than 8 per cent of herds (Table 2.3).

Table 2.3
Distribution of Herd Sizes (1997)

Herd size (sows)	Sows ('000)	Sows (%)	Producers (no)	Producers (%)
Less than 50	31,147	10.4	2,208	66.2
50 – 199	81,831	27.4	886	26.5
200 and more	185,837	62.2	243	7.3

Source: PigStats 97

Pig production is spread throughout the main temperate and mediterranean grain growing areas of Australia. Over half of the national herd is located in New South Wales and Queensland (Table 2.4).

Table 2.4
Geographic Distribution of Pig Prodction (1997)

State	Sows ('000)	Sows (%)	Herds (no)	Av. herd size (sows)
New South Wales	94,223	31.5	1,059	89
Queensland	62,126	20.8	604	103
Victoria	56,258	18.8	435	129
South Australia	47,846	16.0	680	70
Western Australia	33,349	11.2	465	72
Tasmania	4,666	1.6	90	52
Northern Territory	347	0.1	4	87

Source: PigStats 97

Geographical concentration of production in Western Australia has been compared with other countries and shows a dispersed industry (Table 2.5). Whilst total Australian production is slightly more concentrated, particularly in South Australia. New South Wales and Queensland, there are still likely to be higher transport and support costs than in other major producing countries.

Table 2.5

International Pig Population Densities

Region	Total pig population	Pig population density (hd/km^2)
Denmark	11 million	360
Netherlands	14 million	300
France (Brittany)	7 million	100
USA (Mid-West)	48 million	36
Western Australia	350,000	2

Source: WA Pig Industry Taskforce

Estimates of employment in pig production are sparse. ABS data show that 3,780 persons employed in pig farming in 1991 (ABS, 1991). The Industry Commission (1995) used "a commonly accepted industry figure of one person to run a 100 sow piggery" to estimate total employment in pig production at about 2,900 people. The WA Taskforce (1996) used a locally accepted figure of one person per 80 sows farrow-to-finish and equal employment in the ancillary industries (transport, agents, feed and other input supplies). This would suggest employment of 3,750 in Australian pig production and a similar number in the ancillary industries. A survey of WA pig producers in 1997 showed one full-time equivalent person employed per 78 sows farrow-to-finish (Bent and Harman, 1998). The total number of people employed was 20 per cent greater because of part-time employment. This survey would appear to confirm the ABS and WA Taskforce estimates. The majority of this employment is in rural areas and, even in the case of part-time work, is regular rather than seasonal.

2.3 Pig production sector – technical and economic performance

International comparisons of agricultural production are often difficult because of differences in market conditions, product specifications and survey techniques. Pigs produced in Australia are relatively small by international standards. However a 5kg increase in average carcase weight over the last 5 years has reduced this difference.

There are two distinct size categories. Pigs for bacon, ham and small goods manufacturing, 'baconers' are slaughtered to produce carcases of around 70-75kg. 'Porkers' are slaughtered to produce carcases of 45-55kg which are butchered into cuts and joints for fresh meat sales. Carcase weight is an important determinant of technical and economic performance because many of the inputs, particularly of the breeding herd, are fixed irrespective of the size of the finished pig. Larger carcases allow these costs to be spread over a greater weight of meat, other things being equal.

The two major measures of technical efficiency in pig production are the number of pigs raised per sow per year in the breeding unit and the feed conversion ratio in the finishing operation. Daily liveweight gain is also important in the finisher unit. The WA Taskforce concluded that, whilst the better Australian pig producers are technically competitive with overseas producers, the average performance is not internationally competitive.

However differences in the levels of different inputs and the prices of those inputs between Europe, USA and Australia provide some mitigation for differences in technical performance. Average costs of production in Australia have been compared with costs in other countries by several commentators. Australia appears to have slightly higher costs than North America but lower costs than Europe (Table 2.6).

Table 2.6
Estimated costs of production ($/kg dressed weight)

Country	Boddington	Campbell	Loius
Canada	1.41	1.31	1.39
United States	1.52	1.46	1.75
Australia	1.69	1.89	n.a.
Netherlands	3.54	1.97	n.a.
Denmark	n.a.	2.04	n.a.
United Kingdom	2.52	2.05	2.89
Japan	5.27	n.a.	6.04

Source: Industry Commission (1995)

Feed accounts for roughly 60 per cent of the costs of pig production (Table 2.7). Feed grain supplies and prices have fluctuated widely in recent years. Producers in the east have been affected by droughts which not only reduce the yield and supply of feed, but increase the demand from forage-based livestock industries. Although Western Australia has enjoyed more regular harvests and is the major exporter of grain, feed supplies for domestic producers are affected by the export-orientation of the grain industry.

Table 2.7
Costs of Production (¢/kg hot carcase weight)

Costs	1990/1	1991/2	1992/3	1993/4	1994/5	1995/6	1996/7
Herd costs	11	15	14	12	12	12	16
Shed costs	9	10	12	11	10	10	11
Feed costs	101	106	103	107	118	130	127
Labour costs	30	30	32	33	30	33	34
Overhead costs	30	27	32	29	28	30	36
Total costs	181	188	189	191	199	215	224

Source: Australian Pork Corporation

One grievance of pig producers is that pigmeat imports are allowed as part of international trade liberalisation and yet the producers cannot readily import subsidised feed grains that are being exported by the USA and EU.

2.4 Pig processing and slaughtering

There are approximately 130 abattoirs in Australia that kill pigs (Pigstats 97). In 1996/7 the abattoir with the largest annual throughput, Bunge at Corowa NSW, killed 454,000 pigs. The top six abattoirs each killed more than quarter of a million pigs during the year or 5,000 pigs per week. Collectively these six abattoirs kill over 40 per cent of the pigs slaughtered in Australia and the top 20 abattoirs kill 80 per cent of the pigs.

Although national averages can be distorted by large numbers of small processors, Table 2.8 clearly demonstrates that even Australia's top six abattoirs operate well below the throughput of the average abattoir in Denmark or the Netherlands. There are abattoirs in Canada and the USA that individually process as much as the top six Australian abattoirs combined.

Table 2.8
International Abattoir Throughputs

Country	Annual kill (millions)	Number of Abattoirs	Average annual kill (hd)	Average weekly kill (hd)
Denmark	18	24	750,000	14,400
Netherlands	20	35	571,000	11,000
USA	92	921	100,000	1,920
Australia	5	140	38,500	740

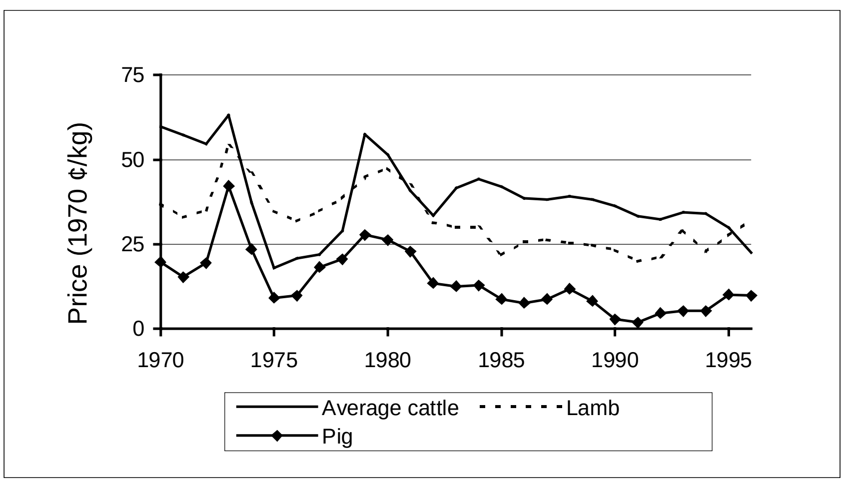
Source: WA Taskforce 96

Analysis of processing costs (slaughtering and cutting but not small goods manufacture) show that the Australian slaughtering and processing sector is not internationally competitive (WA Taskforce, 1996; Hassall and Associates, 1995). The main reasons for lower performance are the relatively low throughputs, low labour productivity and a shorter working week. Even where processing costs per pig were similar, Australia was uncompetitive because the low carcase weights resulted in higher costs per kilogram.

2.5 Pig product marketing

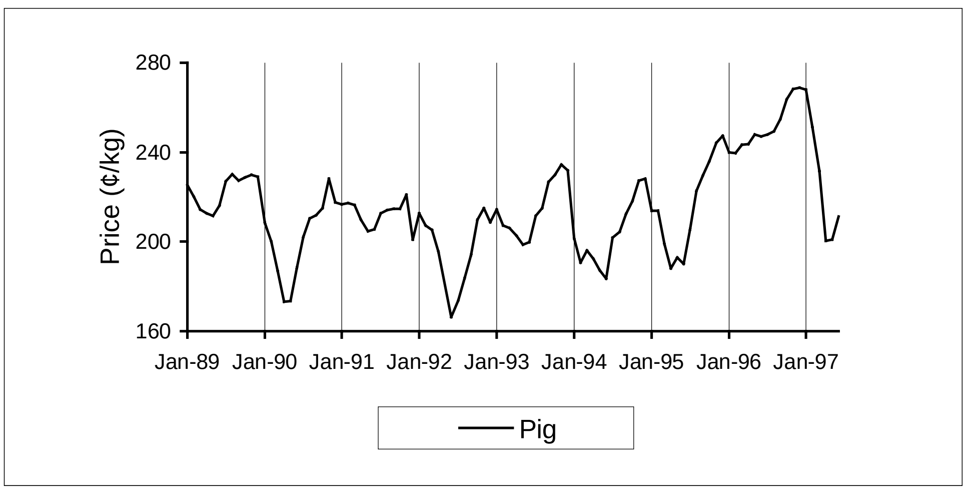
Pig prices have been declining in real terms over many years (Figure 2.1). Fluctuations in prices have been less extreme in the last two decades compared to the 1970s. Pig prices appear to display a pattern that is similar to the trends for cattle and sheep prices.

Figure 2.1
Real Saleyard Prices for Pigs, Cattle and Sheep (1970-97)



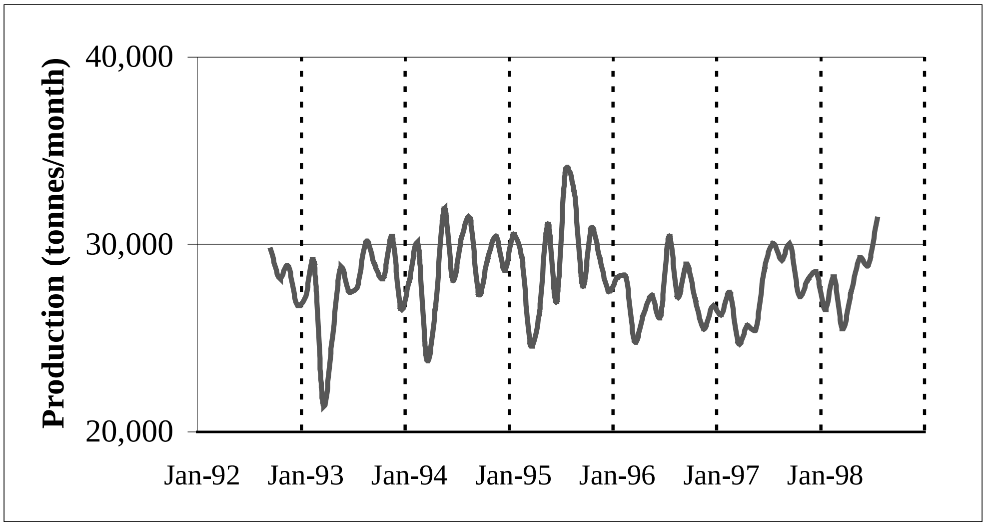
Pig prices have a marked seasonal pattern (Figure 2.2). The increase in prices in the latter half of most years reflects a build up of stocks by processors to meet the summer demand particularly for ham around the Christmas period. Producing pigs for the last quarter requires conception during the previous summer or early autumn, which is adversely affected by the effects of heat on fertility. These imply that the cost of supply is likely to have a lesser influence on the prices.

Figure 2.2
Monthly saleyard prices for pigs (1989-97)



A season production pattern is also evident with high points in the third quarter of the year and a low point in the first quarter (Figure 2.3). Examination of Figure 2.3 would seem to indicate that the claims that the low prices in late 1997 and early 1998 were due to oversupply of domestic production appear to be tenuous. Certainly the supply during that summer was slightly higher than the previous year (1996/7) but it was not as high as the previous four years. Net imports during the 1997/8 year were lower than for the previous four years (Figure 2.5), so the period cannot be considered to represent an "oversupply". With reasonably static consumption levels, one would need to look at the prices of substitutes such as beef, lamb and chicken for an explanation for the pork price decline. During the period in question, the effects of the Asian economic crisis on beef prices and the effect of European food scares on lamb prices are generally recognised in the meat industry.

Figure 2.3
Monthly Pig Production (1992-98)



The pigmeat market can be divided broadly into fresh and processed pigmeat. Processed pigmeat can be sub-divided into bacon, hams, sausages and other smallgoods. The sources of meat for these products are porkers, baconers and imported meat. Sausage and other smallgoods can include varying quantities of other meats such as beef, lamb and mutton. The different sources and uses of these meats are shown in Figure 2.4. The approximate percentage of pigmeat going into each section is also shown (Industry Commission, 1995).

Consumption of pigmeat in Australia is relatively low at 19kg per person per year when compared with consumption in the UK (25kg), USA (28kg), Italy (35kg), Taiwan (38kg) Germany, Hong Kong, Spain, Belgium, Austria and Denmark where annual consumption is over 50kg per person a year.

Figure 2.4
Structure of pigmeat processing

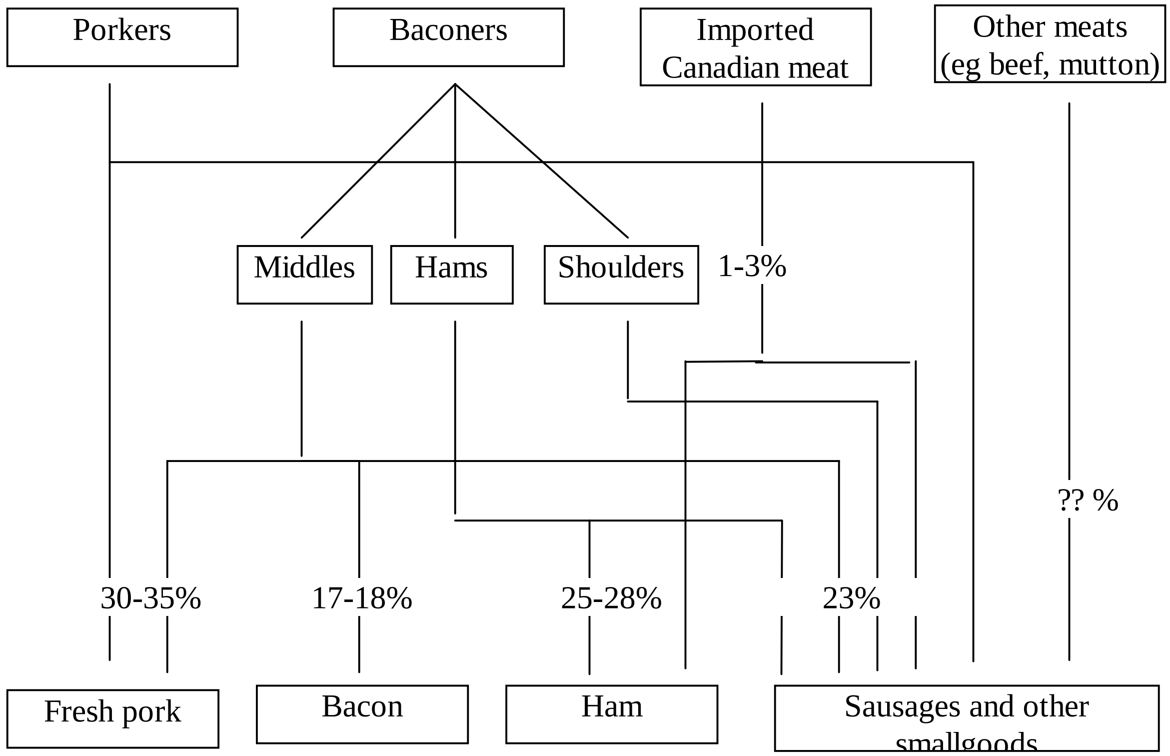


Figure 2.5
Quantities of pigmeat imports and exports (1989-98)

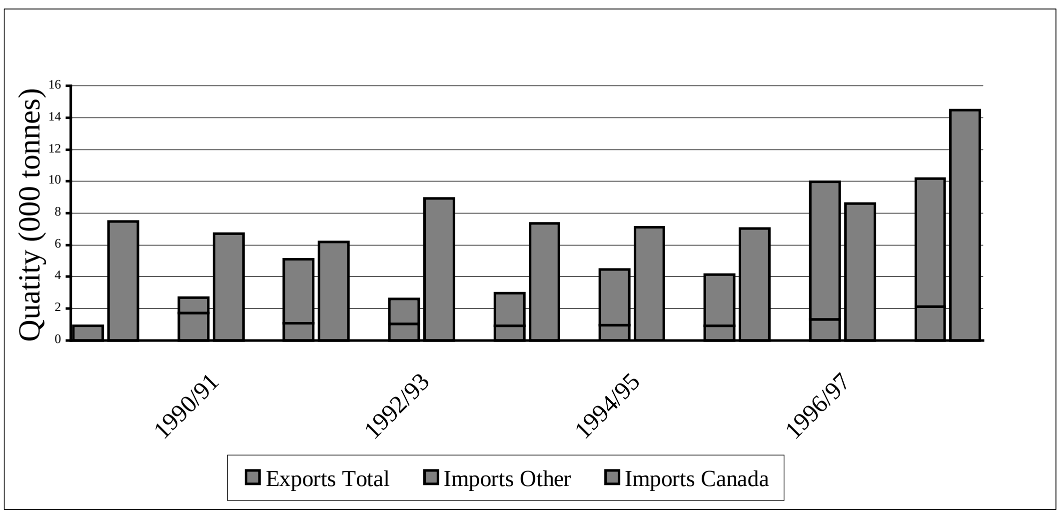
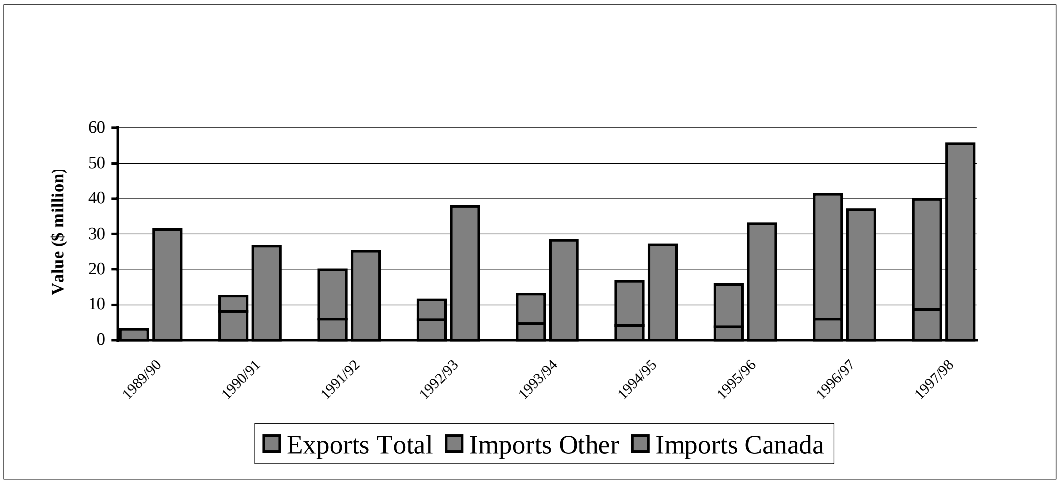


Figure 2.6
Values of pigmeat imports and exports (1989-98)

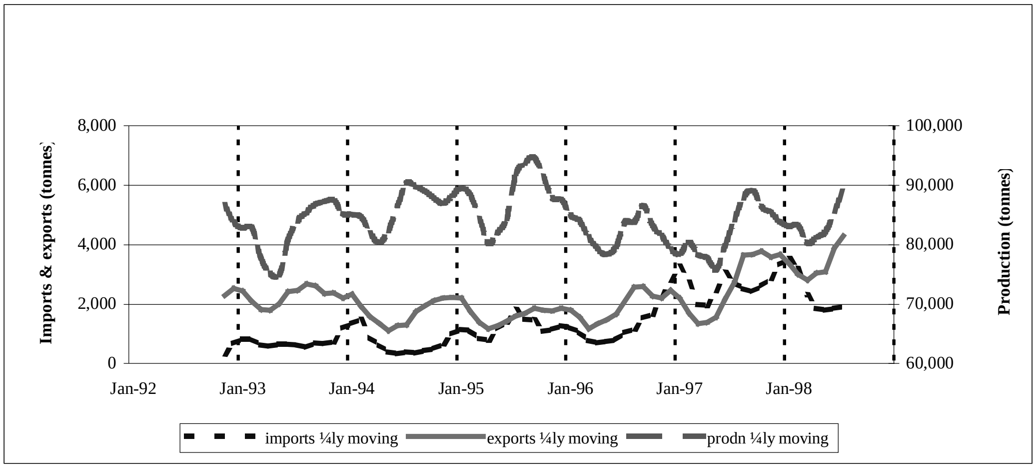


2.6 Imports of pigmeat

Imports of pigmeat, particularly of frozen hams from Canada, have grown during the 1990s. Over the same period Australian exports have also increased. The 1996/7 financial year was the only year in the last decade when Australia was a net importer of pigmeat both in terms of volume and value (Figures 2.5 and 2.6). It should be noted, however that a significant but rapidly declining proportion of Australian exports have been feral game pigs that have little effect in the domestic market.

Examination of the seasonal patterns of imports and exports show a close match between imports, exports and production (Figure 2.7). It would be reasonable to surmise that imports react to market expectations in much the same way as production. Whilst there is a lag of approximately 10 months between a production decision (to mate pigs) and the product reaching the market, there is also a lag between a processor expecting a shortfall, issuing a contract, the shipment arriving and the product coming out of store of 3-6 months. Thus imports arriving during a period of low prices will be the result of a decision taken some six months previously when expectations may have been for a shortfall. Current low domestic prices and a weak Australian dollar appear to provide little incentive to importers.

Figure 2.7
Monthly Pig Production, Exports and Imports (1992-98)



2.7 The main issues

- There does not appear to have been an over supply of domestic produce compared until the past 5-6 years.
- Australia has been a net exporter of pigmeat for most of the decade. The one financial year when Australia was a net importer was 1996/7, which was prior to the current price slump.
- Canadian frozen hams comprise a very small proportion of total pigmeat used in Australia. The most likely impacts will be in the ham and smallgoods market segments rather than the freshmeat segment.
- With stable consumption and little evidence of over supply one of the most likely explanations for pig price declines must lie with substitutes such as beef, lamb and chicken. Recent slumps in beef prices due to Asian economic crisis and lamb prices due to European food scares appear to be sound reasons for a general decline in all meat prices.
- The lags between processors issuing import contracts and product arriving offer some explanation for imports arriving during a period of low prices.
- Low domestic prices and a weak Australian dollar provide little incentive for continued imports.

CHAPTER 3

AUSTRALIAN PIG INDUSTRY STUDIES: A REVIEW

3.1 Introduction

The Federal government lifted the quarantine restrictions on the importing of pigmeat from Canada in 1990. This has led to a number of studies undertaken by the government agencies to examine the impact of imports on the Australian domestic pig and pigmeat industries in relation to the claims on unfair trade and injury to the industry.

This chapter provides an overview of recent studies on the Australian pig and pigmeat industries, particularly the reports submitted to the Industry Commission and the Queensland Department of Primary Industries. An analysis of the strengths and weaknesses of previous studies, especially their quantitative analyses, would facilitate further study on the impact of imports on the domestic pigmeat market

3.2 The Industry Commission

The Industry Commission received three reports, two from ABARE and one from NSW government, on the Australian pig and pigmeat industries. These studies examined the changes occurring in the pig and pigmeat industries and more importantly, the impacts of import on various segments of the domestic pig market.

3.2.1 The 1995 ABARE Report

The 1995 ABARE report examined the impact of pigmeat imports on the Australian pig industry and addressed two major issues:

1) The extent of subsidies provided to the overseas suppliers of pigmeat by their governments, particularly Canada, and their effects on the Australian market.
2) The effects of pigmeat imports on the returns to domestic pig producers which include:
   i) the share of imports to domestic production;
   ii) the competitiveness of Australian producers compared with their overseas counterparts; and
   iii) the impacts of imports on domestic prices.

The ABARE report indicated that the overall level of subsidy provided to the Canadian pig industry has fallen since 1992. For the pig producers in the European Union, a progressive reduction in the volume of their subsidised pigmeat exports has been set under the Uruguay Round Agreement of GATT. These arrangements will result in reduced subsidies over the coming years.

Regarding the effects of imports on the Australian pigmeat industry, this report examined the volume of total pigmeat imports, particularly from Canada. Over the period 1990-95, the share of total imports for pigmeat accounted for around 3 per cent of domestic pigmeat production. The largest category of total pigmeat imports is uncooked frozen pork (with rind and bone removed), and the largest proportion comes mainly from Canada which accounts for 70-80 per cent of total imports. A small proportion comes from New Zealand. As the type of the imported pigmeat is controlled by the quarantine protocol, the effects of imports are expected to be restricted to a small, specific segment of the domestic market. Over the medium term, annual imports of pigmeat are not expected to rise significantly above the 1994-95 level.

On the issue of competitiveness, the costs of producing pigmeat in Australia are found to be higher as compared with Canada, and are at par with the European countries. The cross-price elasticities for pork and other types of meat were computed so as to examine the impact of other meat prices on the pork consumption. Beef prices were found to have the highest cross elasticities with each type of meat. A reduction in the costs of producing and processing pigmeat relative to the red meats is likely to increase the price competitiveness of pigmeat in the domestic retail market.

A quantitative analysis of the impact of imports on the Australian pigmeat prices was performed using the Econometric Model of Australian Broadacre Agriculture (EMABA) model. This study applied cointegration techniques to testing for a long-run relationship (or a cointegrating vector) between saleyard, wholesale and retail prices for pigmeat, saleyard and retails prices for beef, and unit value of imports for frozen bone-out pork. All the six variables were tested to be stationary in first differences (or integrated of order one) except for the unit value of imports, which was found to be integrated of order zero. The empirical results are summarised as follows:

1) A stable long run relationship was found between the prices for beef and pigmeat, and this relationship is not affected by the introduction of pigmeat imports.
2) There is no long run relationship between the unit value of imports and the pigmeat prices at all levels (i.e. saleyard, wholesale and retail), which implies the effect of the import price on pigmeat prices is more likely to be short term.

A sensitivity analysis on the effect of doubling import volumes in 1994-95 on the Australian pigmeat prices was performed using the EMABA model. The results indicated that an increased total supply of pigmeat by 2.5 per cent would lead to a fall of over 6 per cent and 2.5 per cent in saleyard and retail pigmeat prices, respectively. However, domestic prices will eventually adjust to their original level before the shock, when the import volume returns to its initial level. Overall, the statistical evidence indicates that it is the domestic conditions rather than the import prices, which determine the domestic pigmeat prices.

A review of the 1995 ABARE report indicates that it fails to use appropriate econometric modelling methods to analyse the impact of imports on the domestic pig industry. There are a number of key weaknesses. These are:

1) As the quarterly data used appear to exhibit seasonal variations, it is essential to test for data stationarity using seasonal unit roots techniques instead of the conventional unit root tests. If the data exhibit deterministic or stochastic

seasonality, the estimation results obtained without the appropriate seasonal corrections would lead to biased inferences.

2) The report stated that the volatility in pigmeat prices has not increased in the 1990-94 period as compared with the 1985-89 period (p. 9), but this has not been substantiated by any quantitative evidence. One would need to compute and compare the standard deviations of the price series over the two periods to justify the claim. Alternatively, one can determine if the long-run trend of a series has changed over time by testing for any structural break in the data.

3) Further clarification is required on the methodology of the time series analysis used and the specifications of the model. For instance,

   i) The conventional level of significance for rejection of the null hypothesis of non-stationarity is 5 per cent and not 10 per cent.

   ii) There is no distinct referencing of the Dickey-Fuller and Phillips-Perron tests used for the unit root and cointegration tests, where the latter requires a two-step estimation procedure. These residual-based cointegration tests are inefficient and can lead to contradictory results, especially when there are more than two I(1) variables under consideration (see Pesaran an Pesaran, 1997). The Johansen's maximum likelihood procedure is the appropriate approach to testing for cointegration in a multivariate framework.

   iii) It is possible for the imports to have long-run effect on domestic prices of pigmeat even though the unit value of imports (integrated of order zero) cannot be included in the long-run model. One could use another proxy variable such the volume of imports, to test for the impact of imports.

4) Regarding the sensitivity analysis on the effect of doubling import volumes, it is unrealistic to assume that the volume of imports for pigmeat will revert to its initial level in the following year. Although the share of total imports to domestic pigmeat production is fluctuating at around 3 per cent, the trend is likely to continue rising with the further lifting of import restrictions in 1997.

3.2.2 The 1998 ABARE Interim Report

The 1998 ABARE report examined the current situation in the pig industry to determine whether the current prices for pig products are exceptionally low, and thus the industry might require government assistance. To address the issue of low pigmeat prices, ABARE examined the prices in real term (deflated by the consumer price index). This because the prices expressed in nominal terms would tend to fall more when the inflation rates were low.

In the report, the period from March 1984 to March 1994 was selected as the base period for comparison with current trends of pigmeat prices and production. The trend for the pigmeat prices has been observed to be downward sloping for many years both in Australia and overseas. ABARE indicated that the real indicator pig price at current level is not low when it is compared with the estimated long term trend. As the level of pigmeat imports remains at around 3 per cent of total production, the likely reason for the current low prices is a steady increase in domestic production. It has been argued that the relatively low prices for beef in the past few years has weakened the consumer demand for pigmeat.

In the short term, the ABARE report suggested that the prices of pigmeat could continue to fall if the pigmeat production continues to rise. On the other hand, an expectation of higher beef prices is likely to result in a stronger demand for pigmeat, which in turn, would lead to an increase in the pigmeat price.

The 1998 ABARE report aims at explaining the factors that determine the prevailing low prices for pigmeat based on the trends of various variables, such as prices of pigmeat, beef and feedgrain, pigmeat production and imports, and returns to pig producers. A number of queries regarding the arguments expressed in the 1998 report are listed below:

1) There is no justification why the period from March 1984 to March 1994 is selected as the base period for comparison with current trends of pigmeat prices and production.
2) What are the factors that affect the downward sloping trend for the pigmeat prices in both Australian and world markets? If an increase in pigmeat supply has led to falling prices, one needs to determine statistically whether the supply effect comes from domestic production or imports. Furthermore, the increase in

domestic pigmeat production could be attributable to the increase in the volume of pigmeat exports.

3) How does one justify the current pigmeat price has not fallen below its long term trend when one does not know how the long term trend is being derived?
4) When the share of imports to domestic pigmeat production is low, it does not automatically mean that the imports do not have any effect on domestic pigmeat prices.
5) The relationships between pigmeat prices and beef prices need further research. This ABARE report projects a negative relationship, whereas one would expect a positive relationship between the prices of two substitute goods such as pork and beef.

3.2.3 The NSW Government Report

The submission by the NSW Government in 1995 addressed the following three issues:

1) the nature and magnitude of rural assistance provided by the NSW government to their pig producers;
2) the nature of government assistance given to the Canadian pig producers; and
3) the impact of imports on saleyard, wholesale and retail prices.

In the state of New South Wales, the pig farmers are allowed to apply for government assistance for the same programs that are available to the rural producers. Under the Rural Adjustment Scheme, the pig farmers are eligible to apply for Exceptional Circumstances provisions, but they are not eligible for freight subsidies during the drought conditions.

There has been concern over the extent of government assistance given to the Canadian pig farmers by the Canadian government. The NSW report outlined two forms of Federal and Provincial subsidy schemes available to the Canadian pig farmers, namely livestock tax concessions and income support, which were not included in the 1992 preliminary report of the Anti-Dumping Authority. Any form of government support should always be taken into consideration when assessing the effects of overseas government assistance given to its pigmeat industries.

The quantitative analysis of this report was to test the causal relationships between the volume of Canadian pigmeat imports and the pigmeat prices in the NSW market over the period July 1992 to June 1995, using both the Granger (1969) and the Sims (1972) procedures. The appropriate lag length was determined by the residuals (which have to be white noise). With regard to the time series properties of the variables, they were assumed to be jointly covariance stationary. However, to overcome any trend components or nonstationarity of the series, the author suggested using first differencing as a prefilter. In view of the above, the causality tests were conducted on linear and logarithmic functional forms, level and first-difference data, and three different lag lengths, using appropriate F and LR tests as diagnostics.

The results of the causality tests can be summarised as follows:

1) No causal relationship was found between the volume of Canadian pork imports and NSW saleyard and wholesale prices of pigmeat.
2) The test results from the Granger regressions indicated a one-way causal relationship from the volume of Canadian pork imports to the retail price of pork leg chops, while the results from the Sims regressions were less conclusive. In the case of pork loin chop prices, the direction of causality was reversed for the test statistics that were significant.
3) Both the volume of total imports and the unit value of Canadian imports were found to have no causal effects on the saleyard prices of pigmeat, although four significant statistics indicated causation from import unit values to saleyard prices.

On the whole, the focus of this report was to perform rigorous testing for any possible causality relationships between different pairs of variables, such as prices and imports of pigmeat. By considering too many specifications of the models, it led to mixed results and inconclusive evidence. The weaknesses of the study are listed below:

1) Without any detailed analysis of the time series properties of the data, there is no indication whether the appropriate model should be estimated in linear or logarithmic form as well as in levels or first-differences.

2) There is also the question of the appropriate lag length or the preferred testing procedures (Granger and Sims) to be used.
3) Testing for causality between two variables is more of a limited concept of predictability than a cause and effect relationship. It would be more appropriate to conduct tests of causality in a multivariate framework to avoid inconsistent estimates arising from the omission of relevant variables.
4) No conclusive inferences could be drawn regarding the impact of pigmeat imports on domestic pigmeat prices.

3.3 The Queensland Report

A report by Purcell and Harrison (1998) on the impact of trade liberalisation and increasing imports on Australian pig prices was submitted to the Queensland Department of Primary Industries. The objectives of this study were to address the following issues (p. 3):

1) Has the pattern of Australian pigmeat prices changed?
2) Have the imports of pigmeat led to lower domestic pigmeat prices?
3) Have the previous studies adequately modelled the impact of imports on the Australian pig industry?
4) What are the factors to be considered if the government wishes to provide assistance to the pig industry in the current state of low prices?

The Queensland report provided an extensive modelling of price behaviour, and supply and demand relationships for the Australian pig industry using modern econometric techniques. The scope of the study can be summarised as follows:

1) It contained review of the 1995 Industry Commission inquiry, including the 1995 ABARE report, the 1998 ABARE interim report and the NSW government report.
2) As the quarterly data might exhibit seasonal fluctuations, the study utilised the DHF test to test for seasonal unit roots. In addition, the Perron additive outlier test was also used to test for the presence of a structural break in a series. The nine variables considered in the report were production of pigmeat, saleyard

prices for pigmeat and beef, retail prices for pork, pork leg, pork loin and beef, and the import volume and price for pigmeat from Canada. The test results indicated that the nine variables in logarithmic forms do not exhibit stochastic seasonality except for the Canadian pigmeat import volumes and prices. It was noted that the saleyard price for pigmeat appears to follow an I(0) process with a shift due to the introduction of imports (using the Perron additive outlier test), but the results were not conclusive.

3) To examine the possible effect from the lifting of import restrictions on the saleyard price for pigmeat, a test for structural break was conducted. A Chow test was used to test the parameter stability of the supply model (i.e. pigmeat saleyard prices and production, and retail prices for pigmeat and beef) over the period 1984:2 to 1997:2. The test rejected the null hypothesis of no structural break at the first quarter of 1990, and concluded that the introduction of imports has had a significant effect on the saleyard prices of pigmeat.

4) The report also modelled the effect of imports on domestic prices using an autoregressive distributed lag (ARDL) representation. The ARDL approach was used to obtain coefficients that would indicate the sign and the magnitude of the relationships between the variables in the supply model. The results from the estimation of the long run coefficients indicated that the import volume of pigmeat has a greater negative effect on the pigmeat saleyard prices as compared with the domestic pigmeat production, while the import price for Canadian pigmeat does not have significant effect.

5) The demand and supply relationships in the Australian pigmeat market were modelled in a multivariate framework using the Johansen cointegration method. The test statistics indicated that there is no cointegrating relationship in the vector autoregressive (VAR) model that was considered. The variables included in the VAR model were the saleyard and retail prices for pigmeat and beef, production of pigmeat, the Canadian pigmeat import volumes and prices, a constant, time trend and seasonal dummies.

6) The impulse response functions and the decomposition of forecast error variance were computed using the above VAR model. The results indicated that 35 and 25 per cent of the variability in the pigmeat saleyard prices are determined by the pigmeat production and the beef saleyard prices, respectively, while 30 and 20

per cent of the variability in the pigmeat production are determined by the saleyard and retail prices for pigmeat, respectively. On the other hand, the import volume for Canadian pigmeat contributed to 30, 40 and 35 per cent of the variability in pigmeat saleyard prices, retail prices and domestic production, respectively.

7) The same VAR model was used to test for multivariate Granger causality. The results indicated that all the variables except for saleyard and retail prices of pigmeat 'Granger-cause' the other variables in the VAR model. On the other hand, the import volume and price for Canadian pigmeat were also found to 'Granger-cause' the other variables in the VAR model.

8) A review of possible assistance measures such as tariffs and subsidies, for the Australian pig and pigmeat industry was also undertaken. If government assistance to the domestic industry is warranted, subsidy appears to be the preferred policy instrument as compared with tariffs.

The findings of the Queensland report provide some evidence for the negative impacts of trade liberalisation and increasing imports on the Australian pig and pigmeat industries. However, the statistical inferences drawn from the results obtained in this report need to be re-examined. We would like to address a few issues regarding the derived results and the methodology used:

1) The authors discuss the more popular method, the HEGY test, for testing for seasonal unit roots, but choose to use the DHF test instead. One of the weaknesses of the DHF test is its inability to test for the presence of seasonal unit roots at different frequencies.

2) Different testing procedures for unit roots often generate different results, and the test results would be more conclusive using both the ADF tests (Dickey and Fuller, 1981) and the KPSS test (Kwiatkowski et al., 1992). Different test statistics would mean different variables are available to be modelled in the regression or VAR model, and hence different results could be obtained.

3) In testing for a structural break in the supply model (pp.48-49), the chosen break at the first quarter of 1990 seemed rather arbitrary, as the imports of pigmeat from Canada commenced only in the third quarter of 1990. There is no indication as to the robustness of the Chow test if a different period had been chosen as the

possible break point. Given that all the variables in the model were tested to be I(1), the Chow test derived from estimating the non-stationary variables in levels is likely to be biased.

4) The ARDL estimation of the model (pp. 54-57) was conducted in both linear and logarithmic forms. How does one compare and interpret the results from the two models when a time trend and break are included in the level form and not in the logarithmic form? There is no explanation as to why the model is estimated in level form since the authors have transformed all the variables into natural logarithmic form to overcome the problems of heteroscedasticity and non-linear relationships between the variables (p. 28). It appears that the authors chose the results of the level-form model because the estimated coefficient for the import volume of Canadian pigmeat was found to be negative and significant, whereas it was found to be negative and insignificant in the log-linear model.

5) In testing for multivariate cointegration, the model (p. 62) is not properly specified. It is incorrect to include the import volume and price for Canadian pigmeat as the I(0) variables since they are tested to have stochastic seasonality. An appropriate seasonal differencing filter is required for the two variables before they can be included in the model.

6) The authors were unable to provide us the data set used in their study, we were unable to replicate their results using our data set. This raises doubts about the robustness of the Queensland results and suggests that the results may, in part, be due to idiosyncratic data. All of these have great significance at drawing the correct inferences on the impact of imports on domestic pigmeat prices from the obtained estimation results.

3.4 Summary

A review of the past studies yields two conflicting results regarding the possible impact of imports on the Australian pig and pigmeat industries. The reports submitted to the Industry Commission from ABARE and NSW suggest that the imports of pigmeat from Canada do not have any long-term effects on the domestic pigmeat prices, and the domestic price variations are linked to the domestic conditions. On the other hand, the Queensland report clearly indicates the significant negative effects from the imports of Canadian pigmeat on domestic pigmeat prices and production.

The essential question raised is which of the two results is correct. Based on the quantitative analyses, the results obtained from the reports of ABARE, NSW and Queensland could be biased due to various weaknesses discussed above. There are a number of issues that need to be addressed in future study. A major issue is the time series properties of the data used, especially pigmeat saleyard prices and pigmeat production, which exhibit strong seasonal fluctuations. To derive a consistent and unbiased estimate for the impact of imports on domestic pigmeat market, it would require the application of appropriate econometric techniques. They are:

- testing for data stationarity or seasonal unit roots using the HEGY test;
- testing for long-run cointegrating relationships for more than two I(1) variables using the Johansen maximum likelihood procedure; and
- performing the relevant diagnostic tests to determine the statistical adequacy and stability of the model.

It is noted that previous studies did not include the production costs of domestic pigmeat such as the feed costs and the labour costs, in their analyses of the impact of imports on the domestic pigmeat prices. One would expect the costs of production to have significant effects on the saleyard price for pigmeat. In the econometric modelling, omission of relevant variables often leads to biased inferences. However, it appears that adequate data over extended periods for various costs of pigmeat production in Australia are not readily available.

Another important issue is that the number of observations available for estimating the impact of the imports are rather small, as the imports of pigmeat from Canada commenced only in 1990:3. Using the post-1990 data to model the domestic pigmeat market in a multivariate framework is likely to restrict the number of variables included in the VAR model due to insufficient degrees of freedom. In addition, the conventional time series regression that has fixed coefficients estimated from past data might not be able to capture the impact of imports on the falling saleyard prices of pigmeat, which occurred in the last few quarters of the sample. Overall, it is important to consider the weaknesses discussed while assessing the empirical evidence of the impact of imports on the Australian pigmeat market.

CHAPTER 4

TIME SERIES PROPERTIES OF THE DATA

A. Introduction

The development of the concepts of unit roots and cointegration has had an important impact on the time series analysis of economic data, particularly on econometric practice. Time series modelling requires the data generating processes of the series and/or the structural relationships described by the model to be invariant with respect to time. If the underlying stochastic processes of the time series are nonstationary, it would be difficult to modelling the series with an equation that has fixed coefficients estimated from past data. In addition, regressing nonstationary time series against another can lead to spurious results and biased conventional significance tests.

This chapter analyses the time series properties of all the variables available for the modelling of the demand and supply relations of Australian pig industry. The following section outlines data sources, Section 4.3 examines the trends in the data, while Section 4.4 conducts a series of unit root tests for data stationarity in the presence of seasonal variations. This chapter situates the research undertaken in this report in the context of the data limitations and perceived trends in important variables, as identified by the authors.

4.2 Data Sources

Given the complexity of the problem being modelled here, a keen understanding of the data and general measurement issues relating to the Australian pigmeat industry is important. With regard to the collection of data vis-à-vis the modelling in this report, the researchers have identified several important issues:

1) A large component of this project is concerned with the examination of previous empirical work undertaken, principally that done by ABARE (1995) and Harrison and Purcell (1998). For this reason, the choice and definition of variables should follow quite closely those selected in previous studies.

2) The research team perceives aspect of previous modelling attempts as being deficient in terms of under-specification of the model. For instance, previous studies include neither a measure of demand effect from pork consumption nor some measure of production cost such as a grain price or a pig/grain price ratio. Hence, the data search has included these variables.

3) Any discussion of the data will need to include a general discussion of the concerns of industry and policymakers regarding the method of construction of the data and other possible data sources.

4) Standard econometric issues of pre-tests of the data such as stationarity, and the related methodology will be discussed in the latter part of this chapter.

Following point (4) above, the choices made with regard to the general modelling issues will be discussed in Chapter 5.

The Data Set

In keeping with Harrison and Purcell (1998), the span over which this study is conducted includes quarterly data from 1984:1 to 1998:2. This yields 58 observations, with 24 observations before the 1990 March quarter and 34 after. The data set is comprised of:

Saleyard Prices

Beef saleyard prices (cents/kg)

Lamb saleyard prices (cents/kg)

Mutton saleyard prices (cents/kg)

Pig saleyard prices (cents/kg)

Retail Prices

Beef retail prices (cents/kg)

Lamb retail prices (cents/kg)

Pork retail prices (cents/kg)

Poultry retail prices (cents/kg)

Pork leg retail prices (cents/kg)

Pork loin retail prices (cents/kg)

Bacon and ham retail prices (cents/kg)

Production

Pigmeat Production (tonnes)

Import/Export Variables

Volume of Canadian imports (tonnes)

Value of Canadian imports (dollars)

Price of Canadian pigmeat imports (cents/kg)

Volume of total imports of pigmeat into Australia (tonnes)

Value of total imports of pigmeat into Australia (dollars)

Volume of total exports of pigmeat from Australia (tonnes)

Value of total exports of pigmeat from Australia (dollars)

Aside from these, a cost variable based on grain (wheat/barley) prices was also obtained from the Australian Pork Corporation, however this was only expressed in annual terms. Data from ABARE are currently being obtained so that a quarterly version of this variable can be derived. The research team is also seeking a complete quarterly data set on pork consumption from the Australian Pork Corporation. These variables were not available at the time of the writing of this report.

All saleyard prices were obtained from the ABARE publications *Commodity Statistical Bulletin* and *Commodity Statistics* (various editions) as well as from the Bureau itself. Prices in these series are estimated on a dressed weight basis and represent a national price based on estimates from each of the major state markets weighted by production of the relevant meat in each state.

All retail prices series have been obtained from ABARE through either *Commodity Statistics* or a direct request. Each of the series is constructed using meat sub-groups of the Consumer Price Index (CPI) to index forward the relevant price from the December 1973 quarter.

Pigmeat production statistics come from the APC publication *Pigstats* (various editions). There is some controversy over this data set, which is obtained from the ABS. The Productivity Commission has stated in the past that the ABS has systematically excluded a major producer from the collection of these statistics. Our discussions with the ABS on this issue confirm that this is the case. They have indicated to us that this oversight is being rectified in forthcoming editions of ABS publication catalogues 7215 (now a quarterly publication) and 7218 (a new monthly catalogue). Data on Canadian import and total Australian export and import volumes and values also came from *Pigstats.*

Aside from these data, the research team has also received data on wholesale prices for Australian pork leg meat (with the bone in) from the Sydney market. The Productivity Commission provided us with this data set. It is difficult to see what can be achieved using this data set, as it is in monthly terms for June 1993 onwards. Hence, the analysis in this report uses the quarterly data collected by the authors.

4.3 Data Trends

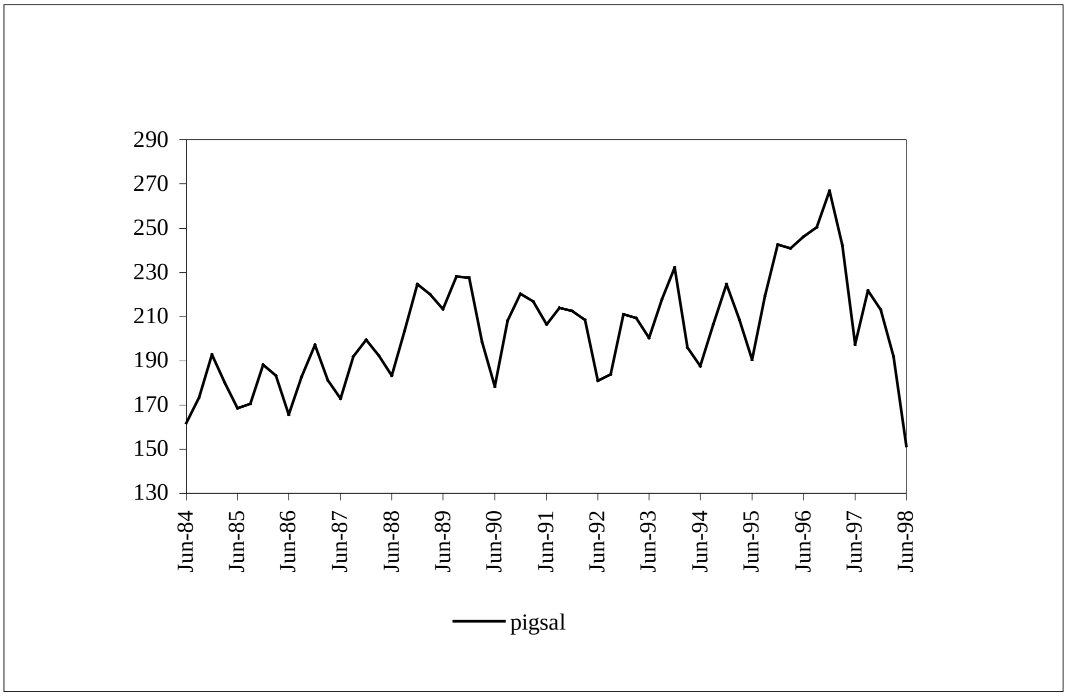
A discussion and graphical representation of key economic variables is presented below.

Figure 4.1 documents the fortunes of the saleyard price for pork since 1984:2. The figure shows that for much of this period the pork saleyard price has been fluctuating between 170 and 240¢/kg. There is a noticeable spike after 1990:2 when the price fell from 227.5 to 178.4¢/kg following the announcement to allow Canadian pigmeat imports into Australia. From this diagram alone, we can not conclude whether this sharp move in the price is part of the underlying data generating process (DGP) or if it is a break in this series (ie. a policy shock).

The other outstanding feature of the pork saleyard series is the sharp decline in price after 1997:2. Over the past years, saleyard prices have fallen from 246 to 151¢/kg. This represents a 62 per cent fall in the price received by producers, an unprecedented decline. The viability of a majority of smaller piggeries across Australia is threatened at this price level.

Figure 4.2 documents the movements in the saleyard price for beef, the main substitute for pork in Australia. As with saleyard prices for pork, beef prices appear to have trended downward in recent years. Of particular note is the sharp decline in beef saleyard prices from March 1996. Prices fell from 193 ¢/kg in December 1995 to 133 ¢/kg in the corresponding quarter of 1996. Over the course of 1998 prices have risen to around 173 cents a kilogram. A potential explanation for this drop is the 'mad cow' disease scare in Europe, which many commentators feel may have dampened demand for beef products around the world. The sharp fall and slight rebound in beef saleyard prices over the past few years is certainly commensurate with this theory. It is

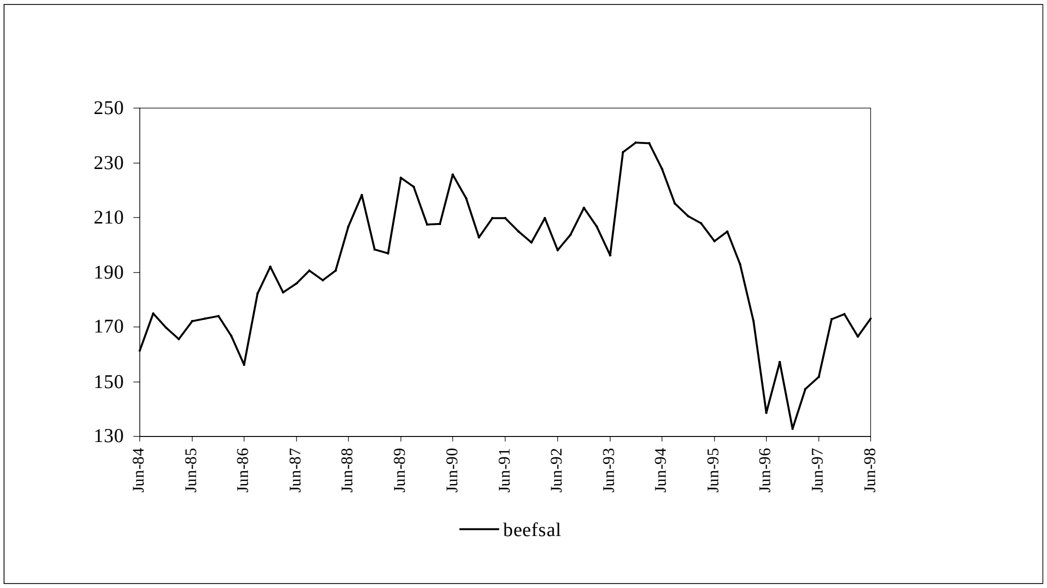
Figure 4.1
Saleyard Prices for Pork, 1984-98 (cents/kg)



Source: ABARE

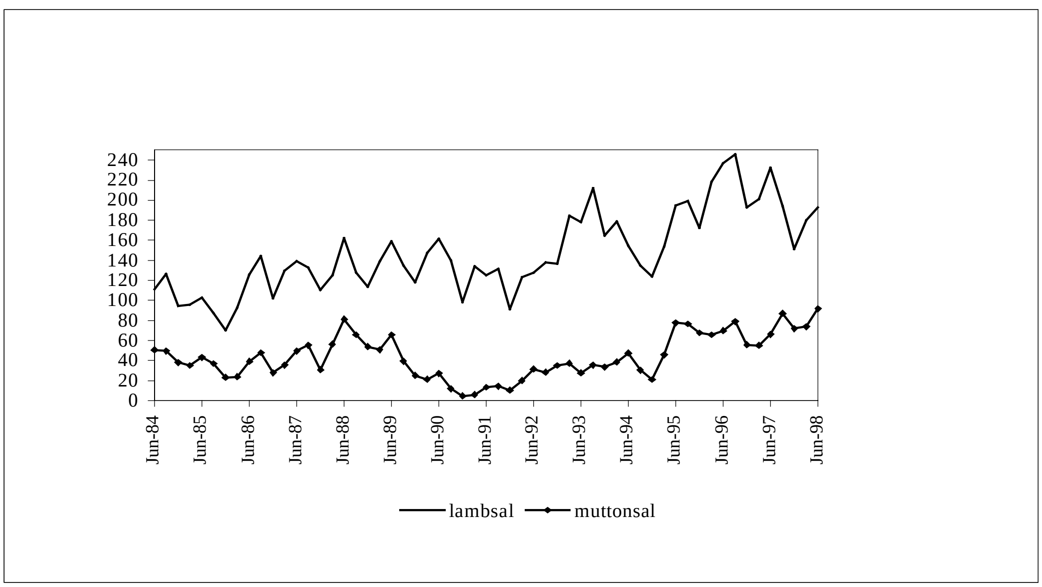
possible that falling pork saleyard prices reflect processors' expectations that consumers will shortly substitute back to beef at lower prices now that health concerns are diminishing.

Figure 4.2
Saleyard Prices for Beef, 1984-98 (cents/kg)



Source: ABARE

Figure 4.3
Saleyard Prices for Lamb and Mutton, 1984-98 (cents/kg)

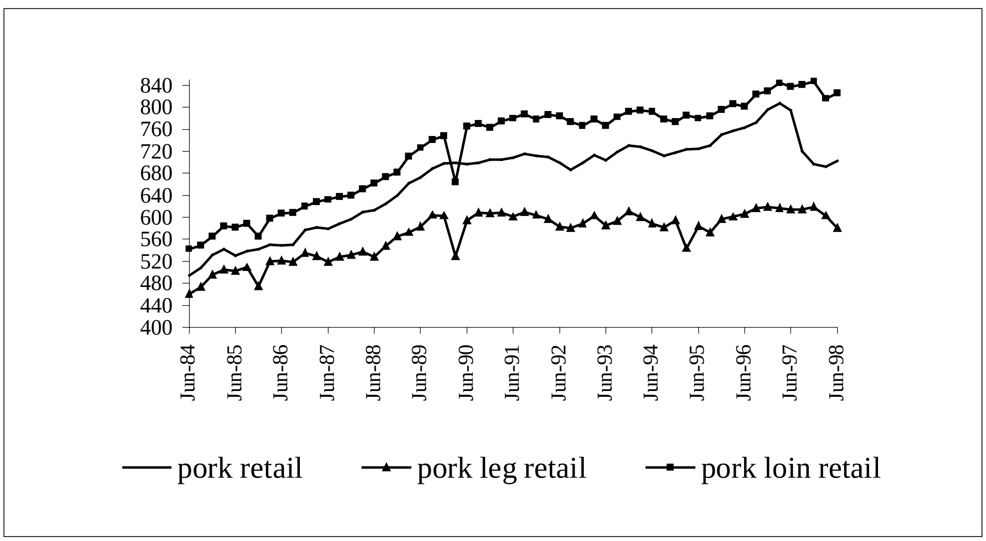


Source: ABARE

Figure 4.3 outlines the trends in prices for two other pork substitutes - lamb and mutton. It appears that prices for these two products have not experienced the extreme downturns seen in the beef and pork markets.

Turning to retail prices for pork products, Figures 4.4 and 4.5 outline trends in prices for pork, pork leg, pork loin and bacon and ham. The figures indicate price trends in the retail market for pork products. Nominal prices for pork products appear to be rising over the period under examination. Both the pork leg and pork retail series have a spike during 1990:2. It is not obvious as to what factor is responsible for this, although this could be an announcement effect relating to the decision to allow Canadian imports in early 1990. Interestingly, the three price series in Figure 4.4 are trending downward over the past two quarters. This reflects the decline in saleyard prices for pork. There is no evidence to suggest that declining pork prices at the retail level have been a significant determining factor in the fall in saleyard prices. In contrast to the other pork series, prices for bacon and ham at the retail level have been trending upward quite strongly over the past decade.

Figure 4.4
Retail Prices for Pork, Pork Leg and Pork Loin, 1984-98 (cents/kg)



Source: Australian Pork Corporation

Figure 4.5
Retail Price of Bacon and Ham, 1984-98 (cents/kg)

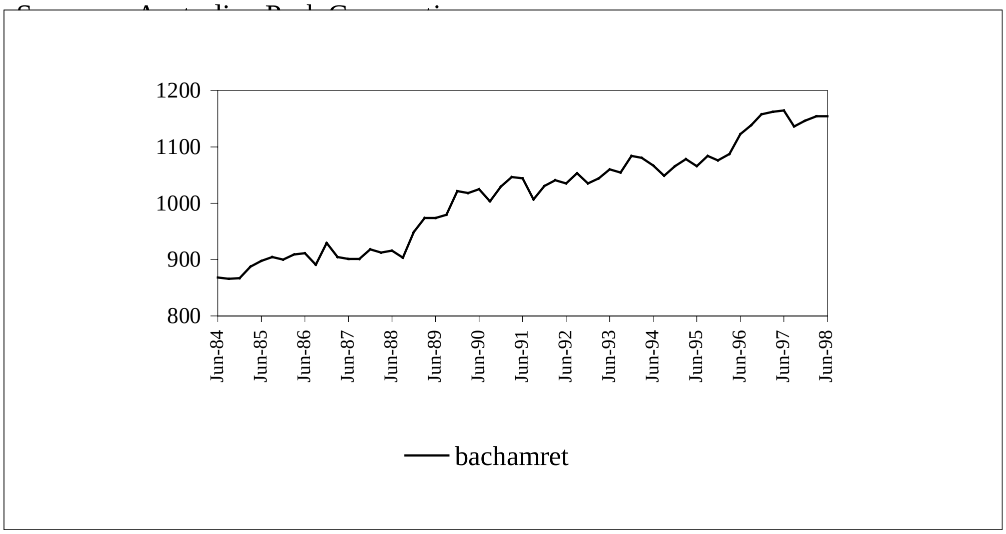
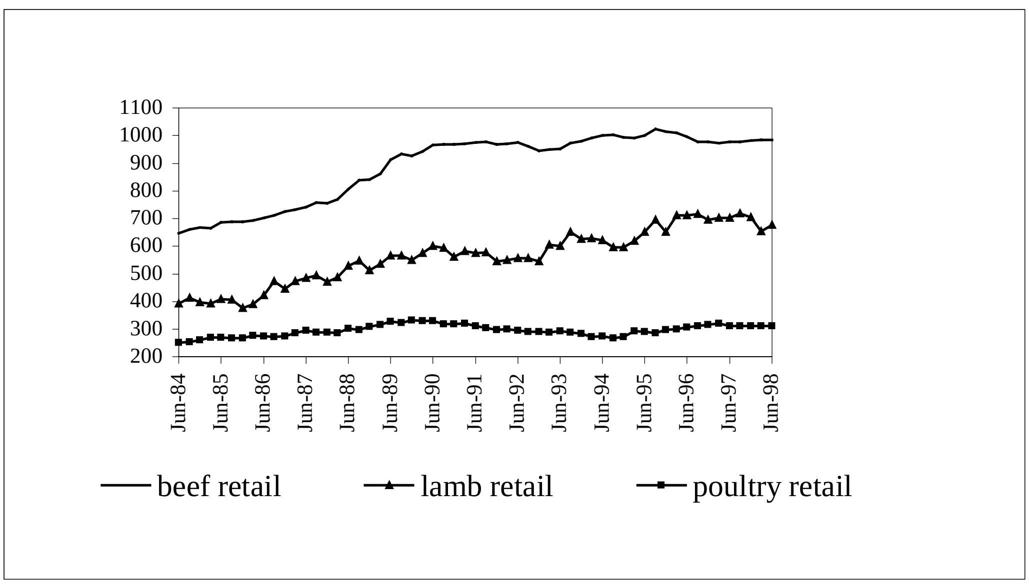


Figure 4.6
Retail Prices for Beef, Lamb and Poultry, 1984-98 (cents/kg)

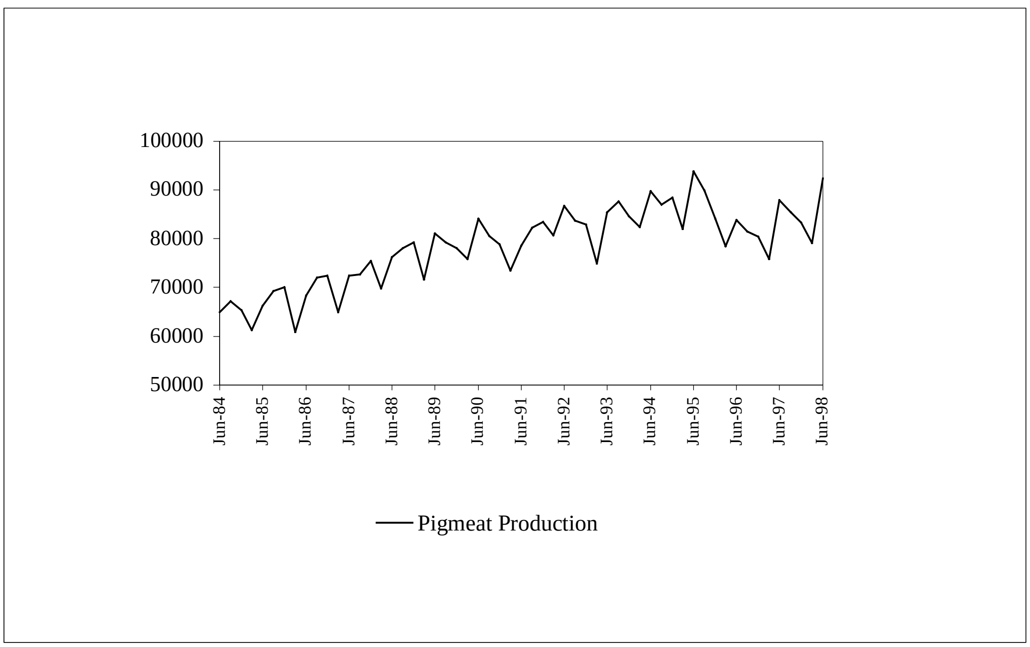


Source: Australian Pork Corporation

Figure 4.6 above outlines movements in the retail price for beef, lamb and poultry. In nominal terms, these prices have been quite stable over the course of the nineties, with poultry declining slightly, lamb prices rising after 1993 and beef prices remaining static.

Figure 4.7 shows the increase in domestic pigmeat production in Australia in recent years. Since 1984:2 domestic production has increased from around 60,000 tonnes per quarter to 92,302 tonnes in 1998:2. Hence, the domestic production has been characterised by an expansion of supply in the 1980s, and fluctuating between the range of 80,000 and 90,000 tonnes since 1990:3, when Canadian pigmeat imports first began. The other notable feature of this series is the strong seasonal pattern in the data, indicating the importance of the Christmas period for pork sales.

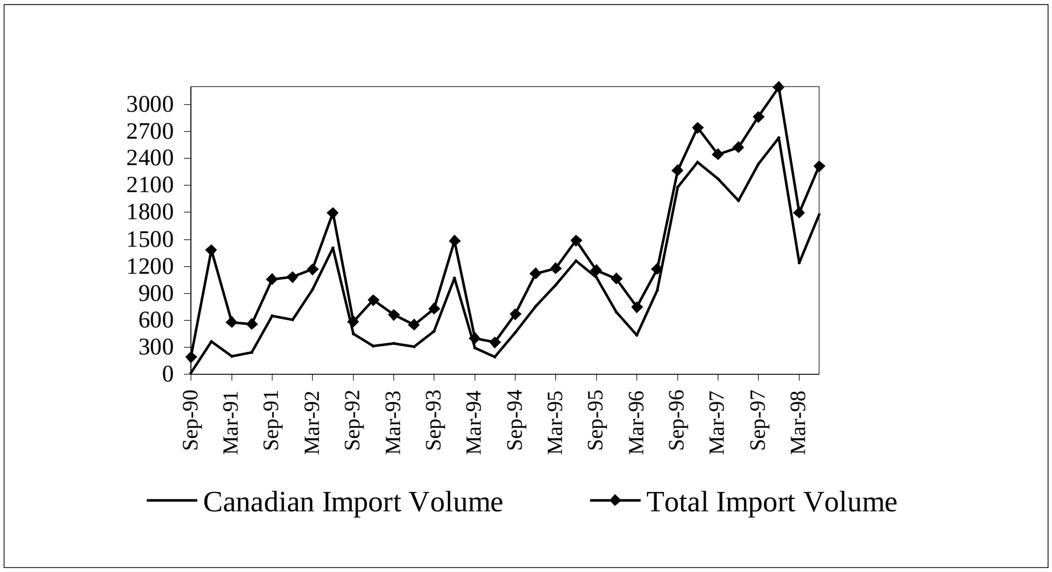
Figure 4.7
Domestic Pigmeat Production, 1984-98 (tonnes)



Source: Australian Pork Corporation/Australian Bureau of Statistics

The following figure documents the flow of pigmeat imports into Australia since September 1990. It appears that the increase in domestic production in Australia has been accompanied by an increase in import volume, with imports increasing from around 189 tonnes in 1990:3 to 3,198 in 1997:4 before falling to 2,315 in 1998:2. On these figures, imports account for roughly 4 per cent of the volume of pigmeat produced in Australia. Canada accounts for the bulk of Australian pigmeat imports.

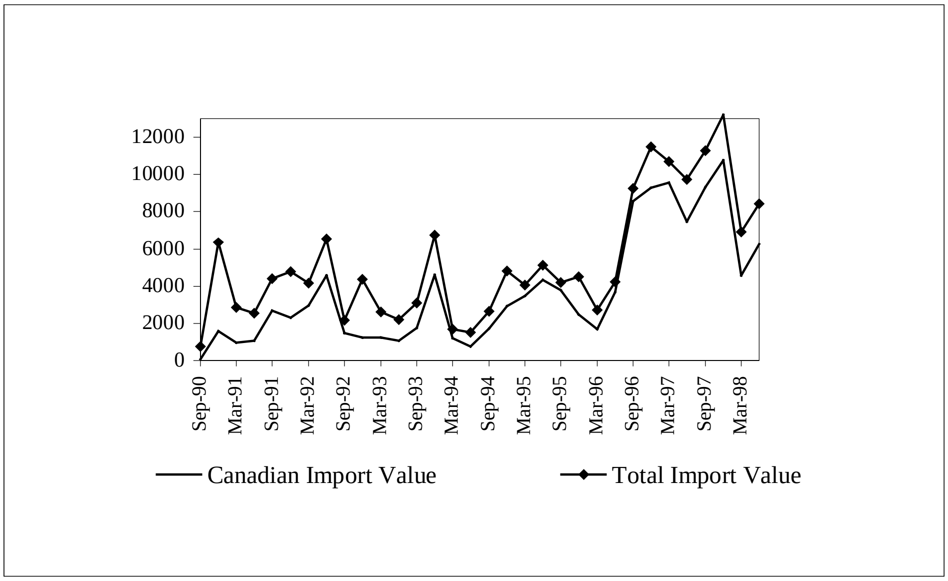
Figure 4.8
Volumes of Total and Canadian Pigmeat Imports, 1990-98 (tonnes)



Source: Australian Pork Corporation

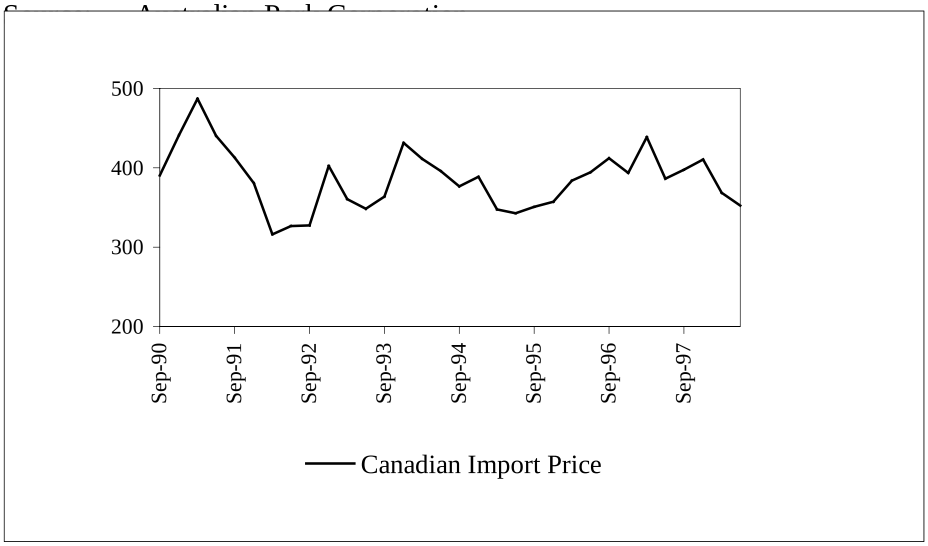
Figures 4.8 and 4.9 outline the movements in the volumes and values of total and Canadian imported pigmeat.

Figure 4.9
Values of Total and Canadian Pigmeat Imports, 1990-98 ($'000)



Source: Australian Pork Corporation

Figure 4.10
Average Price of Canadian Imports, 1990-98 (cents/kg)



The value of total pigmeat imports has moved fairly closely in line with volumes. Again, there is definitely a large surge in imports since 1996:1. In absolute terms, imports are relatively small at around 12 million dollars. Figure 4.10 traces out the movement in the price of imported Canadian pigmeat. The price has seen a quite marked decline, falling from 410 ¢/kg in 1997:4 to 353 ¢/kg in 1998:2. This represents a 13.9 per cent fall over this period. This is in comparison with a 28.8 per cent decline in the pork saleyard price overall. This indicates that recent price changes in Canadian imports are less responsible for declines in Australian producer returns than for instance, domestic issues such as increasing competitiveness of larger producers and previous price movements for the Canadian product.

A graphical analysis of the variables to be included in the modelling in this project indicates that it is difficult to see any evidence of causality between import prices/volumes and domestic price conditions for the pigmeat market. Certainly there appears to be some recent contemporaneous movements in prices, however this needs to be seen in the context of expanding domestic supply over a period where import restrictions have been lifted. Since 1990:3 when Canadian imports first appeared, quarterly production of pigmeat at the domestic level has risen by around 12,000 tonnes, whereas Canadian import volumes have reached 1,773 tonnes a quarter (1998:2).

Total imports are at around 2,315 tonnes per quarter, up from around only 54 tonnes in 1990. In other words, the increase in domestic production over this period is approximately five and half times the size of increases in import volumes. Meanwhile, Australian export volumes have increased sharply from 1,882 tonnes in 1990:3 to 4,292 tonnes in 1998:2, an increase of 2,410 tonnes over this period. Hence, the vast bulk of the increase in domestic production has been absorbed at the domestic level. An important consideration, which qualifies the above statement is the obvious cyclical nature of pig and pigmeat production over the 1990s. Despite the relatively small volumes of Canadian pigmeat entering the country, it is difficult to automatically dismiss claims that they have no effect on prices received by Australian producers. Hence, a thorough econometric analysis of this phenomenon is needed in order to determine these effects.

4.4 Data Stationarity

Most economic time series are nonstationary or random walks, which are often differenced to approximate the stationary processes. If a series is differenced *d* times to make it stationary, it is said to be integrated of order *d*. One popular method used to test for nonstationary of the series is the unit root (or ADF) test, as developed by Dickey and Fuller (1981). As seasonal fluctuation is an important feature of many economic time series, it is also essential to test for the presence of any seasonal unit roots (HEGY test) in the modelling of quarterly or monthly data that are seasonally unadjusted.

The following quarterly data will be tested for stationarity using both the ADF and HEGY tests:

1. Production of pigmeat (tonnes) - PP
2. Saleyard price for pigmeat (cents/kg) – PS
3. Retail price for pigmeat (cents/kg) – PR
4. Saleyard price for beef (cents/kg) – BS
5. Retail price for beef (cents/kg) – BR
6. Import volume for pigmeat from Canada (tonnes) – CV
7. Import unit value for pigmeat from Canada (cents/kg) – CP
8. Import volume for pigmeat (tonnes) – IMV
9. Import unit value for pigmeat (cents/kg) – IMP
10. Export volume for pigmeat (tonnes) – EXV
11. Export unit value for pigmeat (cents/kg) – EXP

All the variables are available from 1984:1 to 1998:2 except for the six variables, namely CV, CP, IMV, IMP, EXV and EXP, which are available from 1989:3 or 1990:3 onwards. As the functional forms of the variables may be nonlinear, the natural logarithmic transformation is applied to each variable. An additional alphabetic letter D denotes the variable is log-differenced. The unit root test results are derived using the Microfit 4.0 econometric software program (Pesaran and Pesaran, 1997).

4.4.1 DF and ADF Tests

The Dickey and Fuller (1981) unit root test with a deterministic trend, given in equation (4.1) below, is commonly used to test for nonstationarity of a time series process:

$$\Delta y_t = a_0 + a_1 t + \beta y_{t-1} + \sum_{j=1}^{p} \delta_j \Delta y_{t-j} + \varepsilon_t \ . \qquad (4.1)$$

Equation (4.1) is the standard specification for the augmented Dickey-Fuller (ADF) test for the series y_t, Δ denotes the differencing operator, t is the deterministic trend, p is the order of the autoregressive process, and $\Delta y_{i,t-j}$ is included to accommodate an autoregressive process in the errors. If the null hypothesis, $\beta = 0$, is not rejected at conventional levels of significance, the series y_t is said to have a unit root, and hence is nonstationary.

Unit root tests have been criticised as having low power when the null is tested against alternatives having values close to one. Kwiatkowski et al. (1992) proposed an alternative unit root test or KPSS test, which is a test of stationarity under the null. On the other hand, Perron (1989) has emphasised the importance of determining the presence of a one-time change in the intercept and/or the slope of the trend function while testing for a unit root in a time series. Contrary to most findings, his study concludes that most macroeconomic time series are trend-stationary after allowing for a trend break in the series. The two events that have a permanent effect on various macroeconomic variables are the Great Depression of 1929 and the oil price shock of 1973.

For the testing of unit roots for the variables listed above, the DF and ADF tests (with and without a time trend) were used. Tests for possible breaks in the output series, as suggested by Perron (1989), are not considered given the short duration of the data that are less than 15 years. For quarterly data, an initial lag length of four is used for the ADF test. If the estimated t-statistic is insignificant or the diagnostic tests indicate the presence of serial correlation, the lag length is reduced successively until a significant lag length is obtained or the residuals appear to be white noise. The estimated t-statistics and non-standard critical values for the DF and ADF tests are presented in Table 4.1.

The results indicate all the variables are I(1) except for the unit values of pigmeat total imports (IMP), Canadian imports (CP) and total exports (EXP), and total volume of pigmeat imports (CV), which are I(0). The diagnostic tests indicate the presence of serial correlation for the test statistics of the pigmeat production (DPP), saleyard price for pigmeat (DPS), retail price for beef (DBR) and total volume of pigmeat exports (DEXV), due seasonal variations in the variables. This problem of serial correlation is overcome by adding seasonal dummies to equation (4.1). However, the HEGY test is the appropriate method for testing the presence of seasonal unit roots in a time series that is seasonal unadjusted.

Table 4.1

DF and ADF Tests for Nonstationarity

Variables	Period of Estimation	t-value	p	Critical Value
DPP	1985:3 – 1998:2	–7.191	0	–2.918
DPS	1985:3 – 1998:2	–5.599	0	–2.918
DPR	1985:3 – 1998:2	–3.805	2	–2.918
DBS	1985:3 – 1998:2	–3.143	4	–2.918
DBR	1985:3 – 1998:2	–3.904	0	–2.918
DCV	1992:1 – 1998:2	–3.833	4	–2.980
CP*	1991:4 – 1998:2	–3.942	4	–2.975
IMV*	1990:4 – 1998:2	–3.579	0	–2.959
IMP*	1990:4 – 1998:2	–3.212	1	–2.959
DEXV	1991:1 – 1998:2	–5.406	0	–2.963
EXP*	1990:4 – 1998:2	–3.534	1	–2.959

Notes: * indicates the variable is I(0).

4.4.2 HEGY Test

The concept of seasonality in economics is defined by Hylleberg (1992, p. 4) as follows:

> Seasonality is the systematic, although not necessary regular, intra-year movement caused by the changes of the weather, the calender, and timing of decisions, directly or indirectly through the production and consumption decisions made by the agents of the economy. These decisions are influenced by endowments, the expectations and preferences of the agents, and the production techniques available in the economy.

There are two types of seasonality, namely deterministic and stochastic seasonality. The deterministic seasonality (or seasonal process) which assumes the series y_t is generated by seasonal dummy variables, are given as:

$$y_t = \alpha + \beta_1 S_{1t} + \beta_2 S_{2t} + \beta_3 S_{3t} + u_t, \qquad (4.2)$$

where S_{it} is a seasonal dummy which equals to one in quarter i and zero elsewhere. If the estimated seasonal dummies from equation (4.2) have significant effects on the dependent variable, this indicates that the series y_t has deterministic seasonality. The appropriate treatment for a series with deterministic seasonality is to include the seasonal dummy variables in the regression model. All the 11 variables are tested for deterministic seasonality using equation (4.2). The results indicate the variables that have deterministic seasonality are PP, PS, EXP, and EXV.

In the case of stochastic seasonality, the seasonal process is generated by a potentially infinite autoregression. Stochastic seasonality can be further subdivided into stationary and integrated seasonal processes. A seasonal process is stationary when all of the roots lie outside the unit circle, whereas an integrated seasonal process would has one or more unit roots integrated at all or some of the seasonal frequencies. One of the common treatments for seasonal variations in quarterly time series without any pre-testing for seasonal unit roots, is to use a quarterly differencing filter, that is, consider the difference between a given quarter of the current year with the same quarter of last year ($1 - B^4$), where B is a backward shift operator.

The modelling of economic time series with unit roots has led to the development of various tests for stochastic seasonality in empirical research. Dickey, Hasza and Fuller (1984) proposed a DHF test of a seasonal unit roots under the null against the alternative of specific dth order autoregression. The DHF test can be written as follows (see Dickey et al., 1984):

$$(1-B^d)y_t = \varepsilon_t$$

$$y_t = \rho\, y_{t-d} + S_t + \nu_t, \qquad (4.3)$$

where y_t is assumed to be generated by an autoregression, ε_t is an iid $(0, \sigma^2)$ error term, d is the number of observations per year, and S_t is either a constant or seasonal dummies. The DHF approach proposes a test of the hypothesis $\rho = 1$ (or a seasonal unit root) against the alternative $\rho < 1$ (or stationary), using equation (4.3).

The limitation of the DHF test is that it does not distinguish the process that is integrated at only some of the seasonal frequencies (see Beaulieu and Miron, 1993, pp. 309-310). A rejection of the null does not imply no unit root presents at all of the frequencies, while failure to reject the null does not identify the frequencies that a series may be integrated. This implies that the DHF test has low power given that one would have difficulties in interpreting the results. However, these problems have been avoided by the HEGY approach, as developed by Hylleberg, Engle, Granger and Yoo (1992).

The formulation of the HEGY testing procedure follows the Dickey and Fuller method, and tests for unit roots in a seasonal framework. The polynomial for quarterly data, $(1 - B^4) = (1 - B)(1 + B)(1 - iB)(1 + iB)$, is assumed to have four roots on the unit circle, namely 1, −1, i, and $-i$. The first root is a non-seasonal (or zero frequency) unit root and the other three roots are seasonal unit roots. The second root −1 corresponds to a semi-annual unit root (i.e., root at ½ cycle per quarter or 2 cycles per year), and the last two complex roots are interpreted as the annual unit roots (i.e., roots at ¼ cycle per quarter or one cycle per year).

The HEGY test for quarterly data is based on the following regression (see Hylleberg et al., 1992, p. 223):

$$y_{4,t} = \pi_1 y_{1,t-1} + \pi_2 y_{2,t-1} + \pi_3 y_{3,t-2} + \pi_4 y_{3,t-1} + \nu_t \quad (4.4)$$

where ν_t is an error term with zero mean and finite variance σ^2, and

$$y_{4,t} = (1 - B^4) y_t = y_t - y_{t-4},$$

$$y_{1,t-1} = (1 + B)(1 + B^2) y_{t-1} = y_{t-1} + y_{t-2} + y_{t-3} + y_{t-4},$$

$$y_{2,t-1} = -(1 - B)(1 + B^2) y_{t-1} = -y_{t-1} + y_{t-2} - y_{t-3} + y_{t-4},$$

$$y_{3,t-2} = -(1 - B^2) y_{t-2} = -y_{t-2} + y_{t-4},$$

$$y_{3,t-1} = -(1 - B^2) y_{t-1} = -y_{t-1} + y_{t-3}.$$

The hypothesis testing for seasonal unit roots using the statistics on the estimated π_i (i = 1, 2 , 3, 4) can be expressed as follows:

1. H_0: $\pi_1 = 0$

   H_1: $\pi_1 < 0$,

2. H_0: $\pi_2 = 0$

   H_1: $\pi_2 < 0$,

3. H_0: $\pi_3 = \pi_4 = 0$

   H_1: $\pi_3 \neq 0$ and/or $\pi_4 \neq 0$.

The first hypothesis tests for a non-seasonal (or zero frequency) unit root in a quarterly series, against the alternative of no unit root, while the second and third hypotheses test for a seasonal unit root at semi-annual and annual frequencies, respectively. Equation (4.4) is estimated by ordinary least squares (OLS), and a *t*-test is used for the first and second hypotheses, whereas an F-test is used for the third hypothesis. If the null hypothesis, $\pi_i = 0$, is not rejected at conventional levels of significance, the series y_t is said to have a unit root. For a quarterly time series to be stationary, it requires the three null hypotheses and the two separate null hypotheses, $\pi_3 = 0$ and $\pi_4 = 0$, to be rejected.

It is important to note that the critical values for the HEGY test do not follow a standard *t*-distribution, and Hylleberg et al. (1992) have provided the non-standard critical values derived from the Monte Carlo simulations. There will be residual autocorrelation in the HEGY regression if a stationary process has roots at the seasaonal frequencies with different moduli. This problem of residual autocorrelation can be overcome by adding lagged terms of the dependent variable ($y_{4,t}$) into equation (4.4) until the residuals appear to be white noise.

Equation (4.4) can be augmented to include a constant, a time trend and seasonal dummies, which allows the possibility of deterministic components in the regression (see Beaulieu and Miron, 1993, p. 309). The augmented HEGY regression is expressed as follows:

$$y_{4,t} = \alpha + \delta t + \beta_1 S_{1t} + \beta_2 S_{2t} + \beta_3 S_{3t} + \pi_1 y_{1,t-1} + \pi_2 y_{2,t-1} + \pi_3 y_{3,t-2} + \pi_4 y_{3,t-1} + \nu_t , \quad (4.5)$$

where α is a constant, t is the deterministic time trend, and S_{it} are seasonal dummy variables. Beaulieu and Miron (1993) have argued that equation (4.5) is preferred to (4.4) for testing seasonal unit roots because the loss of power from the unnecessary inclusion of the deterministic components is insignificant compared with the bias resulting from their incorrect omission. Although the asymptotic and finite sample distributions of the test statistics in equation (4.5) have changed, it can still be estimated by OLS. The appropriate critical values for equation (4.5) are tabulated in Hylleberg et al. (1992).

Table 4.2
Tests for Seasonal Unit Roots

Variable	$T(L)$	H_0: $\pi_1 = 0$	H_0: $\pi_2 = 0$	H_0: $\pi_3 = 0$	H_0: $\pi_4 = 0$	H_0: $\pi_3 = \pi_4 = 0$
PP	54(0)	–1.825	–4.487*	–3.398	–2.540*	11.136*
PS	54(0)	–1.765	–3.558*	–4.161*	–4.147*	27.479*
BS	54(0)	–1.754	–4.241*	–4.586*	–2.824*	19.894*
PR	54(0)	–0.691	–3.735*	–1.528	–5.803*	21.929*
BR	54(0)	–0.971	–5.579*	–3.398	–3.766*	18.526*
CV	26(2)	–2.152	–6.764*	–1.942	–4.314*	12.997*
CP	28(0)	–3.785*	–2.009	–4.493*	–2.088*	24.441*
IMV	32(0)	–2.730	–3.730*	–3.263	–1.898	7.756*
IMP	31(1)	–4.022*	–1.419	–5.056*	–0.722	13.445*
EXV	32(0)	–1.339	–4.670*	–3.604	–2.123*	10.792*
EXP	32(0)	–2.365	–2.975	–4.171*	–1.262	11.104*

Notes: * Indicates significant at 5%.
T and *L* are the numbers of observations and lagged dependent variable, respectively.

The HEGY test results for the 11 quarterly series (in natural logarithms) derived from equation (4.5) are presented in Table 4.2. The unit value of pigmeat for exports (EXP) is the only variable that has both zero frequency and semi-annual unit roots. All the other variables have a non-seasonal (or zero frequency) unit roots, except for the total and Canadian import unit values for pigmeat (IMP and CP) which have semi-annual unit roots. Notice that the test results obtained from the HEGY and ADF tests are different for a number of variables. As the quarterly data available for modelling the impact of imports on domestic pigmeat market are seasonal unadjusted, the unit root test results obtained from the HEGY tests will be used.

CHAPTER 5
MODELLING THE IMPACT OF IMPORTS ON THE PIGMEAT MARKET

5.1 Introduction

In recent years, a number of studies have analysed the impacts of imports on the Australian pig and pigmeat industries. Our review of past studies in Chapter 3, indicates two conflicting results on the effects of Canadian imports on the domestic pigmeat prices.

The aim of this chapter is to assess evidence on the effects of the imports of pigmeat from Canada on the domestic pig market. In the time we had available to produce this report we were unable to obtain adequate data on the costs of production, most importantly the feed costs. It seems fairly obvious that a major determinant of the saleyard price of pigs is the cost of production, which would enter the supply function directly. The influence of other factors such as the price attained by both domestic and foreign competitors, and the price of competing goods also, undoubtedly, play a role as they will influence the perceived price elasticity of demand for the producer's product. In this context, since it would seem reasonable to suggest that the foreign price is independent of the domestic market, it is possible that the opening of the market to foreign competition could drive a wedge between production costs and prices. In the limit, where purchasing power parity is assumed to hold, prices and costs become independent as the weight of foreign competition forced domestic prices to move in tandem with foreign prices. In such a model it might be interesting to test the stability of the relationship between costs and supply prices to see if imported goods have disturbed this relationship. Unfortunately, as noted above we have been unable to obtain an adequate cost of production proxy for our study.

As a result we began with a very simple model specification, based on previous studies. At this stage we have not converted any of the variables into real or per capita magnitudes. This would seem a sensible extension of the work but for now we kept our data in the same form as previous studies to allow some degree of comparability.

The following issues are examined in this chapter:

- Since most of the data tested in Chapter 4 suggested evidence of unit root or non-stationarity, we test for the existence of a cointegrating vector in the data.
- In the context of the estimated equations, an important issue would appear to be the stability of any relationship and we provide tests of the stability of any relationship we find.
- We test for the significance or otherwise of the inclusion of the volume of Canadian imports in the specification in the post 1990 data.

5.2 Data

To examine the demand and supply relationship in the pigmeat market, we begin by looking at the four variables considered in the Queensland study, namely the saleyard prices of baconers (PS) and beef (BS), the production of pigmeat (PP) and the retail price of bacon (PR). The data for these four variables are available from 1984:1 to 1998:2, whereas the data for Canadian imports are only available from 1990:3 onwards.

All data have been converted to natural logarithms, and a D prefix denotes the data is log-differenced. The four variables (PP, PS, PR and BS) were each found to have a non-seasonal unit root, which indicate the variables are difference stationary. As for the Canadian import data, the volume of imports (CV) was found to have a non-seasonal unit root, while the import price (CP) had a semi-annual unit root.[1] This

[1] The Queensland Report found the presence of stochastic seasoanality for both CP and CV using the DHF test.

implies that the variable CP cannot be modelled in a cointegration framework, and CV is the only variable available to assess the possible long-run impact of Canadian imports on domestic pigmeat prices. It is also noted that both the variables PS and PP had deterministic seasonality.

5.3 Methodology

Cointegration techniques are commonly used in empirical economics to test for the existence of long-run linear relationships. In the multivariate framework, Johansen (1988, 1991) proposed a maximum likelihood method to estimate the rank of the cointegrating matrix, where output vector process can be written in the following vector autoregressive (VAR) representation:

$$\Delta Y_t = \Gamma(L)\Delta Y_t + \Pi Y_{t-p} + \mu + \varepsilon_t , \tag{5.1}$$

where Π represents the long-run relationships of cointegrating vectors, $\Gamma(L)$ (is a polynomial of order p - 1) captures the short-run dynamics of the system and ε_t are the independent Gaussian errors with mean zero and variance matrix Ω.

The reduced rank ($0 < \text{rank}(\Pi) = r < n$) of the long run impact matrix is formulated as follows:

$$\Pi = \alpha\beta' , \tag{5.2}$$

where β is the matrix of cointegrating vectors and α is the matrix of weights (or adjustment coefficients). The estimates of α and β are obtained using the maximum likelihood method. Two likelihood ratio test statistics are used to test the reduced rank Π or cointegration, namely the trace and maximal eigenvalue statistics of the stochastic matrix Π.

5.4 Empirical Results

Using the Johansen (1988) method, we began by estimating a VAR of order 5 and then reducing the lag order based on the selection criteria. With the presence of deterministic seasonality, a constant and three dummy variables were allowed to enter the VAR estimation in an unrestricted form.

Tests on the model reduction sequence are reported in Table 5.1 and diagnostics on the estimated VAR are reproduced in Table 5.2. On the basis of these results, a VAR of order 3 was used in the cointegration test. This choice was motivated both by the desire for a low lag order due to degrees of freedom consideration and by the requirement that the estimated system show no evidence of serial correlation (since the Johansen test is based on the assumption of uncorrelated residuals). The F tests on the sequence of model reductions reject the reductions to a VAR(2) model. This can be seen in Table 5.1 below.

Table 5.1: VAR system reduction tests

Progress to date

system	T	p		log-likelihood	SC	HQ	AIC
5	53	32	OLS	721.91869	-24.845	-25.577	-26.242
4	53	48	OLS	731.69016	-24.015	-25.113	-26.611
3	53	64	OLS	757.12869	-23.777	-25.241	-26.571
2	53	80	OLS	777.14403	-23.333	-25.164	-26.326
1	53	96	OLS	791.90965	-22.692	-24.888	-26.883

Tests of system reduction

System 4 --> System 5: F(16, 116) = 0.93590 [0.5309]
System 3 --> System 5: F(32, 126) = 1.7212 [0.0184] *
System 2 --> System 5: F(48, 117) = 1.7584 [0.0074] **
System 1 --> System 5: F(64, 104) = 1.5664 [0.0208] *

System 3 --> System 4: F(16, 104) = 2.4115 [0.0041] **
System 2 --> System 4: F(32, 112) = 2.0769 [0.0027] **
System 1 --> System 4: F(48, 102) = 1.7114 [0.0122] *

System 2 --> System 3: F(16, 92) = 1.6178 [0.0795]
System 1 --> System 3: F(32, 97) = 1.3021 [0.1636]

System 1 --> System 2: F(16, 80) = 1.0012 [0.4643]

Note System 1 is the VAR(5), system 2 the VAR(4) etc.

Table 5.2: System Diagnostics for the estimated VAR systems

```
VAR(5)
PS     :Portmanteau  6 lags=   2.0218
BS     :Portmanteau  6 lags=   2.6226
PR     :Portmanteau  6 lags=   4.7139
PP     :Portmanteau  6 lags=    3.011
PS     :AR 1- 4 F( 4, 25) =      1.272 [0.3074]
BS     :AR 1- 4 F( 4, 25) =    0.60429 [0.6631]
PR     :AR 1- 4 F( 4, 25) =    0.97893 [0.4368]
PP     :AR 1- 4 F( 4, 25) =     2.3112 [0.0857]
PS     :Normality Chi^2(2)=    0.17849 [0.9146]
BS     :Normality Chi^2(2)=     4.2262 [0.1209]
PR     :Normality Chi^2(2)=     0.4077 [0.8156]
PP     :Normality Chi^2(2)=    0.65618 [0.7203]
PS     :ARCH 4  F( 4, 21) =    0.79134 [0.5439]
BS     :ARCH 4  F( 4, 21) =    0.29539 [0.8776]
PR     :ARCH 4  F( 4, 21) =    0.60668 [0.6622]
PP     :ARCH 4  F( 4, 21) =    0.68005 [0.6135]
Vector portmanteau  6 lags=   43.925
Vector AR 1-4  F(64, 41) =    0.76383 [0.8356]
Vector normality Chi^2( 8)=    3.0281 [0.9326]

VAR(4)
PS     :Portmanteau  6 lags=   2.3113
BS     :Portmanteau  6 lags=   3.0762
PR     :Portmanteau  6 lags=   4.1508
PP     :Portmanteau  6 lags=   4.5172
PS     :AR 1- 4 F( 4, 29) =    0.65094 [0.6308]
BS     :AR 1- 4 F( 4, 29) =     0.4339 [0.7830]
PR     :AR 1- 4 F( 4, 29) =     1.8658 [0.1434]
PP     :AR 1- 4 F( 4, 29) =     1.5911 [0.2032]
PS     :Normality Chi^2(2)=   0.095158 [0.9535]
BS     :Normality Chi^2(2)=     5.8411 [0.0539]
PR     :Normality Chi^2(2)=     2.1185 [0.3467]
PP     :Normality Chi^2(2)=    0.56652 [0.7533]
PS     :ARCH 4  F( 4, 25) =     1.0736 [0.3905]
BS     :ARCH 4  F( 4, 25) =     0.3021 [0.8738]
PR     :ARCH 4  F( 4, 25) =    0.48317 [0.7479]
PP     :ARCH 4  F( 4, 25) =    0.79196 [0.5415]
Vector portmanteau  6 lags=   42.955
Vector AR 1-4  F(64, 57) =    0.87098 [0.7053]
Vector normality Chi^2( 8)=    6.1718 [0.6280]

VAR(3)
PS     :Portmanteau  6 lags=   5.1105
BS     :Portmanteau  6 lags=   2.2126
PR     :Portmanteau  6 lags=   3.2562
PP     :Portmanteau  6 lags=   3.9775
PS     :AR 1- 4 F( 4, 33) =     2.4337 [0.0668]
BS     :AR 1- 4 F( 4, 33) =   0.092621 [0.9841]
PR     :AR 1- 4 F( 4, 33) =    0.97549 [0.4342]
PP     :AR 1- 4 F( 4, 33) =     2.1903 [0.0917]
PS     :Normality Chi^2(2)=     3.4248 [0.1804]
BS     :Normality Chi^2(2)=     11.528 [0.0031] **
PR     :Normality Chi^2(2)=     2.1903 [0.3345]
PP     :Normality Chi^2(2)=     2.8989 [0.2347]
PS     :ARCH 4  F( 4, 29) =     1.6904 [0.1792]
BS     :ARCH 4  F( 4, 29) =    0.15696 [0.9583]
PR     :ARCH 4  F( 4, 29) =    0.31095 [0.8683]
PP     :ARCH 4  F( 4, 29) =     1.5724 [0.2081]
Vector portmanteau  6 lags=   61.487
Vector AR 1-4  F(64, 72) =     1.1437 [0.2891]
```

```
Vector normality Chi^2( 8)=    13.066 [0.1096]
VAR(2)
PS      :Portmanteau  6 lags=   3.9714
BS      :Portmanteau  6 lags=    2.176
PR      :Portmanteau  6 lags=   8.2866
PP      :Portmanteau  6 lags=   5.0289
PS      :AR 1- 4 F( 4, 37) =     2.7869 [0.0405] *
BS      :AR 1- 4 F( 4, 37) =    0.41452 [0.7970]
PR      :AR 1- 4 F( 4, 37) =     6.1537 [0.0007] **
PP      :AR 1- 4 F( 4, 37) =     1.1859 [0.3330]
PS      :Normality Chi^2(2)=     5.2667 [0.0718]
BS      :Normality Chi^2(2)=     16.988 [0.0002] **
PR      :Normality Chi^2(2)=     15.925 [0.0003] **
PP      :Normality Chi^2(2)=     1.2814 [0.5269]
PS      :ARCH 4  F( 4, 33) =    0.34137 [0.8480]
BS      :ARCH 4  F( 4, 33) =    0.13744 [0.9672]
PR      :ARCH 4  F( 4, 33) =     1.1311 [0.3588]
PP      :ARCH 4  F( 4, 33) =     1.9806 [0.1204]
Vector portmanteau  6 lags=   88.032
Vector AR 1-4  F(64, 88) =     1.5759 [0.0239] *
Vector normality Chi^2( 8)=    36.544 [0.0000] **


VAR(1)
PS      :Portmanteau  6 lags=    5.941
BS      :Portmanteau  6 lags=   1.2214
PR      :Portmanteau  6 lags=   17.369
PP      :Portmanteau  6 lags=   5.1617
PS      :AR 1- 4 F( 4, 41) =      1.552 [0.2053]
BS      :AR 1- 4 F( 4, 41) =    0.14218 [0.9654]
PR      :AR 1- 4 F( 4, 41) =     4.4666 [0.0043] **
PP      :AR 1- 4 F( 4, 41) =     1.2731 [0.2962]
PS      :Normality Chi^2(2)=     3.2436 [0.1975]
BS      :Normality Chi^2(2)=     6.7453 [0.0343] *
PR      :Normality Chi^2(2)=     14.597 [0.0007] **
PP      :Normality Chi^2(2)=    0.62259 [0.7325]
PS      :ARCH 4  F( 4, 37) =    0.43934 [0.7793]
BS      :ARCH 4  F( 4, 37) =    0.30144 [0.8751]
PR      :ARCH 4  F( 4, 37) =     2.5636 [0.0543]
PP      :ARCH 4  F( 4, 37) =      1.517 [0.2173]
Vector portmanteau  6 lags=   99.582
Vector AR 1-4  F(64,104) =     1.7363 [0.0061] **
Vector normality Chi^2( 8)=     25.93 [0.0011] **
```

Whilst there is disagreement amongst the information criteria regarding the appropriate lag length, the information in Table 5.2 shows that the VAR(3) produces a fairly clean set of diagnostics, in particular with regard to autocorrelation, and the VAR model that goes below 3 lags leads to poor results. So we decided that the VAR model of order 3 was appropriate.

Table 5.3 reports the cointegration results. There is evidence of a single cointegrating vector using the test statistics unadjusted for degrees of freedom. The package used to calculate the tests was PC-FIML (Doornick and Hendry, 1997), which computes a degrees of freedom adjusted tests statistic using a method suggested by Reimers

(1992). Notice that when this adjustment is made, the test is not significant and we would not reject the null of no cointegration. Given that we have a small sample and the Monte Carlo evidence in Kostiel (1994) indicates that the Johansen procedure under-estimates the dimension of the cointegration space in small samples, we are willing to assume that a single cointegrating vector exists. Normalising that vector suggests that we have a relationship where:

$$PS = -0.18BS + 1.67PR - 1.03PP. \tag{5.3}$$

As noted above, interpretation of equation (5.3) is not straight-forward but suggest a sensible positive relationship between the two prices and a negative one with the quantity produced. The sign on the beef price appears counter intuitive but could be justified if the beef price is reflecting demand shocks (increased beef price due to increased demand for beef, which led to lower demand for pork and lower price).

Table 5.3: Cointegration test (PS, BS, PR, PP)

Cointegration analysis 1985 (2) to 1998 (2)

eigenvalue	loglik for rank	
	729.233	0
0.415843	743.479	1
0.289053	752.519	2
0.116984	755.816	3
0.0483232	757.129	4

Ho:rank=p	Max Eigen	DF adjusted	95%	Trace	Adjusted	95%	
p == 0	28.49*		22.04	27.1	55.79**	43.16	47.2
p <= 1	18.08	13.99	21.0	27.3	21.12	29.7	
p <= 2	6.594	5.101	14.1	9.219	7.132	15.4	
p <= 3	2.625	2.031	3.8	2.625	2.031	3.8	

standardized \beta' eigenvectors

PS	BS	PR	PP
1.0000	0.18219	-1.6667	1.0305
35.574	1.0000	-21.487	0.045178
-0.10958	0.29657	1.0000	-2.0800
-0.16129	-0.52005	-0.64320	1.0000

One advantage to the Johansen procedure is the ability to test restrictions on the cointegrating vector. In terms of the vector we have here, two tests on the β matrix are of some interest. First, we are able to restrict individual coefficients to be zero to see if the variables are actually necessary in the cointegrating vector. Secondly, we could place a arbitrary restriction on the coefficient on each variable, namely that it is equal to 1. All the others are set to zero. This is often referred to as a multivariate unit root test (if only one variable produces a rejection of the null of no cointegration then the interpretation is that that variable is stationary). These tests are reproduced in Table 5.4 which shows that the multivariate unit root tests support the assumption that our data are non-stationary. It is evident from Table 5.4 that the LR test of the restriction rejects strongly in each case. Similarly tests of the significance of each of the variables are generally supportive of the notion that all of them are important in the estimated cointegrating vector, with all variables rejecting the restriction at the 5% level (just, in the case of beef saleyard price).

The estimated cointegrating vector can serve a further purpose in relation to the work done in the original Queensland Report. On page 48 they make the assumption that the endogenous variable is the saleyard price of pork whilst the other three variables are assumed to be exogenous. We can test weak exogeneity by imposing zero restrictions on the estimated α matrix calculated in the analysis. Essentially we are testing whether the cointegrating relationship enters the individual equations of the system. Table 5.5 reports individual and joint restrictions on the α matrix for the variables: beef saleyard price (BS), pig production (PP), and pig retail price (PR). As can be seen from the results that the variables as a group do reject the weak exogeneity test, but both the pig production and the beef saleyard price cannot individually reject weak exogeneity.

Finally before going any further, Figure 5.1 plots the estimated cointegrating relationship, which shows some evidence of a mean shift around 1989/90 and then some signs of instability later in the sample, other than that the relationship does appear stationary. In extensions of the work here, it would probably be of some interest to apply the tests of Gregory and Hansen (1996) which allow for the testing of cointegration in the presence of a one off break in the cointegrating relationship.

Table 5.4: Tests on the cointegrating vector

Multivariate Unit Root tests

General cointegration test 1985 (2) to 1998 (2)

beta'

PS	BS	PR	PP
1.0000	0.00000	0.00000	0.00000

LR-test, rank=1: Chi^2(3) = 13.727 [0.0033] ** PS is non stationary

\beta'

PS	BS	PR	PP
0.00000	1.0000	0.00000	0.00000

LR-test, rank=1: Chi^2(3) = 20.645 [0.0001] ** BS is non stationary

\beta'

PS	BS	PR	PP
0.00000	0.00000	1.0000	0.00000

LR-test, rank=1: Chi^2(3) = 17.23 [0.0006] ** PR is non stationary

\beta'

PS	BS	PR	PP
0.00000	0.00000	0.00000	1.0000

LR-test, rank=1: Chi^2(3) = 21.819 [0.0001] ** PP is non stationary

Tests of zero restrictions on individual variables

\beta'

PS	BS	PR	PP
1.0000	0.00000	-2.1758	1.7653

LR-test, rank=1: Chi^2(1) = 3.8218 [0.0506]   BS is non zero at 5% level

\beta'

PS	BS	PR	PP
1.0000	-0.15445	0.00000	-0.44459

LR-test, rank=1: Chi^2(1) = 8.9968 [0.0027] ** PR is non zero at 5% level

\beta'

PS	BS	PR	PP
1.0000	0.42937	-1.1423	0.00000

LR-test, rank=1: Chi^2(1) = 7.9594 [0.0048] ** PP is non zero at 5% level

\beta'

PS	BS	PR	PP
0.00000	0.14171	-1.0391	1.0000

LR-test, rank=1: Chi^2(1) = 5.084 [0.0241] * PS is non zero at 5% level

Table 5.5: Tests of Weak Exogeneity of variables in the cointegrating vector

General cointegration test 1985 (2) to 1998 (2)

\beta'

PS	BS	PR	PP
1.0000	0.17797	-1.6619	1.0031

\alpha

PS	0.029516
BS	**0.00000**
PR	0.21754
PP	0.038690

LR-test, rank=1: Chi^2(1) = 0.54878 [0.4588] - BS is weakly exogenous

General cointegration test 1985 (2) to 1998 (2)

\beta'

PS	BS	PR	PP
1.0000	0.027534	-0.59875	-0.0044031

\alpha

PS	-0.64605
BS	0.018129
PR	**0.00000**
PP	0.048501

LR-test, rank=1: Chi^2(1) = 10.411 [0.0013] ** - PR is endogenous

General cointegration test 1985 (2) to 1998 (2)

\beta'

PS	BS	PR	PP
1.0000	0.18101	-1.6740	1.0426

\alpha

PS	0.062554
BS	-0.16274
PR	0.21379
PP	**0.00000**

LR-test, rank=1: Chi^2(1) = 0.0065371 [0.9356] PP is weakly exogenous

General cointegration test 1985 (2) to 1998 (2)

\beta'

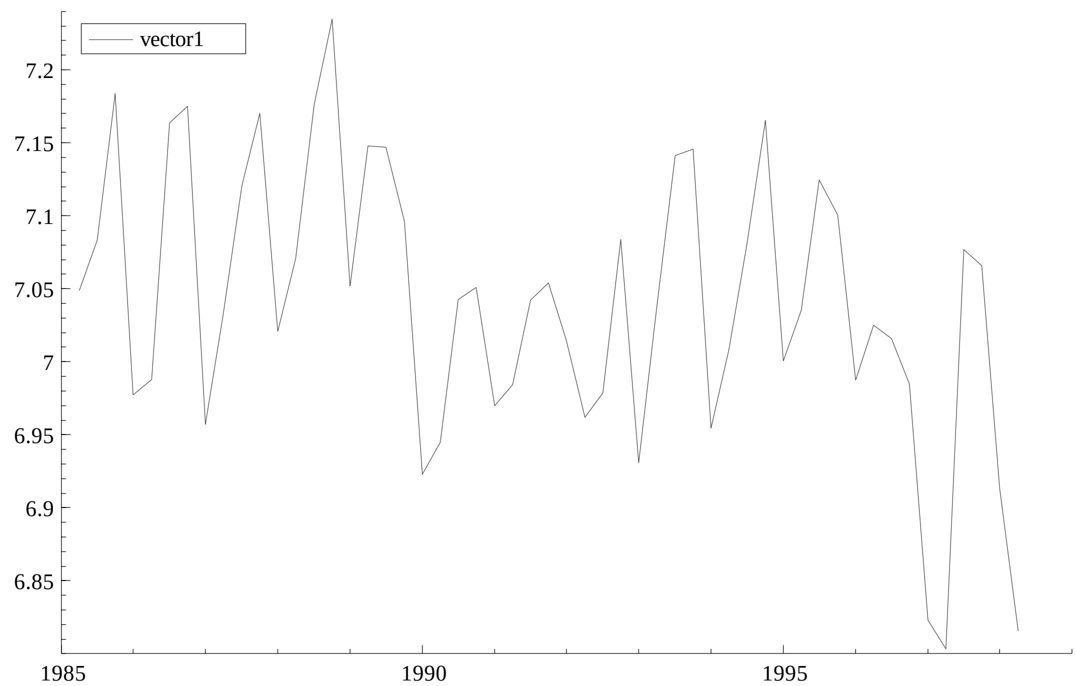
PS	BS	PR	PP
1.0000	0.013685	-0.67742	0.11767

\alpha

PS	-0.62554
BS	**0.00000**
PR	**0.00000**
PP	**0.00000**

LR-test, rank=1: Chi^2(3) = 10.607 [0.0141] *

Figure 5.1: Estimated cointegrating relationship



These results suggest that the model estimated by the Queensland Report and that the inferences drawn from it are potentially biased. There does appear to be a cointegrating relationship between the four variables and the assumption that all of the three right hand side variables are exogenous does not appear to hold.

Where does all of this get us in terms of the effect of imports? Clearly the finding that the four variables cointegrate tells us that there is a long run equilibrium relationship between the variables. Any shocks which disturbs this equilibrium will be corrected for in the long run. It does not necessarily follow that this relationship has not been subject to some instability. Therefore, it is of some benefit to test for the stability of the relationship between the four variables. The obvious question is whether the effects of the beginning of imports in the early 1990's lead to evidence of instability in the relationship. Thus the work done in the Queensland Report uses a Chow test for a structural break in 1990:1. Whilst the theory behind such a test is well known it is undoubtedly the case it is possible that such a priori selection of the breakpoint can lead to misleading inferences. The debate between Perron (1989), Christiano (1992) and Banerjee, Lumsdaine and Stock (1992) regarding the appropriate way to carry out unit root tests in the presence of a break in the underlying trend function illustrates the questions involved. One possible method would be to use recursive estimation and check the stability of the largest eigenvalue, whereby the changes might be informative on the presence of a structural break. However, with a VAR(3) already being used in the analysis and four variables in the model, this leaves few observations on which to carry out such recursions. One potential solution is the use of the FM-OLS type estimators of cointegrating relationships suggested by Phillips (1988) and Phillips and Hansen (1990). This has a number of advantages in the present context. Firstly, the estimation is carried out in a static regression which does not require the estimation of a VAR with its larger number of parameters. Secondly, and perhaps of more relevance in this case, Hansen (1992) has derived test statistics and asymptotic critical values for three tests of parameter instability in the context of such regressions involving I(1) processes. One of the main reasons for the development of alternative testing procedure for cointegration such as Johansen estimation, has been the realisation that tests for cointegration based on static regressions as in the case of the Engle-Granger method can suffer from finite sample bias. A possible solution to such problems turns out to be single equation dynamic regression models. Given the fact that our results above suggest that weak exogeneity of the right hand side variables is rejected, it would seem preferable to use the FM-OLS method. Hansen (1992) details three tests of parameter instability in the context of a regression involving I(1) variables, these are the SupF, MeanF and L_C tests. It is shown that the L_c test can be used as a test of the null of cointegration, thus providing us with a check of the cointegration result obtained above. In order to implement these tests, we used the program GAUSS and its associated Program COINT along with a program written specifically to carry out the tests mentioned above by Hansen[2], for which we are grateful being able to use in this context.

One question that we are unsure about the answer, arising in the application of these tests is how to deal with seasonal dummy variables in the regression equation. The Johansen results above were based on a model where the seasonal dummies could be included in the estimation and the results are to some degree sensitive to the inclusion of these dummy variables. Exclusion of them leads to the maximal eigenvalue test failing to reject the null of zero cointegrating vectors, the trace test still rejects but only at 5% and there is some slight variation in the β vector estimates. What we did was the following. We first carried out the tests using the original data and allowing for the possibility of drift in the unit root processes. The results for this case are presented in Table 5.6 and Figure 5.2. We then carried out prior OLS regressions of each variable on a constant and the seasonal dummies, and carried out the tests of the residuals from these regressions. In both cases a constant only was included in the regression equations. The results are presented in Table 5.7 and Figure 5.3.

Table 5.6: FM-OLS estimates - original data.

Fully Modified Regression Results
Sample Size 58.000000

Parameters Estimates are listed by row
Standard Errors are to the right of each estimate

I(1) variables

BS	-0.017236371	0.065983148
PR	1.3602660	0.11218916
PP	-1.0087316	0.14492983

Constant, Trend, etc

7.9241458	1.0273323

Method of Estimation of Covariance Parameters:
Pre-Whitened
Quadratic Spectral kernel

[2] The programe is available from Professor Hansen's home page on the WWW at: **Error! Bookmark not defined.**

Automatic bandwidth selected :   1.7707116

Tests for Parameter Stability

	Test Statistic	P-value ('.20' means '>= .20')
Lc	0.63878887	0.12206172
MeanF	4.9605053	0.20000000
SupF	13.543049	0.17588646

Infererences drawn, Lc does not reject null of cointegration, MeanF and SupF suggest null of stability cannot be rejected.

Figure 5.2: Sequence of F tests using original data

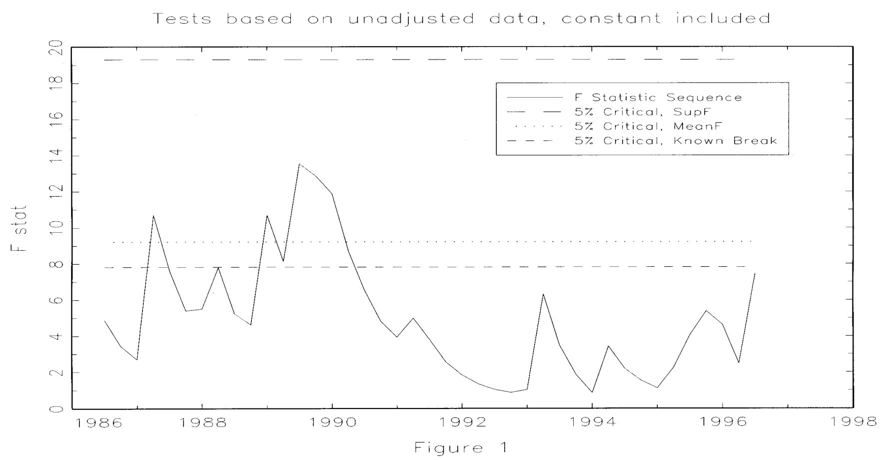


Table 5.7: FM OLS estimates on adjusted data

Fully Modified Regression Results
Sample Size   58.000000

Parameters Estimates are listed by row
Standard Errors are to the right of each estimate

I(1) variables

0.021700940	0.078327708
1.5452769	0.17275098
-1.2207632	0.23901804

Constant, Trend, etc
0.00083138426 0.0088403984

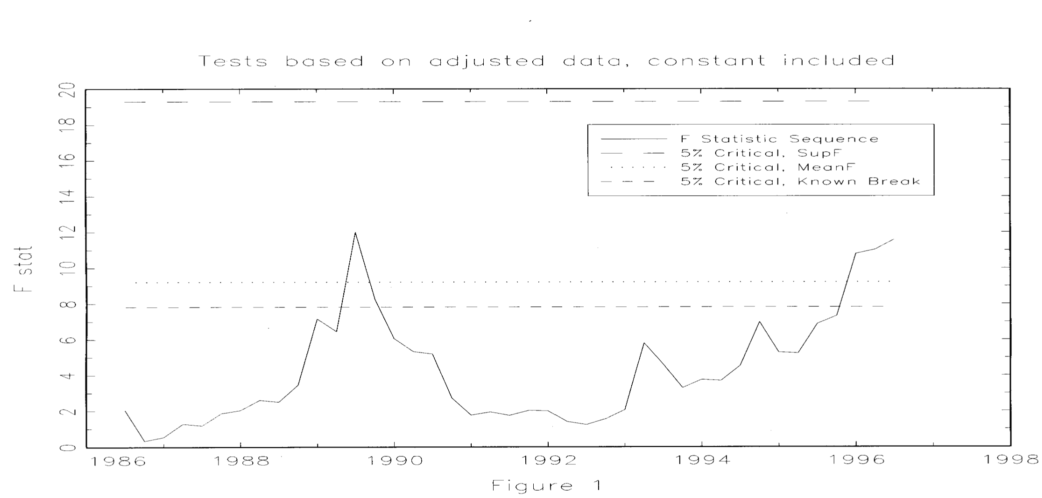
Method of Estimation of Covariance Parameters:
Pre-Whitened
Quadratic Spectral kernel
Automatic bandwidth selected : 1.0793443

Tests for Parameter Stability

	Test Statistic	P-value ('.20' means '>= .20')
LC	0.23321573	0.20000000
MeanF	4.3259629	0.20000000
SupF	11.999412	0.20000000

Infererences drawn, Lc does not reject null of cointegration,
MeanF and SupF suggest null of stability cannot be rejected.

Figure 5.3: Sequence of F tests using adjusted data, constant included



As can be seen from the results, both sequences of tests fail to reject the null of stability, and the graphs of the sequences of F statistics show pronounced peaks in the tests around 1989/90 and again later in the sample. Note also that the Queensland Report suggests that a standard Chow test using any of the dates around this point would indeed have lead to the conclusion that there was a structural break. It would be tempting to suggest that this instability reflects the markets anticipation of the effect of changes in the market, and to then conclude that after the event stability has largely been restored, but the econometrics cannot justify such a statement. Another interesting aspect of the results is that using either adjusted or unadjusted data, the coefficient on beef saleyard price appears to be insignificant (remember it rejected the zero restriction in the Johansen method at the 5.06% level). On the other hand, the coefficients on pigmeat retail price and production appear to be sensibly signed and of the same orders of magnitude to those obtained using the Johansen method.

So there is some evidence of a long-run relationship between pig saleyard prices, pig retail prices, pig production and possibly beef salyard prices. If we now include in our estimation the Canadian import quantity we can attempt to see what effect it has, if any, on that relationship. Whilst Johansen estimation would seem appropriate in this context, in that it would allow us to test restrictions on any cointegrating vector, it must be noted that we are now pushing this data pretty hard in terms of number of observations and number of estimated parameters. Whilst there is evidence, noted above, that the Johansen method tends to underestimate the cointegration space in small samples, Monte Carlo studies by Cheung and Lai (1993) show that the use of unadjusted critical values for these tests lead to both the trace and maximal eigenvalue tests over rejecting the null of no cointegration. The size of this bias was a positive function of T/(T-nk), where T is sample size, n is number of variables and k is the VAR lag length. Indeed the results now suggested that, using unadjusted test statistics there was evidence of two cointegrating vectors, however the adjusted test statistics suggested no cointegrating vector between the variables. This finding was exacerbated on the post 1990 data where the lack of degrees of freedom means that we have little or no faith in the test results. As a result we once again used FM-OLS to back up our tests and indeed we place more faith in these results at this stage.

Bearing these caveats in mind, the results in Tables 5.8 and 5.9 report the cointegration results full and post sample, along with a test of the restriction that the coefficient on imports was zero under the assumption of a cointegrating vector between the variables. In order to free up as many degrees of freedom as possible for the post 1990 estimation, we estimated the lowest order VAR that showed no evidence of serial correlation, this was a VAR(2) model. As can be seen the test cannot reject the zero restriction. More convincing, we feel, are the results of the FM-OLS estimation reported in Table 5.10 which gives an estimate of the parameters in the vector which is similar to those we previously obtained, but once again shows an insignificant coefficient on imports.

Finally, having found evidence of a single cointegrating vector between the four variables, we estimated a simple short-run model in which we allowed Canadian import volumes, pigmeat production and beef saleyard prices to enter as weakly exogenous, giving us a two equation model for pig saleyard and pig retail prices. The cointegrating vector used was the one estimated over the full sample using the original four variables.

Table 5.8: Johansen estimation using Canadian Import Volumes full sample estimates

First VAR(3) diagnostics

PS	:Portmanteau 7 lags=	5.7836
BS	:Portmanteau 7 lags=	3.9026
PR	:Portmanteau 7 lags=	7.0742
PP	:Portmanteau 7 lags=	4.3868
CV	:Portmanteau 7 lags=	13.566
PS	:AR 1- 4 F(4, 32) =	2.4985 [0.0621]
BS	:AR 1- 4 F(4, 32) =	0.30312 [0.8737]
PR	:AR 1- 4 F(4, 32) =	1.9852 [0.1205]
PP	:AR 1- 4 F(4, 32) =	0.49245 [0.7413]
CV	:AR 1- 4 F(4, 32) =	2.3 [0.0802]
PS	:Normality Chi^2(2)=	4.888 [0.0868]
BS	:Normality Chi^2(2)=	12.018 [0.0025] **
PR	:Normality Chi^2(2)=	2.0996 [0.3500]
PP	:Normality Chi^2(2)=	2.0272 [0.3629]
CV	:Normality Chi^2(2)=	3.2065 [0.2012]
PS	:ARCH 4 F(4, 28) =	4.0675 [0.0101] *
BS	:ARCH 4 F(4, 28) =	0.21955 [0.9253]
PR	:ARCH 4 F(4, 28) =	0.21791 [0.9262]
PP	:ARCH 4 F(4, 28) =	2.2934 [0.0843]
CV	:ARCH 4 F(4, 28) =	4.4915 [0.0063] **
Vector portmanteau	7 lags=	149.41
Vector AR 1-4	F(100, 63) =	1.1125 [0.3272]
Vector normality	Chi^2(10)=	16.247 [0.0928]
Vector Xi^2	Chi^2(450) =	449.11 [0.5030]

Now the cointegration full sample

Ho:rank=p	-Tlog(1-\mu)	using T-nm	95%	-T\Sum log(.)	using T-nm	95%
p == 0	34.22*	24.89	33.5	91.05**	66.22	68.5
p <= 1	32.25**	23.46	27.1	56.83**	41.33	47.2
p <= 2	12.08	8.786	21.0	24.57	17.87	29.7
p <= 3	8.182	5.951	14.1	12.49	9.086	15.4
p <= 4	4.311*	3.135	3.8	4.311*	3.135	3.8

standardized \beta' eigenvectors

PS	BS	PR	PP	CV
1.0000	0.091991	-2.1098	1.4801	0.0064501
5.3405	1.0000	-4.9146	-0.82838	0.084389
0.76013	0.82238	1.0000	-2.6393	-0.017129
0.087136	-0.46112	-0.14257	1.0000	-0.023768
-32.824	-16.426	11.760	-51.871	1.0000

standardized \alpha coefficients

PS	0.010222	-0.19107	-0.045737	-0.050390	-0.00047956
BS	-0.099240	-0.017993	0.027622	0.22348	0.0029453
PR	0.16870	-0.0035740	0.036328	0.019286	-3.5033e-005
PP	-0.017315	0.030795	0.074226	-0.10786	0.00086208
CV	-4.1810	-0.74162	1.3681	0.77013	-0.015590

Number of lags used in the analysis: 3
Variables entered unrestricted:
Constant Seasonal Seasonal_1 Seasonal_2

And heres the LR test of a zero restriction test on CV in the cointegrating vector

LR-test, rank=1: Chi^2(1) = 0.14419 [0.7042]] ie cannot reject zero on CV

Table 5.9: Johansen estimation using Canadian Import Volumes post 1990 with a VAR(2)

Diagnostics are:

PS :Portmanteau 4 lags= 2.0477
BS :Portmanteau 4 lags= 5.0845
PR :Portmanteau 4 lags= 5.8042
PP :Portmanteau 4 lags= 3.7801
CV :Portmanteau 4 lags= 10.317
PS :AR 1- 1 F(1, 14) = 0.0037774 [0.9519]
BS :AR 1- 1 F(1, 14) = 1.7483 [0.2073]
PR :AR 1- 1 F(1, 14) = 1.2246 [0.2871]
PP :AR 1- 1 F(1, 14) = 2.3369 [0.1486]
CV :AR 1- 1 F(1, 14) = 2.2379 [0.1569]
PS :Normality Chi^2(2)= 1.8966 [0.3874]
BS :Normality Chi^2(2)= 1.5734 [0.4553]
PR :Normality Chi^2(2)= 0.85759 [0.6513]
PP :Normality Chi^2(2)= 0.31576 [0.8540]
CV :Normality Chi^2(2)= 3.9704 [0.1374]
PS :ARCH 1 F(1, 13) = 0.50485 [0.4899]
BS :ARCH 1 F(1, 13) = 0.42145 [0.5275]
PR :ARCH 1 F(1, 13) = 0.62463 [0.4435]
PP :ARCH 1 F(1, 13) = 0.21088 [0.6537]
CV :ARCH 1 F(1, 13) = 0.018477 [0.8940]

Vector portmanteau 4 lags= 118.77
Vector AR 1-1 F(25, 23) = 0.94605 [0.5557]
Vector normality Chi^2(10)= 8.7953 [0.5516]

Cointegration looks like

Ho:rank=p	-Tlog(1-\mu)	using T-nm	95%	-T\Sum log(.)	using T-nm	95%
p == 0	36.7*	24.05	33.5	86.58**	56.73	68.5
p <= 1	30.77*	20.16	27.1	49.88*	32.68	47.2
p <= 2	10.86	7.112	21.0	19.11	12.52	29.7
p <= 3	7.534	4.936	14.1	8.252	5.406	15.4
p <= 4	0.7176	0.4701	3.8	0.7176	0.4701	3.8

standardized \beta' eigenvectors

PS	BS	PR	PP	CV
1.0000	-0.44741	-2.4699	1.3595	-0.061884
0.52185	1.0000	-0.83918	-1.4558	0.23754
8.5426	11.578	1.0000	5.7057	-1.2763
0.20496	-0.060481	0.098630	1.0000	-0.019378

and here is the LR test of the restriction that CV=0 in the cointegrating vector:

LR-test, rank=1: Chi^2(1) = 0.96678 [0.3255] ie cannot reject zero on CV

Table 5.10: FM-OLS estimation Post 1990 sample

Fully Modified Phillips-Hansen Estimates
Parzen weights, truncation lag= 4 , Non-trended Case

Dependent variable is LPIGS
31 observations used for estimation from 1990Q4 to 1998Q2

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
Intercept	-2.7236	2.7821	-.97897[.337]
PP	-.72337	.17538	-4.1245[.000]
PR	2.3261	.27916	8.3325[.000]
BS	.17404	.097623	1.7827[.086]
CV	.0056842	.016730	.33977[.737]

The model estimates are reported in Table 5.11 and as can be seen the import volumes are not significant in the regressions. The model diagnostics are all acceptable and the model appears to track the data tolerably well (see Figure 5.4).

The full sample results are supported by estimation over the sub-sample post imports with the results presented in Table 5.12, showing once again no role in the equations for Canadian import volumes. The diagnostics for the equations are acceptable and the model appears to track reasonably well as can be seen from the set of graphs in Figure 5.5.

One thing which appeared a little strange in the results was the fact that the cointegrating vector only entered the equation for pigmeat retail price and not saleyard price. This is of course entirely possible and suggests that to the extent that there is a long-run relationship between the variables, it is the retail price of pork which adjusts to that disequilibrium, not the other variables such as the saleyard price. So what do these results tell us about saleyard price? Firstly, on the basis of the data analysed here import of pigmeat which began in the early 1990's does not seem to have had a statistically significant effect on the relationships we have estimated. Looking at the

Table 5.11: The short run model- full sample

Note D indicates the first difference of the series - so DPS is the first difference of the Pig Saleyard Price series.
_1, _2 after a variable indicates the lag length, thus for example CIvec1_1 is the cointegrating vector lagged one preriod

URF Equation 1 for DPS

Variable	Coefficient	Std.Error	t-value	t-prob
DPS_1	-0.16292	0.23404	-0.696	0.4908
DPS_2	0.20465	0.23151	0.884	0.3826
DPR_1	0.21770	0.49263	0.442	0.6612
DPR_2	0.31284	0.41710	0.750	0.4581
CIvec1_1	0.12469	0.15408	0.809	0.4237
DBS	0.091691	0.13289	0.690	0.4946
DBS_1	0.018885	0.12545	0.151	0.8812
DBS_2	-0.018665	0.11962	-0.156	0.8769
DPP	-0.87265	0.28249	-3.089	0.0039
DPP_1	-0.25359	0.34801	-0.729	0.4709
DPP_2	-0.53488	0.33135	-1.614	0.1152
DCV	0.025802	0.013810	1.868	0.0699
DCV_1	-0.022671	0.013658	-1.660	0.1056
DCV_2	0.0074932	0.012738	0.588	0.5600
Seasonal_1	-0.17470	0.055439	-3.151	0.0033
Seasonal_2	-0.077795	0.062371	-1.247	0.2203
Seasonal	-0.26834	0.053137	-5.050	0.0000
Constant	-0.81476	1.1611	-0.702	0.4874

URF Equation 2 for DPR

Variable	Coefficient	Std.Error	t-value	t-prob
DPS_1	0.021606	0.056440	0.383	0.7041
DPS_2	-0.099614	0.055827	-1.784	0.0828
DPR_1	0.42010	0.11880	3.536	0.0011
DPR_2	-0.15549	0.10058	-1.546	0.1309
CIvec1_1	0.18065	0.037156	4.862	0.0000
DBS	-0.0046960	0.032046	-0.147	0.8843
DBS_1	-0.016956	0.030252	-0.561	0.5786
DBS_2	-0.10169	0.028845	-3.525	0.0012
DPP	0.13424	0.068122	1.971	0.0565
DPP_1	-0.14689	0.083922	-1.750	0.0886
DPP_2	-0.14149	0.079906	-1.771	0.0851
DCV	0.0041501	0.0033302	1.246	0.2207
DCV_1	-0.0054601	0.0032937	-1.658	0.1061

```
DCV_2           0.0059369    0.0030718    1.933  0.0612
Seasonal_1      -0.022349     0.013369   -1.672  0.1033
Seasonal_2   -0.00078567     0.015041   -0.052  0.9586
Seasonal     -0.00089148     0.012814   -0.070  0.9449
Constant         -1.3619      0.28000   -4.864  0.0000

\sigma = 0.012574   RSS = 0.005691775782

correlation of URF residuals
                     DPS         DPR
 DPS              1.0000
 DPR           -0.050972      1.0000

standard deviations of URF residuals
          DPS         DPR
     0.052142    0.012574
```

R^2(LR) = 0.819593 R^2(LM) = 0.531393

```
F-test on all regressors except unrestricted, F(28,70) = 3.3859
[0.0000] **
variables entered unrestricted:
  Seasonal_1  Seasonal_2  Seasonal  Constant

F-tests on retained regressors, F(2, 35)
      DPS_1    0.294344 [0.7468]         DPS_2     1.85422 [0.1716]
      DPR_1     6.26771 [0.0047] **      DPR_2     1.38131 [0.2646]
   CIvec1_1     12.0350 [0.0001] **        DBS     0.237469 [0.7899]
      DBS_1    0.159973 [0.8528]         DBS_2    6.09632 [0.0054] **
        DPP     6.24098 [0.0048] **      DPP_1     1.81525 [0.1778]
      DPP_2     2.94013 [0.0660]           DCV     2.57404 [0.0906]
      DCV_1     2.81882 [0.0733]         DCV_2     2.04570 [0.1445]

correlation of actual and fitted
          DPS         DPR
      0.88149     0.86549


Restrictions for testing:
&11=0;
&12=0;
&13=0;
Wald test for general restrictions
```

GenRes Chi^2(3) = 4.6915 [0.1958] testing restriction that coefficients on CV and lags in DPS equation are jointly zero

```
Restrictions for testing:
&25=0;
&26=0;
&27=0;
Wald test for general restrictions
```

GenRes Chi^2(3) = 5.488 [0.1394] testing restriction that coefficients on CV and lags in DPR equation are jointly zero

```
Restrictions for testing:
&25=0;
&26=0;
&27=0;
&12=0;
&13=0;
&11=0;
Wald test for general restrictions
```

GenRes Chi^2(6) = 10.599 [0.1016] testing restriction that coefficients on CV and lags in DPR and DPS equation are jointly zero

Diagnostics on the model

DPS :Portmanteau 6 lags= 1.4409
DPR :Portmanteau 6 lags= 3.6947
DPS :AR 1- 4 F(4, 32) = 0.59497 [0.6688]
DPR :AR 1- 4 F(4, 32) = 0.64154 [0.6368]
DPS :Normality Chi^2(2)= 1.9955 [0.3687]
DPR :Normality Chi^2(2)= 1.8049 [0.4056]
DPS :ARCH 4 F(4, 28) = 0.45471 [0.7681]
DPR :ARCH 4 F(4, 28) = 0.2803 [0.8882]
DPS :Xi^2 F(28, 7) = 0.16787 [0.9997]
DPR :Xi^2 F(28, 7) = 0.7748 [0.7091]
Vector portmanteau 6 lags= 12.643
Vector AR 1-4 F(16, 54) = 0.82599 [0.6515]
Vector normality Chi^2(4)= 3.8689 [0.4240]
Vector Xi^2 F(84, 15) = 0.26787 [0.9999]

Figure 5.4: Graphs of actual and fitted and normalised residuals

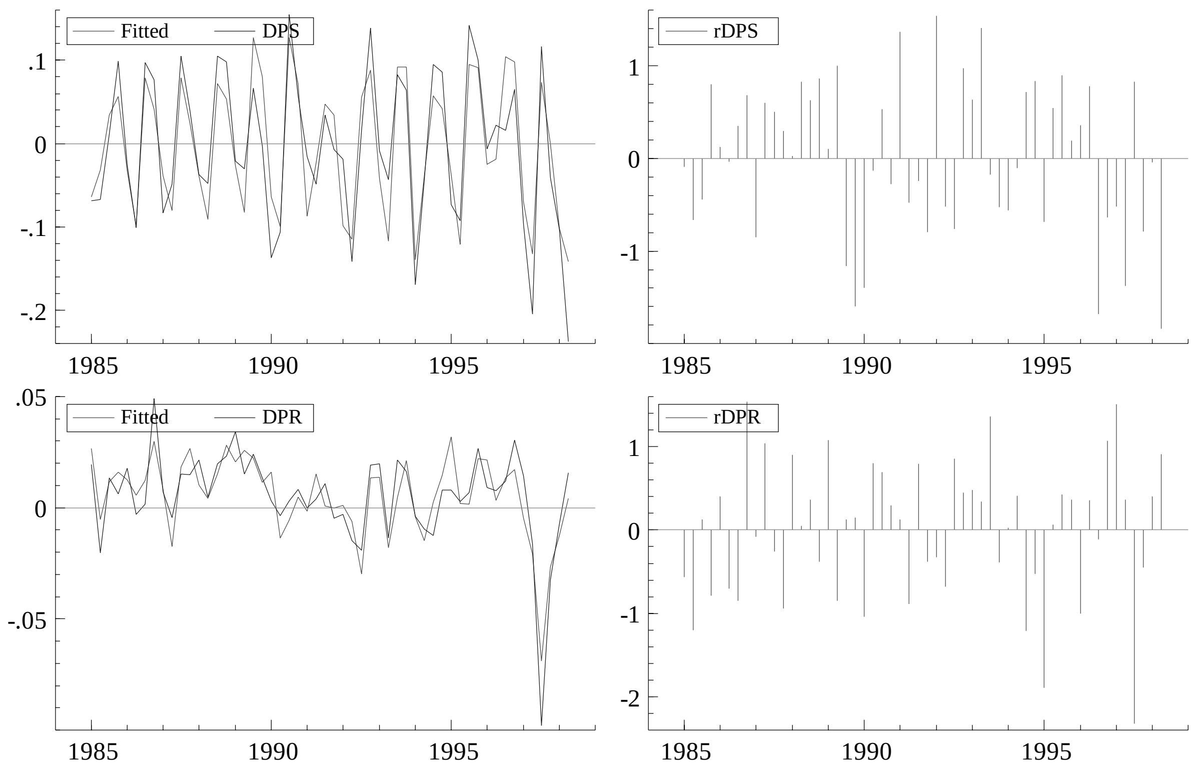


Figure 5.5: Graphs of actual and fitted and normalised residuals

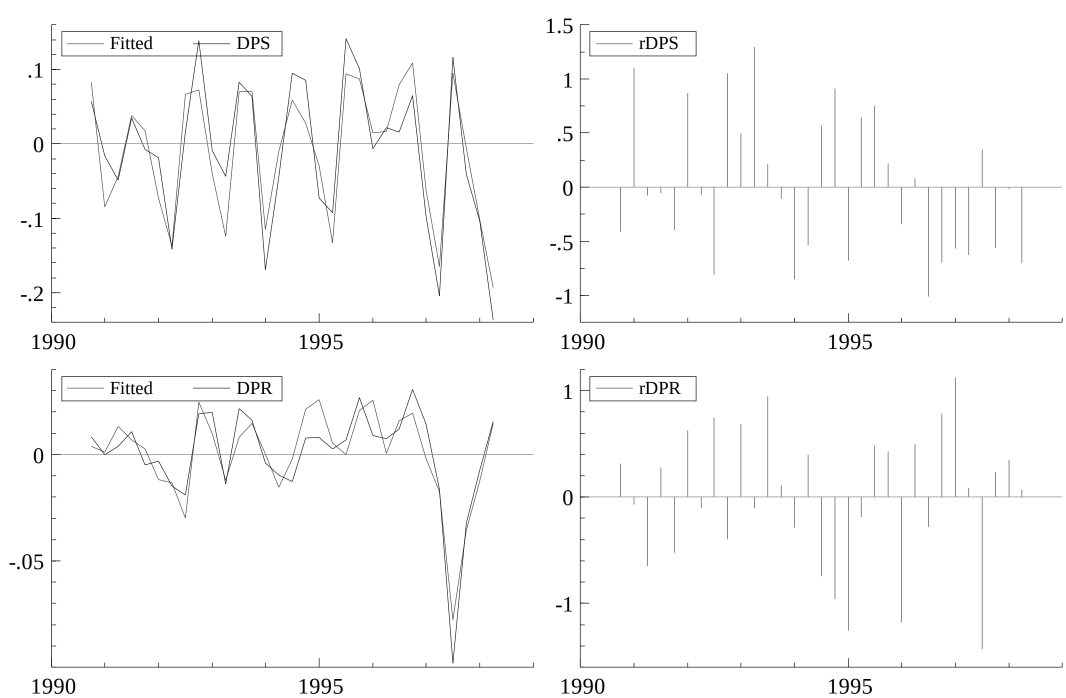


Table 5.12: The short run model- post 1990

Estimating the unrestricted reduced form by OLS
The present sample is: 1990 (4) to 1998 (2)

URF Equation 1 for DPS

Variable	Coefficient	Std.Error	t-value	t-prob
DPS_1	-0.41556	0.50343	-0.825	0.4240
DPS_2	0.31088	0.36330	0.856	0.4076
DPR_1	-0.10177	0.72066	-0.141	0.8899
DPR_2	1.0263	0.76569	1.340	0.2031
CIvec1_1	0.17071	0.33146	0.515	0.6152
DBS	-0.0070641	0.28009	-0.025	0.9803
DBS_1	-3.2967e-005	0.22001	-0.000	0.9999
DBS_2	0.069480	0.18279	0.380	0.7100
DPP	-1.1960	0.54085	-2.211	0.0455
DPP_1	-0.41623	0.81267	-0.512	0.6171
DPP_2	-0.55497	0.67287	-0.825	0.4244
DCV	0.036876	0.022557	1.635	0.1261
DCV_1	-0.026608	0.020204	-1.317	0.2106
DCV_2	0.0045132	0.020684	0.218	0.8307
Seasonal_1	-0.19921	0.094884	-2.099	0.0559
Seasonal_2	-0.10102	0.10440	-0.968	0.3509
Constant	-1.1498	2.4783	-0.464	0.6503
Seasonal	-0.27580	0.085261	-3.235	0.0065

\sigma = 0.0628319   RSS = 0.05132194447

URF Equation 2 for DPR

Variable	Coefficient	Std.Error	t-value	t-prob
DPS_1	-0.012298	0.11334	-0.109	0.9152
DPS_2	-0.14663	0.081792	-1.793	0.0963
DPR_1	0.54752	0.16225	3.375	0.0050
DPR_2	-0.17054	0.17238	-0.989	0.3406
CIvec1_1	0.21442	0.074624	2.873	0.0131
DBS	0.021720	0.063057	0.344	0.7360
DBS_1	-0.014491	0.049532	-0.293	0.7745
DBS_2	-0.097533	0.041154	-2.370	0.0339
DPP	0.22319	0.12177	1.833	0.0898
DPP_1	-0.30512	0.18296	-1.668	0.1193
DPP_2	-0.28906	0.15149	-1.908	0.0787
DCV	0.0016504	0.0050784	0.325	0.7504
DCV_1	-0.0039396	0.0045486	-0.866	0.4021
DCV_2	0.0056624	0.0046568	1.216	0.2456
Seasonal_1	-0.051647	0.021362	-2.418	0.0310
Seasonal_2	-0.011307	0.023504	-0.481	0.6385
Constant	-1.6033	0.55795	-2.874	0.0131
Seasonal	-0.014913	0.019195	-0.777	0.4511

\sigma = 0.0141457   RSS = 0.002601315186

correlation of URF residuals

	DPS	DPR
DPS	1.0000	
DPR	-0.10207	1.0000

standard deviations of URF residuals

DPS	DPR
0.062832	0.014146

R^2(LR) = 0.922092 R^2(LM) = 0.686692

```
F-test  on  all  regressors  except  unrestricted,  F(28,24)  =  2.2137
[0.0258] *
variables entered unrestricted:
  Seasonal_1  Seasonal_2  Constant  Seasonal

F-tests on retained regressors, F(2, 12)
      DPS_1    0.331818 [0.7240]         DPS_2     1.69442 [0.2248]
      DPR_1     5.27538 [0.0227] *       DPR_2     1.16810 [0.3439]
   CIvec1_1     4.11535 [0.0436] *         DBS   0.0548068 [0.9469]
      DBS_1   0.0399248 [0.9610]         DBS_2     2.60124 [0.1152]
        DPP     3.46195 [0.0650]         DPP_1     1.50078 [0.2620]
      DPP_2     2.16527 [0.1574]           DCV     1.34628 [0.2968]
      DCV_1     1.26741 [0.3167]         DCV_2    0.737037 [0.4990]

correlation of actual and fitted
          DPS         DPR
      0.90574     0.91668


Restrictions for testing:
&11=0;
&12=0;
&13=0;
Wald test for general restrictions
```
GenRes Chi^2(3) =   3.808 [0.2830] testing restriction that coefficients on CV and lags in DPS equation are jointly zero

```
Restrictions for testing:
&11=0;
&12=0;
&13=0;
&25=0;
&26=0;
&27=0;
Wald test for general restrictions
GenRes Chi^2( 6) =       5.87 [0.4379]
```
testing restriction that coefficients on CV and lags in DPR and DPS equation are jointly zero

```
Restrictions for testing:
&25=0;
&26=0;
&27=0;
Wald test for general restrictions
GenRes Chi^2( 3) =     1.7431 [0.6274]
```
testing restriction that coefficients on CV and lags in DPR equation are jointly zero

Diagnostics on the model

```
DPS   :Portmanteau  4 lags=  0.41377
DPR   :Portmanteau  4 lags=   2.4895
DPS   :AR 1- 2 F( 2, 11) =    0.16838 [0.8472]
DPR   :AR 1- 2 F( 2, 11) =   0.015746 [0.9844]
DPS   :Normality Chi^2(2)=     3.9545 [0.1384]
DPR   :Normality Chi^2(2)=     2.1637 [0.3390]
DPS   :ARCH 2  F( 2,  9) =    0.23898 [0.7923]
DPR   :ARCH 2  F( 2,  9) =    0.18445 [0.8346]
Vector portmanteau  4 lags=   9.1144
Vector AR 1-2  F( 8, 16) =    0.12076 [0.9975]
Vector normality Chi^2( 4)=    6.1077 [0.1912]
```

short-run equations for saleyard prices, it is clear that the only variable (apart from seasonal effects) which appears to be of importance is quantity or the supply of pigmeat. Thus if imports are to have an effect it will be important only to the extent that those imports represent a more significant proportion of total pigmeat supply. It also seems clear that if we want to model the market more carefully, the cost of production should be included in the model. At the moment this appears to be a gaping omission. What our results cannot say is what would be the effects of further and higher levels of pigmeat imports on the market, to the extent that they would represent a more substantial increase in supply they would on the basis of our results depress saleyard prices, but whether they depress them substantially would depend on volume.

5.5 Conclusions

Our results suggest that there is some evidence of a stable long-run relationship between the four domestic variables considered. Support for this statement comes from two testing procedures, Johansen estimation and FM-OLS estimation. There appears to be no role for import volumes in this relationship. In our short-run model there is no significant evidence for a role for imports in the equation for the domestic saleyard price. Indeed, of the variables modelled the only influence on the dynamics of the pigmeat saleyard price was the dynamics of production with a sensible negative sign. Our conclusions therefore are:

- We find no evidence that imported pigmeat has substantially affected the long-run relationships in the domestic pigmeat market.
- We find no statistically significant role for the dynamics of imported pigmeat volumes in our short-run model of the variables.
- It would seem that import quantities could have a significant role on the saleyard price of pigmeat if those quantities became substantial in that it is clear that the quantity of pigmeat supplied to the market is a major factor determining saleyard price.

CHAPTER 6

CONCLUSION

This report has examined the impact of imports on the Australian pig and pigmeat industries in a time series framework. Time series modelling requires the data generating processes of the series and /or the structural relationships described by the model to be invariant with respect to time. As the quarterly series available for modelling the domestic pigmeat market were seasonally unadjusted, tests for the presence of seasonal unit roots in the data were undertaken. Failure to take into considerations the effects of seasonal fluctuations could generate spurious results and misleading inferences.

To examine the demand and supply relationship in the domestic pigmeat market, appropriate econometric techniques were used to test for the existence of a linear long-run relationship. A simple model specification based on past studies was used to allow for some degree of comparability. The four variables considered in the vector autoregressive (VAR) model were the saleyard prices of baconer (PS) and beef (BS), production of pigmeat (PP) and retail price of pigmeat (PR). Using the Johansen estimation method, a linear long-run cointegrating relationship was found between these four variables over the period 1985:2 to 1998:2. This result is further supported by the FM-OLS estimation. As the imports of Canadian pigmeat commenced only in 1990:3, estimation of a VAR(3) model using the post-1990 data would encounter the problem of insufficient degrees of freedom. Hence, the effects of imports in the early 1990s that led to evidence of instability in the estimated long-run relationship were examined. The results indicate that the imported pigmeat have no statistically significant effects on both the long-run and short-run relationships of the estimated models. Of the variables modelled in the short-run, the only influence on the dynamics of saleyard prices was the dynamics of domestic production, which has a sensible negative sign.

Whilst the above results are the findings of our econometric investigation we feel that a number of caveats are in order:

- Firstly, we are unhappy about the theoretical specification of the model we have estimated, what we have is the result of the data limitations we encountered in the study. We feel that if the Commission and the Industry want to model the saleyard price of pigmeat in Australia, a key issue for the future would be the establishment of a database which would allow modelling using a reasonable theoretical framework. In this context a clear lack is that of data on the costs of production.
- Secondly, whilst we find no statistically significant effect on the pigmeat industry due to imports, we feel that the issue of significance the Commission is considering is probably different to statistical significance. Econometrically an effect could be found to be statistically significant but of small magnitude, and it is clear that such distinctions should be borne in mind by the commission.
- Thirdly, it is also clear that most of the action in the data is at the end of the sample. This places severe restrictions on the econometric models ability to make sensible statements about the effects of the changes occurring in the market. Our tests for structural stability (the Hansen 1992 tests) must, for theoretical reasons[3] be based on a trimmed sample. In implementing the test we could not calculate the test statistic using the first 15 or last 15 per cent of the sample. Whilst we believe this is a better procedure than carrying out tests which are biased by arbitrary selection of the breakpoint they are clearly, nevertheless, limited in their applicability here. More generally, it is our view that, at this stage the econometrics must remain somewhat agnostic about the events at the end of the sample. Whilst they are not entirely without precedent in the data, it is, we feel, impossible to say whether they represent temporary aberration or a significant shift in the data generation process.

Given that the domestic supply of pigmeat is a major factor determining the saleyard price of pigmeat, it would seem reasonable to assume that imports could have a significant role only if the volume of their increase is substantial. However, it has been

[3] Including the end points of the data sample would cause the test statistic to diverge to infinity, Anderson and Darlin (1952), Andrews (1990).

noted that the Canadian imports comprise a relatively small fraction of the overall pigmeat market, with the most significant impact on the industry being felt in the ham and smallgoods market. Furthermore, Australia has been a net exporter of pigmeat over the 1990s with the exception of 1996/97 (prior to the current price slump). It is likely that the lags between the issuing of contracts and the arrival of imported products may have led to the over supply of pigmeat in certain quarters, which in turn, affect the pigmeat prices.

A review of the pigmeat industry indicated that there does not appear to be an over supply of domestic produce compared with past 5-6 years. Given the stable consumption patterns for pork, it seems likely that substitute prices have had a large effect on pork prices, and our test results also indicated that the saleyard price of beef has a negative long-run effect on the saleyard price of pigmeat. On the basis of our data analysis, it would seem that it is the domestic conditions rather than the imports that affect the saleyard price of pigmeat in Australia. However, it is important to bear in mind that the conventional time series regression might not be able to capture the dynamics of imports on the saleyard prices due to the seasonal fluctuations, small sample size and the abnormal price fall occurred at the end of the sample.

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