The effect of imports on the Australian pig industry*

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Abstract

In 1990 the Australian Government relaxed restrictions on the importation of pigmeat from Canada. In response to declining producer prices and their consequent effect on profitability, the Australian pig industry raised concerns with the Australian Government that the decline in producer price was due to lower priced imports from Canada and this was seriously injuring the industry. This paper attempts to identify the factors affecting changes in the market equilibrium of the pig industry in Australia. The results suggest that prior to 1990 pig producer prices were relatively stable and producers could be confident of being able to predict market movements. After 1990 there is a structural break which has induced volatility in pig producer prices, not only making producer decisions more difficult, but removing any long-run equilibrium relationship. Unlike previous studies, this report has found a statistically significant relationship between import volumes and import prices and domestic production and domestic prices at all levels of the marketing chain. The results indicate that import volumes and prices depress producer and retail prices. Producer prices seem to be more affected than retail prices, indicative of an asymmetric price transmission effect. The increasing marketing margin suggests that the benefits of trade liberalisation, resulting from a reduction in consumer price, have been captured by one particular interest group and not spread throughout the economy.

Keywords: Trade Liberalisation, Market Power, Seasonal Unit Roots, Autoregressive Distributed Lag Models, Vector Error Correction Models.

JEL Classification: C22, C32, L22, Q11, Q17

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1. Introduction

In response to declining producer prices from late 1997 and their consequent effect on profitability, the Australian pig industry raised concerns with the Australian Government that the decline in producer price was due to lower priced imports from Canada and this was seriously injuring the industry. A Productivity Commission inquiry into the effects of imports on the Australian pig industry was set up in June 1998 with a view to determining whether Safeguard provisions of the Agreement on Safeguards and Article XIX of the General Agreement on Tariffs and Trade (GATT) 1994 [10] could be imposed on imports. In November 1998 the Productivity Commission made a finding that imports were seriously injuring the industry and that a temporary tariff was justified under WTO Safeguard rules although structural adjustment assistance was probably more beneficial to the industry [29].

Several submissions [32], [30], [8] to the Productivity Commission inquiry presented quantitative evidence in the form of econometric modelling, as an adjunct to the Commission's own commissioned research [12], [18]. This paper reports some of the central econometric modelling work from the Queensland Department of Primary Industries submission [32], [30] to the inquiry. The methodology presented in this paper is directly comparable with the research commissioned by the inquiry [12], [18]. The three reports form a useful comparison of the methodology under different assumptions of market structure and show that the underlying assumptions are critical in identifying whether imports have had an effect on the Australian pig industry.

After presenting a brief history of the Australian pig industry under trade liberalisation in Section 2 this paper presents a model of the Australian pig industry which takes into consideration the dynamic interactions between prices and production as the market equilibrium shifts over time. A Vector Error Correction (VEC) model is an appropriate methodology to use to investigate these effects as it allows short-run shifts in prices and quantities to be modelled alongside long-run convergence to market equilibrium in a dynamic, simultaneous setting.

In attempting to estimate the effect of imports on the domestic market equilibrium of the Australian pig industry there is a question as to what is the appropriate market structure to model. Whereas it is expected that domestic market prices and quantities will have simultaneous feedback effects on each other, that is, they are endogenously determined, whether cattle prices and imports are endogenous or exogenous is another matter. Exogeneity tests carried out by the Institute for Research into International Competitiveness (IRIC) [18] suggest that producer and retail prices are endogenous but domestic production, import prices and volumes and cattle prices are all weakly exogenous. A priori the expectation is that import volumes and prices and cattle prices are exogenous but the finding that domestic production is also exogenous is puzzling. A possible explanation for this is the highly inelastic nature of production in the short run which results in production being erroneously identified as exogenous. In due consideration of the different types of market structure and their possible effects on model outcomes three different models are constructed. In Section 3 the first model treats domestic producer and retail pig prices, domestic production and cattle prices as being endogenously determined with imports as exogenously determined in a deterministic seasonal pattern. The long-run equilibrium of the market in an error correction framework is estimated using Johansen's maximum likelihood test for cointegration before the VEC model is estimated and impulse response functions calculated. In Section 4 the second model assumes imports are exogenously determined in a stochastic, non-stationary manner. In Section 5 the third model assumes that both cattle prices and imports are treated as non-stationary exogenous variables. Finally, Section 6 contrasts the modelling results with those obtained from the research commissioned by the Productivity Commission.

2. Background

In 1990 the Australian Government relaxed restrictions on the importation of pigmeat from Canada. In response to a downward trend in prices, the pig industry made representations to the Australian Customs Service (ACS) and the Anti-Dumping Authority (ADA) to initiate anti-dumping and countervailing (ADCV) proceedings against the Canadian pig industry [7]. A 1992 ACS inquiry that concluded that frozen pork exports from Canada had not caused and did not threaten material injury to the Australian industry. Accordingly there was not sufficient grounds for an ADCV notice.

The ADA report concentrated on the issue of dumping or subsidisation of Canadian pigmeat, which relies on a narrow (but technically correct) definition of dumping - that the product under investigation is offered at a lower price in the foreign country than in the domestic country. This narrow definition ignores the heterogeneity of most agricultural produce and assumes that there is no cross subsidisation between joint products. At issue is the different elasticities of demand for different components of the pig carcass across countries. In North America and Asia (for example Japan, Taiwan and Korea - significant export markets for Canadian and US pigmeat), there is considerable value placed on the forepart of the pig - especially pork bellies - whereas a much lesser value is placed on the hinds of the pig - the legs. As such, with consumer demand being for pork bellies, and the joint product nature of pig production, there is an oversupply of hinds leading to a lower price for hinds compared with fronts. In contrast, Australian consumers place a much higher value on legs than on pork bellies and thus there is a natural arbitrage for exports of hinds into the Australian market. Any determination of dumping will conclude in the negative as hinds are offered at a lower price in both markets. In essence, hinds are dumped in both markets due to the higher valued pork bellies inducing producers to increase production to cater for that segment of the market. The cross-subsidisation between pork bellies and hinds due to the jointness of production makes it profitable for producers to sell hinds at a much lower, if not below cost level in both markets. Despite the negative findings of the ADA report, the pig industry continued to believe that a contributing factor of declining prices, declining profitability, and closing of piggeries and processing plants was the imports of Canadian pigmeat. Accordingly, in 1995 the Federal Primary Industries Minister agreed to refer the matter to the Industry Commission. The report handed down by the Industry Commission [17] after extensive consultation with interested parties had several main conclusions:

1. Imports of pigmeat formed only a small fraction of total supply on the domestic market and, as such, were unlikely to influence the demand and supply equilibrium.

2. Economic analysis by ABARE [1], using their Econometric Model of Australian Broadacre Agriculture (EMABA), and the New South Wales Government [11], using Granger Causality, found little support for the contention that imports had an effect on saleyard, or farmgate, pigmeat prices.

3. Increasing feed grain costs due to drought, declining beef prices and increasing domestic supply were plausible explanations for declining profitability and prices rather than imports.

4. Economy-wide trade liberalisation under GATT-WTO will bring long-term benefits to the economy which will more than offset the declining fortunes of the pig industry.

The Commission relied heavily on the results of the econometric modelling work carried out by ABARE [1] and the NSW Government [11] in reaching its conclusions. As both Purcell and Harrison [32] and the Institute for Research into International Competitiveness (IRIC) [18] show, the methodological basis for such results are dubious as they failed to take into consideration non-stationarity of the data and seasonal effects.

In November 1997 the Australian Government relaxed the import protocols on the importation of processed pigmeat from Canada (previously only fresh, frozen pigmeat destined for manufacturing could be imported) and broadened the former protocol arrangements to include imports from Denmark. At the same time a reduction in exports and an increase in imports to capture the lucrative Christmas ham market resulted in a processor oversupply which saw slaughtering demand reduced with a consequent plummet in producer prices. Renewed calls from producers for protection against "unfair imports" again prompted the Australian Government to institute an inquiry into the effect of imports. In June 1998 a Productivity Commission inquiry was set up to determine whether Safeguard provisions of the GATT could be imposed on imports and in November made a finding that imports were seriously injuring the industry.

3. A VEC model of the Australian pig industry

In modelling relationships between variables such as prices and quantities over time one usually finds that the relationship is confounded by short-run deviations from the long-run equilibrium. The non-stationarity of prices, of which inflationary effects are one example, results in non-robust estimates of the relationships unless such non-stationarity is taken into consideration.

Seasonal unit root tests undertaken by Purcell and Harrison [32] suggest that prior to 1990 producer prices were stationary but the introduction of imports resulted in a structural break with producer prices becoming non-stationary. The dataset of Purcell and Harrison is again used in this analysis. The results of the unit root tests in Table 3.1 suggest that prior to the commencement of imports the saleyard price for baconers, or the producer price for pigs, was stationary and the other variables of interest were non-stationary. In this situation a Vector Error Correction (VEC) model framework, which incorporates an ECM, would be appropriate.

As a fist step the lag length of the VEC model needs to be determined. An unrestricted VAR was estimated over the period 1984:3 to 1997:2 which regressed the endogenous variables (SPQ, SBFQ, RPQ, and PPDQ), exogenous variables (CAMVQ and CAMPQ, an intercept, a time trend, and the 1^{st} to 3^{rd} seasonal dummies) for a maximum of eight lags due to data constraints. The Akaike Information Criterion (AIC) [4] and Schwarz Bayesian Criterion (SBC) [33] for different lag lengths were calculated and both the AIC and SBC suggested that a lag length of one was appropriate (Figure 3.1). The AIC gradient is relatively flat between one and five lags,

Table 3.1: Pig industry dataset and unit root tests

Variables	<1990Q1 $SI_s(d,D)$	>1990Q1 $SI_s(d,D)$	Deterministic seasonality
Saleyard price for baconers (¢/kg) (SPQ)[2]	$I(0)$	$I(1)$	$Q_t^1, Q_t^2, Q_t^3, Q_t^4$
Saleyard price for beef cattle (¢/kg) (SBFQ)[2]	$I(1)$	$I(1)$	
Retail price for pork (¢/kg) (RPQ)[2]	$I(1)$	$I(1)$	
Imports of pigmeat from Canada (kg) (CAMVQ)[6]	NA	$SI_4(0,1)$	
Price of imports from Canada (¢/kg) (CAMPQ)[6]	NA	$SI_4(0,1)$	
Domestic production of pigmeat (kg) (PPDQ)[5]	$I(1)$	$I(1)$	Q_t^1, Q_t^2

suggesting that any test for significant difference would conclude that there was no difference between the lag lengths[1]. The AIC generally selects the least parsimonious model whereas the SBC generally selects the most parsimonious model. Pesaran and Pesaran [26, p. 354] suggest that the SBC is a consistent criterion, in that for a large enough sample size it will lead to the correct model choice. Because the AIC over parameterizes the model and the SBC may under parameterize the model in small samples, the appropriate lag length appears to be two lags[2].

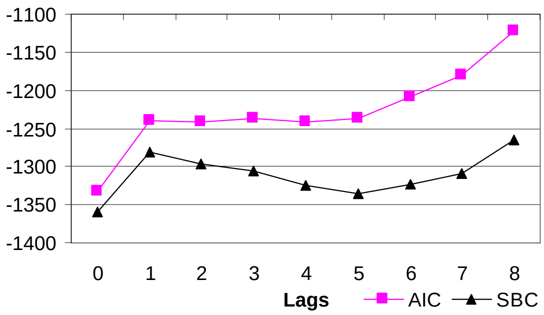


Figure 3.1: Lag length selection

The Johansen maximum-likelihood test for cointegration [19], [20] is carried out on a VAR(2) with unrestricted intercepts and trends. The $I(1)$ variables are SPQ, SBFQ, RPQ, PPDQ and the $I(0)$ variables are CAMVQ and CAMPQ along with the 1^{st} to 3^{rd} seasonal dummies. The time frame is 1984:3 to 1997:2. The results indicate that the hypothesis of two cointegrating vectors is not rejected (Table 3.2 and 3.3). The likelihood ratio test for the trace of the stochastic matrix suggests that only one cointegrating vector exists, but both the SBC and Hannan-Quinn Criterion (HQC) [13] (not reported) confirm the result of the likelihood ratio test for the maximal eigenvalue of the stochastic matrix that two cointegrating vectors exist. Likelihood

[1] IRIC [18], in analysing the same dataset, conducted a system reduction starting from a maximum of five lags and reducing down to a more parsimonious system based on F-tests of the deleted lags. With such a flat AIC gradient such a general-to-specific approach would result in an overspecificed model structure.

[2] IRIC [18] also carried out lag length tests on their VEC model of the pig industry market equilibrium, but only relied on the AIC estimates which over parameterised their model and consequently diluted the significant effects across their variables.

Ratio tests of restricting the cointegrating vector indicate that none of the variables can be eliminated from the cointegrating vectors, suggesting that all the variables play a significant role in the determination of the long-run equilibrium.

Table 3.2: Results of the Johansen ML test for cointegration, Model 1

H_0	H_1	Max-Eigenvalue	$\text{LR}_{Crit,0.05}$	Trace	$\text{LR}_{Crit,0.05}$
$r=0$	$r=1$	32.0006	31.0000	64.0025	58.9300
$r\leq 1$	$r=2$	24.5079	24.3500	31.9699	39.3300
$r\leq 2$	$r=3$	6.5702	18.3300	7.4492	23.8300
$r\leq 3$	$r=4$	0.86690	11.5400	0.90834	11.5400

Table 3.3: Cointegrating vectors for VEC Model 1

CI vector	SPQ	$SBFQ$	RPQ	$PPDQ$
β_1	0.26541×10^{-2}	-0.014617	-0.3579×10^{-3}	0.9749×10^{-7}
β_2	0.026606	-0.54977×10^{-2}	-0.78578×10^{-2}	0.5483×10^{-7}
$\tilde{\beta}_1$	-1.0000	5.5075	0.13486	-0.3673×10^{-4}
$\tilde{\beta}_2$	-1.0000	0.20663	0.29534	-0.2061×10^{-5}

CI matrix $= [\beta_1, \beta_2]$, Normalised CI matrix $= \left[\tilde{\beta}_1, \tilde{\beta}_2\right]$

Inder [16, p. 12] notes the large coefficient for domestic production in the first cointegrating vector $\left(-0.3673\times 10^{-4}\right)$, suggesting that this indicates that for every 1000 tonnes increase in production, producer price decreases by around $37¢/kg$. This is not correct, as the negative sign on the normalised producer price coefficient results in the coefficient for domestic production becoming positive when compared with producer prices. However, the magnitude of the effect is indeed puzzling, given the rather small effects shown in the comparable ADL models. It is difficult to attach an economic interpretation to individual coefficients when you have multiple cointegrating vectors in a multi-dimensional system. In a panel discussion on this topic David Hendry

> "...expressed concern at people seeing how many cointegrating vectors they came up with and then trying to interpret them. He felt that you should have a good idea as to how many cointegrating vectors you anticipate and what they should look like and then check that your findings are consistent with this."[14, p. 4].

Assuming that the model structure is correctly specified, vis-a-vis lag length and appropriate treatment of variables, one possible explanation is that the existence of two cointegrating vectors identifies multiple long-run data generating processes (DGPs) (possibly out of phase with each other) and thus the large coefficient for one of the cointegrating vectors is balanced by the smaller coefficient for the other cointegrating vector. Inder [16, p. 12] also suggested that a change in the lag length or model structure may change the ECM results. This is certainly possible, but brings into play the obvious question as to which is correct model structure. Increasing the lag length to three quarters results in the coefficient for production in the resulting single ECM becoming -0.1971×10^{-4}, relative to a normalised coefficient for producer prices of 1.0, indicating that producer prices fall by around 20¢/kg for every 1000 tonnes increase in production.

Changing the model structure has more substantial effects; allowing imports to be $I(1)$ exogenous (still with 3 lags in the model structure) results in the coefficient for production in the resulting single ECM becoming -0.6105×10^{-5}, indicating that for every 1000 tonnes increase in production producer prices fall by 6¢/kg. This result is comparable with the results of Purcell and Harrison [32], given that imports are treated as $I(1)$ exogenous in the Autoregressive Distributed Lag (ADL) framework used in that paper.

HEGY tests [15] for seasonal unit roots carried out by the Institute for Research into International Competitiveness (IRIC) [18] indicate that import volumes and prices have a semi-annual unit root, $SI_2(0,1)$, whereas the DHF tests [9] for seasonal unit roots carried out by Purcell and Harrison [32] suggest that imports are seasonally integrated, $SI_4(0,1)$. IRIC treated imports as $I(1)$ exogenous in their VEC models and therefore the question is whether imports should be treated as $I(1)$ exogenous or $SI_4(0,1)$ (proxied by $I(0)$ with deterministic seasonal dummies). Including the import variables as $SI_n(0,1)$ is more appropriate than treating them as $I(1)$ or $I(0)$, but leads to a loss in degrees of freedom and long-run information and therefore treating the variables as $I(0)$ with seasonal dummy variables is a second-best solution in the presence of a restricted dataset. In other words, it was explicitly assumed that the stochastic seasonality could be approximated by deterministic seasonality. Osborn and Rodrigues [22] show that the DHF test is asymptotically equivalent to the HEGY test and therefore the only question as to which test for seasonal integration to use is which one is more robust under small sample sizes. Whereas the HEGY test requires the estimation of coefficients for each seasonal unit root under investigation and a corresponding reduction in the degrees of freedom, the DHF test only requires one coefficient to be estimated for the particular seasonal differencing under examination and thus a substantially less reduction in degrees of freedom. A priori imports would be expected to have a seasonal unit root, as opposed to a semi-annual unit root, since examination of the data series indicates a seasonal pattern to imports designed to capture the lucrative Christmas ham market.

In consideration of the Johansen tests for cointegration above, a VEC(2,2) model[3] is estimated which is presented in Tables 3.4 and 3.5[4].

The results in Tables 3.4 and 3.5 suggest that over the period 1984:3 to 1997:2 changes in the saleyard price for baconers was significantly affected by import volumes. For every 1000 tonnes of imports of pigmeat from Canada the saleyard price for baconers dropped by $10.78 \pm 4.697¢/kg$ this is within the range of values estimated by Purcell and Harrison [31] from ADL models[5].

[3] That is, 2 lags with 2 ECMs.

[4] Lagrange Multiplier F-tests indicated that none of the equations exibited significant heteroscedasticity or serial correlation.

[5] One of the criticisms leveled at the results of our previous report [31] was that we failed to take into consideration the effect of exports on the data generating process and in so doing may have biased the results. The reason for this omission is that adequate export data that shows the division of exports into farmed and feral pigmeat in not available for Commerical-in-Confidence reasons. We re-estimated the VEC model (results not reported) incorporating export volumes and unit values. The results indicate that saleyard prices for baconers are depressed by $13.74 \pm 9.285¢/kg$ for every 1000 tonnes of imports. This is compable with the $10.78 \pm 4.697¢/kg$ result estimated in Table 3.4 and the $13.42 \pm 6.094¢/kg$ result in the wholesale price VEC model estimated by Purcell and Harrison [32, p. 167]. The p-value for the import volume coefficient in the VEC model incorporating exports is 0.157, indicating that the probability of a Type I error for a one tailed test is borderline significant at

Table 3.4: VEC representation for pig industry market equilibrium, Model 1

Coefficients	ΔSPQ_t		ΔRPQ_t	
	$\hat{\beta}_i$	S_{β_i}	$\hat{\beta}_i$	S_{β_i}
α_0	-78.0800	51.0063 [0.134]	-74.8367	33.3079 [0.030]
ΔSPQ_t	0.18479	0.23148 [0.430]	0.061371	0.15116 [0.687]
ΔRPQ_t	0.078242	0.21438 [0.717]	-0.30998	0.1400 [0.033]
$\Delta SBFQ_t$	0.17626	0.14339 [0.226]	0.33953	0.093636 [0.001]
$\Delta PPDQ_t$	-0.6644×10^{-6}	0.8671×10^{-6} [0.448]	-0.6689×10^{-6}	0.5663×10^{-6} [0.245]
$CAMVQ_t$	-0.1078×10^{-4}	0.4697×10^{-5} [0.027]	-0.5324×10^{-5}	0.3067×10^{-5} [0.090]
$CAMPQ_t$	0.012735	0.019841 [0.525]	-0.0032767	0.012956 [0.802]
T	-0.67795	0.46852 [0.156]	-0.20531	0.30595 [0.506]
Q_t^1	-25.0232	4.8735 [0.000]	-6.4576	3.1825 [0.049]
Q_t^2	-14.3638	8.7211 [0.108]	-2.5518	5.6950 [0.657]
Q_t^3	8.0844	6.9339 [0.251]	7.7729	4.5279 [0.094]
ECM_{t-1}^1	-0.063532	0.026097 [0.020]	-0.0056527	0.017042 [0.742]
ECM_{t-1}^2	0.11316	0.26161 [0.668]	-0.62527	0.17083 [0.001]
R^2	0.75276		0.67481	

Table 3.5: VEC representation for pig industry market equilibrium, Model 1

Coefficients	$\Delta SBFQ_t$		$\Delta PPDQ_t$	
	$\hat{\beta}_i$	S_{β_i}	$\hat{\beta}_i$	S_{β_i}
α_0	-141.5357	61.4323 [0.027]	3.23×10^7	1.07×10^7 [0.005]
ΔSPQ_t	-0.54372	0.27880 [0.058]	-88179.5	48708.5 [0.078]
ΔRPQ_t	-0.092445	0.25820 [0.722]	-41399.8	45110.8 [0.364]
$\Delta SBFQ_t$	0.12427	0.17270 [0.476]	-66516.5	30172.6 [0.033]
$\Delta PPDQ_t$	-0.8044×10^{-6}	0.1044×10^{-5} [0.446]	-0.022389	0.18247 [0.903]
$CAMVQ_t$	-0.4863×10^{-5}	0.5657×10^{-5} [0.395]	1.8933	0.98825 [0.063]
$CAMPQ_t$	0.026511	0.023896 [0.274]	-4105.2	4174.9 [0.332]
T	-1.3565	0.56429 [0.021]	239310.1	98586.4 [0.020]
Q_t^1	-2.0305	5.8697 [0.731]	-5411762	1025500 [0.000]
Q_t^2	7.0393	10.5037 [0.507]	1317273	1835099 [0.477]
Q_t^3	7.5987	8.3512 [0.368]	-983720.7	1459044 [0.504]
ECM_{t-1}^1	-0.057727	0.031431 [0.074]	20120.4	5191.4 [0.001]
ECM_{t-1}^2	-0.48608	0.31508 [0.131]	-13670.4	55047.6 [0.805]
R^2	0.33165		0.88703	

The saleyard price for beef cattle exhibits a significant downward trend (each quarter sees the price for cattle drop by around $1.36 \pm 0.56¢/kg$) and every \$1.00 increase in the saleyard price for baconers drops the saleyard price for cattle by around $\$0.54 \pm 0.28/kg$.

The retail price for pork is significantly influenced by the saleyard price for cattle where every \$1.00 increase in cattle prices results in around a $\$0.34 \pm 0.09/kg$ increase in the retail price for pork. This implies that retailers conduct spatial price averaging, as the increase in cattle prices flows onto increases in retail prices for beef, leading to a substitution of consumer demand out of beef and into pork. The retail price is also influenced by import volumes; every 1000 tonnes of imports of pigmeat from Canada results in a drop in retail price of around $5.324 \pm 3.067¢/kg$. The asymmetric response of retail prices compared with producer prices suggests that retailers possess market power.

The production of pigmeat exhibits a significant upward trend, every quarter sees production increase by around 239 ± 99 tonnes. The increase in the saleyard price for baconers depresses production, each $1¢/kg$ increase in the saleyard price for baconers reduces production by around 88 ± 49 tonnes. As with the ADL model for production the negative relationship is an indication of the cobweb cycle impacting on producer decisions. The increase in the saleyard price for cattle likewise has a depressing effect, each $1¢/kg$ increase in the saleyard price for cattle reduces production by around 67 ± 30 tonnes. Increases in imports of pigmeat from Canada increase production by $1.9 \pm 0.99kg$ for every kg imported.

With producer prices decreasing more than retail prices the increased marketing margin brings into question the extent to which retailers through their market power are capturing the benefits of lower prices brought on by trade liberalisation. A similar scenario has been observed in both Canada and the United States with the present depression in producer prices not accompanied by a concomitant decline in retail prices (Table 3.6).

One of the advantages of a VEC framework is that the orthogonalisation of the residuals to eliminate contemporaneous correlations is that the individual equations can then be used for dynamic simulation and projection. For example, impulse response functions are used to answer the question as to what the likely change in x_t over time is if y_t changes by one unit at time t (effectively a shock to the error term in the equation for x_t). In addition to impulse response functions, forecast error variance decompositions, which partition the change in a particular variable into its component parts, and dynamic forecasts can be generated. The impulse response functions and forecast error variance decompositions generated from the orthogonalised variance-covariance matrix are order dependent (that is, dependent on the order of the variables within the VEC framework), and Koop et al [21] and Pesaran and Shin [28] suggest a generalised version which is not order dependent. The generalised impulse response functions and forecast error variance decompositions are presented in Figures 3.2 to 3.4.

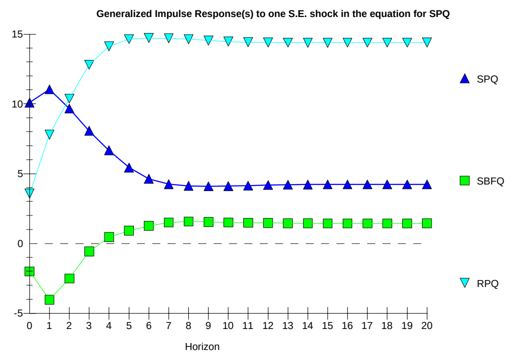
The impulse response functions for the variables in the VEC model (Figures 3.2 and 3.3) indicate that an exogenous shock to the system of equations causes a perma-

7.85%. Since the value of the coefficient is almost the same as that of the coefficient in the wholesale prices VEC model ($13.42 \pm 6.094¢/kg$), the implication is that including export volumes and values adds to the variability of the coefficients, rather than changing the value of the coefficient. The coefficients of the export volume and value variables are not significant (p=0.797,0.740 respectively) indicating that deleting them from the model will not change the results.

Table 3.6: United States farm to retail price spreads for pigmeat

		Dec – 97	*Oct* – 98	*Nov* – 98	*Dec* – 98
Hog prices	Barrows and gilt	40.50	26.91	17.66	14.00
($/cwt)	Iowa/S. Minn No. 1-3	39.85	26.98	17.80	14.00
	Sows	34.08	20.98	16.09	11.00
Wholesale prices	Pork cutout composite	57.76	48.18	42.09	37.50
($/cwt)	Loins, 14-19 lb.	79.44	99.63	79.90	70.25
	Bellies, 12-14 lb	47.52	42.05	39.13	35.75
	Hams, 23-27 lb.	*NA*	44.75	34.47	32.50
	Trimmings, 72% fresh	45.24	21.43	18.68	14.50
Retail prices	Pork	231.3	231.2	230.2	226.9
(¢/lb)	Bacon	266.5	257.6	256.7	261.9
	Chops	347.7	322.6	317.7	309.5
	Sausage	210.0	242.6	245.3	242.6
Spread	Farm to wholesale	38.0	45.3	49.1	56.5
(¢/retail lb)	Wholesale to retail	123.4	138.0	139.1	142.3
	Farmers share (%)	30.0	21.0	18.0	12.0

Source: USDA [34]



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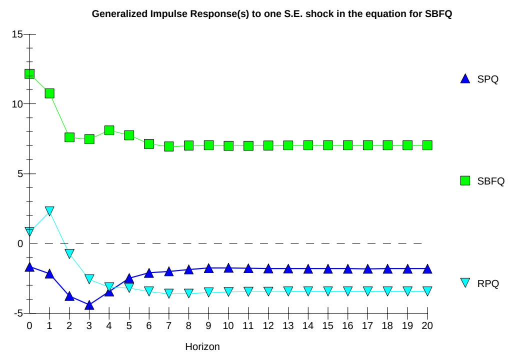

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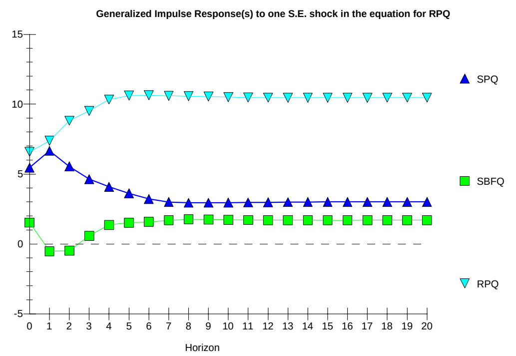

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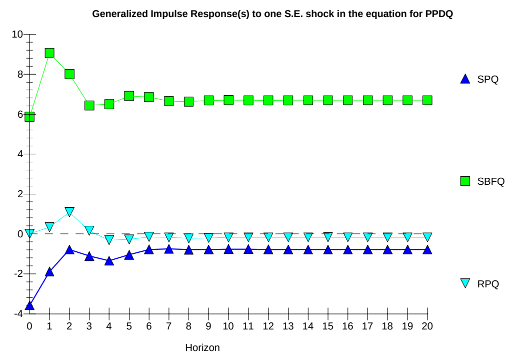
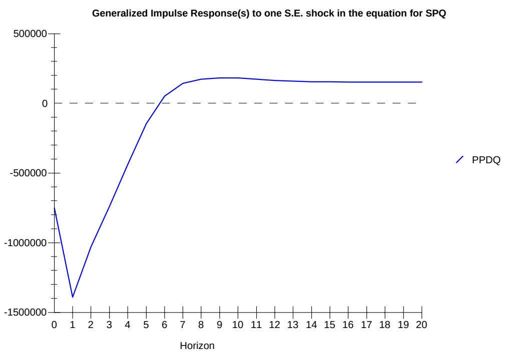
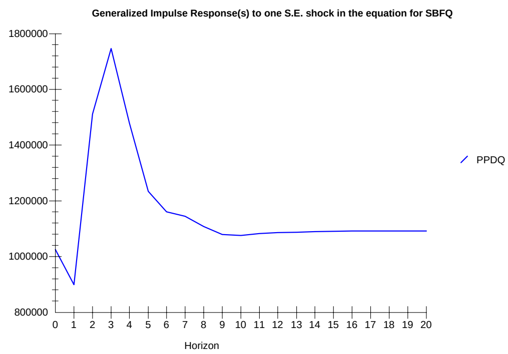


(*d*)

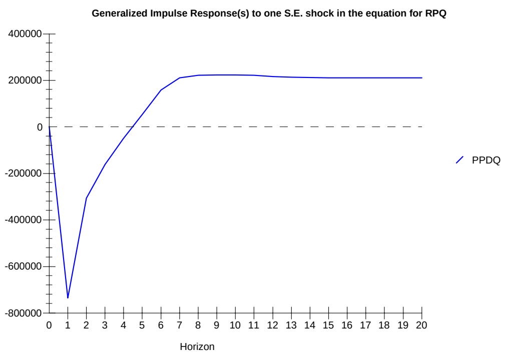
Figure 3.2: Generalised Impulse-Response Functions



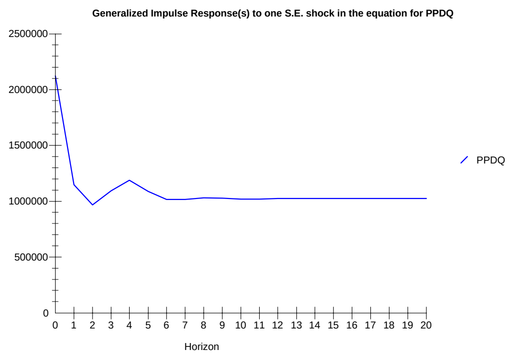
(a)



(b)



(c)



(d)

Figure 3.3: Generalised Impulse-Response Functions for production of pigmeat

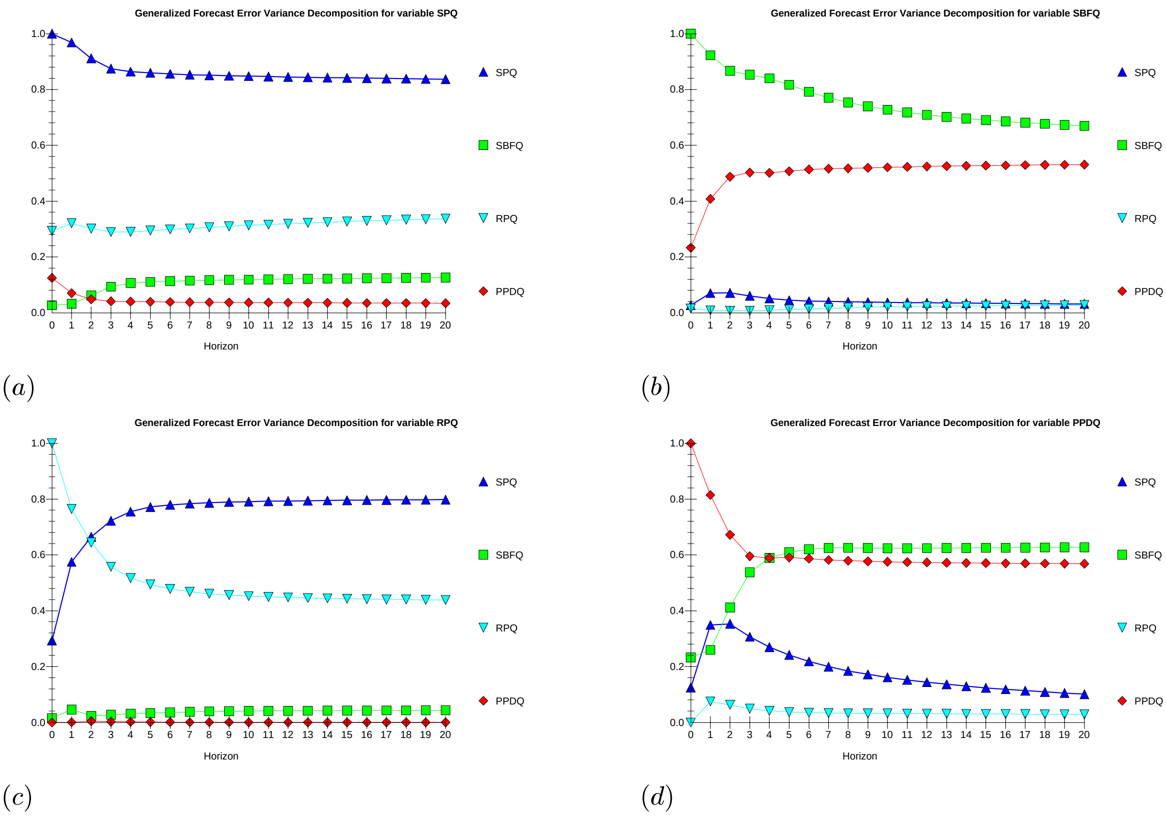


Figure 3.4: Generalised Forecast Error Variance Decompositions

nent effect. ABARE [1, 3] using simulations conducted on their Econometric Model of Australian Broadacre Agriculture (EMABA) suggested that any shock to the domestic market equilibrium due to imports would have temporary effects on prices and production and, in addition, would not have any lasting effects on the domestic market[6]. EMABA does not take into consideration short-run deviations from the long-run equilibrium (that is, it assumes that the variables are stationary) but the non-stationarity component of the variables means that a shock has a permanent effect resulting in the variables moving to a new equilibrium in the short-run. In a VEC framework the impulse response functions also have permanent effects, unlike the impulse response functions in a VAR framework, due to the rank deficiency of the long-run multiplier matrix, which results in the impulse-response functions having effects which do not die out over time.

The forecast error variance decompositions are shown in Figure 3.4. The relative importance of each variable to the variation in the variable under investigation in the long run (five years) is presented in Table 3.7[7].

Table 3.7: Generalised Forecast Error Variance Decompositions after 20 quarters

Variation in	SPQ	SBFQ	RPQ	PPDQ
SPQ	0.83706	0.12622	0.33740	0.034570
SBFQ	0.032258	0.67039	0.027423	0.53111
RPQ	0.79840	0.043593	0.43864	0.0004003
PPDQ	0.10145	0.62745	0.028979	0.56867

Due to the rank deficiency of the long-run multiplier matrix resulting in persistence effects for the impulse-response functions, a better indication of the convergence back to equilibrium of the individual equations in the VEC system is the impulse-response of the ECM component in the equation under investigation [26]. In addition, Pesaran and Shin [27] suggest that a better indication of the speed of convergence back to equilibrium for the system is the persistence profile of the cointegrating vectors. The impulse response functions of the error correction terms in the VEC model exhibit a slow return to equilibrium, taking around two years (eight quarters) after a shock to a particular variable (Figures 3.5(a-d)). For the system as a whole these ECMs seem to counterbalance each other and after a system wide shock the market returns to equilibrium in five quarters (Figure 3.5(e)).

Multivariate dynamic forecasts for the VEC model are reported in Figure 3.6. The forecasts indicate that although the model is a good fit to in-sample data the forecasts fail to predict movements in producer prices and production (See Table 3.8). The failure to predict movements in saleyard prices for cattle (See Figure 3.6(b)) is understandable, given that the data generating process for cattle prices would be exogenous to the VEC model. Given that the model predicts movements in retail prices reasonably well, the failure to predict movements in producer prices and production for pigmeat may be due to a structural break caused by the introduction of new import protocols in November 1997, an increase in seasonal imports and the reduction in

[6] Specifically, ABARE treated imports as having a pulse effect rather than a shift effect on the market equilibrium. In a modelling framework which assumes all variables as stationary a pulse shock will have a temporary effect whereas a shift shock will have a permanent effect. Conversely, in a modelling framework where the variables are treated as non-stationary both a pulse and shift shock will have a permanent effect on the market equilibrium [23], [24], [25].

[7] The decompositions do not add up to 100% due to the feedback effects across equations.

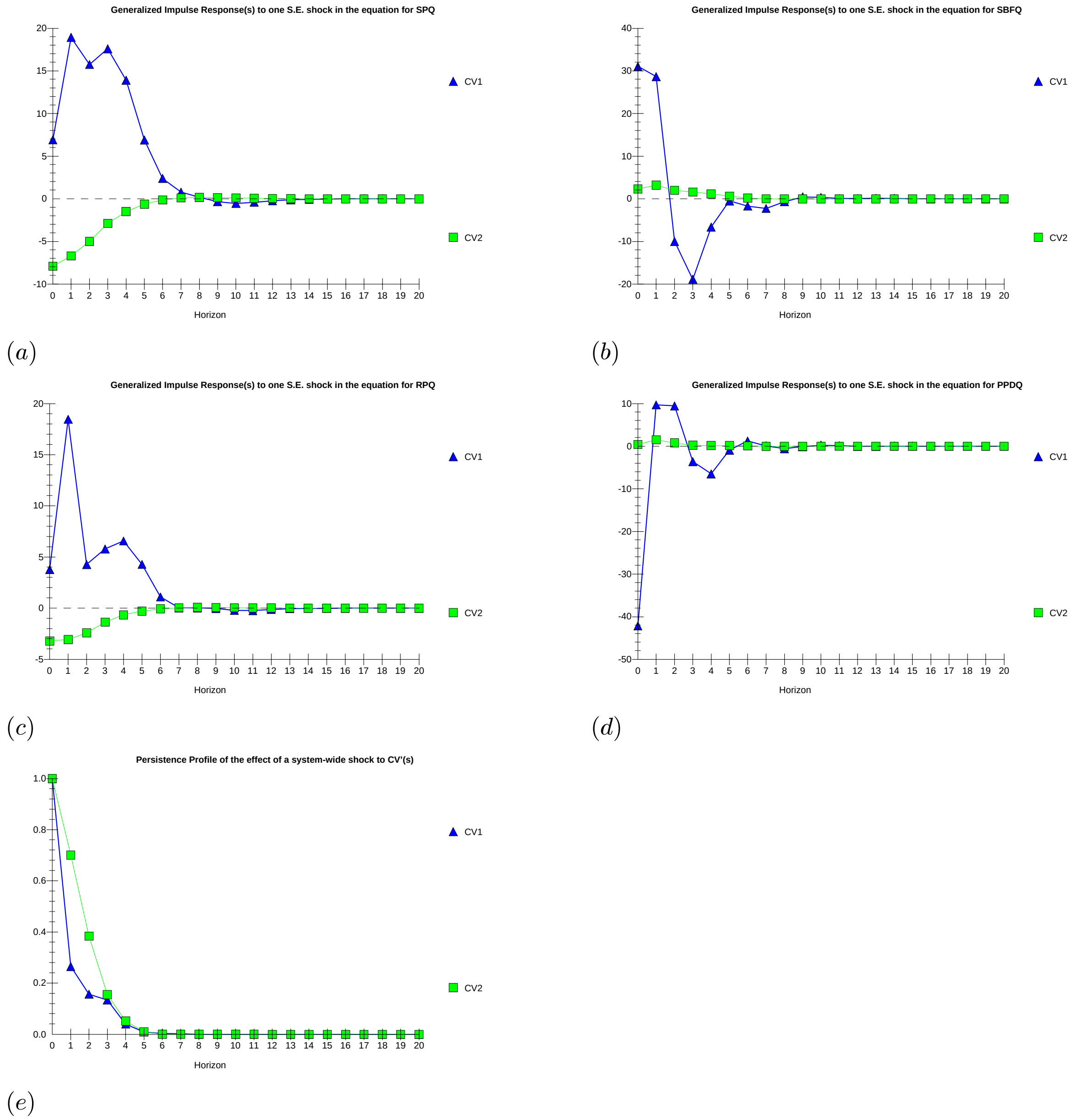


Figure 3.5: Impluse-Responses and Persistence Profile for Cointegrating Vectors

exports due to the Asian financial crisis at the same time . The actual producer prices for pigs in 1998:2 is 162.67¢$/kg$ compared with the forecast value of 206.024¢$/kg$. In order to see whether the model can predict future variations in variables, and to take into account the possibility that a structural break in 1997:4 has changed the DGP, the VEC model was re-estimated using data from 1984:3 to 1995:4 and forecasted ahead to 1998:2 (Figure 3.7). The results indicate that the model predicts reasonably well up to around 4 quarters ahead but then the forecast accuracy breaks down after that. This is the general experience of forecasting models. The forecasts suggest that although the model's predictive ability starts to break down after a year, the forecasts for the VEC model (Figure 3.6) should predict reasonably well two to three quarters ahead. This implies that there could be a regime change which has impacted on the data-generating process and the fall in producer prices could well be due to the change in import protocol after November 1997, an increase in seasonal imports, or a reduction in exports at the same time.

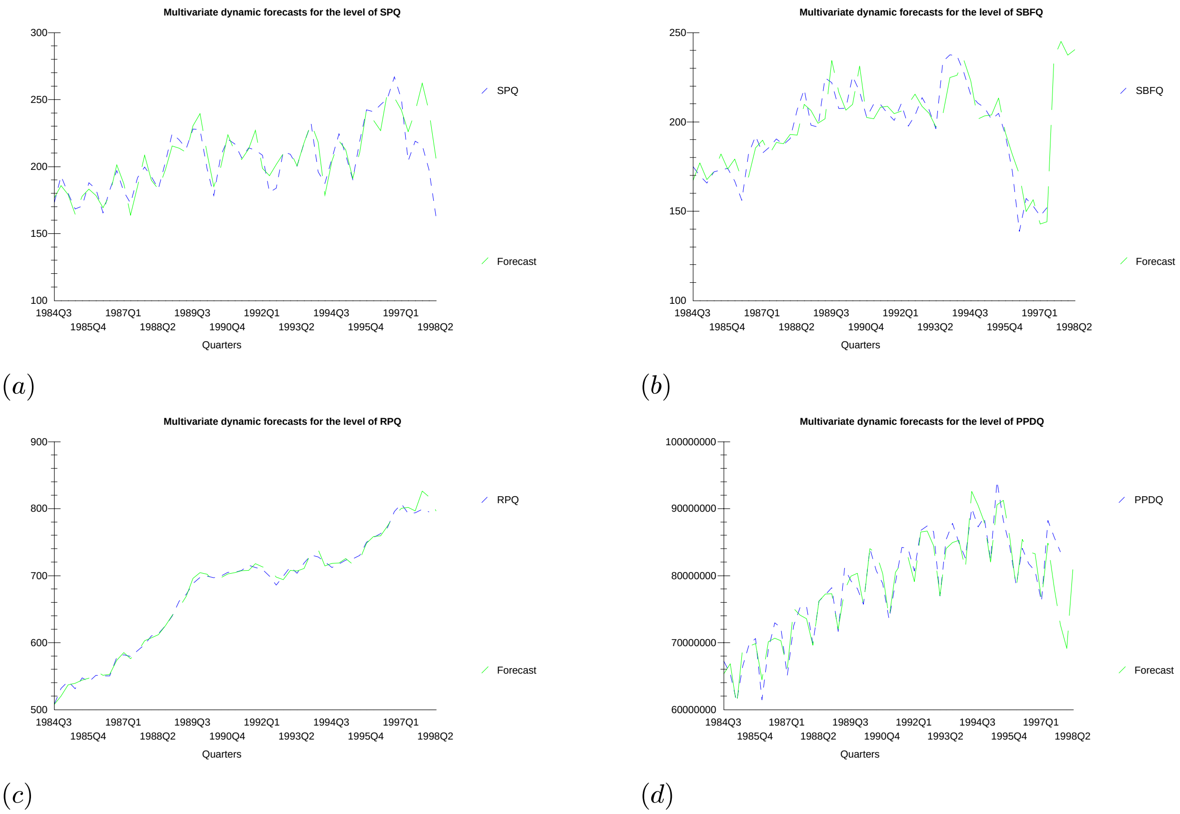


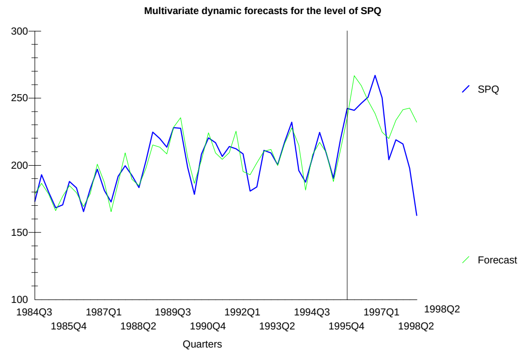
Figure 3.6: VEC model multivariate dynamic forecasts

4. Modelling imports as an exogenous non-stationary process

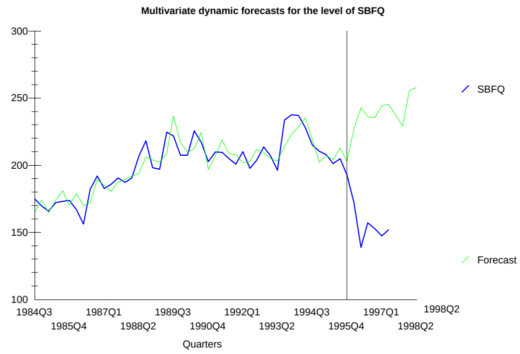
As mentioned above, there is a question of whether imports should be treated as $SI_4(0,1)$, $I(0)$ with deterministic seasonal dummies, or $I(1)$ with deterministic seasonal dummies. IRIC [18] in their modelling framework treated imports as being $I(1)$

Table 3.8: Multivariate dynamic forecasts Mean Square Errors

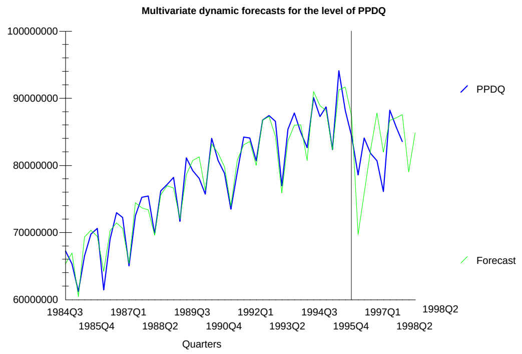
Variable	In-sample	Forecast
SPQ	72.4497	1604.6
$SBFQ$	105.2458	
RPQ	31.3456	424.3182
$PPDQ$	3.21×10^{12}	8.82×10^{12}



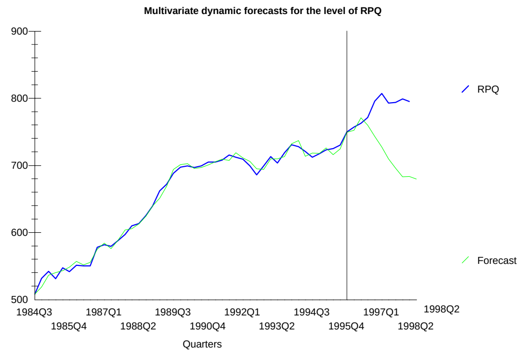
(A)



(B)



(C)



(D)

Figure 3.7: Multivariate dynamic forecasts for 1996:1 to 1998:2

exogenous whereas in the models above imports are treated as $I(0)$ exogenous. It is therefore of interest to see what the implications are of changing model structure.

The model chosen is a VEC model over the period 1984:3 to 1997:2 with unrestricted intercepts and trends, $I(1)$ endogenous variables (SPQ, SBFQ, RPQ, and PPDQ), $I(1)$ exogenous variables (CAMPQ and CAMVQ), and $I(0)$ exogenous variables (1^{st} to 3^{rd} seasonal dummies).

As a first step the lag length of the model needs to be determined (Figure 4.1). The lag length is determined from an unrestricted VAR(6) of the model above with an explicit constant and time trend. The results of this model formulation are not substantially different from the original model formulation where imports were treated as exogenous in the VEC framework. The SBC selects a model with a lag length of one but the AIC has no maximum value over the range of lags considered. The AIC does flatten out over the range of one to three lags and thus on balance a lag of two is considered to be appropriate.

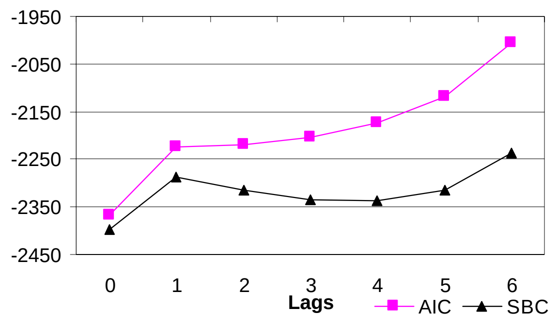


Figure 4.1: Lag length determination for VEC with I(1) exogenous imports

The Johansen test for cointegration presented in Table 4.1 gives conflicting results, with the Maximal Eigenvalue statistic indicating that there exists two cointegrating vectors but the Trace statistic indicating only one. The SBC and HQC (not reported) confirm the Maximal Eigenvalue statistic result that there exists two cointegrating vectors which are presented in Table 4.2.

Table 4.1: Results of the Johansen ML test for cointegration, Model 2

H_0:	H_1:	Max-Eigenvalue	$LR_{crit,0.05}$	Trace	$LR_{crit,0.05}$
$r = 0$	$r = 1$	43.2516	37.0800	91.0171	77.1400
$r \leq 1$	$r = 2$	34.7778	30.9200	47.7655	53.4800
$r \leq 2$	$r = 3$	10.5859	24.1800	12.9878	33.3900
$r \leq 3$	$r = 4$	2.4019	17.1400	2.4019	17.1400

The cointegrating vectors were restricted, with SPQ and SBFQ being set to their normalised values (Table 4.3). Likelihood ratio tests for restricting the cointegrating vectors indicate that for the first cointegrating vector neither import volumes nor prices play a role in determining the long-run equilibrium relationship. In the second cointegrating vector retail prices and import prices do not play a role but import volumes do.

Table 4.2: Cointegrating vectors for VEC Model 2

CI vector	SPQ	$SBFQ$	RPQ	$PPDQ$	$CAMVQ$	$CAMPQ$
β_1	0.020750	-0.0038475	-0.0069576	0.4834×10^{-7}	-0.3761×10^{-7}	-0.1016×10^{-3}
β_2	-0.0016206	-0.013518	-0.7979×10^{-4}	0.8482×10^{-7}	-0.2607×10^{-6}	0.2200×10^{-3}
$\hat{\beta}_1$	-1.0000	0.18542	0.33530	-0.2330×10^{-5}	0.1813×10^{-5}	0.0048984
$\hat{\beta}_2$	-1.0000	-8.3411	-0.049233	0.5234×10^{-4}	-0.1608×10^{-3}	0.13574

Table 4.3: Restricted Cointegrating Vector: Model 2

Variable	$\bar{\beta}_1$	$S_{\bar{\beta}_1}$[p-value]	$\bar{\beta}_2$	$S_{\bar{\beta}_2}$[p-value]
SPQ	1.0000	–	1.000	–
$SBFQ$	-0.18540	–	-8.3400	–
RPQ	-0.33530	0.047355[0.000]	-0.70306	0.69060[0.237]
$PPDQ$	0.2330×10^{-5}	–	0.5461×10^{-4}	0.7223×10^{-5}[0.000]
$CAMVQ$	-0.1812×10^{-5}	0.3566×10^{-5}[0.351]	-0.1574×10^{-3}	0.5314×10^{-4}[0.005]
$CAMPQ$	-0.0048987	0.011039[0.362]	0.12024	0.15990[0.301]

The final restricted cointegrating vectors, presented in Table 4.4 were used in the VEC model presented in Tables 4.5 to 4.6[8]. The results indicate that unlike the VEC model that treated imports as $I(0)$ exogenous, imports do not play a significant short-run role in producer price determination, although they do play a highly significant role in determining the long-run equilibrium price for producers. In this model specification short-run effects do not play a significant role for producer price formation, with all effects coming through seasonal effects and the ECM. Cattle price formation is poorly determined within this modelling framework, with only pig producer prices having a significant short-run effect. The R^2 for the cattle price equation is 0.32566, indicating that the model is a poor fit of the DGP for cattle prices, as expected.

Table 4.4: Final Restricted Cointegrating Vectors: Model 2

CI vector	$\hat{\beta}_1$	S_{β_1}	$\hat{\beta}_2$	S_{β_2}
SPQ	1.0000	–	1.0000	-
$SBFQ$	-0.18540	–	-8.3400	-
RPQ	-0.31888	0.042456	0.0000	-
$PPDQ$	0.2441×10^{-5}	–	0.5290×10^{-4}	0.6896×10^{-5}
$CAMVQ$	0.0000	–	-0.1357×10^{-3}	0.5130×10^{-4}
$CAMPQ$	0.0000	–	0.0000	-

Retail price formation is determined in the short run by changes in cattle prices, probably manifesting themselves in changes in beef prices which are not incorporated

[8] Lagrange Multiplier F-tests indicate that the model equations do not suffer from serial correlation or heteroscedasticity.

Table 4.5: VEC model results for pig industry: Model 2

	ΔSPQ		$\Delta SBFQ$	
Coefficients	$\hat{\beta}_i$	S_{β_i}[p-value]	$\hat{\beta}_i$	S_{β_i}[p-value]
α	-56.0345	40.9791[.179]	-113.1464	51.6083[.034]
T	-0.68795	0.29722[.026]	-0.90253	0.37431[.021]
ΔSPQ_{t-1}	0.18502	0.21375[.392]	-0.52785	0.26920[.057]
$\Delta SBFQ_{t-1}$	0.19941	0.13824[.157]	0.10998	0.17410[.531]
ΔRPQ_{t-1}	0.15707	0.20158[.441]	-0.12675	0.25387[.620]
$\Delta PPDQ_{t-1}$	-0.1042×10^{-5}	0.8487×10^{-6}[.227]	-0.5945×10^{-6}	0.1069×10^{-5}[.581]
$\Delta CAMVQ_{t-1}$	-0.6360×10^{-5}	0.4563×10^{-5}[.171]	0.3321×10^{-5}	0.5747×10^{-5}[.567]
$\Delta CAMPQ_{t-1}$	-0.0091874	0.029884[.760]	0.043339	0.037635[.257]
ECM^1_{t-1}	-0.33789	0.20806[.112]	0.34459	0.26202[.196]
ECM^2_{t-1}	0.050183	0.016670[.005]	0.032017	0.020994[.135]
Q^1_t	-22.0762	4.4169[.000]	0.42075	5.5625[.940]
Q^2_t	-20.4368	8.2968[.018]	5.5845	10.4488[.596]
Q^3_t	8.2257	6.5143[.214]	5.2860	8.2040[.523]
R^2	0.77185		0.32566	

Table 4.6: VEC model results for pig industry: Model 2

	ΔRPQ		$\Delta PPDQ$	
Coefficients	$\hat{\beta}_i$	S_{β_i}[p-value]	$\hat{\beta}_i$	S_{β_i}[p-value]
α	-92.6641	27.2372[.002]	2.75×10^7	8846985[.003]
T	-0.47582	0.19755[.021]	189310.5	64167.0[.005]
ΔSPQ_{t-1}	-0.045168	0.14207[.752]	-73689.8	46147.2[.118]
$\Delta SBFQ_{t-1}$	0.33097	0.091883[.001]	-76488.4	29844.7[.014]
ΔRPQ_{t-1}	-0.22001	0.13398[.109]	-41247.0	43519.4[.349]
$\Delta PPDQ_{t-1}$	-0.1108×10^{-5}	0.5641×10^{-6}[.057]	.0015328	0.18323[.993]
$\Delta CAMVQ_{t-1}$	-0.6880×10^{-5}	0.3033×10^{-5}[.029]	$-.38536$	0.98518[.698]
$\Delta CAMPQ_{t-1}$	0.0082475	0.019863[.680]	-8155.3	6451.7[.214]
ECM^1_{t-1}	0.66363	0.13829[.000]	45180.8	44917.7[.321]
ECM^2_{t-1}	0.0060234	0.011080[.590]	-14059.3	3598.9[.000]
Q^1_t	-6.7177	2.9357[.028]	-6087383	953559.0[.000]
Q^2_t	-5.3985	5.5145[.334]	2259500	1791195[.215]
Q^3_t	9.6973	4.3298[.031]	-506423.8	1406369[.721]
R^2	0.69152		0.89026	

in this model, domestic production (every 1000 tonnes increase in domestic production drops retail prices by 1.1¢/kg), and import volumes (every 1000 tonnes increase in imports drops retail prices by 6.88¢/kg). In the long run, retail price formation is influenced significantly by the first cointegrating vector which links the domestic market prices and quantities together.

Changes in domestic production are determined to a large extent by changes in cattle prices in the short run and by the second cointegrating vector in the long run - indicating that imports affect domestic production.

5. Modelling imports and cattle prices as exogenous non-stationary processes

Exogeneity tests carried out by the Institute for Research into International Competitiveness (IRIC) [18] suggest that producer and retail prices are endogenous but domestic production, import prices and volumes and cattle prices are all weakly exogenous. The third model estimated takes imports and cattle prices as being non-stationary exogenous variables and assumes that producer and retail prices and domestic production are endogenously determined. The weak exogeneity result for domestic production found by IRIC is suggested to be due to the highly inelastic nature of production in the short run and therefore domestic production should in fact be endogenously determined.

The estimated lag length is the same as in Section 4 and the resultant VEC(2) model is regressed on data from 1984:3 to 1997:2, with unrestricted intercepts but with restricted trends[9], SPQ, RPQ and PPDQ being $I(1)$ endogenous and SBFQ, CAMPQ, and CAMVQ being $I(1)$ exogenous with deterministic seasonal dummies. The Johansen test for cointegration suggests that there exists one cointegrating vector (Table 5.1). The cointegrating vector and it's normalised and final restricted form are presented in Table 5.2.

Table 5.1: Results of the Johansen ML test for cointegration, Model 3

H_0:	H_1:	Max-Eigenvalue	$LR_{Crit,0.05}$	Trace	$LR_{Crit,0.05}$
$r = 0$	$r = 1$	43.0720	34.6500	77.3463	63.5400
$r \leq 1$	$r = 2$	23.9948	27.8000	34.2743	40.3700
$r \leq 2$	$r = 3$	10.2795	20.4700	10.2795	20.4700

The tests for over-identifying restrictions indicate that only producer and retail prices play any role in the long-run determination of domestic prices. The VEC model was estimated using the restricted ECM and the results reported in Tables 5.3 to 5.4[10]. The model results indicate that although imports do not enter into the long-run determination of domestic prices and production they do have short-run effects. Import volumes significantly depress producer prices in the short run, with every 1000 tonnes of imports lowering producer prices by around 8.2¢/kg. This compares with the 10¢/kg drop in prices due to imports in the VEC models specified above.

[9] We assume, like the model estimated by IRIC [18], that in this case there is only a trend term in the cointegrating vector, not a deterministic trend. The deterministic trend was included in the other model specifications to explicitly account for inflationary effects not captured by first differencing the (nominal) variables.

[10] Lagrange Multiplier F-tests indicate that none of the equations exhibit any evidence of serial correlation or heteroscedasticity.

Table 5.2: Cointegrating vectors for VEC Model 3

Variables	β	$\tilde{\beta}$	$\bar{\beta}$	$S_{\bar{\beta}}$
SPQ	-0.020706	-1.0000	1.0000	
RPQ	0.0069115	0.33379	-0.23710	0.016309
$PPDQ$	-0.3585×10^{-7}	-0.1731×10^{-5}	0	
$SBFQ$	0.0019383	0.093611	0	
$CAMVQ$	0.6678×10^{-8}	0.3225×10^{-6}	0	
$CAMPQ$	0.1397×10^{-3}	0.0067487	0	
$Trend$	0.0019319	0.093300	0	

CI Vector $= [\beta]$, Normalised CI Vector $= \left[\tilde{\beta}\right]$, Restricted CI Vector $= [\bar{\beta}]$

Retail prices are also affected by import volumes, with every 1000 tonnes of imports depressing retail prices by 6¢/kg. This compares with the $5.3¢/kg$drop in retail price due to imports in the VEC models specified above. Domestic production does not appear to be affected by imports, neither in the short nor long-run.[11]

Table 5.3: VEC representation for pig industry: Model 3

	ΔSPQ		ΔRPQ	
Coefficients	$\hat{\beta}_i$	$S_{\hat{\beta}_i}$	$\hat{\beta}_i$	$S_{\hat{\beta}_i}$
α	24.9650	7.0954[0.001]	-10.9762	4.8154[0.028]
ΔSPQ_{t-1}	0.31114	0.19593[0.120]	0.16925	0.13297[0.210]
ΔRPQ_{t-1}	0.10470	0.21283[0.625]	-0.27518	0.14444[0.064]
$\Delta PPDQ_{t-1}$	0.7904×10^{-7}	0.7007×10^{-6}[0.911]	-0.8148×10^{-7}	0.4755×10^{-6}[0.865]
$\Delta SBFQ_{t-1}$	0.0098436	0.12444[0.937]	0.25677	0.084455[0.004]
$\Delta CAMVQ_{t-1}$	-0.8188×10^{-5}	0.4562×10^{-5}[0.080]	-0.6036×10^{-5}	0.3096×10^{-5}[0.058]
$\Delta CAMPQ_{t-1}$	-0.015771	0.030139[0.604]	-0.011673	0.020454[0.571]
ECM^1_{t-1}	-0.30814	0.16034[0.062]	0.43623	0.10882[0.000]
Q^1_t	-23.0685	4.4829[0.000]	-5.2749	3.0424[0.090]
Q^2_t	-22.4596	8.6660[0.013]	-8.0604	5.8813[0.178]
Q^3_t	4.1756	6.4683[0.522]	4.8174	4.3898[0.279]
R^2	0.73715		0.62947	

The results indicate that imports do play a role in the formation of domestic prices, and that the magnitudes of the effects are consistent with the results of the previous VEC models above. There is a conflict in the results in that the inclusion of imports in the long-run cointegrating vector is dependent on the particular model formulation; Treating imports as $I(0)$ exogenous results in imports having both a short and a long run effect, treating imports as $I(1)$ exogenous, with domestic industry variables endogenous, results in imports only having a long-run effect for producer prices but a long and short run effect on retail prices. Finally, treating imports as $I(1)$ exogenous, along with cattle prices and neglecting a deterministic trend to account for inflationary effects, results in imports only having a short-run effect.

[11] The specification of a deterministic trend in the VEC model does not substantially alter the results; for example the effect of import volumes on producer prices is $-0.8602\times10^{-5} \pm 0.4806\times10^{-5}$ for the model with a deterministic trend compared with $-0.8188 \times 10^{-5} \pm 0.4562 \times 10^{-5}$ for the model without a determinstic trend.

Table 5.4: VEC representation for pig industry: Model 3

	$\Delta PPDQ$	
Coefficients	$\hat{\beta}_i$	S_{β_i}
α	−1883098	1642737[0.258]
ΔSPQ_{t-1}	−131950.2	45362.9[0.006]
ΔRPQ_{t-1}	−30338.2	49275.1[0.542]
$\Delta PPDQ_{t-1}$	−0.35456	0.16222[0.035]
$\Delta SBFQ_{t-1}$	−10581.2	28811.4[0.715]
$\Delta CAMVQ_{t-1}$	−0.30618	1.0563[0.773]
$\Delta CAMPQ_{t-1}$	−4432.6	6977.9[0.529]
ECM^1_{t-1}	73393.7	37122.2[0.055]
Q^1_t	−6017381	1037886[0.000]
Q^2_t	2908513	2006372[0.155]
Q^3_t	901579.2	1497548[0.550]
R^2	0.85459	

These results indicate that the model specification, and underlying assumptions, will have a major impact on the significance, or non-significance, of a particular variable in a particular equation. What does appear to be consistent across all model formulations is that imports, and specifically import volumes, are having a significant negative effect on domestic prices in the Australian pig industry.

6. Review of the Productivity Commission's commissioned research

In the models above the effect of imports on domestic prices appears to be clear cut; imports depress both producer and retail prices in the short and long run, depending on the model formulation chosen. Modelling analysis carried out by Griffith [12] and the Institute for Research into International Competitiveness (IRIC) [18] for the Productivity Commission arrived at contrasting conclusions.

Modelling work by Griffith [12] on the NSW pig industry suggested that retail and wholesale prices in NSW have been affected by imports but there was insufficient data to conclude that producer prices had been affected. Griffith undertook Granger and Sims Causality testing in a bivariate and VAR framework which does not take into account the effects of cointegration in the model structure. As with all the model structures considered in this paper the issue of lag length is critical. Griffith used monthly data in his analysis of the NSW pig industry and arbitrarily selected seven months as the appropriate lag length in constructing his VAR model. In his Granger and Sims Causality analysis Griffith considered lags of nine, six, three and one months and tested each for evidence of causality:

> Certainly there is no consistent evidence about the causal relationship between the level of Canadian imports of pigmeat and farm, wholesale or retail prices in NSW. If there is a pattern at all, it is that wholesale prices and Canadian imports may be jointly determined over longer lag periods, that none of the price impact at wholesale is transmitted to the retail pork market, and that NSW prices of pigs are only causally effected

by import volumes in the very short run as extra supplies come up against very inelastic demand and supply schedules.[12, p. 10]

In consideration of the differing effects of imports according to lag length chosen it is perhaps relevant to ask which lag length is the more appropriate one over which to conduct analysis. Using monthly data for the Australian-wide pig industry an unrestricted VAR(9) was estimated regressing producer prices, retail prices[12], cattle prices, production volumes, import volumes and prices as endogenous variables and a constant, time trend and 1^{st} to 11^{th} seasonal dummies as exogenous variables over the period 1991:5 to 1997:10. The AIC and SBC for lag length suggest that a VAR(1) is the more appropriate model to use, with the AIC being relatively flat over the first six lags, as indicated in Figure 6.1.

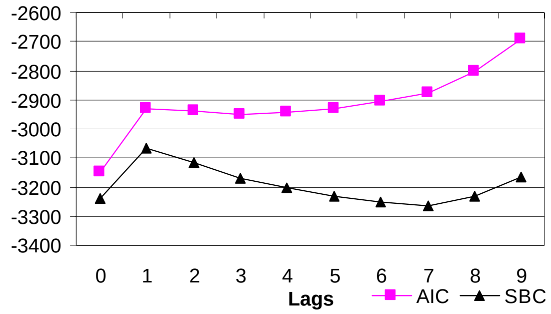


Figure 6.1: Lag length selection for monthly VAR model

The results suggest that the selection of the appropriate lag length for the VAR model of the NSW pig industry may have shed some light on the real effects of imports and that a lag length selection of seven months may have resulted in an over-parameterization of the model and a consequent change in the actual size of the test relative to its nominal size.

In contrast to Griffith's finding of some effect of imports on wholesale and retail prices the modelling work carried out by IRIC [18] suggested that there was no significant short or long-run role for imports in the determination of market equilibrium for the Australian pig industry. This result hinges on the model specification used by IRIC. Like analysis carried out in this paper IRIC conducted tests of appropriate lag length [18, p. 63, Table 5.1]. On the basis of the AIC they concluded that the appropriate lag length was three lags. As shown in this paper, the reliance on the AIC rather than on the more parsimonious, and consistent, SBC may result in a misspecified model with consequent dilution of significant effects. Having specified a VEC(3) the IRIC report estimated a cointegrating vector based solely on the domestic market variables (producer prices, domestic production, retail prices and cattle prices) while ignoring the possibility of imports playing a role in the cointegrating vector. The results of this model specification will be biased as the presence of imports over the time period used in estimating the cointegrating vector will impact on the long-run

[12] Australia-wide retail prices are available only as quarterly series and because retail prices do not exhibit significant volatility from quarter to quarter it was felt that disaggregating this series would not bias the results significantly.

market equilibrium. By failing to take into consideration the effect of imports on the cointegrating vector the Johansen test for cointegration will estimate an incorrect cointegrating vector.

Having estimated their cointegrating vector IRIC [18, p. 69] test for exogeneity and conclude that only producer and retail prices are endogenous. Whereas economic theory suggests that there is a case for exogeneity of cattle prices the finding of exogeneity of domestic production is highly suspect. A more plausible explanation is the relatively low supply elasticity for domestic production.

In order to test whether imports have had an effect on the domestic market equilibrium, IRIC estimated a VEC(2) model allowing imports, domestic production and cattle prices to enter as $I(1)$ exogenous [18, p. 80 Table 5.11]. From their regression output it appears that IRIC made an error in their model formulation. Having claimed to estimate a VEC(2) they actually estimate a VEC(2) in difference format, that is, they have two lags of each log-differenced variable enter into the model structure. What this means is that they actually estimated a VEC(3), not a VEC(2). The implication is that they have inadvertently diluted the effects of their variables down by over-parameterizing their model.

A more serious error is that they use the cointegrating vector formulated from their previous VEC(3) model which did not incorporate imports but incorporated domestic production and cattle prices as endogenous variables. The use of this cointegrating vector for a totally different model specification is spurious and no reliance can be placed on the subsequent results.

7. Conclusions

In this paper the effect of imports on the Australian pig industry is considered in a Vector Error Correction (VEC) framework. Three model specifications were considered, each incorporating a different assumption about the structure of the Australian pig industry. In the first model, where imports are assumed to follow a seasonal non-stationary stochastic process and are exogenously determined, the model results suggest that for every 1000 tonnes of imports the producer price drops by around $10¢/kg$ and retail prices fall by around $5¢/kg$. The differing effects of imports on producer prices and retail prices suggests an asymmetric price transmission between the different levels of the marketing chain. There is evidence of an increased marketing margin which appears to be capturing the benefits of trade liberalisation and preventing the full flow-on of trade benefits to consumers.

The results depend critically on the lag length chosen in the model and assumptions underlying the treatment of imports. In the second model, treating imports as first-difference stationary, as opposed to seasonally integrated, suggests that imports do not play a significant short-run role in producer price and production determination, although they do play a highly significant role in determining the long-run equilibrium price (and production). In contrast, retail price formation is determined in the short run by changes in import volumes with every 1000 tonnes increase in imports depressing retail prices by around $7¢/kg$ but in the long-run retail prices are determined by domestic market factors and not imports.

The third model chosen assumes that both imports and cattle prices are exogenously determined and the results indicate that although imports do not enter into the long-run determination of domestic prices and production they do have short-run effects. Import volumes significantly depress producer prices in the short run, with every 1000 tonnes of imports lowering producer prices by around $8.2¢/kg$. This compares with the $10¢/kg$ drop in prices due to imports in the first VEC model specified above. Retail prices are also affected by import volumes, with every 1000 tonnes of imports depressing retail prices by 6¢/kg. This compares with the $5.3¢/kg$ drop in retail price in the first VEC model. Domestic production does not appear to be affected by imports, neither in the short nor long-run. The results indicate that imports do play a role in the formation of domestic prices, and that the magnitudes of the effects are dependent on the particular model formulation.

Modelling work carried out for the Productivity Commission by the Institute for Research into International Competitiveness suggested that imports did not have any effect on the market equilibrium in domestic pig industry. That modelling work was flawed as it initially estimated the long-run market equilibrium under the assumption of imports not impacting on that equilibrium and then estimated what the effect of imports on the short and long-run equilibrium would be in an overparameterised model that diluted the effects across non-significant parameters.

The results of the modelling work in this paper indicate that the model specification, and underlying assumptions, will have a major impact on the significance, or non-significance, of a particular variable in a particular equation. What does appear to be consistent across all model formulations is that imports, and specifically import volumes, are having a statistically significant negative effect on domestic prices in the Australian pig industry.

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