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Advertising and Australian Pig Producers Welfare

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The aim of this paper is to provide information on the impact of advertising on Australian pig meat consumption and welfare changes of pig producers from 1985 to 1997. A simultaneous model that links the production and marketing of pig meat and combines farm level market, retail market and export market of pig meat is established to estimate the relationship between advertising, consumption of pig meat and welfare of pig producers. The results from this research will be quite useful not only to pig producers but also to pork marketing agents. Producers will become clearer of their levy investment, the Australian Pork Corporation (APC) as the marketing agent may get some ideas on the best investment strategies for future marketing.

The paper consists of six sections. The paper begins with a brief introduction to Australian pig industry. The second section is the review of previous studies in this area. The third section is the empirical model. The fourth section is the estimation and results. The fifth section is simulation results and the last section is the conclusion with implications for Australian producer investment strategies.

Background

Originally as a sideline to the dairy industry, the Australian pig industry has developed very rapidly, even though it is still quite small compared to the rest of the world. Australia imports frozen and canned pig meat from Canada, New Zealand, Denmark and other countries and mainly exports its pig meat to Japan. Even though, it is still a net exporter of pig meat. During the process of development, pig producers voiced their concerns over their market share and the need to gain an increased portion of the consumer's dollar. This led to the establishment of a marketing agent with the statutory power to levy all producers to carry out policy formulation and executive functions. Currently, the Australian Pork Corporation (APC) levies producers at a rate of A\$ 1.65/head (Annual Report). The levy has been used for advertising, administration, public relations, equipment and plant etc. Approximately two-thirds of the levy is invested in advertising.

Figure 1 shows the levies have been collected from pig producers and the advertising expenditure on pig meat for the period of 1985-1997.

Pig meat advertising in Australia can be mainly disaggregated into generic advertising and brand advertising. Generic advertising, as the dominant pattern, is concentrating on fresh pork, while brand advertising generally focuses on bacon, ham and other processed products. However, brand advertising is becoming more and more extensive in Australia. Nowadays, restaurant advertising is also playing a role for certain meats. For example, McDonald's features beef as part of their advertising. It also appears on menus and recipes in the restaurant as a combination of generic advertising and brand advertising. Generic advertising is more likely to increase total industry sales, while brand advertising is more likely to increase or maintain a specific firm's market share. In Australia, generic advertising on pork is either done by APC or through the cooperation between the APC and supermarkets or butchers' shops. Brand advertising is supported by different brand companies. Many examples can be seen on TV programs, magazines, press kits, radio etc.

The economic problem the industry faces is the determination of the best investment to maximize producers' welfare. Investments could include not levying producers or allowing them

to invest themselves in a range of alternative investments in promotion or research. This can only be achieved if accurate measurement of returns to existing investments can be established.

Empirical Studies

Empirical studies of advertising are typically expressed in the rate of return such as elasticities. Advertising elasticities indicate the percentage change in demand that would have been resulted from a 1 percent change in advertising expenditure. Table 1 presents selected studies on meat advertising.

Economists have different results on the impact of advertising on meat demand. Brester and Schroeder (1995) found that impact of generic advertising on meat demand is not significant, while the impact of branded advertising is significant. Ball and Dewbre (1989) found that generic advertising increased the profits of pork producers in Australia. Hoover et al. (1992) found that generic advertising on pork is effective in short term. Their simulation results indicated that when supply-response and cross-commodity impacts are taken into account, even if advertising causes demand to shift, expected producer returns temporarily increase but long-run returns are not appreciably different from returns where no advertising had occurred. However, the analysis suggests there are some positive long-run advertising impacts such as increased market share, potential for using advertising to smooth out price variability faced by producers, and the like.

There have been a number of studies done on the demand analysis of meat in Australia, but not many on the effectiveness of generic meat advertising in Australia. Existing studies on advertising were done by Ball & Dewbre, Goddard & Griffith, Piggott, Alston & Chalfant. These three studies on advertising used different equations with different functional forms in estimating meat sales response to advertising in the period of 1977-1988. However, the previous studies only looked at generic advertising and did not account for other media information as brand advertising effects on meat consumption. So far, nobody has included the brand advertising and fast food advertising or any advertising on chicken in their analysis, so results may have been biased by the exclusion. As well, the previous studies are contradictory about the effects of generic pork advertising. Ball & Dewbre found that generic advertising in Australia in 1977-1988 increased pork consumption while Goddard & Griffith found that in the same period advertising response was insignificant. Piggott concluded that in 1978-1988 APC advertising was not significant in the pork market.

The rate of return to an investment such as advertising expenditure can be defined in terms of effectiveness and returns to advertising are generally measured with the change in economic surplus that results from the outward shift in the demand curve (Forker and Ward, 1993).

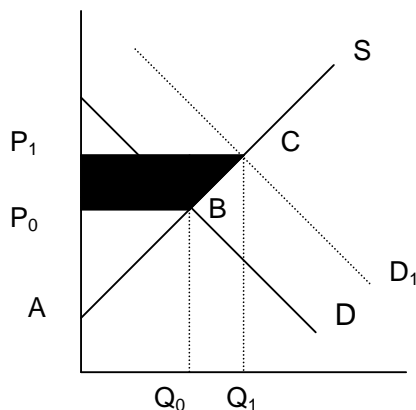


Figure 2 Producer Surplus

Changes in producer surplus resulting from policies that shift demand is shown in Figure 2. From the initial equilibrium at P_0 and Q_0 , a shift in demand to D_1 increases producer surplus from area ABP_0 to ACP_1 and increases the equilibrium price from P_0 to P_1 . The shaded area is the change in producer surplus due to advertising. The more inelastic the demand is, the more producers gain from outward shifts in demand. If the change in producer surplus is greater than the cost of advertising, then advertising is effective. The benefit-cost ratio is one of the common approaches to express advertising effectiveness. It is the ratio of total benefits to total cost and it gives the discounted benefits per dollar of discounted cost. If the ratio is greater than 1, the investment is considered successful, if the ratio equals 1, it indicates that there is no difference from the investment. If the ratio is less than 1, then the investment is unsuccessful (Davis, 1999). Therefore, the focus of this paper will be, do producers gain from advertising provided they invest in advertising.

Empirical Model

In this section, an econometric model of Australian pig and pig meat markets is specified to measure pig meat sales response and therefore, net producer returns from pig meat advertising investments.

The empirical model used for analyzing the retail demand for meats in Australia is a two-stage Australian meat demand system with a translog functional form. A model representing the aggregate demand for meat in Australia is specified in the first stage, and then a system of equations representing the individual commodities in the meat market is specified in the second stage.

The first stage of the model specification corresponds to the first stage of the two-stage budgeting procedure. An aggregate demand for meat can be formulated, giving total expenditure on meat as a function of expenditure weighted average price of meat, real household disposable income, real advertising expenditure, quarterly dummy variables and time trend. Dummy variables are used here to capture consistent seasonal variation in meat consumption. A time trend is included to account for changes in taste over time. Lagged dependent variable is omitted through the specification test in the first stage. All the advertising on meat products in this study are combined into one variable in the first stage and is specified in the inverse form to impose diminishing returns. They remain individually for each meat product in the second stage.

A number of studies have been conducted in an attempt to discriminate among some of the available functional forms. On the basis of conformity to standard restrictions and statistical tests, the translog was found to be the preferred form by Berndt, Darrough and Diewert (1977). Others have found the generalized Leontief form to perform better in some cases and the translog form to produce better results in other cases (Wales 1977).

As the first attempt at estimation of a complete demand system for Australian meats, translog is a reasonable choice. The translog functional form has been found the best choice in some of the previous studies and the fact that it has not been rejected in any other studies suggests that so far, at least on the empirical evidence, it provides a good approximation of consumers true preferences (Tielu 1987).

Supply of pigs is assumed to be a function of some lagged producer price, a similarly lagged feed price, seasonal dummies, time trend and lagged dependent variable. Lagged price is used here because it is assumed that there is a time lag between the producer's decision to produce pigs and pigs are ready for the market. Producers are making their decisions on the bases of expected price, therefore, this model is an adaptive expectation model. A time trend is included here to indicate the speed and degree of change in number of slaughtered. Seasonal dummies

are for seasonal changes and lagged dependent variable is for dynamic. Number of pigs slaughtered times the average slaughtered weight will be the production of pig meats.

Processor demand for pigs is required to link the pig and pig meat markets. It is assumed to be a function of both the pig and average pig meat prices, labor costs, seasonal dummies, time trend and a lagged dependent variable.

A price linkage equation is required to relate bacon & ham prices and pork prices. The Australian bacon & ham price is assumed to be a function of Australian pork price, seasonal dummies and a lagged dependent variable.

Finally, a trade equation is required to link pig prices across borders. As the most powerful market in the world, the US pig price is used as a proxy for the international price. Therefore, the Australian pig price is assumed to be a function of the U.S. pig price, net trade of pig meat and a lagged dependent variable.

To summarize, equations are estimated as follows:

Total expenditure on meat in Australia:

$$\text{Error! Not a valid link.} \quad (2)$$

$i=1, 2, 3, 4, 5$ representing beef, lamb, chicken, pork and bacon & ham individually

Australian supply of pigs:

$$pslaus = v_1 + v_2 pfrau(-7) + \sum_{i=1}^3 v_3 d_i + v_4 t + v_5 pslaus(-1)$$

(3) **Error! Not a valid link.**

Australian demand for pigs:

$$pslaud = x_1 + x_2 pprou + x_3 wage + \sum_{i=1}^3 x_4 d_i + x_5 t + x_6 pslaud(-1) \quad (4)$$

Price linkage equation:

$$p_{bh} = y_1 + y_2 p_{pk} + \sum_{i=1}^3 y_3 d_i + y_4 p_{bh}(-1) \quad (5)$$

Pig meat trade equation:

$$p_{pg} = z_1 + z_2 p_{us} + z_3 (p_{imp} - p_{exp}) + z_4 p_{pg}(-1) \quad (6)$$

Australian pig market clearing:

$$pslaus = pslaud \quad (7)$$

Australian pig meat - pig linkage:

$$propig = pslaus * cpgau \quad (8)$$

Australian bacon & ham – pig linkage:

$$probm = propig * rprobm \quad (9)$$

Australian pork market clearing:

$$acpkau = ((propig + pstock + p_{imp} - p_{exp}) - (probm + bm_{imp} - bm_{exp})) * rpgau \quad (10)$$

Australian bacon & ham market clearing:

$$acbmau = probm + bm_{imp} - bm_{exp} \quad (11)$$

where: $\ln \text{exp}$ = log of total expenditure on meat

p_b = real retail beef price

p_l = real retail lamb price

p_c = real retail chicken price

p_k = real retail pork price

p_{bh} = real retail bacon & ham price

a_1 = real per capita beef & lamb advertising expenditure

a_2 = real per capita chicken advertising expenditure

a_3 = real per capita pork advertising expenditure

a_4 = real per capita bacon & ham advertising expenditure

i = real per capita disposable income in Australia

w_1 = expenditure share for beef

w_2 = expenditure share for lamb

w_3 = expenditure share for chicken

w_4 = expenditure share for pork

w_5 = expenditure share for bacon & ham

p_{frau} = the ratio of Australian pig prices over feed prices

p_{prau} = the ratio of Australian pig prices over average prices for bacon & ham

p_{slaus} = number of pigs slaughtered in Australia

p_{propig} = production of pig meat

p_{probm} = production of bacon & ham

c_{pgau} = Australian average carcass weight for pig meat

r_{probm} = carcass proportion of bacon & ham

p_{imp} = pig meat import in Australia

p_{exp} = pig meat export from Australia

b_{mimp} = bacon & ham import in Australia

b_{mexp} = bacon & ham export from Australia

p_{us} = pig price in U.S.

All variables are current period unless otherwise noted. Prices and income in the consumer demand system are deflated by consumer price indices to satisfy homogeneity. All the advertising variables are deflated as well as all the prices on the supply side.

Estimation and Results

Data used in this study were quarterly data from the first quarter 1985 (1985:1) to the fourth quarter 1997 (1997:4).

The apparent consumption of meat was calculated in the following manner:

Disappearance = net change in stocks + commercial production + estimated home production + imports – exports

Retail weights were calculated using the apparent consumption figure and an assumed conversion factor, representing the proportion of carcass weight that is converted into the retail products in their final forms.

Per capita consumption of beef, lamb, chicken, pork and bacon & ham after conversion are shown in Figure 3.

Figure 4 describes the generic, brand and fast food advertising expenditure spent on beef & lamb, pork, chicken and bacon & ham individually for the period of 1985 to 1997.

The model was estimated using Time Series Processor (TSP) version 4.4. The theoretical restrictions such as homogeneity and adding up were imposed in the model without testing, because they follow consumer demand theory. Homotheticity, symmetry and negative semi-definiteness of the substitution matrix were tested and the results turned out that these restrictions were rejected. However, to consume less degree of freedom, symmetry was still imposed.

The log likelihood ratio test for the model was carried out to select the best model specification for the demand system and the elasticities were calculated under this specification.

Different advertising variables were tested through log likelihood test. Based on goodness of fit, correctly signed price elasticities and test results, one advertising variable that is the combination of generic, brand and fast food advertising lagged by one period for individual meat product was selected as the form to be incorporated into the model.

The log likelihood ratio test results for the model specification and advertising variables were reported in Table 2.

Retail Level Price and Expenditure Elasticities

Price and expenditure elasticities for the period 1985–1997 are reported with t-statistics underneath in the brackets in Table 3.

Economic theory suggests that consumers' demand for a product is inversely related to price and positively related to expenditure. The results are consistent with consumer demand theory, except for the expenditure elasticity for bacon & ham. The results indicate that people will consume less bacon & ham if their meat expenditure increase and this impact is significant at the 1 percent level. All the expenditure elasticities are significant except for beef. Except for bacon & ham, all the other meats are price elastic. In terms of uncompensated price elasticities, they are consistently negative, implying downward sloping demand curves.

On the basis of consumer demand theory, consumers are expected to respond negatively to changes in own price and prices of complementary goods, but positively to changes in substitutes' prices. The results show that all the cross price elasticities are significant at the five percent level except the demand for lamb with respect to the price of chicken, pork and bacon & ham, the demand for pork with respect to the price of lamb and bacon & ham individually. Most of the cross price elasticities are positive, suggesting gross substitute relationships between these products.

Price and expenditure elasticities compared to previous studies are reported in Table 4. Results from this study are different from those from previous studies, because this study used different consumption data, estimated for different period and the elasticities calculated are simultaneous ones across two stages, while others are only second stage elasticities.

Retail Level Elasticities of Substitution

Elasticity of substitution measures the responsiveness of the ratio of two quantities to changes in the ratio of their prices. Substitution elasticity results obtained were reported in Table 5. All of the own elasticities of substitution are quite large and they are significant at a five percent level. All of the elasticities of cross substitution are positive with the exception of the lamb-chicken, which means these meat products are net substitutes except lamb and chicken.

Retail Level Advertising Elasticities

The estimated advertising elasticities given in Table 6 indicate the average percentage change in demand that would have been resulted from a one percent change in advertising expenditure. Thus, for example, an one percent increase in advertising expenditure on beef & lamb is estimated to result in a 0.0002 percent increase in beef demand as well as 0.045 percent increase in lamb demand. The advertising effect on pork is positive and significant. Applying the same interpretation to the other advertising elasticities, it can be seen that an one percent increase in advertising on beef & lamb will have a positive influence on pork demand and negative effect on chicken and bacon & ham consumption. Pork consumption will be increased by 0.039 percent, bacon & ham demand will be reduced by 0.045 percent and chicken consumption will be reduced by 0.018 percent.

Comparisons on advertising elasticities are presented in Table 7. By using the same data set but different demand equations, both Goddard's and Piggot's studies indicate that APC advertising is not significant, while Ball & Dewbre's study says that APC advertising is significantly affecting pork consumption. By using the more recent and improved data from the Australian Independent Media Pty Ltd with translog demand system, APC advertising on pork turned out significant.

Farm Level Supply and Demand Elasticities

Pig supply and demand elasticities were reported in Table 8. The goodness of fit for both supply and demand equations suggest that 80 percent of the equations can be explained by their independent variables. The elasticity results show that pig supply is inelastic with respect to pig price and feed price. One percent increases in the pig price leads to 0.04 percent increase in the supply in the short run and 0.153 percent increase in the long run. Pig demand with respect to pig price is inelastic too, one percent increases in the pig price leads to 0.168 percent decrease in demand in the short run and 0.614 percent decrease in the long run.

The supply elasticities obtained in this study were compared with previous studies in Table 9.

Calculation of Producer Surplus

Since supply is not explained by the current price, so a producer expected price is required.

The expected price is specified as:

$$EP_t = \theta P_{t-7} + \theta(1-\theta)P_{t-8} + \theta(1-\theta)^2 P_{t-9} + \theta(1-\theta)^3 P_{t-10} + \dots$$

$1 - \theta =$ coefficient of the lagged dependent variable

Producer surplus is defined as the area above the supply curve and below an expected price. This is equivalent to the revenue less the integral of the supply curve less advertising cost:

$$PS = EP_0 Q_0 - \int_0^{Q_0} MC(Q) dQ - ADV$$

A modification needs to be made due to the presence of the lagged advertising and lagged dependent variables, which means that the benefits and costs of investment in period t are felt in successive years. These future values are discounted by a discount rate of 5% (annual). Producer surplus measures were also adjusted for inflation and presented in 1988 Australian dollars.

$$PS_{NPV} = \sum_{t=1}^i PS / (1+r)^t \quad \text{where } r \text{ is the discount rate}$$

Simulation Results

The empirical model was extended to a simulation model capable of demonstrating changes in endogenous variables to shocks in certain exogenous variables. The dynamic simulation was conducted over the period of 1988:1 – 1997:4. The model validation test was carried out and the statistics were presented in Table 10. These statistics indicate that the simulation model tracks actual values reasonably well except for pig meat import and bacon & ham import.

The simulation model was then shocked to track response in endogenous variables over time to one-period and sustained changes in advertising variable. Shocks include single period change in pork advertising (1988:4), single period change in bacon & ham advertising (1989:1), single period changes in pork and bacon & ham advertising (1988:4, 1989:1), sustained change in pork advertising in pork advertising, sustained change in bacon & ham advertising and sustained change in pork and bacon & ham advertising over the simulation period. Shock results in view of pig meat import, bacon & ham import, per capita consumption of pork, per capita consumption of bacon & ham, expected producer price and producer surplus were reported in Table 11. The shock results indicate that the current pork advertising is profitable to pig producers in Australia, while bacon & ham advertising is ineffective. Changes in producer surplus and the associated benefit-cost ratios for each scenario were presented in Table 12.

Conclusions

This study established a simultaneous econometric model to be able to examine the economic relationship between advertising, pig meat consumption and Australian pig producers welfare. The results tell us that generic pork advertising in Australia is bringing significant positive effect on pork sales, therefore to net returns of producers.

Results of this study may be extended to policy recommendations. Pork advertising increases pork consumption, so there may exist the potential for gains from increasing pork advertising. The own advertising elasticity for bacon & ham turned out negative due to overestimation. However, since it is insignificant, its effect on consumption can be assumed to be zero. Therefore, reducing bacon & ham advertising may not have great impact on producers welfare. Benefit cost ratios suggest that sustained increases in pork advertising may result in much benefits to producers.

Further research could extend to determine the optimal advertising expenditure for pig meat marketing. It might give different results if pork and bacon & ham are included as a subgroup of pig meat in a three-stage system. Different aggregation of the advertising data can be used in the future and different functional forms are suggested to test.

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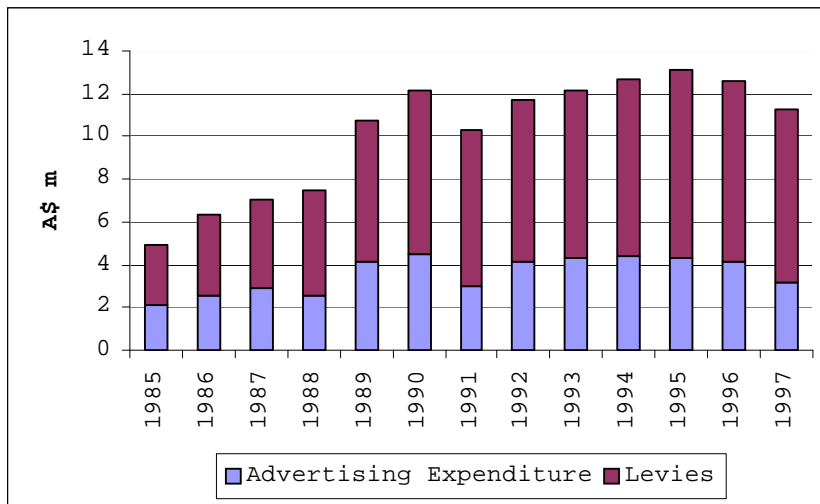
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Table 1 Studies on Meat Advertising

Study	Commodity	Country	Model	Advertising Specification	Results
Goddard & Cozzarin 1967 -1986	Beef, pork, chicken, turkey	Canada	Translog & AIDS (demand system)	Current advertising of each meat	Beef: -.0008 Pork: .011 Chick: .014 Turkey: .060
Goddard & Griffith 1972 -1989 1979 -1989	Beef, chicken, pork	Canada	Linear (single equation) & Translog & AIDS (demand system)	Current advertising of each meat	Beef: -.003, -.79 Pork: .02, -.10 Chick: .033, .035
Goddard & Griffith 1966 - 1988 1977 - 1988	Beef, lamb, chicken, pork	Australia	Linear (single equation) & Translog & AIDS (demand system)	Current advertising of beef and pork	Beef: .003, -.0004 Pork: .005, -.001
Brester & Schroeder 1970.1 – 1993.4	Beef, pork, chicken	US	Rotterdam (demand system)	Current advertising of each meat	G. bef: .007 B. beef: .006 G. pork: not sig. from 0 B. pork: .033 B. chick: .05 G. chick: sig. diff. from 0
Piggot 1979.1 – 1995.2	Beef, pork	US	Nested PIGLOG (demand system)	Advertising lagged by four quarters	Beef: .015 Pork: .033
Piggot, Chalfant, Alston & Griffith 1978.3 – 1988.4	Beef, lamb, pork, chicken	Australia	Double logarithmic & LA & AIDS	Current advertising and three lags of AMLC and APC	AMLC: sig. APC: insig. AMLC: insig. APC: insig. AMLC: sig. APC: insig.
Hoover, Hayenga & Johnson Feb 1987	Pork	US	Linear (single equation)	Current advertising	
Ball & Dewbre 1977 - 1988	Beef, lamb, pork	Australia	Linear (single equation)	Current advertising	Beef: 0.037 Lamb: 0.009 Pork: 0.029

* G refers to generic and B refers to brand



Source: Australian Pork Corporation

Figure 1 Advertising Expenditure & Levies Collected in the Australian Pig Industry 1985-1997

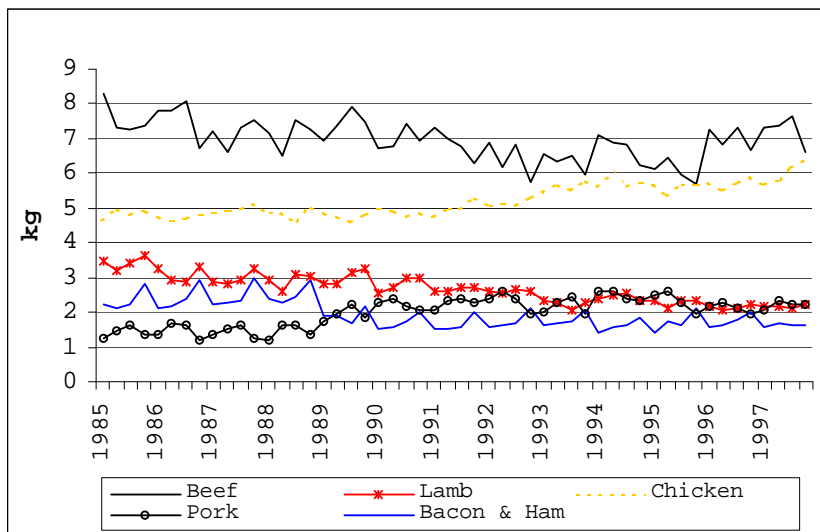


Figure 3 Per Capita Consumption of Meat in Australia

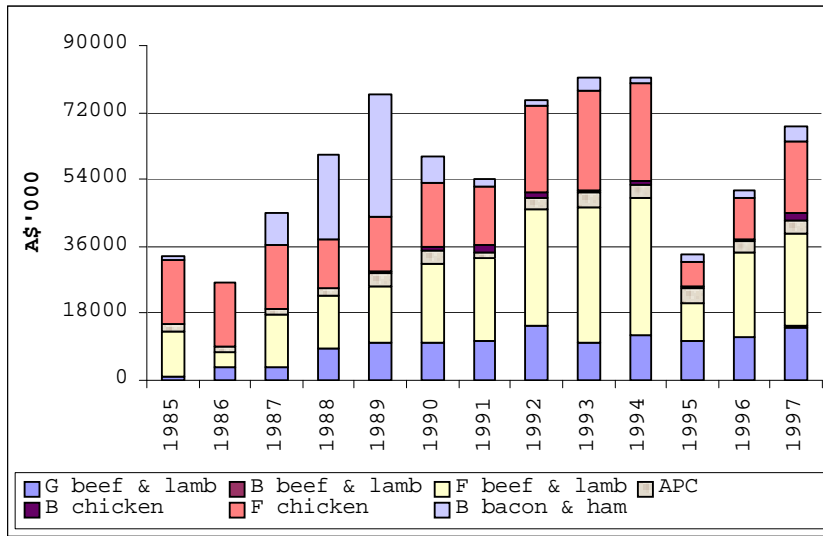


Figure 4 Annual Advertising Expenditure on Meat

Table 2. Price and Expenditure Elasticities

Price Elasticity	Beef	Lamb	Chicken	Pork	Bacon & Ham	Expenditure Elasticity
Beef	-1.50 (-11.85)	0.449 (6.461)	0.619 (8.058)	0.541 (3.906)	0.471 (4.351)	0.228 (1.200)
Lamb	0.661 (2.644)	-2.205 (-4.378)	-0.381 (-1.044)	0.070 (-0.098)	0.311 (1.136)	2.493 (5.113)
Chicken	-1.775 (-6.748)	-1.128 (-3.486)	-5.870 (-8.525)	1.845 (1.973)	-1.048 (-4.461)	8.783 (22.982)
Pork	-1.098 (-1.906)	-0.678 (-0.879)	2.320 (2.071)	-7.138 (-3.539)	-0.006 (-0.010)	7.408 (8.529)
Bacon & Ham	5.307 (14.725)	1.542 (7.396)	1.398 (6.662)	1.749 (4.313)	-0.925 (-2.548)	-8.262 (-15.013)

Table 3 Price and Expenditure Elasticities from Previous Studies

Price Elasticity	Beef	Lamb	Fresh Pork	Ham	Bacon	Chicken	Expenditure Elasticity
Cashin (1967.1 – 1990.2)							
Beef	-0.822	-0.113	-0.019	-0.102	-0.016	-0.356	1.376
Lamb	-0.018	-0.989	0.103	-0.082	0.001	0.260	0.769
Fresh Pork	0.419	0.356	-1.202	0.680	-0.141	-0.316	0.305
Ham	-0.250	-0.164	0.249	-1.185	0.185	0.294	0.333
Bacon	0.384	0.053	-0.179	0.512	-0.948	-0.073	0.344
Chicken	1.074	0.993	-0.111	1.166	0.176	-0.227	1.114
This study (1985.1 – 1997.4)							
Beef	-1.50 (-11.85)	0.449 (6.461)	0.541 (3.91)	0.471 (4.35)		0.619 (8.06)	0.228 (1.200)
Lamb	0.661 (2.644)	-2.205 (-4.38)	0.070 (-0.10)	0.311 (1.14)		-0.381 (-1.044)	2.493 (5.113)
Chicken	-1.775 (-6.748)	-1.128 (-3.49)	1.845 (1.973)	-1.048 (-4.46)		-5.870 (-8.525)	8.783 (22.98)
Pork	-1.098 (-1.906)	-0.678 (-0.88)	-7.138 (-3.54)	-0.006 (-0.01)		2.320 (2.071)	7.408 (8.529)
Bacon & Ham	5.307 (14.73)	1.542 (7.396)	1.749 (4.313)	-0.925 (-2.55)		1.398 (6.662)	-8.262 (-15.013)

Note: Bacon & ham are combined into a group in this study, so ham column is for bacon & ham.

Price Elasticity	Beef	Lamb	Chicken	Pork	Expenditure Elasticity
Goddard & Griffith (1977.1 – 1988.4)					
Beef	-1.33 (-16.1)	0.07 (1.6)	-0.09 (-3.3)	-0.03 (-0.4)	1.38 (13.8)
Lamb	0.53 (3.9)	-1.27 (-10.0)	-0.06 (-0.9)	-0.09 (-0.8)	0.89 (5.3)
Chicken	0.24 (3.0)	0.081 (0.935)	-0.63 (-7.0)	0.013 (1.2)	0.23 (2.7)
Pork	0.40 (2.9)	0.03 (0.5)	0.05 (0.7)	-1.04 (-5.5)	0.50 (2.8)
Fisher (1962.1 – 1977.2)					
Beef	-1.19 (10.68)	0.14 (5.73)	0.04 (1.38)	0.14 (6.00)	0.54 * (9.11)
Lamb	0.47 (5.73)	-1.58 (11.17)	-0.12 (2.52)	0.33 (3.78)	0.09 * (2.52)
Chicken	0.28 (1.38)	-0.25 (2.52)	-0.23 (2.31)	-0.27 (2.70)	0.20 * (5.70)
Pork	1.00 (6.00)	0.70 (3.78)	-0.27 (2.70)	-0.95 (4.44)	0.04 * (0.48)
Murray (1949/50 – 1978/79)					
Beef	-1.424	0.151	0.013	0.131	0.925
Lamb	0.512	-1.345	0.019	0.223	0.798
Chicken	0.258	0.075	-0.647	-0.062	0.572
Pork	0.564	0.401	-0.191	-1.866	1.731
Piggot & Griffith (1977.1 – 1988.4)					
Beef	-1.215	-0.008	-0.218	-0.198	1.676
Lamb	0.481	-1.269	-0.068	0.183	0.562
Chicken	-0.029	0.018	-0.430	0.412	0.204
Pork	0.234	0.216	0.260	-0.890	0.018
Cashin (1967.1 – 1990.2)					
Beef	-1.235	-0.023	-0.194	-0.196	1.650
Lamb	0.507	-1.326	0.044	0.249	0.525
Chicken	0.027	0.118	-0.469	0.262	0.061
Pork	0.236	0.221	0.143	-0.829	0.228
Hyde & Perloff (1970:1 – 1988:4)					
Beef	-1.411				1.244
Lamb		-1.714			0.928
Pork				-1.037	0.405

* refers to income elasticity

Table 4 Elasticities of Substitution

	Beef	Lamb	Chicken	Pork	Bacon & Ham
Beef	-2.972 (-11.486)	3.901 (7.477)	5.00 (9.358)	5.068 (4.252)	3.050 (4.920)
Lamb		-15.553 (-3.772)	-0.444 (-0.167)	1.865 (0.293)	4.354 (2.719)
Chicken			-36.445 (-7.056)	25.278 (3.016)	2.510 (1.785)
Pork				-56.416 (-3.137)	7.371 (2.096)
Bacon & Ham					-13.801 (-6.314)

Table 5 Advertising Elasticities

	AMLC	Chicken	Pork	Bacon & Ham
Beef	0.0002 (0.019)	0.013 (1.381)	-0.002 (0.819)	0.001 (1.359)
Lamb	0.045 (2.161)	-0.077 (-3.508)	-0.0008 (-0.112)	-0.0003 (0.161)
Chicken	-0.018 (-1.300)	0.033 (2.030)	-0.003 (-0.465)	-0.001 (-0.771)
Pork	0.039 (1.019)	0.045 (1.148)	0.028 (2.116)	0.003 (0.927)
Bacon & Ham	-0.045 (-1.533)	-0.036 (-1.147)	-0.009 (-0.988)	-0.005 (-0.708)

Table 6 Advertising Elasticities from Previous Studies

	AMLC	APC
Goddard & Griffith (1977.1 – 1988.4)		
Beef	-0.0004 (-0.153)	0.0006 (0.548)
Lamb	0.003 (0.846)	-0.002 (-1.33)
Chicken	-0.006 (-2.28)	0.002 (0.964)
Pork	0.003 (0.639)	-0.001 (-0.758)
Piggot, Alston & Chalfant (1978.1 – 1988.4)		
Beef	0.016	0.004
Lamb	-0.008	-0.007
Chicken	-0.054	-0.025
Pork	0.001	0.012
Ball & Dewbre (1977-1988)		
Beef	0.037	-0.004
Lamb	0.009	-0.008
Pork	-0.018	0.029

Table 7 Pig Supply and Demand Elasticities**Pig supply with respect to**

Pig price (short run)	0.04
Pig price (long run)	0.153
Feed price (short run)	-0.04
Feed price (long run)	-0.153

Pig demand with respect to

Pig price (short run)	-0.168
Pig price (long run)	-0.614
Average price for pork and bacon & ham (short run)	0.168
Average price for pork and bacon & ham (long run)	0.614

Table 8 Comparison of Australian Pig Supply Elasticities

Study	Period	Price Elasticity
Gruen <i>et al.</i>		0.4*
Hill	1948/49 – 1963/64	0.7*
Richardson O'Connor	1953/54 – 1974/75	0.78*
West		0.41*
Griffith & Gellatly	1965.1 – 1980.4	0.10* 0.52**
Ball & Dewbre	1977.1 – 1988.4	0.39*
This Study	1985.1 – 1997.4	0.04* 0.153**

Note: * refers to short run elasticity and ** refers to long run elasticity

Table 9 Validation Statistics for the Simulation Model

Endogenous variable	Mean	Correlation Coefficient	RMSPE	Theil Fraction of Error Due to Bias
<i>Expenditure shares</i>				
Beef (w1)	0.48	0.83	3.7	0.03
Lamb (w2)	0.119	0.9	4.58	0.03
Chicken (w3)	0.128	0.38	10.76	0.11
Pork (w4)	0.120	0.64	18.56	0.28
Bacon & ham (w5)	0.153	0.69	18.96	0.24
<i>Import quantities</i>				
Pig meat (pimpau)	1545848	0.08	3105.22	0.36
Bacon & ham (bmimpau)	230750	0.27	217.06	0.04
<i>Expenditures</i>				
Total (texp)	117.497	0.45	4.06	0.04
Total (ltexp)	4.766	0.44	0.86	0.04
<i>Per capita consumption</i>				
Beef (pacbfau)	6.822	0.48	7.07	0.03
Lamb (paclbau)	2.519	0.93	4.73	0.0006
Chicken (pacchau)	5.346	0.62	9.01	0.10
Pork (pacpkau)	2.155	0.73	14.8	0.28
Bacon & ham (pacbmau)	1.800	0.60	22.81	0.32
<i>Prices</i>				
Log of beef price (p1)	1.018	0.89	1.54	0.04
Log of lamb price (p2)	0.980	0.81	1.34	0.04
Log of chicken price (p3)	1.006	0.93	1.09	0.04
Log of pork price (p4)	0.986	0.38	2.79	0.14
Log of b & h price (p5)	0.965	0.16	2.93	0.15
Pork (prpkau)	6.564	0.45	8.36	0.04
Bacon & ham (prbanm)	9.945	0.21	6.78	0.07
Pig (pgau)	1.988	0.64	8.50	0.05
pig price/feed price (pfrau)	12.711	0.92	8.34	0.03
pig price/average price (pprau)	0.303	0.60	10.24	0.51
<i>Supplies</i>				
Pig demanded (pslaud)	1238075	0.83	2.66	0.04
Pig supplied (pslaus)	1238075	0.83	2.66	0.04
Production of pork (propig)	81795000	0.91	2.71	0.04
Produ. of b & h (probm)	31482200	0.99	2.59	0.02
<i>Apparent consumption</i>				
Pork (acpkau)	48971700	0.74	15.18	0.28
Bacon & ham (acbmau)	31584200	0.59	23.69	0.31

Table 10 Summary of Shock Results (Mean over 1988:1 – 1997:4)

	Shocked Advertising Variable	Pig Meat Import (kt)	Bacon & ham Import (kt)	Per Capita Pork Consumption(kg)	Per Capita Bacon and Ham (kg)	Expected Price (A\$)	PS (1988 A\$m)
Base	Pork	2.228	4.517	1.987	2.031	2.04	160.275
Single period shock (decreased by 90%)	Pork (1988:4)	2.532	7.561	1.86	2.204	2.019	158.307
	Bacon & ham (1989:1)	2.228	4.518	1.987	2.031	2.04	160.276
	Pork and bacon & ham	2.532	7.561	1.86	2.204	2.019	158.308
Sustained shock (decreased by 45%)	Pork	2.994	15.516	1.524	2.652	1.99	155.948
	Bacon & ham	2.216	4.4	1.992	2.024	2.041	160.341
	Pork and bacon & ham	2.951	15	1.546	2.622	1.993	156.2

Table 11 Return on Investment

	Shocked Advertising Variable	Change in PS (1988 A\$m)	Benefit-Cost Ratio
Sustained shock (decreased by 45%)	Pork	119.914	12.2
	Bacon & ham	-1.896	-7.3
	Both pork and bacon & ham	112.832	11.2