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The Payoff from Generic Advertising by the Australian Pig Industry in the Presence of Trade*

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Abstract

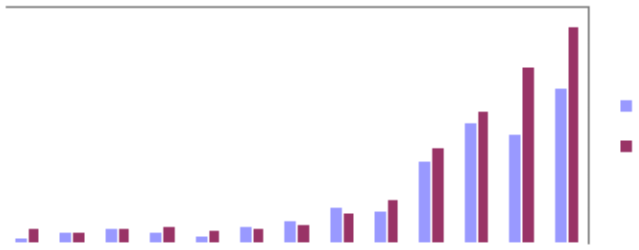
The Australian pig meat industry today competes in a global market environment, with significant quantities of both pork exports and pork imports for further processing. In March 2003 Australian Pork Limited (APL) launched a advertising campaign to raise domestic per capita consumption of pork, and increase consumer awareness and preference for identified Australian pig meat. This is funded from producer levies. Over the period 2003 to 2005, APL advertising expenditure is forecast to be at least 15 per cent above 2001-02 domestic advertising expenditure levels. Domestic advertising expenditure by APL for the 2002-03 financial year was actually 30 per cent above the previous year's level. The question is whether these pig producer funds are being well spent. Evaluation of pig meat advertising expenditure has been undertaken in the past, but not in the context of a trading industry.

An equilibrium displacement model of the Australian pig meat industry accounting for imports and exports was specified to study the returns to producers from different advertising scenarios. Total returns in terms of producer surplus gains were estimated for each scenario. The results indicated that producers receive the largest returns from domestic bacon/ham advertising and the least from export pork advertising. Producer surplus changes associated with a 30 per cent increase in domestic pork advertising expenditure were calculated for three different trade scenarios, including a hypothetical no-trade scenario. Returns to producers were shown to be very sensitive to the value chosen for the elasticity of demand response to advertising, but were unlikely to be positive based on past estimates of the relevant parameter values. Returns to producers were also dependent on assumptions made about the trade status of the industry and the way in which the advertising was funded.

1. Introduction

Over the last fifteen years the structure of the Australian pig meat industry has changed significantly. Increased international competition, trade policy reforms and food safety concerns have exposed the industry to global market conditions. Prior to 1990, pig meat in Australia was almost exclusively produced for the domestic market as quarantine restrictions limited imports to minimal quantities of canned hams. Revisions of quarantine regulations in subsequent years have contributed to a sharp increase in the quantities of imported pig meat entering Australia (see Figure 1). Imported pig meat in carcass weight equivalent terms, comprised only one per cent of Australian pig meat consumption in 1990, but by 2002 this share had grown to represent nearly 20 per cent of consumption (APL 2003b). Approximately 94 per cent of total pig meat imports are fresh, chilled or frozen cuts that must be boned out prior to shipment, cooked on arrival in Australia (as required by quarantine) and used in the manufacturing of bacon, ham and smallgoods (APL 2002a). Consequently, the majority of imported pig meat competes directly with, and displaces, locally produced product on the domestic processed pig meat market. Subsidised pork products originating from Canada and Denmark accounted for more than 90 per cent of total import quantities in 2002 (APL 2003b). The adverse impact of these imports on the domestic pig meat industry has been well-documented (Productivity Commission 1998, Griffith and Chang 2000).

Figure 1. Australian Pig Meat Imports and Exports, 1990-2000



Coinciding with the recent surge in imports has been the development of Australia's export markets (also shown in Figure 1). The Australian pig meat industry has been able to capitalise on its 'disease free' status following food safety concerns associated with animal disease outbreaks throughout the world, and proximity to Asia has enabled Australian exporters to access and expand shipments of pork into the Singapore and Japanese markets. In 2002, exports of pig meat accounted for approximately 20 per cent of Australian pig meat production compared to only three per cent in 1990 (APL 2003b).

In July 2001 Australian Pork Limited (APL) took over the roles and responsibilities of the former Pig Research and Development Corporation, Australian Pork Corporation and Pork Council of Australia. APL is funded by government contributions and statutory levies, which are primarily directed into policy, research and development, and marketing activities. Domestic producers currently pay a levy of $2.43 per head on every pig slaughtered for human consumption and of this amount, two-thirds or $1.65 is allocated to marketing (APL 2003a). Total levy funds for the 2002-03 financial year amounted to $13.4 million (APL 2003c). In the marketing area, APL mainly undertakes generic advertising of fresh pork in Australia, either individually or in conjunction with retail outlets. Brand advertising of processed pig meat such as bacon and ham is more likely to be undertaken by a specific manufacturer.

In response to concerns expressed by Australian pig producers about the increased competition from imports, APL launched a major national marketing campaign in March 2003 aimed at increasing domestic consumption of pork. Domestic marketing expenditure undertaken by APL in 2001-02 totalled $5.3 million whilst total export marketing was $3.5 million (APL 2002c). Export marketing expenditures are expected to decline over the 2003-2005 period, however, allocations of domestic marketing expenditure for each of those years are forecast to be at least 15 per cent above the domestic marketing expenditure for 2001-02.

The merits of generic advertising strategies have been a topic of much discussion in recent times (see for example, Freebairn, Goddard and Griffith 2004). The importance and accountability of

producer-funded expenditure is no more relevant than at the present time. Australian pig producers now compete in a global market face and direct competition from subsidised lower priced imports and higher production costs as a result of the 2002 drought. APL calculated a 24 per cent increase in the average indicative national cost per kilogram of producing pigs between October 2001 and December 2002 (APL 2002b). This was directly attributed to a 73 per cent increase in Australian feed grain prices in the 12-month period ending November 2002. Efficient allocation of producer-funded advertising investment dollars is essential to achieve the highest possible return at any time, but more so in the current difficult trading environment.

This paper develops an equilibrium displacement model (EDM) of the Australian pig meat industry to assess the economic impacts of advertising campaigns on returns to pig producers. Morris, Mullen, Griffith and Wohlgenant (1991) developed such a model, but in the context of the pre-1990s non-trading environment. This paper has three broad aims.

Firstly, to update and extend the research of Morris *et al.* (1991) by developing a model that reflects the industry in its present form. This includes a separate sector representative of the export industry and an allowance for substitution between imported pig meat and domestically produced carcasses in the manufacturing of processed pig meat;

Secondly, to provide a relatively disaggregated framework, both vertically and horizontally, of the Australian pig meat industry to enable returns among various industry sectors and markets from other types of changes, such as new technologies, to be estimated; and

Thirdly, and more specifically, to estimate and compare the returns to pig producers from advertising in the domestic pork market, advertising in the export pork market, and advertising in the domestic processed pig meat market. In total, seven advertising scenarios are examined under a number of different assumptions.

This is the same type of model developed for examining R&D and advertising scenarios in the Australian beef industry, published in an earlier volume of this *Review* (Zhao, Griffith and Mullen 2001).

2. The Structural Model[1]

The structure of the model depicting the Australian pig meat industry is shown in Figure 2. Each rectangle represents a production function and each arrowed line represents the supply and demand for a product, with the non-arrowed end indicating the supply of the product and the arrowed end indicating the demand for the product. The supply and demand schedules, where an exogenous shift may occur, are represented by the ovals.

Figure 2: Model Structure

Horizontally, the industry is modelled as three main sectors producing exported pork, domestically consumed pork and domestically consumed processed pig meat. The three sectors are linked in farm production and the domestic pork and processed pig meat sectors are also linked by substitution in consumption. Vertically, the Australian pig meat supply chain consists of a series of linked and interacting sectors with some producers undertaking activities in more than one sector. In some cases, links extend from pig farming through to the processing of pig meat into bacon, ham and smallgoods. Larger abattoirs operate their own boning rooms but independent boning rooms, butchers, supermarkets and bacon, ham and smallgoods manufacturers also process a significant number of carcasses.

Vertical disaggregation of the industry as represented in the model is subject to a number of assumptions. The slaughtering and initial processing sectors are thought of as undertaking all activities, using processing inputs and suitable pigs, necessary to produce pork for the export market, and wholesale carcasses of porkers and baconers for further processing in the respective domestic sectors. The domestic pork primary processing sector undertakes boning and cutting operations, and distributes cuts of meat to the retail sector and food service industry. The process involves cutting the carcass into primal cuts such as shoulders, middles and legs, and the treatment of primal cuts to obtain end use products. This sector is assumed to include vertically integrated abattoir-boning rooms, independent boning rooms and butchers or supermarkets that

may undertake the same process. The secondary-processing sector is assumed to carry out all boning, cutting, manufacturing and distribution activities necessary to supply bacon, ham and smallgoods to the retail sector and food service industry. The sector can purchase carcasses, half carcasses or boned/unboned primal cuts for use in manufacturing, depending on the price of each. For consistency within the model it is assumed that this sector purchases wholesale carcasses from the slaughtering and initial processing sector and has a choice between purchasing domestically produced wholesale carcasses or imported cuts of pork.

For this analysis, a few further simplifying assumptions relating to the structure of the industry have been made:

The fresh pork market (export and domestic) is assumed to comprise 40 per cent of total pig meat production with the processed pig meat market comprising 60 per cent of total pig meat production. (McElhone, C. 2003, pers. comm).

Exported pig meat classified under tariff code sub-heading 0203 (APL 2002a) comprising fresh, chilled or frozen, carcasses, half carcasses and cuts of meat account for approximately 94 per cent of total pig meat exported. Roughly four per cent of total exports are offal and edible livers with the remaining two per cent consisting of preserved pig meat (APL 2002a). Preserved pig meat, offal and livers are not included due to the small share of total exports represented by each. It is assumed that total exports consist entirely of pork classified under tariff code sub-heading 0203 (APL 2002a).

Approximately 94 per cent of all imported pig meat is used in the secondary processing sector. Imported pig meat in this category also falls under tariff code sub-heading 0203 and must be boned out prior to arriving in Australia. The remaining six per cent of total imports are preserved prior to shipment and are sold at the retail level (APL 2002a). Preserved or processed imports are not included in the model and it is assumed that 100 per cent of imports are used in secondary processing.

Wohlgenant (1997) has shown that producer surplus measures may be incorrect when there are infra-marginal firms, as the shape of the supply curve for the industry may differ from that of an individual firm. To accurately calculate producer surplus changes under these circumstances, additional information such as the distribution of firms by cost structure are needed. This is particularly relevant when analysing the impact of a shift due to technical change. Although shifts of this nature are not examined in this paper, an objective is to develop a model capable of permitting such changes to be implemented. Therefore, it is assumed that all sectors within the industry are characterised by constant returns to scale.

The structural model of the Australian pig meat industry based on these assumptions is fully specified in Mounter *et al.* (2004). This model defines equilibrium in all markets. As can be determined from Figure 2, there are 12 product markets comprising a possible 24 endogenous price and quantity variables. The export price is assumed to be endogenous in the model due to the disease free, niche positioning of Australian pork in export markets. Thus Australian pork is different from other sources of pork sold in these markets. However, the import price is assumed to be exogenous, so that imported pork from all sources is assumed to be identical. Also, there is one aggregated input index variable and one aggregated output index variable for the multi-output slaughtering and initial pork-processing sector. Hence the model is a system of 25 equations with 25 endogenous variables. The exogenous variables include the import price, the six supply shifters representing the impact of new technologies (the T variables) and the three demand shifters representing the impact of advertising (the N variables). Integrability conditions such as homogeneity and symmetry have been imposed implicitly.

The equilibrium displacement version of this model, the version used to conduct the simulation experiments, is outlined in the Appendix. Definitions of the variables and parameters in this model are given in Table 1.

Table 1: Definition of Variables and Parameters

Endogenous Variables:	
X_1:	Quantity of exported pork
X_2:	Quantity of domestic pork

X_3: Quantity of domestic bacon

X_5: Quantity of initial processing inputs in the pork industry

X_6: Quantity of initial processing inputs in the bacon industry

X_7: Quantity of wholesale pork carcass for primary processing in the domestic pork industry

X_8: Quantity of wholesale baconer carcass for secondary processing in the domestic bacon industry

X_9: Quantity of primary processing inputs in the domestic pork industry

X_{10}: Quantity of secondary processing inputs in the bacon industry

X_{11}: Quantity of porkers

X_{12}: Quantity of baconers

X_{14}: Quantity of imported pig meat for secondary processing in the bacon industry

P_1: Price of export pork

P_2: Price of pork at retail

P_3: Price of bacon at retail

P_5: Price of initial processing inputs in the pork industry

P_6: Price of initial processing inputs in the bacon industry

P_7: Price of wholesale pork carcass for primary processing in the domestic pork industry

P_8: Price of wholesale baconer carcass for secondary processing in the domestic bacon industry

P_9: Price of primary processing inputs in the domestic pork industry

P_{10}: Price of secondary processing inputs in the bacon industry

P_{11}: Price of porkers

P_{12}: Price of baconers

Z: Aggregated input index of initial processing sector

Y: Aggregated output index of initial processing sector

Exogenous Variables

W_{14}: Price of imported pig meat for secondary processing in the bacon industry

N_1: Demand shifter for export pork

N_2: Demand shifter for domestic pork consumption

N_3: Demand shifter for domestic bacon consumption

T_1: Supply shifter for porkers

T_2: Supply shifter for baconers

T_3: Supply shifter for initial processing inputs in the pork industry

T_5: Supply shifter for initial processing inputs in the bacon industry

T_6: Supply shifter for secondary processing inputs in the bacon industry

T_7: Supply shifter for primary processing inputs in the domestic pork industry

3. Data Requirements

To solve the 25-equation equilibrium displacement model specified in the Appendix, estimates of a number of market parameters and base equilibrium values for all sectors are required. The various Marshallian demand and supply elasticities, and the elasticities of input substitution, product transformation and price transmission, were chosen on the basis of previous empirical estimates, theoretical considerations and the judgement of the authors. The elasticity values used in the model are provided in Table 2. The base equilibrium values and associated cost shares were taken as an average of prices and quantities for the three years 2000-2002 and are summarised in Table 3.

Table 2: Market Elasticity Values

Own price elasticity of demand for pork: $\eta_{(x2, p2)} = -1.2$

Own price elasticity of demand for bacon/ham: $\eta_{(x3, p3)} = -0.9$

Own price elasticity of demand for export pork: $\eta_{(x1, p1)} = -5$

Elasticity of demand for pork with respect to the price of bacon/ham: $\eta_{(x2, p3)} = 0.6$

Elasticity of demand for bacon/ham with respect to the price of pork: $\eta_{(x3, p2)} = 0.2$

Own price elasticity of supply of pigs: $\varepsilon = 1.5$

Inverse of elasticity of supply of input x ($x = X_5, X_6, X_9, X_{10}$): $Sx = 0.2$

Elasticity of price transmission between farm prices of pigs: $\theta = 0.74$

Elasticity of substitution between domestic and imported pig meat: $\sigma_{(x8, x14)} = 0.5$

Allen's elasticity of input substitution between input x and input y: $\sigma_{(x, y)} = 0.1$

Allen's elasticity of product transformation between output x and output y: $\tau_{(x7, x1)} = -0.5$

Quantity share of porkers in total pig meat production : $\beta x_{11} = 0.4$

Quantity share of baconers in total pig meat production: $\beta x_{12} = 0.6$

Table 3: Base Equilibrium Prices, Quantities and Revenue and Cost Shares

	Quantity (X variables, CWE tonnes) Price (P variables, $/kg) Sector revenue (TV variables, $m)	Revenue and Cost Shares
Final Pig Meat Products	Domestic Bacon/Ham $X_3 = 297,991$ $P_3 = 18.65$ $TV_3 = 5557.53$ Domestic Pork $X_2 = 88,101$ $P_2 = 11.97$ $TV_2 = 1054.57$	
Wholesale Carcass	Domestic Bacon Carcass $X_8 = 230,033$ $P_8 = 3.57$ $TV_8 = 821.22$ Imported Carcass $X_{14} = 67,958$ $W_{14} = 2.36$ $TV_{14} = 160.38$ Domestic Pork Carcass $X_7 = 88,101$ $P_7 = 3.70$ $TV_7 = 325.97$ Export Pork Carcass $X_1 = 65,255$ $P_1 = 3.29$ $TV_1 = 214.70$ $TV_{(1+7)} = 540.67$	Bacon/Ham Secondary Processing Cost Shares $k_{X8} = 0.15$ $k_{X10} = 0.82$ $k_{X14} = 0.03$ Pork Primary Processing Cost Shares $k_{X7} = 0.31$ $k_{X9} = 0.69$ Pork Initial Processing Revenue Shares $\gamma_{X1} = 0.40$ $\gamma_{X7} = 0.60$
Live Pig	Baconers $X_{12} = 230,033$ $P_{12} = 2.47$ $TV_{12} = 568.18$ Porkers $X_{11} = 153,356$ $P_{11} = 2.80$ $TV_{11} = 429.40$	Bacon/Ham Initial Processing Cost Shares $k_{X6} = 0.31$ $k_{X12} = 0.69$ Pork Initial Processing Cost Shares $k_{X5} = 0.21$ $k_{X11} = 0.79$

Demand elasticities

While there is a considerable amount of literature dealing with estimated demand elasticities for

pig meat, the availability of disaggregated estimates for fresh pork, bacon and ham is quite limited. Of the studies reviewed, Cashin (1991) is the most recent published study that provides elasticity values for Australian pig meat at a disaggregated level.

Cashin (1991) suggests that fresh pork and ham are substitutes, fresh pork and bacon are complements while ham and bacon are substitutes. In this study, bacon and ham are defined as a composite good and are assumed to be a substitute for pork in consumption. It would be expected that the own-price elasticity of bacon and ham as an aggregate would be smaller in absolute value than the individual own-price elasticities of each. In the base model, -0.9 and -1.2 are used as the bacon/ham and fresh pork elasticities for domestic demand, respectively.

Under the assumption that ham comprises a larger share than bacon in the processed pig meat market, a cross-price elasticity value of 0.6 is used to represent the cross-price elasticity of fresh pork with respect to changes in the price of bacon/ham as a composite good. Similarly, a value of 0.2 is used in the base model to represent the cross-price elasticity of bacon/ham with respect to changes in the price of fresh pork.

While there have been a few studies on the export demand elasticity for Australian beef, there have not been any studies on the export demand elasticity for Australian pork. Scobie and Johnson (1979) estimated a value of -10.3 for the export demand elasticity of Australian beef and Cronin (1979) estimated a value of - 4 when Australian beef is not assumed to be homogeneous with beef from all other countries. Wittwer and Connolly (1993) calculated export beef demand elasticity values of - 4.5 in the short run and -14 in the long run. In an equilibrium displacement model of the Australian beef industry, Zhao (1999) assumed export demand elasticities of -5 and -2.5 for grass fed and grain fed beef, respectively. Balancing the small country argument, that changes in the quantity of Australian pork exports exert little influence on export prices, and the perceived heterogeneity of Australian pork in its major markets, a value of -5 is assumed as the export pork demand elasticity in the base model.

Supply elasticities

Following Morris *et al.* (1991), the long run elasticity of supply of pigs in aggregate is assumed to be 1.5. As they pointed out, individually, the supply of the two pig types are more elastic than this because increases in supply result from an increase in total production and by switching production from one pig type to another in response to relative price changes.

In general, it is believed that, since most of the other inputs in the processing sectors such as labour and capital are not specialised, the supply of these inputs is highly elastic (Zhao 1999). In the case of a nearly perfectly elastic supply for mobile inputs, previous studies have chosen to use a value of 5 (Zhao 1999; Zhao, Anderson and Wittwer 2003). Similarly, a value of 5 is assumed for all other inputs to the pig industry processing sectors in the base model.

Elasticity of price transmission

It is reasonable to expect that there is a close relationship between the farm prices of porkers and baconers due to the possibility of substitution in production. Morris *et al.* (1991) commented that the price relationship could be estimated econometrically given a specification of the differences in feed costs and price differentials for quality. Alternatively, assuming that the supply of processing inputs is close to perfectly elastic, the elasticity of price transmission can be approximated as the ratio of the value of a porker to the value of a baconer. Using average prices and weights in 2002, this value was calculated as 0.74.

Elasticities of input substitution

For each of the industry sectors in the model, estimates for elasticities of input substitution are required. One approach is to assume farm inputs and other processing inputs are used in fixed proportions implying a zero elasticity of substitution. However, even a small degree of input substitution can have a significant impact on the distribution of benefits between producers and consumers (Alston and Scobie 1983; Mullen, Wohlgenant and Farris 1988). Diewert (1981) pointed out that input substitution at the industry level is generally greater than substitution displayed at the firm level. Wohlgenant (1989) estimated a substitution elasticity value of 0.35 for the US pork industry. Most EDM studies of agricultural industries have assumed a value of 0.1 for the elasticity of substitution between farm inputs and other inputs (Mullen, Wohlgenant and Farris 1988; Mullen, Alston and Wohlgenant 1989; Zhao *et al.* 2000; Zhao, Anderson and Wittwer 2003). Consequently, in the absence of any empirical estimates for Australia, an input substitution elasticity of 0.1 has been assumed between farm inputs and other processing inputs for all sectors in the base model.

There are no empirical estimates for the elasticity of substitution between domestically produced pig meat and imported pig meat used in the secondary-processing sector. Dixon *et al.* (1997) used

a value of 2 to represent the elasticity of substitution between various imported and domestic commodities in the ORANI computable equilibrium displacement (CGE) model of the Australian economy. Although it would seem reasonable to assume the substitution between domestic and imported pig meat may be quite high, quarantine restrictions and the decision by some major manufacturers not to use imported product suggest the substitution possibilities are restricted to a certain extent. Here, a value of 0.5 is assumed for the elasticity of substitution between domestic and imported pig meat.

Elasticity of product transformation

In the ORANI model, a value of -2 is assumed for the product transformation elasticities among all agricultural products. For the slaughtering and initial pork processing sector, carcasses produced for the export and domestic markets exhibit some level of heterogeneity. A significant amount of porkers are produced at the farm level specifically for sale in the export market. For example, 55 per cent of total pork exports are sold in the Singapore market where product specifications are for larger and heavier carcasses than those produced for the domestic market. However, some degree of product transformation is possible, as different product specifications are applicable to other export markets and unsold export quantities are inevitably processed in the domestic sector. In the base model, the product transformation elasticity between export and domestic carcasses for the slaughtering and initial pork processing sector is assumed to be -0.5.

Base equilibrium price and quantity values

All quantity values are expressed in terms of carcass weight equivalent tonnes and all prices and quantities, with the exception of retail prices, were obtained from APL. Retail prices were sourced from the Australian Bureau of Statistics (ABS) and *Australian Commodity Statistics* (ABARE 2002). The cost and revenue shares required for the different sectors within the model are derived from the base price and quantity values. The cost shares for other inputs into the processing sectors are calculated as a residual from the specified equilibrium conditions for each sector.

The average annual quantity of pig meat produced for the period 2000 to 2002 was 383,389 tonnes. Under the assumption that pork comprises 40 per cent of total pig meat production, the quantity of pork produced was 153,356 tonnes and the quantity of pig meat produced for the manufacture of bacon/ham was 230,033 tonnes. APL adjusted the shipped weight of exported pork to a carcass weight equivalent basis using a conversion factor of 0.8. Using this conversion factor, the average annual quantity of exported pork was calculated as 65,255 tonnes, leaving the quantity of pork consumed at the domestic retail level as 88,101 tonnes. Similarly, a conversion factor of 0.56 was used to derive an average annual carcass weight equivalent of 67,958 tonnes for imported pig meat. The imported pig meat quantity was added to the quantity of domestically produced bacon/ham to yield total consumption of bacon/ham at the retail level equivalent to 297,991 tonnes.

The farm prices for porkers and baconers of $2.80 and $2.47 per kilogram, respectively, are based on average national dressed carcass weight prices. The average wholesale price was estimated to be $3.70 per kilogram for a pork carcass and $3.57 per kilogram for a bacon carcass, based on Sydney wholesale prices. Export and import prices were calculated as per unit values by dividing the total dollar values of exports and imports by the respective carcass weight equivalent quantities. The average export price for pork was $3.29 per kilogram and the average price for imported pig meat was $2.36 per kilogram. Data were not readily available to enable the calculation of retail carcass weight equivalent prices for pork and bacon/ham. The retail price for pork was obtained from ABARE (2002) and is based on average retail prices of selected cuts of pork (weighted by expenditure) in state capitals. The average retail price of the bacon/ham composite good was obtained from ABS and is based on the average retail price of bacon rashers in state capitals, as price estimates for ham were unavailable. Average retail prices of pork and bacon/ham for the period 2000 to 2002 were estimated to be $11.97 per kilogram and $18.65 per kilogram, respectively. Note that because carcass weight equivalent retail prices for pork and bacon/ham have not been used, the revenues or total sector values specified in Table 3 for the pork and bacon/ham retail-sectors (TV_2 and TV_3) are over-estimated. As a result, the cost shares associated with the other processing inputs used in the pork primary processing and bacon/ham secondary processing sectors (k_{X9} and k_{X10}) are also over-estimated.

In the model, there are six possible exogenous supply shift variables and three possible exogenous demand shift variables. One aim of this study is to determine and compare the returns to pig producers from different advertising scenarios. This involves a separate, hypothetical 1 per cent vertical, parallel shift of the demand curve in each of the markets in which the advertising is assumed to occur. In each of the following scenarios the shift represents a 1 per cent increase in consumers' willingness to pay due to the advertising.

(1) Domestic pork advertising

(2) Domestic bacon/ham advertising

(3) Export pork advertising

(4) Domestic pork advertising (assuming a perfectly elastic export demand)

(5) Domestic bacon/ham advertising (assuming a perfectly elastic export demand)

(6) Domestic pork advertising (assuming no trade)

(7) Domestic bacon/ham advertising (assuming no trade).

The second aim of the study is to calculate the returns to pig producers from actual pork advertising programs.

4. Results

Hypothetical one per cent selected advertising scenarios

In the first set of experiments, advertising is assumed to be effective in shifting the demand curves for the relevant products upwards by one per cent, and the benefits to Australian pig producers of these shifts are calculated. More formally, the percentage changes in the price and quantity variables for each of the seven advertising scenarios are obtained by solving equations (13a) – (37a) (in the Appendix) with the relevant demand shifter set at 0.01. The associated changes in producer surplus are calculated as the sum of the producer surplus changes measured in each of the porker and baconer markets as follows:

where: and

The sum is a measure of the change in producer surplus for the two producer groups as a whole, not an estimate of the producer surplus changes to each producer group (Zhao, Mullen and Griffith 2001). Producer surplus changes for each of the scenarios are presented in Table 4.

Table 4: Producer Surplus Changes ($ million) from Various Hypothetical Advertising Scenarios

Scenario		Δ PS ($m)
Scenario 1	(N_2 =1%)	1.51
Scenario 2	(N_3 =1%)	2.62
Scenario 3	(N_1 =1%)	0.16
Scenario 4	(N_2 =1%)	1.62
Scenario 5	(N_3 =1%)	2.59
Scenario 6	(N_2 =1%)	1.82
Scenario 7	(N_3 =1%)	2.48

The largest changes in producer surplus result from the advertising scenarios involving a one per cent exogenous shift in the demand curve for bacon/ham. These results are consistent with expectations given that the processed pig meat industry is considerably larger than the pork industry. In Scenario 2 (where Australian pork is assumed to exhibit some degree of heterogeneity from pork originating in other countries), the gain to pig producers from domestic bacon/ham advertising is $2.62 million annually. When export demand is assumed to be perfectly elastic, implying that Australian pork is homogeneous with pork from other countries, the return to producers is slightly less (Scenario 5, $2.59 million). Excluding trade from the model (Scenario 7)

results in the smallest change in producer surplus ($2.48 million) of the three-bacon/ham advertising scenarios. The results indicate that in the absence of trade, the changes in producer surplus are less than the gain to producers from the inclusion of trade in Scenarios 2 and 5. It would be expected that surplus changes would be larger if production and consumption were completely confined within the domestic market and insulated from the influence of world prices. However, due to the large differences in the assumed cross-price elasticities, the producer surplus changes are slightly bigger when trade is taken into consideration.

Producer surplus changes associated with a one per cent exogenous shift in the domestic demand for pork reveals that producers would receive the largest returns ($1.82 million) under non-trading circumstances (Scenario 6). When Australian pork is assumed to be homogeneous with other pork (Scenario 4), the benefit to producers is $1.62 million and producers gain $1.51 million when Australian pork is assumed to be a differentiated product from pork in other countries (Scenario 1). The producer surplus changes for the trading and non-trading scenarios in this instance are the reverse of those obtained for the bacon/ham advertising scenarios and are what would intuitively be expected. That is, when an industry operates in a trading environment, the returns from generic advertising would be expected to be less than those if it were in a non-trading environment. This is because adjustment to the displacement of the domestic demand curve may occur in export and import markets as well as in the domestic market, so price rises are curtailed and producer surplus is lower.

The smallest change in producer surplus, from the seven different scenarios, is $0.16 million resulting from a one per cent exogenous shift in export demand (Scenario 3). Exports are a relatively small part of the total industry and demand in this market is quite elastic, even though Australian pork is considered to be different from pork from other suppliers in these markets.

Profitability to producers of the recent increase in advertising expenditure

The hypothetical scenarios described above assume that advertising is effective in shifting demand, and the model estimates what the benefits would be if the various one per cent shifts were to occur. But with only this information, the question of how much expenditure is required to achieve these shifts, cannot be resolved. Information on the values of the elasticities of demand response to advertising as well as the costs involved is required to evaluate the effectiveness of actual or proposed advertising expenditure. A case in point is the $6.9 million of domestic marketing expenditure undertaken by APL in 2002-2003, a 30 per cent (or $1.6 million) increase on the expenditure level of $5.3 million in the previous financial year. Based on the sorts of potential benefits from generic advertising outlined above, it would be useful for industry decision making to evaluate whether this $1.6 million increase in expenditure is likely to generate a positive return to the pig producers who are funding it.

Empirical estimates of the demand response to advertising for Australian pig meat products are scarce. Piggott *et al.* (1996) estimated a value of 0.0122 for pork, using data from 1978 to 1988, but this estimate was not statistically significant from zero. Similarly, Zhang and Goddard (1999) estimated a value of 0.055 for pork using data from 1985 to 1997, but again this estimate was not significantly different from zero. Overseas, Brester and Schroeder (1995) investigated the impacts of brand and generic advertising on US meat demand. The estimated elasticity of demand for pork with respect to branded pork advertising was significant with a value of 0.033; however, generic pork advertising was not significantly different from zero. Duffy and Goddard (1995) examined the benefits to Canadian pig producers of brand versus generic advertising of pork. They found that the relevant advertising elasticity values of 0.101 for fresh pork and 0.048 for ham were significant whereas a value of 0.006 for bacon was not significant. Zhang and Goddard (1999) estimated a statistically significant but negative elasticity of –1.03 for bacon/ham advertising in Australia. There have been no empirical estimates of the elasticity of export demand response to advertising for Australian pork.

Based on the above review, it appears that an evaluation of the effectiveness of pork advertising and the consequent returns to Australian pig producers, is quite straightforward. All previous studies using Australian data and all but one study using North American data have estimated generic pork advertising elasticities not significantly different from zero. So it would not be unreasonable to say that the elasticity of demand response to generic pork is zero. In this case there would no benefit from advertising and producers would incur a loss equal to the amount of the advertising expenditure.

However, it may be useful to calculate changes in producer surplus that would accrue to pig producers from an increase in APL marketing expenditure, for various values of generic pork advertising elasticities, just to get an idea of what the payoff may be if significant advertising responses were found in the future. These producer surplus changes can be estimated for different estimates of the demand response to domestic pork advertising, different trade scenarios, and different ways of funding the advertising expenditure.

In relation to advertising responses, a value of 0.055 is used as the upper bound of the demand response to pork advertising and 0.0122 as the mid-range estimate (and of course zero as the lower bound estimate). In relation to the trade status of the industry, Scenarios 1, 4 and 6 described above are used. Finally, in relation to funding alternatives, a lump-sum and levy-based system are compared.

Lump sum funding option

The change in producer surplus from a 30 per cent increase in advertising can be calculated as , where is the change in producer surplus from the advertising, is the elasticity of demand response to advertising and is the change in producer surplus associated with a one per cent shift in the domestic demand for pork. The benefit-cost ratio (BCR) for each scenario is given by , where is the lump sum (possibly accrued from unspent levies in previous years) corresponding to the 30 per cent increase in advertising expenditure. Since a lump sum is not considered to be a variable cost, there is no impact on the supply curve, but conversely, there is no mechanism whereby producers can pass on any of the lump sum on to other participants in the market. Producers pay all of . The results for each of the three domestic pork trade scenarios are summarised in Table 5.

Table 5: Producer Surplus Changes from a 30% Increase in Domestic Pork Advertising Expenditure Funded by a Lump Sum, Across Different Trade Scenarios and Different Advertising Response Elasticities

	Scenario 1	Scenario 4	Scenario 6
from a 1% shift in domestic demand ($m)	1.51	1.62	1.82
30% change in advertising expenditure ($m) – lump sum	1.60	1.60	1.60
= 0.0122 (mid range)			
($m)	0.55	0.59	0.67
BCR	0.35	0.37	0.42
= 0.055 (upper bound)			
($m)	2.49	2.67	3.00
BCR	1.56	1.67	1.87

The disparity evident in the measurement of producer surplus changes between the mid-range and upper-bound elasticity estimates used highlights the extreme sensitivity of the results to the value chosen for the elasticity of demand response to advertising. When 0.0122 is used as a measure of the elasticity of demand response to advertising, in all three scenarios the returns to producers are considerably less ($0.55m, $0.59m and $0.67m) than the increase in advertising expenditure ($1.6m). The BCRs are all less than one and in fact less than 0.5. In contrast, for the upper bound elasticity estimate of 0.055, the benefits to producers ($2.49m, $2.67m and $3.0m) exceed the outlay in advertising expenditure, and the BCRs lie between 1.5 and 2.0.

In the base case scenario, the elasticity of demand response to advertising would have to exceed 0.035 for pig producers to gain from a generic advertising program for domestic pork, funded by a lump sum.

The producer surplus changes also vary across the three trade scenarios, in a similar way to that shown in Table 4 and described in the text above. That is, the expected returns from a specific generic advertising program would always be expected to be less when the industry operates in a trading environment (Scenarios 1 and 4), than the expected returns if it operated in a non-trading environment (Scenario 6), all else constant. Thus, in the non-traded scenario, the breakeven advertising response elasticity would be a little lower than in the trade scenarios.

Per unit levy funding option

A per unit levy is considered to be a variable cost, so there is an impact on the supply curve, and there is a mechanism whereby producers can pass on some of the levy on to other participants in the market. Thus, the net effects of a generic advertising program funded by a levy depend on the relative sizes of the farm price increase effect of the advertising-induced increase in demand, and the farm price reduction effect of the levy. If there is a net increase in farm price, producer surplus increases.

To model this funding option, the first task is to calculate the per unit levy equivalent of the $1.6 million increase in advertising expenditure. From Table 3, the equilibrium production of baconers equals 230,033 tonnes pa and that for porkers equals 153,356 tonnes pa, or 383,389 tonnes pa in total. Taken from both pork producers and baconer producers, the levy would equal $4.17/tonne,

or 0.417 c/kg. Also from Table 3, the farm price of porkers is $2.80/kg, and the farm price of baconers is $2.47/kg. Thus the supply shifter for porkers (T_1) equals an increase of 0.15 per cent, and the supply shifter for baconers (T_2) equals an increase of 0.17 per cent.

When these two supply shifters are simultaneously implemented into the base model (Scenario 1), the change in producer surplus is calculated to be -$1.37 million. Thus Australian pig producers pay only $1.37 million (or about 85 per cent) of the cost of the generic advertising program. Consumers and other market participants pay the remainder through reduced consumer surplus due to the lower quantities and higher prices emanating from the upward shift in the two supply curves.

Based on the formulae , the implied shift in domestic pork demand (N_2) equals when = 0.0122 and equals 1.650 when = 0.055. These alternate demand shifts were implemented into the base model, simultaneously with the two supply shifts due to the levy. The results are shown in Table 6.

Table 6: Producer Surplus Changes from a 30% Increase in Domestic Pork Advertising Expenditure Funded by a Levy, Across Different Advertising Response Elasticities

	Scenario 1
30% change in advertising expenditure ($m) – levy	1.37
= 0.0122 (mid range)	
Net ($m)	-0.817
BCR	0.60
= 0.055 (upper bound)	
Net ($m)	1.138
BCR	1.83

For the mid-range estimate of the elasticity of demand response to advertising, = 0.0122, the net change in producer surplus from the simultaneous shifts in the demand and supply curves is

-$0.817 million. Based on the approximate levy cost of $1.37 million, this implies a gross change in producer surplus from the advertising of $0.553 million, quite close to the value under the lump sum funding, and a BCR of 0.60. As in the lump sum case, at this level of advertising effectiveness, the costs of the program far outweigh the benefits, although the extent of the losses are a little less because producers have been able to pass on some of the levy cost to other market participants.

For the high-range estimate of the elasticity of demand response to advertising, = 0.055, the net change in producer surplus from the simultaneous shifts in the demand and supply curves is $1.138 million with a BCR of 1.83. Again this is similar to, but a little more favourable, than the lump sum option.

In this base case scenario, the elasticity of demand response to advertising would have to exceed 0.030 for pig producers to gain from a generic advertising program for domestic pork, funded by a levy. This is less than under the lump sum option because the net costs to producers are lower.

The major conclusion however is that without a reliable estimate of the demand response of pork to advertising in the Australian market, the effectiveness of a 30 per cent increase in domestic pork advertising expenditure, with respect to the welfare of pig producers, is indeterminate. It would seem to be a risky business investing an extra $1.6 million in producer funds, whichever way those funds are raised, without any empirical evidence of what the rate of return on this investment may be.

5. Conclusions and implications

In this paper, an equilibrium displacement model of the Australian pig meat industry accounting for imports and exports was specified to study the returns to producers from different advertising scenarios. Total returns in terms of producer surplus gains were estimated for each scenario. The results indicate that producers receive the largest potential returns from domestic bacon/ham advertising and the least from export pork advertising. Producer surplus changes associated with a 30 per cent increase in domestic pork advertising expenditure were calculated for three different scenarios, including a hypothetical no-trade scenario. Returns to producers were shown to be sensitive to the value chosen for the elasticity of demand response to advertising, but were unlikely to be positive. Based on the assumptions made in the development of this model, a

significant value of the demand response to advertising of at least 0.035 would be required to be able to demonstrate a positive impact on producer profits from the recent 30 per cent increase in APL advertising expenditure. Given the lack of current knowledge about the value of this parameter, it would seem to be an urgent area for future study.

Aside from the value of the elasticity of demand response to advertising, a degree of caution about some other issues needs to be exercised when interpreting the results reported here. Elasticity estimates for the other market parameters in the model were specified on the basis of previous work and judgement of the authors. The results from the EDM may vary considerably depending on the values specified for the market-related parameters. The sensitivity of the base model results to changes in any of the market parameters could be further studied using a stochastic approach to sensitivity analysis as proposed in Zhao *et al.* (1999) or Vere *et al.* (2003).

As suggested by a referee, this will be the subject of a follow-up analysis.

Another crucial assumption relating to the model is that all sectors within the Australian pig meat industry exhibit perfectly competitive behaviour. Supply chain developments have seen a reduction in the number of producers, meat wholesalers, butchers and independent supermarkets (Ramsey 2002). Supply chains increasingly exhibit overlapping and interacting segments, with retailers and manufacturers sourcing product from 'preferred' suppliers capable of providing the critical mass required to meet their demand. The rapid structural change in recent years and evidence of extensive vertical integration in the supply chain, highlight the need for studies focused on determining the competitive behaviour of the industry and its sectors. However, the more that industry structure deviates from a competitive market, the less likely it is that producers will benefit from generic advertising (Zhang and Sexton 2002).

Finally, pig meat products are generally regarded as substitutes in consumption with beef, lamb and chicken. The partial equilibrium nature of the model developed in this study does not allow for market interactions with other meat products to be taken into account. Although a model accounting for interaction with other meat industries would be more realistic, the measurement of economic surplus changes become much more complicated when more than two products are related in supply and demand (Zhao 1999). A more complete analysis of the impacts arising from advertising might be possible using a two-stage approach as suggested by Zhao (1999). This would incorporate an exact approach involving explicit specification of profit and expenditure functions to study the general equilibrium interaction between meat industries, and a partial equilibrium framework to estimate the distribution of welfare changes among individual sectors within the pig meat industry. Again however, the more that cross-commodity interactions are taken into account, the less likely it is that producers will benefit from generic advertising (Dent *et al.* 2003).

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Appendix 1. The Model in Displacement Form

Equations (13a)-(37a) reported below are derived by totally differentiating the system of general functional form equations (13)-(37) described in Mounter *et al.* (2004). The equations are differentiated at the initial equilibrium points and all market parameters refer to elasticity values at the initial equilibrium points (Zhao 1999). A small finite relative change of variable is expressed as . The equation numbers are kept the same as in the source document for ease of comparison.

Supply of Pigs

(13a)

(14a)

Other Slaughtering and Initial Pork Processing Inputs Supply

(15a)

Output Constrained Input Demand of Slaughtering and Initial Pork Processing Sector

(16a)

(17a)

Input Constrained Output Supply of Slaughtering and Initial Pork Processing Sector

(18a)

(19a)

Slaughtering and Initial Pork Processing Sector Equilibrium

(20a)

(21a)

Export Demand for Australian Pork

(22a)

Other Domestic Pork Primary Processing Inputs Supply

(23a)

Output Constrained Input Demand of Domestic Pork Primary Processing Sector

(24a)

(25a)

Domestic Pork Primary Processing Sector Equilibrium

(26a)

Domestic Pork Retail Demand

(27a)

Other Slaughtering and Initial Bacon/Ham Processing Inputs Supply

(28a)

Output Constrained Input Demand of Slaughtering and Initial Bacon/Ham Processing Sector

(29a)

(30a)

Slaughtering and Initial Bacon/Ham Processing Sector Equilibrium

(31a)

Other Bacon/Ham Secondary Processing Inputs Supply

(32a)

Output Constrained Input Demand of Bacon/Ham Secondary Processing Sector

(33a)

(34a)

(35a)

Bacon/Ham Secondary Processing Sector Equilibrium

(36a)

Domestic Bacon/Ham Retail Demand

(37a)

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[1] The material in this section is quite technical, justifying in formal economic terminology why the model is constructed in the way that it is. The full structural model is described in Mounter *et al.* (2004) for readers who wish to work through these details. The equilibrium displacement form of the model is retained in an Appendix, as that is the form that is solved in the simulation experiments and to which the data requirements relate. Other readers may fast-forward to Section 3.

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