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Generic advertising without supply control: implications of funding mechanisms for advertising intensities in competitive industries†

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Producer profit-maximising rules for generic commodity advertising programs and associated funding levies are derived. Lump-sum, per unit and ad valorem levies, and government subsidy funding arrangements are compared and contrasted. The initial single-product competitive market model is extended to incorporate international trade, government price policies, and multiple commodity interactions.

1. Introduction

Generic commodity advertising programs are an important feature of Australian agriculture (IAC 1976) and of agriculture in other countries (in the United States, for example, Forker and Ward (1993), and Vande Kamp and Kaiser (1999), estimate annual expenditure at over US$1 billion). Many commodities have some generic advertising (especially livestock products, including dairy, meats, wool and eggs, and tree crops such as apples, citrus, and various nuts). For some commodities, producer levies to fund generic advertising have been as high as 2 per cent of gross sales, and in some cases, especially where exports are involved, governments have provided matching grants. This article reviews and extends models for determining generic advertising expenditure, and associated producer levy rates, that would maximise net returns or profits to commodity producers, and clarifies the effects of differences in funding mechanisms and market situations on the producer optimum.[1]

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[1] No assessment is made about the more controversial implications of advertising for the welfare of buyers and of society.

There is a very large literature on modelling the choice of profit-maximising advertising. Most of the industrial organisation literature in this area considers the case of firms with market power, including monopoly, oligopoly and monopolistic competition, where firms have control over supply as well as advertising. In the context of generic advertising of agricultural commodities, our interest is with firms acting as price takers, and the advertising choice takes a competitive supply response as beyond the control of the organisation in charge of the advertising and other promotional decisions.

Models of generic advertising also vary in terms of their treatment of the source of funding. Here we distinguish between whether the funds are regarded as a lump-sum charge, as was initially studied by Nerlove and Waugh (1961) and more recently by Goddard and McCutcheon (1993), or collected as a levy. We draw a further distinction between a specific (per unit) levy and a percentage (ad valorem) levy. IAC (1976), De Boer (1997) and Chang and Kinnucan (1991) present diagrams to represent a model of levy-based promotion, and Alston *et al.* (1994), Alston *et al.* (1998), and Kinnucan (1999a, b) provide more formal analyses. In addition, we evaluate the case where the government provides a grant to supplement the producer levy (see also Kinnucan and Christian 1997). Not surprisingly, the source of funds affects the profit-maximising level of generic advertising and levy rates.

Most of the reported models consider the case of a closed economy or non-traded commodity. Kinnucan (1999a) and Cranfield and Goddard (1999) specifically allow for trade, and this is a more realistic framework for consideration of generic advertising for most agricultural commodities in most countries, including Australia. As we show, recognition of the export or import status of an agricultural commodity influences the producer profit-maximising level of generic advertising

A number of other model extensions to capture greater realism have been considered. These include explicit allowance for the effects of policy interventions, for example, Goddard and Tielu (1988) and Kinnucan (1999b), and multi-stage production systems, for example, Wohlgenant (1993). Of recent interest, and with likely important implications, are multi-product models that recognise a number of cross-product effects of generic advertising flowing from one product to another. Here the studies by Piggott *et al.* (1995), Hill *et al.* (1996), Kinnucan (1996) and Kinnucan and Miao (2000) point to the different cross-product price and advertising effects influencing producer returns, but they do not formally derive profit-maximising levels of generic advertising and associated levy rates.

In this article we synthesise these various elements within a unified framework to show the differences in results for producer's optimal advertising expenditures, with different funding mechanisms, and under a range of market and policy situations. The rest of the article is organised as follows. Diagrams and algebra are used to derive profit-maximising advertising strategies. Initially, we consider a single commodity, closed economy, with no government intervention. For this case we derive producer profit-maximising advertising and levy rates for the cases of lump-sum funding, and funding by per unit and ad valorem levies; and, in the case of a per unit levy, we allow for a matching government subsidy. The next section adds an international dimension, with most of the emphasis on an export commodity. Then we compare and contrast the marginal conditions and elasticity rules for the producer profit-maximising advertising levels and levy rates derived under the different funding options and trade status. We illustrate how government policy interventions can be incorporated into the models and how they can alter producer profit-maximising choices. Then we note some of the likely implications of taking into account multiple-product interactions as they affect producer profit-maximising generic commodity advertising strategies, and suggest further directions of analysis. Finally we discuss some implications of our analysis for the specification of econometric models of the demand response to advertising and summarise the main findings.

2. Profit-maximising advertising in a closed economy

We begin with a single-market model of supply, demand, and market equilibrium for a commodity, say, wool or bananas, and then we specify special features for the different options to fund advertising expenditure. Functions for demand, supply and market clearance specified at the farm level are given by:[2]

$$Q^d = f(P, A; Z_d) \tag{1}$$

$$Q^s = g(P_p; Z_s) \tag{2}$$

$$Q = Q^d = Q^s \tag{3}$$

where Q is quantity supplied and demanded, P is buyer price, P_p is producer price, A is the advertising expenditure,[3] and Z_d and Z_s are demand and supply curve shift variables (which are ignored in the remainder of the

[2] The demand function at the farm level can be considered a derived demand taking into account retail demand and the farm-to-retail marketing activities of transport, storage, processing, and distribution.

[3] In this article we take A to measure the opportunity cost of funds. This means we can drop the ρ term found initially in Nerlove and Waugh (1961) and some subsequent work.

article). Advertising, if effective, shifts out the demand curve, that is $\partial Q^d/\partial A > 0$, and it may reduce (or increase) the elasticity of demand, that is $\partial^2 Q^d/\partial P \partial A >$ (or $<$) 0.

The way in which the advertising is funded influences the producer profit-maximising expenditure on advertising, because it influences the share of advertising costs ultimately borne by the producers. Under a lump-sum funding arrangement, producers both pay and bear all the final economic incidence of the costs of advertising, and the net producer price is the market price ($P_p = P$). In the case of a per unit (fixed, or specific) levy, for example, \$T per kilogram of wool or bananas, advertising expenditure is equal to the levy times output ($A = TQ$), but some of the economic costs are passed on to consumers, and the net producer price is the market price minus the levy ($P_p = P - T$). With an ad valorem levy at a rate t, for example, $t * 100$ per cent of the value of wool or banana sales, advertising expenditure is equal to the levy times the value of sales ($A = tPQ$), and the net producer price is a fraction $(1 - t)$ of the market price ($P_p = (1 - t)P$). Finally, when the government provides a subsidy, for example, \$$x$ per \$ of producer funds raised by a levy collected from growers, the advertising expenditure is greater than both the levy revenue and the producer cost.

In all the cases below, both the advertising expenditure and the associated levy rate, if relevant, are chosen to maximise producer profit or quasi-rent. Profit, π, is

$$\pi = PQ - TVC - A \tag{4}$$

where P and Q are price and quantity determined by market equilibrium of equations (1), (2) and (3), A is advertising expenditure from producer funds raised by commodity levies or lump-sum assessments, and TVC is total variable cost, or the integral of the competitive supply curve in equation (2) so that:

$$TVC = \int g^{-1}(P_p)dQ. \tag{5}$$

(Implicitly we assume the absence of avoidable fixed costs or no change in avoidable fixed costs when we measure changes in profit as changes in producer surplus.) In the model solutions below we use the converse result that $dTVC/dQ = MC$ (where MC is marginal cost), and under competitive behaviour producers choose output to equate MC and P_p, so that MC corresponds to the supply curve, given by equation (2). With this model framework, we consider the profit-maximising advertising expenditure, A, and levy rates T and t if relevant, in turn for each of the advertising funding options.

2.1 Lump-sum funding

Nerlove and Waugh (1961) first developed the optimal rule for advertising given lump-sum funding. Figure 1 illustrates the story. Initially, D_0 is demand, S_0 is supply, P_0 and Q_0 are the market-clearing price and quantity, and area aP_0e is producer surplus or industry profit.

An increase in effective advertising (by dA) shifts the demand curve out. One perspective shown in figure 1 is a parallel outwards shift to D_1, with $ef = (\partial Q/\partial A)dA$. The new equilibrium is at price P_1 and quantity Q_1, and gross producer surplus increases by area P_0P_1ge. Alternatively, advertising also may make demand less elastic, say, shifting the demand curve from D_0 to D_2 (passing through point f). Note that, in comparing the shift of demand to D_2 rather than D_1, a case where demand becomes more inelastic as well as the curve shifting outwards, the new equilibrium at h is at a higher price and quantity, with a larger increase in gross producer surplus. If the supply curve at some time in the future were to shift downwards, say, because of R&D, a more inelastic demand might mean lower producer surplus in time, as was pointed out by Quilkey (1986). For completeness, we could consider other advertising strategies that shift demand out, but not as far as point f, and make it less elastic, with the new price-quantity equilibrium outcome

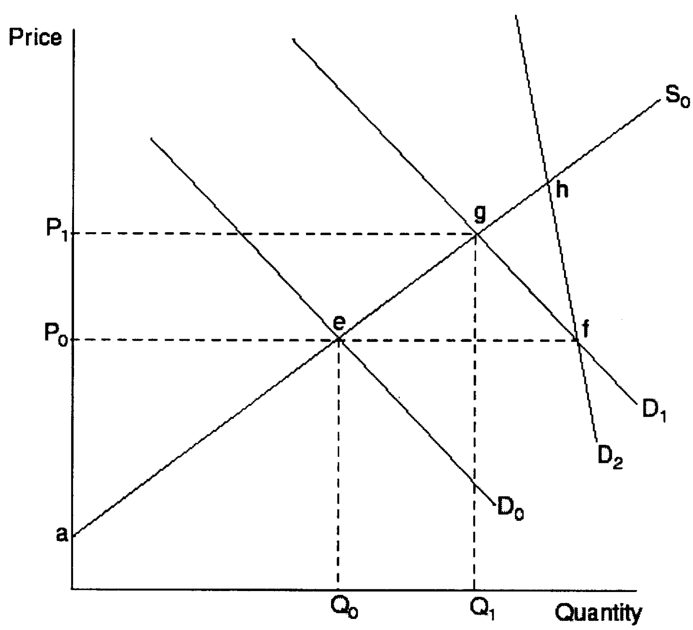

Figure 1 Lump sum funding model

being to the left or right of point g; or advertising might result in a more elastic demand curve.

Intuitively, the profit-maximising advertising expenditure would be that amount where the marginal gross benefit from additional advertising, given by $(dP/dA)Q$, equals the marginal cost of advertising, which is one $(dA/dA = 1)$. An expression for the profit-maximising lump-sum expenditure on advertising can be derived more formally by solving for the value of A that will maximise profit π in equation (4) subject to equations (1), (2) and (3). Taking the derivative of π in equation (4) and setting it to zero:[4]

$$\frac{d\pi}{dA} = 0 = P\frac{dQ}{dA} + Q\frac{dP}{dA} - \frac{dTVC}{dA} - 1 \tag{6}$$

Now, expanding $(dTVC/dA) = (dTVC/dQ)(dQ/dA)$, recognising that $dTVC/dQ = MC = P$, the first and third right-hand terms of equation (6) cancel, and the first-order necessary condition from equation (6) can be expressed as:

$$Q\frac{dP}{dA} = 1. \tag{7}$$

In equation (7), the left-hand side represents the marginal revenue gain from more advertising, and the right-hand side is the marginal cost of a dollar increase in the lump-sum advertising budget.

An expression for dP/dA in equation (7) can be obtained by taking total derivatives of the market demand and supply curves (1) and (2) and equating them via equation (3).[5] After substituting for dP/dA in equation (7), and some rearrangement, we obtain:

$$Q\frac{\partial f}{\partial A} = \frac{\partial g}{\partial P} - \frac{\partial f}{\partial P} \tag{8}$$

which can be used to find the optimal value for A, given the marginal effect of advertising on demand, $\partial f/\partial A$, and the price slopes of demand and supply, $\partial f/\partial P$ and $\partial g/\partial P$. Alternatively, equation (8) can be re-expressed as:

$$\phi^{LS} = \frac{A}{PQ} = \frac{\alpha}{\varepsilon + \eta} \tag{9}$$

[4] For simplicity we assume an interior solution. As noted by a referee, in some cases the optimum solution will be a corner solution of zero advertising. An implicit assumption when we say that we have found a maximum is that the marginal return from the advertising is downward sloping (i.e., that $\partial^2 Q/\partial A^2 < 0$) which means that the advertising elasticity is positive but less than one (i.e., $0 < (\partial Q/\partial A)(A/Q) < 1$).

[5] Full details of the derivation of these and other formulae are available from the authors.

where $\alpha = (\partial f/\partial A)(A/Q)$ is the elasticity of demand with respect to advertising, $\eta = -(\partial f/\partial P)(P/Q)$ is the absolute value of the own-price elasticity of demand (i.e., $\eta > 0$), $\varepsilon = (\partial g/\partial P)(P/Q)$ is the elasticity of supply, and $\phi^{LS} = A/(PQ)$ is the profit-maximising advertising intensity (advertising expenditure as a share of total revenue), with all elasticities measured at the profit-maximising equilibrium point. Equation (9) is the Nerlove–Waugh rule for choosing a profit-maximising, lump-sum advertising budget.

2.2 Per unit levy funding

In most cases generic advertising of agricultural products is funded by a levy on output collected from producers (or the first handler of a farm product), either a fixed (or per unit quantity) levy, or an ad valorem levy. Figure 2 illustrates the situation for a fixed levy. As for figure 1, in figure 2, in the initial situation, D_0 is demand, S_0 is supply, P_0 and Q_0 are the market-clearing price and quantity, and area aP_0e is producer surplus or industry profit.

Collection of a levy, which is used to fund generic advertising, can be analysed as a shift of both the demand curve and the supply curve. Advertising, as before, shifts demand outwards to D_1. At the same time, the

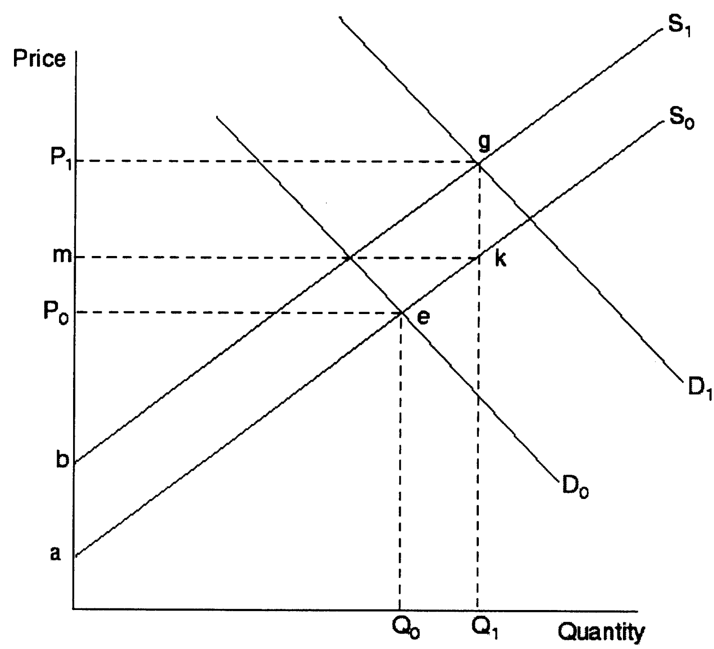

Figure 2 Per unit levy funding

per unit levy adds to variable and marginal costs, with the latter moving the supply curve upwards by the amount of the levy to S_1. A new equilibrium is established with a higher price and quantity, at P_1 and Q_1, respectively. Producer surplus becomes area $bP_1g(= akm)$. The net gain in producer surplus is $bP_1g - aP_0e$, or area P_0mke. The levy will increase so long as the additional sales revenue gained exceeds the extra levy costs and the increased costs of production associated with greater output. At the optimum, the vertical increase in demand (from a marginal increase in advertising) just balances the vertical shift in supply (from an increase in the levy to finance the marginal increase in advertising) so that the quantity produced and consumed, and producer surplus, do not change (i.e., $dP/dA = dP/dT$ and $dQ/dT = 0$).

We wish to derive an expression for the levy, T (and the associated advertising expenditure, A, that will maximise π in equation (4) given equations (1), (2), and (3), and subject to the constraints that advertising expenditure is equal to the amount of revenue raised by the levy (i.e., $A = TQ$) and that net producer price is $P_p = P - T$. To do this, we substitute for $A = TQ$ in equation (4), take the derivative of π with respect to T, and set it to zero, which gives the profit-maximising first-order necessary condition:

$$\frac{d\pi}{dT} = 0 = P\frac{dQ}{dT} + Q\frac{dP}{dT} - \frac{dTVC}{dT} - Q - T\frac{dQ}{dT}. \tag{10}$$

Then, using $dTVC/dT = (dTVC/dQ)\ (dQ/dT)$, and recognising that $dTVC/dQ = P_p = P - T$, the first, third, and last terms on the right-hand side cancel, and the first-order condition in equation (10) can be expressed as:

$$Q\frac{dP}{dT} = Q, \text{ or } \frac{dP}{dT} = 1. \tag{11}$$

In equation (11), the left-hand side (QdP/dT) is the marginal gain in revenue from extra advertising funded by an incremental increase in the levy, and the right-hand side (Q) is the marginal cost of an increase in the levy. At the maximum, a marginal increase in the levy to fund advertising increases marginal cost by the same amount as the extra advertising in shifting out demand increases price, and hence $dQ/dT = 0$, and producer surplus (or profit) is unchanged.

To obtain an expression for dP/dT in equation (11), we take the total derivatives of the market demand and supply curves (1) and (2), recognising that $P_P = P - T$ and $A = TQ$, and equate them using the market clearing identity (3). After substituting the resulting expression for dP/dT in (11), and cancelling some terms, we obtain:

$$Q\frac{\partial f}{\partial A} = -\frac{\partial f}{\partial P} \tag{12}$$

Further manipulation of equation (12) to obtain elasticities leads to the following condition for the profit-maximising levy and advertising intensity:

$$\phi^{PU} = \frac{A}{PQ} = \frac{T}{P} = \frac{\alpha}{\eta} \tag{13}$$

where ϕ^{PU} is the optimal advertising intensity funded by a per unit levy, T/P is the levy as a proportion of the market price, and, as before, α is the advertising elasticity and η is the absolute value of the demand price elasticity.

Note that, coincidentally, equation (13) is the same as the Dorfman–Steiner advertising rule, but it is derived for very different circumstances and the parameters represent different forces. Dorfman and Steiner (1954) considered the case of a price-maker who chooses production and advertising to equate marginal cost and marginal revenue, with marginal revenue below market price. Essentially, assuming a constant price and marginal cost (or, less strongly, a constant margin of price less marginal cost) around the profit-maximising point, the seller's benefit from extra sales driven by advertising (measured by the advertising elasticity), is equal to price less marginal cost. For a monopolist, the margin of price minus marginal cost is equal to price times the inverse of the demand elasticity. In contrast, the context here is one of collective action in advertising by a set of price-taking producers without supply control powers, such that production is chosen to equate marginal cost with price, not the industry marginal revenue. At the profit-maximising advertising level and levy rate, quantity is constant, that is, $dQ/dT = 0$. The inverse of the demand elasticity is used to convert the quantity-expansion effect of advertising into a price-increase effect, and it is the price-increase effect that determines the benefits from generic advertising for the industry with competitive producers.

2.3 Ad valorem levy funding

Compared with the per-unit levy, which causes a parallel shift upwards of the supply curve, an ad valorem levy results in a proportional shift of the supply curve, but otherwise the story is similar. We wish to derive an expression for the levy, t, that will maximise π in equation (4) given equations (1), (2), (3), and subject to the constraints that advertising expenditure is equal to the amount of revenue raised by the levy (i.e., $A = tPQ$) and that the producer price is given by $P_p = P(1 - t)$. To do this, we substitute for A in equation (4) and take the derivative of π with respect to t, and set it to zero, which gives the first-order necessary condition for profit maximisation:

$$\frac{d\pi}{dt} = 0 = Q(1-t)\frac{dP}{dt} + P(1-t)\frac{dQ}{dt} - \frac{dTVC}{dt} - PQ. \tag{14}$$

Expanding the second last right-hand term — using $dTVC/dt = (dTVC/dQ)(dQ/dt) = P(1-t)(dQ/dt)$ — the first-order condition from equation (14) can be expressed as:

$$\frac{dP}{dt} = \frac{P}{1-t}. \tag{15}$$

To obtain an expression for dP/dt in equation (15) involves taking total derivatives of the demand and supply equations (1) and (2), and using $A = tPQ$ and $P_p = (1-t)P$. Substituting for dP/dt in equation (15), the first-order condition can be restated as:

$$\frac{\partial f}{\partial A} Q = -\frac{\partial f}{\partial f} \tag{16}$$

which can be expressed in terms of the profit-maximising advertising intensity and elasticities of demand with respect to price and advertising as:

$$\phi^{AV} = \frac{A}{PQ} = t = \frac{\alpha}{\eta} \tag{17}$$

where ϕ^{AV} is the optimal advertising intensity funded by an ad valorem levy, t, and all the terms are as defined above. Note that the producers' optimal levy is the same, regardless of whether it is specified as per unit or ad valorem, which can be seen by noting that $t = T/P$ and comparing equations (13) and (17).

2.4 Government subsidy for promotion

In some cases governments top up or provide a matching grant for industry-provided funds for advertising, effectively an advertising subsidy. For example, in Australia prior to 1993–94, producer wool promotion levies were matched dollar for dollar, and in Japan governments contribute to the generic advertising of fluid milk (Suzuki *et al.* 1994). In the United States, subsidies have applied for export promotion under the Temporary Export Assistance (TEA) program, established under the 1985 farm bill, and the Market Promotion Program (MPP) established under the 1990 farm bill.[6]

[6] Ackerman and Henneberry (1992) discuss the programs, and various papers in Nichols *et al.* (1991), for example, provide more specific analysis of US export promotion programs with support from the TEA program. Vande Kamp and Kaiser (1999) provide more recent data.

This kind of government subsidy could be specified as a lump sum, or as a per unit or ad valorem rate. Here, we consider an alternative case where the government provides a matching grant in proportion to the amount raised by a per unit levy, raising the advertising budget from $A = TQ$ to $A = (1 + x)T^M Q$ where x is the proportion of the budget provided by the government, and the superscript M denotes that this levy rate will differ from the one derived in the absence of the matching funds.[7] In essence, the producer cost per dollar of advertising is reduced from one dollar to $1/(1 + x)$ dollars; alternatively, advertising generates a larger demand expansion per dollar of producer levy.

We follow the procedures for deriving the profit-maximising levy T from the section 'Per unit levy funding' above. The profit-maximising amount of advertising is given by similar first-order conditions as in the absence of the matching support — i.e., $dQ/dT^M = 0$, and $dP/dT^M = 1$. The marginal condition in terms of slope parameters becomes:

$$Q\frac{\partial f}{\partial A}(1 + x) = -\frac{\partial f}{\partial P} \tag{18}$$

and the elasticity rule for the advertising intensity becomes:

$$\phi^M = \frac{T^M}{P}(1 + x) = \frac{\alpha}{\eta}(1 + x). \tag{19}$$

In terms of the optimal check-off rate, the form of the rule is unchanged. That is:

$$\frac{T^M}{P} = \frac{\alpha}{\eta} \tag{20}$$

where, as before, T^M is the levy per unit collected from producers, α is the elasticity of demand with respect to advertising, and η is the absolute value of the price elasticity of demand. However, now these elasticities are defined for the equilibrium with a matching grant, which means a higher advertising intensity, $\phi^M = (1 + x)(\alpha/\eta)$, given a higher advertising expenditure, $A^M = (1 + x)T^M Q$, which is funded partly by the levy and partly by the government subsidy, x.

The levy rate T in equation (13) without the government subsidy (or with $x = 0$) can be compared with the levy rate T^M in equation (20) with a subsidy (or with $x > 0$). For a common demand elasticity (i.e., $\eta = \eta^M$), the optimal

[7] Alternatively, the subsidy could be represented as $T + X$. Similarly, for an ad valorem industry levy t, the subsidy could be represented as $t(1 + x)$ or as $tP + X$. Likewise, government subsidies could be used to augment producer lump-sum funding of generic advertising.

levy rate (T^M/P) implied by the matching grant is greater than (less than) the levy rate with no matching grant (T/P) if the advertising elasticity with the matching grant, α^M, is greater than (less than) the advertising elasticity with no matching grant, α. With a larger total advertising budget, that is, $A^M = T^M(1+x)Q > TQ = A$, given diminishing marginal returns, the marginal return to advertising in the profit-maximising area is lower, that is $\partial^2 Q/\partial^2 A < 0$, a result broadly found in the quantitative literature when allowed (Lambin 1976, and Forker and Ward 1993) and a result required to meet second-order conditions for profit maximisation. Even though the advertising intensity is higher ($\phi^M > \phi$), if the advertising elasticity, α, is a declining function of the amount of advertising, then, $\alpha^M < \alpha$. In turn, this means that the introduction of a matching government grant implies a lower profit-maximising producer levy rate, but a higher total advertising expenditure, and these effects will be larger, the larger is the subsidy, x. Whether the government grant crowds out producer spending to the extent of reducing total levy revenue is less clear, since the lower rate of levy is applied to a larger total value of sales revenue.

3. International trade

The single-market model might be regarded as a closed economy, or non-traded product model. In reality, most agricultural commodities are traded internationally. For export goods, the analysis must distinguish between advertising that applies only to the domestic market, only to the export market, or to both. And care must be given to the definition of the tax base for collecting levies to fund the advertising. Both the target market and the levy base will influence the answer. Also of interest is the comparison of profit-maximising advertising and levy rates based on a closed-economy model when the commodity is actually traded. Kinnucan (1999a), Cranfield and Goddard (1999), and Kinnucan and Myrland (2000) have developed models where the advertised commodities are exported or imported. To illustrate some key implications of explicit recognition of international commodity trade, in this section we extend the model to encompass both export sales and domestic sales, and derive producer profit-maximising rules for a per unit levy on total production to fund advertising on the domestic market.

Figure 3 illustrates the case for a homogeneous product sold domestically and exported. For simplicity, free trade is assumed and transport costs are ignored. Then, the same producer and buyer prices apply for domestic and export sales. Before advertising, domestic demand is D_0^d, export demand is D_0^e, and total market demand is $D_0 = D_0^d + D_0^e$. With initial supply S_0, market equilibrium is given by price P_0, quantities Q_0^d, Q_0^e, and $Q_0 = Q_0^d + Q_0^e$, and initial producer surplus is area aP_0e.

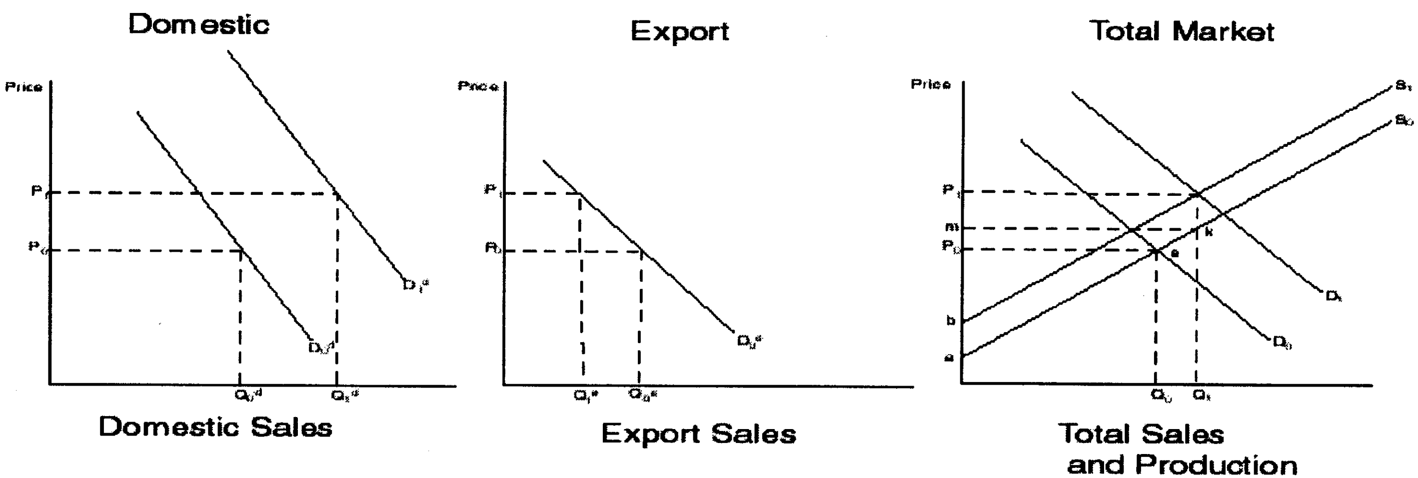

Figure 3 Per unit levy funding of domestic market advertising

Now, suppose a levy, T, is collected on all sales, Q, to provide advertising funds, $A^d = TQ$, which are used to promote domestic sales. The domestic demand shifts out to D_1^d, export demand does not change, and total demand shifts out to $D_1 = D_1^d + D_0^e$. The levy shifts the supply curve upwards to $S_1 = S_0 + T$. The new equilibrium price is P_1, domestic sales rise to Q_1^d, export sales fall to Q_1^e and total sales rise to Q_1. Producer surplus rises by P_0mke, as was the case in figure 2 where, for convenience, the same notation has been used for figure 2 and the third panel of figure 3, representing the total market.

Focusing on the third panel of figure 3, and analogous to the discussion in section 2 and figure 2, the levy T should be raised to fund advertising on the domestic market to the point where the marginal benefit to producers from the advertising-induced increase in price (QdP/dA^d) is equal to the marginal cost to producers of the levy (QdT). This, in turn, gives the first-order condition for profit maximisation:

$$\frac{dP}{dT} = 1. \tag{21}$$

This is the same form as equation (11), except we now interpret P as the market price that clears domestic and export sales. An analogous set of arguments could be made for using the levy to fund export promotion, or more generally both domestic and export promotion.

A key result in both equation (11) for the non-traded good, and equation (21) for the traded good, is that for advertising to be profitable in a competitive industry (with upwards-sloping supply), it must induce an increase in price. Indeed, since a levy of T per unit increases average costs by T per unit, the resulting advertising expenditure must give rise to an increase in average revenue of at least T per unit. The result in equations (11) and (21) is an optimum since, at the margin, the increase in producer revenue is exactly balanced by the increase in producer costs but, for inframarginal quantities of advertising and levies, because of diminishing returns, the marginal benefit exceeds the marginal cost.

A formal expression for dP/dT for equation (21) can be derived from the traded-good commodity model, defined by:

$$Q^d = f_d(P, A^d), \text{ where } A^d = TQ \tag{22}$$

$$Q^e = f_e(P), \tag{23}$$

$$Q = g(P_p), \text{ where } P_p = P - T \tag{24}$$

$$Q^d + Q^e = Q \tag{25}$$

where equation (22) is the domestic demand equation with domestic advertising equal to A^d, equation (23) is the export demand equation,

equation (24) is the supply equation as in (2), and equation (25) is the market clearing identity. Taking total derivations of equations (22) to (24), and using equation (25), an expression can be obtained for dP/dT.

After substituting the expression for dP/dT into equation (21), and some further manipulation, the optimal advertising intensity for an export good, ϕ^E, can be derived similarly to equation (13) as:

$$\phi^E = \frac{A^d}{PQ} = \frac{T}{P} = \frac{w_d \alpha^d}{w_d \eta^d + (1 - w_d)\eta^e} \tag{26}$$

where w_d denotes sales on the domestic market as a share of total sales (i.e., the quantity share $w_d = Q_d/Q$ or, equivalently, the value share $w_d = PQd/PQ$), $\alpha^d = (dQ^d/dA^d)(A^d/Q^d)$ is the elasticity of domestic demand response to advertising, and $\eta^i = -(dQ^i/dP)(P/Q^i)$ is the absolute value of the own-price elasticity of demand in market i (for $i = d$ or e, representing the domestic and export demands, respectively).

In equation (26), the profit-maximising advertising intensity and levy rate will be greater the larger is the sales response to advertising (the larger is α^d), the less elastic is demand in both the advertised and non-advertised segments (the smaller are η^d and η^e), and the more important is the advertised market in total sales (the larger is w_d). The same equations could be used to represent export market advertising funded by a levy on all of production, simply by reversing the roles of the two markets (i.e., switching the indexes, d and e in the equations). Further, a model with both domestic and export advertising could be represented, approximately, by simply adding the two components together.

Further inspection of figure 3 and equation (26) enables several observations to be drawn about profit-maximising levels of advertising on either the domestic or export markets. For the situation of a small-country producer (in the sense that its export demand curve is perfectly elastic, or in equation (26) $\eta^e = \infty$), no amount of domestic advertising or export advertising is worthwhile, with absent government intervention in the commodity market. This is because, in such a case, no matter how effective advertising is in increasing the domestic demand, it cannot give rise to increases in the domestic and world price. Policy interventions and other forces that separate the markets and break the law of one price can alter this story (as illustrated in figure 4). However, in the absence of such interventions, it is unlikely to be profitable to promote domestic sales of agricultural products that are also sold on export markets where the country faces a highly elastic export demand. The same is true for goods that compete with highly elastically supplied imports. For instance, in the Australian citrus industry, the promotion of fresh oranges on the domestic market might give rise to an increase in demand and quantity sold. But since Australia is a small country in the world market for orange juice, the main effect is likely to be a diversion of Australian oranges from processing to the fresh market, with little if any impact on price or average revenue.[8] Even when prices are not exogenous, in a multimarket setting arbitrage effects will dampen the price-enhancing effects of advertising in one market segment, diminishing the producer returns and optimal advertising expenditure relative to what would be implied by a single-market analysis as shown above.

The results of this section can be used to choose levy rates to fund advertising of domestic sales and export sales, or to allocate a given advertising sum between the two markets.[9] Clearly, this type of analysis can be extended in many ways. Examples include more than two market segments, or markets may be segmented by product type — such as the various dairy products and fruit products — as well as geographically.[10] As before, situations of lump-sum funding and of matching subsidies also could be analysed. And, as shown in Kinnucan (1999a), these procedures can be applied to a commodity that is imported.

4. Some comparisons

At this point it is useful to compare and contrast the rules derived for producer profit-maximising levels of advertising, and associated levy rates, from the different models presented in the preceding two sections. Table 1 provides a summary of first-order conditions that are used to derive the profit-maximising levels of advertising, and of the advertising intensities expressed as functions of elasticities at these optimum levels, for a number of the models. The models differ with respect to assumptions about trade status (i.e., non-traded versus export), and about funding options (i.e., lump sum, per unit levy, ad valorem levy, and per unit levy with a matching government

[8] This fact did not prevent the citrus fruit marketing board from spending levy funds on fresh citrus promotion in the 1980s, although, interestingly, the advertising intensity was higher in the Riverina than in Melbourne.

[9] In a typical case where the export demand is relatively elastic, raising the price on both markets through levy-funded export promotion has some elements in common with price discrimination against the more inelastic domestic market. When the 'promotion' means price discounts rather than advertising, then the arrangement is in effect an export subsidy financed by an output tax, and this is identical in effect to a price discrimination and pooling arrangement (e.g., see Alston and Freebairn 1988, for discussion). The same may be true if the two markets are for different end-uses rather than different markets for the same end-use.

[10] The conference volume edited by Nichols *et al.* (1991) is devoted to generic promotion programs for agricultural exports. Also, see Goddard and Conboy (1993).

Table 1 Profit-maximising advertising rules: effects of funding methods and trade status

Funding method	Expenditure	First-order conditions	Advertising intensity and levy rate
Closed economy			
Lump sum, A	A	$Q\frac{dP}{dA}=1$	$\phi^{LS}=\frac{A}{PQ}=\frac{\alpha}{\varepsilon+\eta}$
Per unit levy T	TQ	$\frac{dP}{dT}=1; \frac{dQ}{dT}=0$	$\phi^{PU}=\frac{A}{PQ}=\frac{T}{P}=\frac{\alpha}{\eta}$
Ad valorem levy, t	tPQ	$\frac{dP}{dt}=\frac{P}{1-t}; \frac{dQ}{dt}=0$	$\phi^{AV}=\frac{A}{PQ}=t=\frac{\alpha}{\eta}$
Per unit levy, T^M and Matching subsidy, x	$(1+x)T^MQ$	$\frac{dP}{dT}=1; \frac{dQ}{dt}=0$	$\phi^M=\frac{A}{PQ}=\frac{T^M}{P}(1+x)=\frac{\alpha}{\eta}(1+x)$
Export market			
Lump sum, A	A	$Q\frac{dP}{dA}=1$	$\phi=\frac{A}{PQ}=\frac{w_d\alpha^d}{\varepsilon+w_d\eta^d+(1-w_d)\eta^e}$
Per unit levy, T	TQ	$\frac{dP}{dT}=1$	$\phi^E=\frac{A}{PQ}=\frac{w_d\alpha^d}{w_d\eta^d+(1-w_d)\eta^e}$

Source: Derived from text. P is price, Q is quantity, A is total advertising expenditure, T is the per unit levy, t is the ad valorem levy, and x is the matching government subsidy. For the closed economy, α is the elasticity of demand with respect to the advertising expenditure, η is the absolute value of the price elasticity of demand, ε is the price elasticity of supply, and the M superscript distinguishes the matching government subsidy case. For the export market case with advertising of domestic sales, w_d is the share of the product sold domestically, α^d is the advertising elasticity for domestic sales, and η^d and η^e are the absolute values of the price elasticities of demand for domestic and export sales, respectively.

subsidy). There are some important similarities, and some subtle contrasts, in the derived profit-maximising advertising levels and levy rates for the different sets of assumption.

For the typical agricultural commodity production system, with many competitive producers and no industry-wide supply control, advertising can improve producer returns only if it results in an increase in market price. Producers gain primarily from the higher price on existing sales, and to a lesser extent from the increases in output. A number of factors in turn influence the potential producer price-enhancing effect of advertising. First, the more effective is advertising in increasing demand at any price, *ceteris paribus*, the larger will be the price gain and the profit-maximising advertising intensity. In all cases, the optimal advertising intensity increases with the advertising elasticity, α. Second, elasticities of demand and supply determine the price-increasing effect of both advertising-induced increases in demand and levies to fund the advertising. In particular, when demand is less elastic, a given demand shift in the quantity direction translates into a greater shift in the price direction, and thus, everything else equal, the advertising is more profitable for producers. Hence, in table 1, for a nontraded commodity the advertising intensity is inversely related to the absolute value of the elasticity of demand, η.

For an export commodity, we can see that the result for the overall advertising intensity is equivalent, given that the overall elasticity of demand is equal to the share-weighted sum of the domestic and export market elasticities of demand, i.e., $\eta = w_d\eta^d + (1 - w_d)\eta^e$. Hence, the optimal levy rate decreases with increases in either the elasticity of demand in the market where the advertising applies, or the elasticity of demand in the other market for the good. Further, if the export demand is relatively elastic (as is the typical case), the optimal levy rate increases with an increase in the domestic market share (because this means a less elastic overall demand). In the extreme case of a small country ($\eta^e = \infty$), or even in a less-extreme case of heavy dependence on export sales and a relatively elastic export demand (w_d is small and η^e is large), little is to be gained by advertising domestic sales.

The supply elasticity directly affects the optimal amount of advertising only for the lump-sum funding model. Regardless of the funding arrangements, a more-elastic supply function implies a smaller price increase and smaller benefits to producers from a given advertising-induced demand shift. With levy funding, however, an increase in the supply elasticity implies changes in the producer costs of a given advertising expenditure along with the changes in the producer benefits. The supply elasticity drops out of the advertising intensity formulae because, at the profit-maximising margin, the advertising-induced price increase just offsets the increase in marginal cost from the higher levy associated with the increased advertising. More generally, for inframarginal advertising levels, the less elastic is supply the greater will be the *net* price increase and increase in producer quasi-rents resulting from the levy and advertising.

An interesting result in table 1 is that there is essentially no difference between an ad valorem levy and a per unit levy. At the profit-maximising level of advertising, an ad valorem levy, t, is readily transformed to an equivalent per unit levy, T, and vice versa, using $t = T/P$ and $T = tP$, where P is price. Hence, the elasticity rules for the optimum advertising intensity are equivalent for the two types of levy.[11] However, this similarity is a long-run or average outcome. Shifts in demand and supply curves from year to

[11] This result, in particular, rests on the maintained assumption of competition. If, for instance, processors were oligopsonistic, there might be significant differences in implications of per unit versus ad valorem levies for the distribution of the costs of the levy and thus for the producers' optimum. Zhang and Sexton (2000) have compared lump-sum and per unit levies to fund advertising with imperfectly competitive middlemen.

year, for example, because of seasonal conditions and the stage of the business cycle, may mean that constant values for t and T over time would mean different patterns of annual advertising expenditures — the particular value for t that is equivalent to a given value of T will vary from year to year because of variations of price, P, and may be hard to determine *ex ante*.[12]

There are fundamental differences between the producer profit-maximising advertising expenditure when comparing lump-sum funding and levy funding. Interestingly, more advertising is profitable with levy funding.[13] This arises because both the statutory and final costs of lump-sum funding are borne entirely by producers, whereas levy funding shifts the marginal cost and supply curve upwards, and as a result some of the levy costs are passed on to buyers. The more elastic is product supply or product demand, the smaller is the price-increasing effect of lump-sum funded advertising, and hence the smaller is the profit-maximising advertising expenditure.

A comparison of the formulae in table 1 for a closed economy model and for an export model provides salutary warnings about applying the closed economy model to derive profit-maximising advertising and levy rates when the commodity of interest is traded. The formula for the levy rate on production to fund advertising of domestic sales of a good that is also exported is still equal to the overall demand elasticity with respect to advertising divided by the overall elasticity of demand with respect to price. But these elasticities depend on market shares and price elasticities on the different markets. To just apply elasticities for the domestic market would lead to an over-investment in domestic advertising, and the more so the more important the export market and the more elastic export demand.

5. Policy interventions

In many parts of the world, and still in some industries in Australia, agriculture is subject to government policy interventions affecting farm

[12] In addition, if industry gross revenues are more stable than aggregate quantities (because of downward-sloping demand and supply variability being the main source of variability in prices and quantities), an ad valorem levy is likely to generate a more stable stream of revenues to fund promotion expenditures. Also, a constant per unit levy implies different percentage tax rates applying to different qualities of the same good at a point in time, which will distort the quality mix and implies some inequities. In spite of these apparent advantages of ad valorem levies, per unit levies are widely used. One possible explanation is that per unit taxes might involve lower collection costs or less potential for tax evasion; obligations under an ad valorem tax can be reduced by under-reporting the value, for instance.

[13] This point is noted by Goddard and McCutcheon (1993) and explained more clearly in the elaboration by Kinnucan (1999a).

product prices (see, for example, Godden 1997). Interventions for traded goods can take the form of import restrictions via tariffs, quotas and phytosanitary regulations, export subsidies, and price discrimination schemes with pooling of returns to producers across markets or product type. These policy interventions are likely to affect the optimal advertising strategy. Hence, we require a more elaborate model than those discussed above. Although the general structure, first-order conditions, and solution forms are essentially the same, regardless of the market situation, different market structures and policies and funding mechanisms imply different market clearing conditions and thus imply different specific solutions for optimal advertising. In every case, however, as for the simpler models, producer benefits from advertising arise only if the advertising raises the producer price or average revenue.

In many industries that engage in generic advertising programs, for instance, the fluid milk industries in individual states in Australia and the United States, the relevant commodity market model would be the small-country trade model, whether we were thinking in terms of trade with other countries or with other states within the same country. That is, the state of Victoria ought to be regarded as a price taker in the national and world markets for milk. As our results above show, in a setting of competitive markets and no policy interventions, advertising fresh milk could not be profitable for Victoria. The possibility of privately profitable product advertising is created through trade barriers that separate the Victorian fluid milk market from the fluid milk markets in other states, and the manufacturing milk market. Recent changes, that deregulated the milk markets in Australia, might well have eliminated any such possibility. At a minimum these changes imply that serious scrutiny should be given to the question of further generic advertising of milk and dairy products in Australia.

In cases like this, when the potential for profitable advertising is entirely a consequence of price policies that separate markets, the benefits from advertising and the producer optimum depend on how the impact of advertising-induced demand growth is apportioned between price and quantity changes, which depends on the details of the policy (e.g., see Alston *et al.* 1994). To illustrate, take the case of home consumption price schemes as originally modelled for dairy products by Parish (1962), and since applied to many other products (e.g., see Alston and Freebairn 1988). Figure 4 describes the simplest case. A relatively high domestic price P^d is set for home sales, with P^d greater than the world price P^w. For simplicity assume a small country so that P^w is fixed, and further that P^d is predetermined. Producers receive an average or pool price as shown by the pool price line, $P^p = P^w + P^d(Q - Q^d)/Q$, where Q^d is domestic sales and Q is total production.

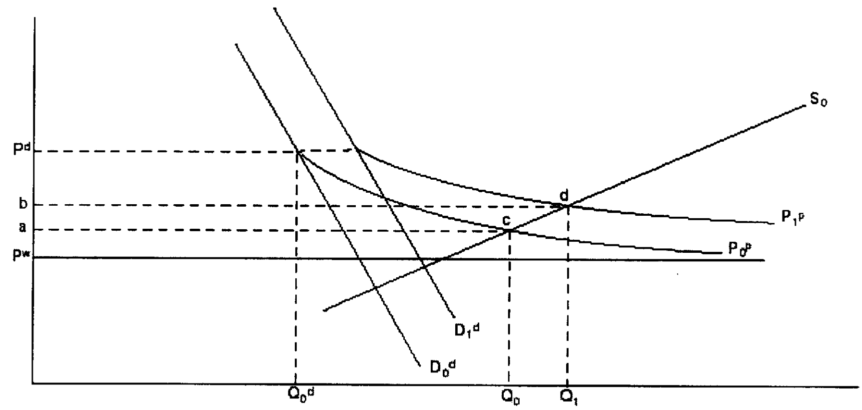

Figure 4 Lump-sum funded advertising with a home consumption price scheme

Now, in figure 4, suppose an increase in lump-sum funded advertising shifts the domestic demand curve out from D_0^d to D_1^d. This raises the pool price curve from P_0^p to P_1^p and the producer price and quantity outcome is given by point *d* rather than point *c*. Producers receive additional gross profits equal to area *abdc*, and optimal advertising would be at the point where $QdP^p/dA = 1$; that is, equation (7) but with the pool price P^p replacing the competitive market price *P*.

In short, using more elaborate and realistic models of the determination of market prices and quantities to reflect government policy interventions, the procedures of sections 2 and 3 can be extended readily to take into account the effects of various government policy interventions. Also, levy funding of advertising and government subsidy funding can be added to the model. Similar extensions can be used to incorporate elements of market power behaviour, for example as modelled in Goddard and McCutcheon (1993), Suzuki *et al.* (1994), and Zhang and Sexton (2000).

6. Multiple commodity effects

In some situations, the single-commodity, partial equilibrium model of the preceding sections might miss important cross-commodity price and advertising effects and provide misleading estimates of the profit-maximising advertising level and levy rate. For example, advertising of one of the meats (or fruits) may directly shift the demand curve for the other meats (or fruits). Or, indirectly, the advertising-induced changes in prices of one meat (or fruit) is likely to have cross-commodity effects on the demand for and supply of other meats (fruits), and a set of price feedback effects following these changes in turn have second-round effects on market outcomes. These direct and indirect second-round effects for interrelated commodity prices will alter the realised profit for the advertised meat (or fruit), and for the other meats (fruits).

Cross-commodity price and advertising effects can be captured in a multiple product model, for example, for the meats, fruits, dairy products, and so forth. Structural demand equations would include cross-commodity prices and advertising variables as well as the own-price and advertising variables. Structural supply equations similarly would include cross-commodity prices. Piggott *et al.* (1995) provide a good example of the formal modelling of cross-commodity price and advertising effects to obtain total derivatives of prices and quantities with respect to advertising. Kinnucan (1996) and Kinnucan and Miao (2000) have used formal multiple commodity models in considering the implications of cross-commodity effects on measures of the benefits of advertising a particular product.

For the advertisers of a particular commodity for which there are cross-commodity effects, the second-round effects may increase or decrease the returns to advertising, and thus the optimal advertising expenditures. Both the advertising-induced demand increase and the levy cost effect give rise to a higher price for the advertised product, which in turn gives rise to an increase in the demand for substitute products and in their prices. Then, indirectly, there will be a second-round increase in demand for the advertised commodity; for complementary products the converse happens. On the other hand, in the likely case where advertising of one commodity directly reduces demand for substitute commodities and in turn their prices fall, this line of causation will reduce the demand for the advertised commodity and reduce the returns to its advertising. The net outcome of these potential positive and negative direct and indirect second-round effects, and the magnitude of the full effects relative to the first-round effect captured by the single-commodity model, become an empirical issue depending on own- and cross-commodity elasticities of demand and supply with respect to advertising and prices. Where advertising one commodity has important direct and indirect cross-commodity effects, the returns to other commodity producers are also altered, but the direction of effect is ambiguous.

Discussion of the choice of profit-maximising levels of advertising and associated levy rates where there are important cross-commodity advertising and price effects raises a whole new set of issues related to strategic relations by the different commodity decision makers. Here the returns to advertising by one set of commodity producers depend on the advertising strategy adopted by advertisers of other commodities. In essence, we enter the world of strategic games between duopolists and oligopolists with control over advertising, but with competitive or price-taking supply response behaviour.

The choice of profit-maximising strategies may be considered as various types of cooperative and noncooperative games. Alston *et al.* (2000) provide some initial results along this line of analysis.

7. Some implications for econometric model specification

Use of the formulae summarised in table 1 to derive producer profit-maximising amounts of generic advertising imposes a number of restrictions that might be treated as testable hypotheses in econometric models of the demand response to advertising. In some senses the restrictions are more binding than those required to make positive assessments of the effects of advertising, and many published econometric studies have not allowed for or tested for some of the more subtle effects of advertising. However, these additional restrictions on parameters or elasticities to be used to derive profit-maximising levels of advertising add to the demands on data needed for estimation.

The derivation of profit-maximising advertising expenditures requires estimates of a demand function that is consistent with diminishing marginal returns to advertising. This means that the demand function, $Q^d = f(A, ...)$, must be at least twice differentiable in the advertising expenditure variable, and that the second derivative must be negative.[14] Estimates of simple linear functions of the form $Q^d = a_0 + a_1 A$, found in many studies do not meet this requirement. Such functions can be used to test hypotheses that advertising affects sales, and to assess whether current advertising levels are profitable or not, but they are not useful in determining the profit-maximising advertising level. Richer, but nevertheless parsimonious, functional forms that allow a diminishing marginal sales response to advertising include $Q = a_0 - a_1/A$, $Q = a_0 - a_1 Q/A$, and $Q = a_0 + a_1 \ln A$, each of which is discussed and used in estimation by Goddard and McCutcheon (1993). Several studies have used variants of the square-root model: $Q = a_0 + a_1 A^{1/2}$. The logarithmic function $\ln Q = a_0 + a_1 \ln A$ allows for a diminishing marginal return to advertising, but it imposes a constant advertising elasticity. Alternatively, quadratic (and even higher-order) advertising terms can be added to a linear function, such as $Q = a_0 + a_1 A - a_2 A^2$. Compared with the simpler models, the extra terms require additional variation of advertising levels in the data if reliable estimates are to be made.

In some cases, the transmission process from more advertising to higher profits is via further differentiation of the commodity and, in turn, a less

[14] General advertising response models sometimes posit zones of increasing returns to advertising in addition to a zone of decreasing returns. Profit maximisation requires that the advertising expenditure be chosen in the zone of diminishing returns.

price elastic demand (Quilkey 1986 also discusses cases where the opposite effect is achieved — where the purpose of advertising is to position the commodity more closely to a competitor, to increase the elasticity of demand — and discusses conditions when each strategy might be better). The shift from D_0 to D_2 in figure 1 provides an illustration. To test for this effect of advertising requires the inclusion of a cross-product term for price and advertising (for example, not just $Q = a - bP + \ldots$, but also as $Q = a - bP + cPA + \ldots$). Brester and Schroeder (1995), and several references therein, include some specifications of this nature and they find limited empirical support for the idea that advertising reduces the price elasticity of demand for some agricultural commodities. The addition of cross-price and advertising explanatory variables adds to the required independent variation of price and advertising in the data if significant effects of advertising on price elasticities are to be detected. In a world in which it is challenging to obtain good and robust estimates of the direct effects of advertising on the position of the demand curve, it might be asking too much to try to measure also the effects on the slope of the curve, and the rates of change of these responses with respect to the total advertising budget.

Among the econometric problems to be considered, issues of endogeneity and simultaneity might be important when advertising is funded using levy funds rather than lump-sum funding. Carman and Green (1993) discuss the issue of 'supply response to promotion'. In our derivations above, there is a strict link between the levy-induced supply shifts and corresponding advertising-induced demand shifts. In reality the statistical linkages may be weakened by the differences in timing between collection of funds and expenditure or actual advertising, and the fact that some levy funds are spent on other activities. It is sufficient for now to note the potential for such problems, and the fact that the funding method might play a role in determining their importance.

The optimisation models might also be extended to allow for dynamic effects (for example, Nerlove and Arrow 1962).[15] Most of the recent econometric studies of demand response to generic advertising have allowed for persistence effects, especially those studies using monthly or quarterly data. It is common to see findings where advertising effects persist for several periods — for instance, several quarters beyond the quarter in which the advertising took place (or, at least, when the expenditure was made), even for products like milk or meat for which intrinsic demand dynamics are not

[15] The models discussed in the article use single-period effects of advertising. They readily can be extended to include multiperiod effects. Essentially, the partial advertising derivatives, or advertising elasticities, would be represented by the discounted or present value of the stream of current and future effects of advertising.

usually important compared with other goods that have aspects of fashion (such as wine), addiction (such as tobacco), or durability (such as woollen apparel or cars). Estimates of the multiperiod effects of advertising on commodity demand require time-series or panel data sets for models with current and lagged advertising variables as explanatory variables. Again, the extra explanatory variables, even when supported by restrictions on lag structures, add to the required independent variation of advertising outlays.

Of course, estimation of the effects of advertising involves the usual long list of specification, estimation and evaluation challenges. Attention needs to be given to such factors as (1) allowing for the effects of other explanatory variables such as prices, incomes, and non-advertising demand-shift variables; (2) measurement of advertising; and (3) potential spurious correlations from non-stationary dependent and explanatory variables. The volume by Kinnucan *et al.* (1992) provides a review of some of the challenges and of progress so far.

8. Conclusion

We have collated rules for the generic advertising expenditures that will maximise producer quasi-rents or profits in a competitive commodity market setting in which individual producers choose output quantities to equate their marginal cost with the market price. A single-market, single-period model can be generalised easily to allow for international trade, government policy interventions, multiple commodity interactions, and to incorporate dynamic and lagged responses of sales to advertising.

Effective advertising shifts out the commodity demand curve and also may make demand less (or more) elastic. In order to raise producer profits, advertising must cause the producer price to increase. In many instances this outcome would not be possible without government intervention, the imposition of price policies that allow markets to be separated and prevent arbitrage from eliminating any advertising-induced price increases. This is surely the case for state-level generic milk advertising programs, which are in aggregate perhaps the most economically important generic commodity advertising programs. The profit-maximising advertising expenditure equates marginal returns, given by the increase in average producer revenue (simply price in the case of undistorted markets) times output, with the marginal cost to producers of the advertising.

Four different methods of funding generic commodity advertising were considered. Much of the literature focuses on lump-sum funding, however, this seems more applicable to industries with market power than the competitive industry structure considered in this article. Levies on producers made compulsory by supporting government legislation are more common in practice. A per unit or fixed levy and an ad valorem levy were found to be equivalent at the profit-maximising level of advertising. The levy effectively shifts the supply curve up, and a portion of the incidence is passed on to buyers as higher prices; in contrast, under the lump-sum funding option, costs of advertising are fully borne by producers. A fourth funding option allows for a government subsidy or matching grant for producer funds collected for advertising.

Generally, the effects of the subsidy are to raise the profit-maximising total advertising budget and to lower the producer levy rate. In other words, relative to the lump-sum funding option, the use of levies shifts some of the marginal cost of advertising onto consumers, and the use of subsidies shifts some of the marginal cost onto taxpayers, and both of these elements make the advertising more profitable for producers; hence, their optimal advertising expenditure is higher.

In our analysis of levy-funded advertising, we imposed a restriction that the levy funds were fully spent on advertising in the same period in which the funds were collected. This is a very strong link imposed between the fund-raising and expenditure sides of the problem, which might not be matched exactly in practice, even in the absence of matching government grants. In practice, funds must be spent after they are raised (unless some kind of debt finance is being used), some funds are spent in administration or on activities other than advertising (including production research, market research, market information, public relations, other forms of promotion), and some funds are carried forward into future periods. This means that the linkage in practice between taxing and spending is not as tight as we have formally modelled, and the real-world situation might fall in some senses in between lump-sum and levy funding as we have modelled them.

The advertising intensity, the advertising budget as a share of gross sales, equals the ad valorem levy rate. At the profit-maximising level of advertising funded by a levy, a Dorfman–Steiner rule is found: the advertising intensity and the levy rate are equal to the elasticity of quantity demanded with respect to advertising divided by the (absolute value of the) price elasticity of demand. Then, when the demand for a commodity is more responsive to advertising, or less responsive to price, the price increase and benefits to producers from more advertising will be greater, and therefore so will the optimal levy and the advertising budget be greater.

Application of the profit-maximising advertising rules requires quantitative information on the demand response to advertising and price, not just the average impact multipliers or elasticities, but information on how those multipliers and elasticities vary with the quantity of advertising. Diminishing marginal returns to advertising is a necessary condition for defining a maximum, and meeting this requirement places extra demands on the specification, data, and estimation of the demand function. In particular, the demand equation needs to be twice differentiable in the advertising explanatory variable, and interaction terms between price and advertising are required if we wish to test for advertising-induced changes in the price elasticity or slope of demand.

Our results have some direct and indirect policy implications. We have observed that generic advertising cannot pay in the small open-economy case in the absence of government intervention in the market. This observation raises questions about the future profitablity, in a deregulated market, of the types of generic milk promotion programs that have been important in Australia to date. The US government has recently introduced a requirement for regular assessment of the consequences of commodity promotion schemes funded by mandatory levies, under federal marketing orders. Although we do not yet have such requirements in Australia, it would seem reasonable to introduce some conditions when mandatory levies are being collected to fund generic advertising, sanctioned by the government. For instance, at a minimum, we could require the organisation in question to collect data and make it available, to permit an independent assessment of the effects of the advertising and the levy. This would improve the information flow to producers and to policy makers for future decision-making.

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