Middlemen behaviour and generic advertising rents in competitive interrelated industries†

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This article focuses on the role of middlemen in determining the returns to generic advertising in a competitive industry where supply is uncontrolled, the price of marketing inputs is endogenous, and retail markets are interrelated through consumer preferences. Theoretical analysis suggests farm-gate returns (quasi-rents) are overstated when input substitution at middlemen level is ignored, a result confirmed in the empirical application. As for mark-up behaviour, represented by the farm-retail price transmission elasticity, a general result is that farm-gate returns to generic advertising always increase as the transmission elasticity decreases, provided retail demand is more elastic than input substitution. Endogenising the price of marketing inputs has little effect on advertising rents.

1. Introduction

Despite a proliferation of studies designed to measure the economic impacts of generic advertising (Ferrero *et al.* 1996), no consensus exists on the key issue of whether promotion pays. Part of the problem, as emphasized by Piggott, Piggott and Wright (1995), is that a *statistically* significant advertising effect is not a sufficient condition for an *economically* significant advertising effect. The economic impact of generic advertising depends fundamentally on how advertising affects farm price, which, in turn, depends on policy setting and structure (e.g., Alston, Carman and

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Chalfant 1994). A key element of structure is the behaviour of middlemen, as this determines the extent to which advertising-induced shifts in demand at retail are translated into benefits at the farm level.

The purpose of this research is to determine the effect of middlemen behaviour on generic advertising's ability to raise farm price. The analysis builds on Piggott, Piggott and Wright's (1995) study by drawing a distinction between the retail market, where advertising occurs, and the farm market, where returns are to be measured. It differs from similar work by Wohlgenant (1993) in that middlemen behaviour is represented by the farm-retail price transmission elasticity, with the less-readily observed input substitution elasticity serving a passive role as a technology indicator. An advantage of the model proposed here is that it is capable of reflecting alternative (polar) marketing technologies while simultaneously endogenising the price of marketing inputs. The model is based on parameters readily available in the literature (e.g., retail demand and farm supply elasticities), and thus provides a framework for advertising benefit-cost analysis that has certain advantages over econometric-based industry models.

The analysis begins with the simple case in which the advertised good is assumed to be strictly separable from all other goods. The model is then generalised to incorporate demand interrelationships. The generalised model's utility for benefit-cost analysis is demonstrated utilising recent demand and advertising response estimates for US meats. A key insight from the analysis is that marketing technology has an important bearing on the farm-level profitability of generic advertising programs.

2. Basic model

With the initial assumption that the advertised good is strictly separable from all other goods, the basic model is:

$$\mathrm{dln}Q \; = \; - \, N \, \mathrm{dln}P_r + B \, \mathrm{dln}A \qquad \text{(retail demand)} \qquad (1)$$

$$\mathrm{dln}X \; = \; E \, \mathrm{dln}P_f \qquad\qquad\quad \text{(farm supply)} \qquad (2)$$

$$\mathrm{dln}P_r \; = \; T \, \mathrm{dln}P_f \qquad\qquad\; \text{(farm-retail price linkage)} \qquad (3)$$

$$\mathrm{dln}Q \; = \; \mathrm{dln}X \qquad\qquad\qquad \text{(Leontief market-clearing)} \qquad (4a)$$

or

$$\mathrm{dln}Q \; = \; \mathrm{dln}X + \mathrm{dln}P_f - \mathrm{dln}P_r \quad \text{(C–D market-clearing)} \qquad (4b)$$

where $\mathrm{dln}Y \; = \; \mathrm{d}Y/Y$ is the relative change in variable Y (for example, $\mathrm{dln}Q \; = \; \mathrm{d}Q/Q$ represents the relative change in quantity); Q is quantity demanded at retail; X is the quantity supplied at the farm level; P_r is retail

price; P_f is farm price; A is advertising expenditures; N is the absolute value of the retail-level demand elasticity; B is the advertising elasticity; E is the farm-level supply elasticity; and T is the farm-retail price transmission elasticity. The model consists of four endogenous variables, Q, P_r, X, P_f, and one exogenous variable, A. Given the negative sign in (1), N, E, T and B are assumed to be positive.

The foregoing model is similar to Nerlove and Waugh's (1961) in that competitive market-clearing is assumed and advertising is treated as an exogenous lump-sum expenditure. Testing for competitive market-clearing for major US food groups, Wohlgenant (1989) and Holloway (1991) each found the assumption to be valid. The exogenous lump-sum treatment of advertising implicitly assumes that advertising represents a fixed cost; if this is not the case, the price and welfare impacts produced by the model may be *understated* (Conboy, Goddard and McCutcheon 1992; Alston, Carman, and Chalfant 1994).

The price-linkage equation (equation (3)) is a quasi-reduced form that reflects the behaviour of middlemen (Hildreth and Jarrett 1955). That the equation depicts accurately the relationship between retail and farm price rests on the assumption that forces that cause the two prices to change (shifts in retail demand or farm supply) exert their influences separately rather than in combination (Gardner 1975, p. 404). If this is not the case, a more complicated form of the price-transmission equation may need to be specified (Wohlgenant and Mullen 1987).[1]

The equilibrium mechanism in the model (equations (4a) and (4b)), derived in the Appendix, indicates market-clearing under two alternative aggregate marketing technologies: Leontief (fixed proportions) and Cobb–Douglas (C–D). Leontief and C–D technologies are viewed as alternative marketing technologies because both imply constant returns to scale (CRTS), an hypothesis that is consistent with US data (Wohlgenant 1989, p. 251). In addition, the substitution elasticities implied by the two technologies (0 for Leontief and 1 for C–D) cover the range of substitution possibilities that appear to be relevant for the US food system (Wohlgenant 1989, p. 250). Substitution elasticities indicate the extent to which food marketing firms (in the aggregate) can substitute marketing inputs for

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[1] Although equation (3) is specified with retail price as the 'dependent' variable, this does *not* imply that farm price 'causes' retail price, as retail price and farm price are endogenous and determined simultaneously. If retail and farm prices are determined in a recursive fashion, or if the price-spread is exogenous, as appears to be the case in the Australian lamb industry, at least in the short run (Vere and Griffith 1995), the price-transmission mechanism in the model would have to be modified accordingly.

the farm-based input in response to an increase in the relative price of the farm-based input induced by advertising.[2]

The first task is to determine the effect of marketing technology on advertising's ability to raise farm price. The relevant reduced-form equations are:

$$\mathrm{dln}P_f = [B/(E + T\,N)]\,\mathrm{dln}A \qquad\qquad \text{(Leontief technology)} \quad (5a)$$

$$\mathrm{dln}P_f = \{B/[E + T\,N + (1 - T)]\}\,\mathrm{dln}A. \quad \text{(C–D technology)} \qquad (5b)$$

Comparing (5a) and (5b), it is evident that marketing technology has an important bearing on advertising's ability to raise farm price. In particular, the price effect, which is always positive under Leontief technology, becomes indeterminate under C–D technology.

The conditions necessary for advertising to raise farm price under C–D technology hinge on the transmission elasticity, which, in turn, reflects middlemen mark-up behaviour (George and King 1971, pp. 60–2). For example, if mark-up behaviour results in a *constant percentage spread* ($T = 1$) or a *constant absolute spread* ($0 < T < 1$), the indeterminacy in (5b) is resolved. Actual mark-up behaviour, however, is likely to be more complex than indicated by either of these simple rules.

To see why, consider the theoretical expression for the farm-retail price transmission elasticity, derived by Gardner (1975, p. 403), for situations involving isolated shifts in retail demand, the relevant case for advertising:[3]

$$T = (\sigma + S_x\,e_m + S_m\,E)\,/(\sigma + e_m). \qquad (6)$$

In this expression, σ is the elasticity of substitution between the farm-based input and the bundle of marketing inputs; S_x and S_m are cost shares

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[2] A reviewer questioned how the analysis would be affected by (i) price-levelling or price-averaging behaviour, (ii) the time pattern of advertising effects, and (iii) middlemen market power. As noted by Griffith, Green and Duff (1991, p. 190), price levelling and price averaging are properly viewed as reflecting short-run (disequilibrium) behaviour. For longer-run analysis, the focus of this study, the relationship between farm and retail price is better described by a static-equilibrium model such as Gardner's (1975), provided markets are competitive. If markets are not competitive, price-transmission behaviour depends on whether oligopoly or oligopsony forces are at work (Schroeter and Azzam 1991). If middlemen display purely *oligopoly* behaviour, Holloway's model is applicable, and advertising rents based on competitive market-clearing are *understated* (Kinnucan and Hsia 1997). The effects of *oligopsony* behaviour on advertising rents are as yet unknown. The time pattern of advertising effects is taken into account by utilising long-run, rather than short-run, advertising elasticities when simulating the equilbrium-displacement model.

[3] The economic forces that govern farm-retail price transmission differ depending upon whether observed changes in the price spread derive from shifts in farm supply or retail demand. For further discussion of this issue, see Kinnucan and Forker (1987, pp. 288–91).

Table 1 Elasticity of farm-retail price transmission: theoretical values and implied restrictions for isolated shifts in retail demand

Theoretical value	Restriction
$T = (\sigma + S_x\, e_m + S_m\, E)/(\sigma + e_m)$	CRTS marketing technology
$T = (S_x\, e_m + S_m\, E) \,/\, e_m$	Leontief marketing technology
$T = (1 + S_x\, e_m + S_m\, E)/(1 + e_m)$	Cobb–Douglas marketing technology
$T = 1$	$E = e_m$, constant percentage mark-up
$T < 1$	$E < e_m$
$T = S_x$	$e_m -> \infty$, constant absolute mark-up

for the farm-based and marketing inputs, respectively; e_m is the marketing inputs' supply elasticity; and E is the previously defined supply elasticity for the agricultural input. Equation (6) is a general expression for the transmission elasticity under conditions of competitive market clearing and CRTS. It can be specialised to the present analysis by setting $\sigma = 0$ (Leontief technology) or $\sigma = 1$ (C–D technology) as noted in table 1.

From (6) the constant percentage mark-up rule implies that supply elasticities for the agricultural input and the marketing services' input are identical, i.e., $E = e_m$. This condition appears implausible, especially given the inelasticity of the farm supply schedule for most agricultural commodities and the tendency to treat the price of marketing inputs as exogenous (e.g., Wohlgenant 1993; Holloway 1991), which implies that e_m approaches infinity. Although implausible, this case is of interest for several reasons. First, equations (1)–(4) reduce to Nerlove and Waugh's model when $T = 1$. Thus, Nerlove and Waugh's analysis can be seen as a restrictive special case of the present analysis. Second, if $T \neq 1$, ignoring the marketing channel as in Nerlove and Waugh will cause the price effect of advertising at the farm level to be distorted, *unless the demand elasticities in (5) are measured at the farm level*.

Consider now the case in which $T = S_x$, a more plausible scenario given the empirical estimates of T reported by George and King (1971, p. 62). This case is consistent with a constant absolute mark-up under fixed proportions (George and King 1971, p. 60), or a horizontal supply curve for marketing inputs under variable proportions (table 1). Employing the latter assumption, Wohlgenant (1993, p. 645) derives the following reduced form for farm price (in my notation) using duality concepts:

$$\mathrm{d}\ln P_f = [B/(E + S_x N + (1 - S_x) \sigma] \, \mathrm{d}\ln A \qquad (5\mathrm{c})$$

Comparing equations (5a), (5b) and (5c), it is evident that the equations are consistent. In particular, equation (5c) reduces to (5b) if $\sigma = 1$ and to (5a) if $\sigma = 0$ and the supply schedule for marketing services is non-horizontal. This illustrates a key advantage of the model developed in this study: it provides a flexible method of representing the range of input substitution relationships that appear to be relevant to the food system without requiring the supply schedule for marketing inputs to be horizontal.

With the maintained hypothesis that $T = S_x$, it is possible to investigate the relationship between cost share and advertising effectiveness. Consider first a situation in which technology is fixed proportions. In this case, equation (5a) applies, and it is immediately evident that the farm price impact of an increase in generic advertising is amplified as the agricultural input becomes *less* important in the total cost of the final product. Or, equivalently, as the transmission elasticity gets smaller (approaches 0 from above) the price-enhancement ability of generic advertising increases, *ceteris paribus*.

Turning to the case of variable proportions, let ζ equal (5b)'s reduced-form coefficient, i.e., $\zeta = B/[E + T N + (1 - T)]$. Taking the partial derivative of this expression with respect to T yields:

$$\partial \zeta / \partial T = B(1 - N) / [E + T N + (1 - T)]^2.$$

From this expression it is evident that the relationship between the agricultural input's cost share (recall that $T = S_x$) and advertising effectiveness under C–D technology depends on the retail-level demand elasticity. In particular, for effectiveness to increase with decreases in S_x under C-D technology, it must be the case that retail demand is price elastic ($N > 1$). If retail demand is unitary elastic ($N = 1$) or inelastic ($N < 1$), the price-enhancement ability of generic advertising is either unaffected by the transmission elasticity (and by implication the farmers' share parameter when the price of marketing inputs is exogenous) or is *amplified* as the transmission elasticity increases.

Bearing in mind that Leontief and C–D technologies imply that the substitution elasticity for marketing inputs is 0 and unitary, respectively, the foregoing results suggest that the 'importance of being unimportant' (to use Hicks's phraseology – see below) hinges on the relationship between the retail demand elasticity and the substitution elasticity. In particular, an inverse relationship between the agricultural input's cost-share and advertising effectiveness holds only if $N > \sigma$, i.e., consumers can more easily substitute away from the finished product than

middlemen can substitute away from the raw agricultural product as the relative price of the raw product increases in response to an increase in advertising. This interpretation is consistent with Hicks's result with respect to whether a supply restriction that raises the relative price of an input benefits input suppliers. Hicks finds (quoting from Bronfenbrenner 1965, p. 258):

> if technical change is easy, while the product has an inelastic demand, the rule works the other way. For example, a factor may find it easier to benefit itself by a restriction in supply if it plays a large part in the process of production than if it plays a small part. *It is 'important to be unimportant' only when the consumer can substitute more easily than the entrepreneur.* (italics in original)

That advertising rents might be affected by the cost share of the farm-based input has heretofore gone unrecognised in the literature. In instances where substitution possibilities at the middlemen level are limited, it suggests that agricultural industries that account for a modest share of the total cost of the finished product will have a stronger incentive to promote, *ceteris paribus*, than agricultural industries that account for a relatively large share of total retail value. To the extent that retail demand elasticities exceed (in absolute value) substitution elasticities, this result provides theoretical support for the increased emphasis in the United States on the promotion of 'value added' products in the allocation of federal subsidies for export promotion (Kinnucan and Xiao 1996).

3. Incorporating demand interrelationships

Demand interrelationships can be incorporated into the analysis with some rather straightforward matrix algebra. First, rewrite the structural model (deleting the Leontief market-clearing condition, as this drops out as a special case of C-D market clearing) as:

$$\mathbf{I} \, d\ln\mathbf{Q} = \mathbf{N} \, d\ln\mathbf{P} + \mathbf{B} \, d\ln\mathbf{A} \tag{7}$$

$$\mathbf{I} \, d\ln\mathbf{P} = \mathbf{T} \, d\ln\mathbf{W} \tag{8}$$

$$\mathbf{I} \, d\ln\mathbf{X} = \mathbf{E} \, d\ln\mathbf{W} \tag{9}$$

$$\mathbf{I} \, d\ln\mathbf{Q} = \mathbf{I} \, d\ln\mathbf{X} + \mathbf{I} \, d\ln\mathbf{W} - \mathbf{I} \, d\ln\mathbf{P} \tag{10}$$

where $\mathbf{I}$ is an identity matrix; $\mathbf{N}$ is a square matrix of retail-level demand elasticities; $\mathbf{B}$ is a square matrix of advertising elasticities; $\mathbf{T}$ is a square matrix with price-transmission elasticities along the main diagonal and zeroes elsewhere; $\mathbf{E}$ is a square matrix with farm-level supply elasticities

along the main diagonal and zeroes elsewhere;[4] $d\ln\mathbf{Q}$ is a vector of retail quantity changes; $d\ln\mathbf{P}$ is a vector of retail price changes; $d\ln\mathbf{X}$ is a vector of farm-level quantity changes; $d\ln\mathbf{W}$ is a vector of farm-level price changes; and $d\ln\mathbf{A}$ is a vector of advertising changes. Letting n denote the number of commodities in the system, all matrices are $n \times n$ and all vectors are $n \times 1$.

Equations (7)–(10) represent a generalisation of Piggott, Piggott and Wright's model in the same way that equations (1)–(4) represent a generalisation of Nerlove and Waugh's model. In particular, Piggott, Piggott and Wright's model is derived from (7)–(10) by setting $\mathbf{T} = \mathbf{I}$, which is tantamount to assuming that demand elasticities at retail and farm are identical *and* that marketing technology is fixed proportions. These assumptions, as indicated earlier, are stringent. The reduced-form equation for farm price is obtained by substituting equations (7)–(9) into (10) and collecting terms, which yields:

$$\mathbf{C} \, d\ln\mathbf{W} = \mathbf{B} \, d\ln\mathbf{A}$$

where

$$\mathbf{C} = (\mathbf{E} - \mathbf{T} \, \mathbf{N} + (\mathbf{I} - \mathbf{T}) \, \sigma). \tag{11}$$

The σ term in (11) is a scalar to indicate whether marketing technology is Leontief ($\sigma = 0$) or C-D ($\sigma = 1$). In the former case, the $(\mathbf{I} - \mathbf{T})$ term in $\mathbf{C}$ disappears, as it must to indicate Leontief technology (compare (5a) and (5b)). Premultiplying the above expression by $\mathbf{C}^{-1}$ gives the reduced form for farm price:

$$d\ln\mathbf{W} = \mathbf{C}^{-1} \, \mathbf{B} \, d\ln\mathbf{A} \tag{12}$$

Equation (12) can be made more intelligible by considering the case in which $n = 2$, and only the first good is advertised. In this case, the own-price effect is:

$$d\ln W_1 = \{(B_{11}(E_2 + L_{22}) + B_{21}T_2N_{12}) \, / \, ((E_1 + L_{11})(E_2 + L_{22}) - \\ T_2N_{12}T_1 \, N_{21})\} \, d\ln A_1 \tag{13}$$

where i indexes the good, Q_i and P_i refer to retail quantities and prices; X_i and W_i refer to farm quantities and prices; and A_1 is advertising for good 1. The parameters E_1 and E_2 are farm-level supply elasticities; N_{12} and N_{21} are cross-price elasticities; B_{11} is the own-advertising elasticity; and B_{21} is

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[4] If competition for common resources at the farm level is deemed important (e.g., between lamb and beef production in Australia, see Piggott, Piggott, and Wright 1995), the off-diagonal elements of the $\mathbf{E}$ matrix would be non-zero to reflect cross-price elasticities of supply.

the cross-advertising elasticity. The L_{ii} term in (12) is $L_{ii} = T_i N_{ii} + (1 - T_i) \sigma$, where N_{ii} is the absolute value of the retail-level own-price elasticity for good i, and σ is the previously defined scalar.

Equation (13) highlights the complexity that demand interrelationships bring to the analysis. Even in the relatively simple two-good case, it is impossible to predict how advertising affects farm price without stringent assumptions about the relative magnitudes of the cross-price and cross-advertising elasticities. In particular, as demonstrated by Kinnucan (1996), for an increase in own-advertising to have a positive effect on own-price, two conditions must hold. The first condition is that the own-price elasticity for the advertised good must exceed in absolute value the cross-price elasticity of the substitute good with respect to the advertised good. The second condition is that the own-advertising elasticity must exceed the absolute value of the cross-advertising elasticity of the advertised good with respect to the substitute good. Because the latter condition is unlikely to hold unless the expenditure share of the advertised good is small in relation to the expenditure share of the substitute good, the economic impact of generic advertising in general is an empirical issue.

4. An application

The utility of the foregoing model from a benefit-cost perspective is now demonstrated utilising equations (7)–(12) and the parameters and baseline data for the three-sector US meat industry given in table 2. To assess the bias associated with misspecification of marketing technology, the price impacts of isolated 10 per cent increases in beef and pork advertising were simulated by setting σ in equation (12) alternatively to 0 (Leontief scenario) and 1 (C–D scenario). The quantity impacts are obtained by back substitution of equation (12) into equation (9).

The price and quantity impacts measured by the foregoing procedure were converted to welfare changes using the equation:

$$\Delta PS_i = S_x^i P_i Q_i \, d\ln W_i (1.0 + 0.5 \, d\ln X_i) \tag{14}$$

where ΔPS_i is the change in producer surplus in the ith meat sector associated with an isolated 10 per cent increases in beef and pork advertising, and S_x^i, P_i, and Q_i are as defined in table 2. Equation (14) implicitly assumes that advertising generates parallel shifts in linear demand schedules, an assumption deemed innocuous if equilibrium displacements are small (Alston, Norton and Pardey 1995, pp. 48–50), as they are in this study.

Two alternative sets of demand and advertising elasticities are used in

Table 2 Parameter and baseline (1990) values for US beef, pork, and poultry industries

Parameter/ variable	Definition	Value Beef	Pork	Poultry
N_{1j}	Price elasticity w.r.t. beef demand[a]	−0.56 (−0.42)	0.10 (0.29)	0.05 (0.10)
N_{2j}	Price elasticity w.r.t. pork demand[a]	0.23 (0.61)	−0.69 (−0.65)	0.04 (−0.06)
N_{3j}	Price elasticity w.r.t. poultry demand[a]	0.21 (0.33)	0.07 (−0.10)	−0.33 (−0.17)
B_{1j}	Advertising elasticity w.r.t. beef demand[a] [b]	0.006 (0.0013)	0.002 (0.0006)	0.017 (n.a.)
B_{2j}	Advertising elasticity w.r.t. pork demand[a] [b]	−0.009 (0.0017)	0.0 (0.0)	0.0 (n.a.)
B_{3j}	Advertising elasticity w.r.t. poultry demand[a]	−0.011 (−0.0059)	−0.010 (−0.0006)	0.047 (n.a.)
E_i	Farm-level supply elasticity[c]	0.15	0.40	0.31
S_x^i	Farmers' share of retail dollar[c]	0.60	0.41	0.51
e_m	Elasticity of supply of marketing services[d]	2, ∞	2, ∞	2, ∞
T_i	Elasticity of farm-retail price transmission[e]	—	—	—
A_i	Advertising expenditures ($ million)[f]	35.0 (1.0)	9.0 (50.0)	— (52.0)
P_i	Retail price ($/lb)[c]	2.81	2.13	0.90
Q_i	Retail quantity (lb/capita)[c]	67.0	51.1	83.4
$P_i Q_i$	Total consumer expenditures ($ billion)[g]	46.5	26.9	18.5

Notes: [a] Top number is Brester and Schroeder's (1995, p. 977) estimate; number in parentheses is Kinnucan, Xiao and Hsia's (1996) estimate.
[b] Beef and pork elasticities from Brester and Schroeder are for *generic* advertising. Kinnucan, Xiao and Hsia did not estimate an advertising elasticity for poultry. Non-significant (*t*-ratio less than 1) elasticities are set to 0.
[c] Sources are given in Kinnucan, Xiao and Hsia.
[d] Assumed values.
[e] To be computed from equations given in table 1.
[f] Top number is generic expenditures; number in parentheses is brand. Data refer to 1990 expenditures based on Brester and Schroeder's figure 1 (p. 972).
[g] Based on a US 1990 population of 246.9 million.

the simulations. The first set is from Brester and Schroeder (BS) (1995) based on data through 1993.IV; the second set is from Kinnucan, Xiao and Hsia (KXH) (1996) utilising data through 1991.III. The advertising elasticities for beef and pork pertain to generic, not brand, advertising. Advertising elasticities with *t*-ratios of less than 1 in absolute value were set to 0. To gauge the sensitivity of results to supply response, the simulations based on BS estimates are repeated with the supply elasticities in table 2 doubled.

Empirical estimates of the supply elasticity for marketing services are unavailable. Wohlgenant (1993) set the elasticity to infinity; Gardner (1975) seemed to prefer a value of 2. Both values are used in the simulations to gauge the sensitivity of results to this parameter. Numerical values for the transmission elasticities under each scenario were calculated from the appropriate equations given in table 1 and the parameter values for S_x^i, e_m, and E in table 2 (note: $S_m^i = 1 - S_x^i$).

Results confirm the direction of the biases suggested by theory. That is, when technology is Leontief, the advertising effects are more pronounced than when technology is Cobb-Douglas (table 3). Advertising rents are relatively insensitive to supply response, but quite sensitive to demand and advertising elasticities. In general, the simulations based on the BS demand estimates produce larger welfare impacts than the simulations based on the KXH estimates. However, the overall pattern of welfare effects being overstated under fixed proportions is preserved. The slope of the marketing services' supply schedule has only a modest effect on advertising rents.

Bearing in mind that a 10 per cent increase in beef advertising represents an incremental expenditure of $3 million, a general conclusion to be drawn from table 3 is that the beef program is highly effective from the perspective of the beef industry. That is, incremental returns to the beef sector exceed incremental expenditures in all the simulations by a substantial margin. The pork program, however, is ineffective, at least from the standpoint of the pork industry. The incremental returns to increased pork advertising are not sufficient to cover the incremental cost of $0.9 million, unless technology is fixed proportions and the KXH elasticities apply. In the latter case, incremental returns are just sufficient to cover incremental expenditures, so the program is at best a break-even proposition.[5]

The distributional consequences of generic advertising are readily apparent from table 3. The beef and pork programs, for example, each generate negative externalities for the poultry sector. The external losses associated with increased beef advertising are large enough in some instances to negate the internal gains, resulting in a net welfare loss for meat producers as a group. Pork advertising confers positive externalities on the beef sector, which reinforces the internal gains experienced by the

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[5] Technically, producers in competitive markets are not expected to bear the full incidence of the advertising levy unless supply is perfectly inelastic. The equation for producers' incidence is $I_f = 1/(1 + E/(S_x N))$ (Chang and Kinnucan 1991, p. 170). For pork, $E = 0.40$, $S_x = 0.41$, and $N = 0.65$ (table 2), so $I_f = 0.40$. Thus, pork producers in reality may pay only 40 per cent of the $0.9 million increment, or $0.36 million. In this case, simulation 3 in table 3 would indicate a positive return to pork advertising, provided the marketing services' supply schedule is not perfectly elastic.

Table 3 Producer welfare impacts of isolated 10 per cent increases in beef and pork advertising under fixed proportions

Item	10 per cent increase in beef advertising				10 per cent increase in pork advertising			
	$\sigma_1 = \sigma_2 = \sigma_3 = 0$		$\sigma_1 = \sigma_2 = \sigma_3 = 1$		$\sigma_1 = \sigma_2 = \sigma_3 = 0$		$\sigma_1 = \sigma_2 = \sigma_3 = 1$	
	$e_m = 2$	$e_m = \infty$	$e_m = 2$	$e_m = \infty$	$e_m = 2.0$	$e_m = \infty$	$e_m = 2.0$	$e_m = \infty$
Simulation 1:				million dollars				
Beef	26.9	28.6	17.3	17.2	8.0	8.5	5.4	5.5
Pork	−11.6	−12.9	−7.7	−7.2	−0.05	0.02	−0.01	0.06
Poultry	−19.0	−19.8	−11.8	−10.1	−18.0	−19.0	−11.1	−9.5
All	−3.7	−4.1	−2.3	−0.2	−10.1	−10.4	−5.7	−3.9
Simulation 2:								
Beef	21.6	23.5	15.2	15.0	6.8	7.4	4.8	4.9
Pork	−7.2	−8.2	−5.9	−5.6	0.06	0.12	0.02	0.06
Poultry	−11.5	−12.1	−8.9	−7.7	−10.9	−11.6	−8.3	−7.2
All	2.8	3.1	0.4	1.8	−4.1	−4.0	−3.5	−2.3
Simulation 3:								
Beef	7.7	7.8	4.6	4.1	4.4	4.4	2.3	2.0
Pork	4.8	5.2	2.6	2.1	0.9	1.0	0.4	0.2
Poultry	−12.8	−13.2	−7.5	−6.1	−0.7	−0.7	−0.5	−0.5
All	−0.3	−0.2	−0.3	0.1	4.7	4.7	2.2	1.7

Note: [a] Simulation 1 uses Brester and Schroeder's (1995) demand and advertising elasticities and the supply elasticities in table 2. Simulation 2 replaces simulation 1's supply elasticities with twice the value of table 2's supply elasticities. Simulation 3 uses table 2's supply elasticities and Kinnucan, Xiao and Hsia's (1996) demand and advertising elasticities. Totals may not sum due to rounding.
[b] ($\sigma_i = 0$) and variable proportions ($\sigma_i = 1$) for alternative values of the supply elasticity for marketing services (e_m), farm-level supply elasticities, and retail-level demand and advertising elasticities, United States, 1990

beef sector from its own advertising. Overall, the clear winner, according to these simulations, is the beef sector.

Would the meat industry be better off if *both* beef and pork producers ceased to advertise? The answer depends on which set of elasticities is deemed valid. For the BS elasticities, the answer is 'yes,' as the lines labelled 'All' in table 3 for simulations 1 and 2 sum to a negative number for combined increases in beef and pork advertising. For the KXH elasticities, a simultaneous decrease in beef and pork advertising would result in a net loss to the meat sector, as the total effects are positive for combined increases in advertising. But again, distributive impacts are important, with beef producers losing and poultry producers gaining.

5. Concluding comments

The basic theme of this article is that middlemen behaviour is important in determining the farm-level impacts of generic advertising programs. The analysis builds on Nerlove and Waugh's theory of cooperative advertising and Piggott, Piggott and Wright's analysis of advertising in interdependent markets by extending their models to distinguish between the retail market, where advertising occurs, and the farm-level market, where returns are measured. A key finding is that ignoring the marketing channel is tantamount to assuming that middlemen use a constant-percentage mark-up *and* that marketing technology is fixed proportions. Although the latter assumption might hold in some instances, the former assumption, which implies a unitary price-transmission elasticity, is untenable from a theoretical perspective. Fortunately, the biases introduced when both assumptions are false tend to be offsetting, so advertising rents derived from models that ignore the marketing channel may not be too far from the 'truth'.

The preferred approach, however, is to use a structural model that incorporates the marketing channel at the outset so that the biases can be avoided altogether. The model developed in this article is one such model; Wohlgenant's (1993) model is another. An advantage of the present model, besides endogenising the price of marketing services, is its flexibility in incorporating demand interdependencies at retail and supply interdependencies at the farm level. Specifically, owing to the matrix representation of market equilibrium, the dimensionality of the problem can easily be extended to accommodate any number of commodities as needed to represent the important substitution relationships at retail. Similarly, if important substitution relationships exist at the farm level, as would be true if production is unspecialised and the commodities compete for common resources (Gardner, 1979), the matrix containing the supply

elasticities could be augmented to include supply cross-price elasticities. With the availability of matrix-manipulation software (e.g., *Mathematica*®), vertical market models of the type proposed in this article, regardless of their size or complexity, are easily simulated.

A caveat in using equilibrium-displacement models to evaluate generic advertising programs is that they are in essence comparative-static models and for this reason are best suited for studying the effects of small changes in advertising expenditures where the paths of adjustment from one equilibrium position to another are of no particular interest (Piggott 1992). Simulations based on equilibrium-displacement models assume that advertising elasticities are constant, an assumption that becomes tenuous as the simulation's time horizon lengthens (Kinnucan and Venkateswaran 1994). Still, equilibrium-displacement models offer distinct advantages over econometric models, not the least of which is their ability to reflect in a transparent and explicit manner the structural detail (e.g., supply response, cross-commodity substitution, marketing technology, mark-up behaviour) that is so essential for sound benefit-cost analysis.

Appendix: Derivation of market-clearing conditions under variable proportions (Cobb–Douglas Technology)

First, define initial equilibrium as:

$$Q_d = k \, X_s \tag{A.1}$$

where Q_d is the quantity demanded at retail; X_s is the quantity supplied at the farm level; and k is the number of units of retail product per unit of the farm product, i.e., $k = Q_s / X_d$, where Q_s is the quantity supplied at retail, and X_d is the quantity demanded at farm. k hereafter is referred to as the 'dressing percentage'.

Recognising that in competitive equilibrium $Q_d = Q_s = Q$ and $X_s = X_d = X$, the logarithmic total differential of (A.1) yields:

$$d\ln Q = d\ln X + d\ln k \tag{A.2}$$

where $k = Q/X$ (average product). Equation (A.2) indicates that the relationship between changes in equilibrium quantities at the two market levels depends on the behaviour of the dressing percentage. Two special cases of interest in this article are (i) the dressing percentage is a constant and (ii) the dressing percentage varies, but in a manner consistent with a Cobb–Douglas processing/marketing technology. A constant dressing percentage implies that $d\ln(Q/X) = 0$, which is consistent with a Leontief processing/marketing technology (Chambers 1988, p.16). In this case, (A.2) reduces to:

$$\mathrm{d}\ln Q = \mathrm{d}\ln X \qquad \text{(Leontief market-clearing)} \qquad (A.3)$$

To derive the market-clearing condition under a Cobb–Douglas marketing technology, consider the production function:

$$Q = X^c M^{(1-c)} \qquad (A.4)$$

where M is a bundle of marketing inputs and $0 < c \leqslant 1$. The implication of (A.4) for the behaviour of the dressing percentage is determined by solving the production elasticity c ($= (\partial Q/\partial X)/k$) for k, which yields $k = (\partial Q/\partial X)/c$. Under the maintained hypothesis of competitive markets, inputs are paid the value of their marginal products. Thus, $k = (P_f/P_r)$ $(1/c)$. The total derivative of this expression is:

$$\mathrm{d}k = \mathrm{d}(P_f/P_r)\,(1/c) + \mathrm{d}\,(1/c)\,(P_f/P_r)$$

Setting $\mathrm{d}\,(1/c) = 0$ (the production elasticity is constant), and dividing both sides of the above expression by k yields:

$$\mathrm{d}k/k = [\mathrm{d}(P_f/P_r)\,(1/c)]/[(P_f/P_r)(1/c)]$$

$$\mathrm{d}\ln k = \mathrm{d}\ln(P_f/P_r) = \mathrm{d}\ln P_f - \mathrm{d}\ln P_r \qquad (A.5)$$

Substituting (A.5) into (A.2) yields:

$$\mathrm{d}\ln Q = \mathrm{d}\ln X + \mathrm{d}\ln P_f - \mathrm{d}\ln P_r. \qquad \text{(C-D market-clearing)} \qquad (A.6)$$

QED.

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