Advertising Traded Goods

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Nerlove and Waugh's theory of cooperative (generic) advertising is extended to the case of traded goods. Results suggest that trade reduces the incentive to promote by enlarging the effective supply or demand elasticity facing the industry. This is especially true in the net exporter situation where the enlarged demand elasticity (relative to the autarky case) limits the ability to shift advertising costs onto consumers. Simulations of the model using data and parameter values for the California egg industry suggest that ignoring trade prejudices benefit-cost ratios in favor of the promotion program. The upward bias, moreover, is significant even when the trade share is modest.

Key words: benefit-cost analysis, generic advertising, Nerlove-Waugh theorem

Introduction

This article focuses on returns to generic advertising for agricultural products that move freely across political boundaries, hereafter referred to as "traded goods." Traded goods represent the norm rather than the exception for the some 55 commodities covered by promotion checkoffs (Forker and Ward, pp. 102–03; Neff and Plato). Yet the scholarly literature is virtually devoid of studies that elucidate the economic impacts of advertising traded goods in any systematic fashion. Early work by Nerlove and Waugh remains the theoretical foundation for much of the literature on advertising benefit-cost analysis (e.g., see Ferrero et al.). Nerlove and Waugh's analysis, however, applies strictly to nontraded goods. Trade is taken into account in recent work by Piggott, Piggott, and Wright, and by Kinnucan and Christian, but their models assume that the promoting industry is a net exporter. In an important paper, Alston, Carman, and Chalfant consider the returns to generic advertising in a small, open-economy setting, but their analysis is confined to a graphical treatment of the problem and does not consider the net importer case.

The purpose of this research is to determine the effectiveness of generic advertising in instances where the advertised good faces competition from foreign supplies and trade barriers are low or absent so that open-economy conditions prevail. The analysis builds on Nerlove and Waugh's theory of cooperative (generic) advertising by extending

their model to the traded-good case in which a portion of the advertising cost is shared with consumers via "tax shifting" (Chang and Kinnucan). The model is general in the sense that trade status is endogenous. That is, both the net importer and the net exporter case can be analyzed with a simple redefinition of the trade variable. For the net importer case, a parameter is included to take into account cost sharing with foreign producers when a promotion levy is imposed on imports to prevent free riding.

Following presentation of the model and comparative-static results, we apply the model to egg advertising in California to demonstrate its empirical utility. A key finding is that ignoring trade can prejudice benefit-cost ratios in favor of the advertising program—and this is true even if trade exposure is modest.

The Model

Consider a competitive industry that produces a tradeable good and that advertises strictly in the domestic market.[1] Assume further that price is determined by market forces, not the government. The industry ordinarily exports a portion of its production, but depending upon domestic supply and demand conditions, the trade status can switch from net exporter to net importer. The domestic market for the industry's product is integrated with the world market so that the law of one price holds across all markets, domestic and foreign. The industry represents a sufficiently small portion of the total economy such that the supply and demand for goods that are related to the industry's good through consumer preferences or production technology can be safely ignored, at least as a first approximation.[2]

With these assumptions, and holding constant all exogenous factors that affect supply and demand except advertising, the structural model for this industry that defines initial equilibrium is:

$$(1) \qquad q_D = D(p, A),$$

$$(2) \qquad q_S = S(p),$$

$$(3) \qquad q_T = T(p),$$

$$(4) \qquad q_T = q_S - q_D,$$

$$(5) \qquad R = pq_S - \int_0^{q_S} S^{-1}(u)\, du - \Omega \phi A,$$

where q_D is the domestic quantity demanded, q_S is the domestic quantity supplied, q_T is the quantity traded, p is market price, A is domestic advertising expenditures, and R is net economic surplus (quasi-rent) accruing to domestic producers.

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[1] The focus on domestic market promotion is for analytical convenience. Principles derived from the domestic promotion case apply equally to export market promotion.

[2] This assumption is in keeping with Nerlove and Waugh's analysis. For models that relax this assumption, see Wohlgenant (1993); Piggott, Piggott, and Wright; and Kinnucan (1997).

The five endogenous variables in the system are assumed to be measured at the farm level, i.e., the quantity variables (q_T, q_S, and q_D) are expressed in farm-equivalent units, p is the farm-gate price, and R is rent at the farm level. Thus, D is a derived demand relationship and S is a primary supply relationship.

The trade relation, T, differs in its interpretation depending on trade status. If the country or region in question is a net exporter of the advertised commodity, then $q_T > 0$, and T is an export demand relation. If the country or region is a net importer, then $q_T < 0$, and T is an import supply relation.

S^{-1} is the primary supply curve written in inverse form, i.e., price as a function of quantity in equation (2). The Ω term in the rent equation is an incidence parameter to account for "tax shifting," i.e., the hypothesis that a portion of the advertising cost is shifted to consumers when advertising funds are raised through a per unit levy in a competitive market (Chang and Kinnucan). Specifically, Ω is the proportion of the per unit levy that is borne by producers. (A precise mathematical definition is given later.)

When the trade status is net importer, a promotion tax is frequently levied on imports to prevent free riding. In these instances, the cost of advertising is shared with foreign producers. The ϕ parameter in (5) is the portion of the advertising funds collected from domestic producers. If no levy is imposed on imports, $\phi = 1.0$; otherwise ϕ is a positive fraction.

Following Nerlove and Waugh, A is treated as exogenous.[3] It appears as a shift variable in the derived demand relation, even though advertising ordinarily occurs at retail. Thus, we abstract from the marketing channel—a simplification that is innocuous as long as the demand elasticity is measured at the farm level and the industry's aggregate marketing technology is fixed proportions (Kinnucan 1997), a maintained hypothesis in this study.

More difficult to justify is the simple-shift specification, since generic advertising in some instances may cause the demand curve to rotate (e.g., Quilkey). However, the simple-shift specification is consistent with Stigler and Becker's view that advertising provides information, a view that enjoys empirical support (e.g., Ding and Kinnucan, pp. 359–60; also see Kinnucan et al. and the references cited therein). The simple-shift specification is also consistent with Nerlove and Waugh's model, and thus permits direct comparison of results.

Analysis

The first task is to determine the effect of an increase in advertising on net producer surplus. For this purpose, express (1)–(5) in total differential form:

$$(1')\qquad\qquad d\ln(q_D) = -\eta\, d\ln(p) + \beta\, d\ln(A),$$

$$(2')\qquad\qquad d\ln(q_S) = \epsilon\, d\ln(p),$$

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[3] A reviewer suggested that perhaps it may be more appropriate to model advertising as endogenous, dependent on the tax rate and industry output. However, as will be shown later, the optimality conditions are unaffected by the exogeneity assumption as long as incidence is taken into account.

(3') $d\ln(q_T) = e \, d\ln(p),$

(4') $d\ln(q_T) = (q_S/q_T)d\ln(q_S) - (q_D/q_T)d\ln(q_D),$

(5') $dR = pq_S d\ln(p) - \Omega\phi dA,$

where $d\ln(x)$ $(= dx/x)$ is the relative change in variable x, η is the absolute value of the domestic demand elasticity, ϵ is the domestic supply elasticity, e $(= (\partial q_T/\partial p)(p/q_T))$ is the price elasticity corresponding to the T function, and β $(= (\partial q_D/\partial A)(A/q_D))$ is a parameter that indicates the percentage change in demand associated with a 1% change in advertising expenditures, *holding prices constant*, hereafter referred to as the "advertising elasticity." Given the negative sign in equation (1'), all elasticities except e are defined to be positive. That is, the domestic supply curve is upward sloping, the domestic demand curve is downward sloping, and advertising causes the domestic demand curve to shift to the right.

The sign of e depends on trade status. For a net exporter, $q_T > 0$, and $e = e_D$ is interpreted as an export demand elasticity. For a net importer, $q_T < 0$, and $e = e_S$ is interpreted as an import supply elasticity. In this analysis, e_D is assumed to be negative, and e_S is assumed to be positive. Specifically, the excess demand function is nonincreasing and the excess supply function is nondecreasing.

The term dR in (5') represents the change in net producer surplus (hereafter called "profit") associated with a small change in advertising expenditure. It can be seen that price enhancement is a necessary condition for an increase in advertising to be profitable. The conditions conducive to price enhancement are determined by substituting (1')–(3') into (4') and solving for $d\ln(p)$:

(6) $d\ln(p) = \{\beta/[(1 + k)\epsilon + \eta - ke]\}d\ln(A),$

where $k = (q_T/q_D)$ is the "trade share." Note from (6) that regardless of trade status, under the stated assumptions, an increase in advertising always increases price (unless e is plus or minus infinity). For example, if the trade status is net importer, $k < 0$ and $e > 0$, which means that $-ke$ in (6) is positive, so the total expression is positive. [Since $(1 + k) = q_S/q_D > 0$, the first term in (6)'s denominator is always positive.] Similarly, if the trade status is net exporter, $k > 0$ and $e < 0$, which again produces a positive sign for $-ke$, and thus for (6).

That (6) represents a generalization of Nerlove and Waugh's analysis can be seen by considering their comparable expression [p. 818, equation (5)], which, in our notation, is:

(7) $d\ln(p) = [\beta/(\epsilon + \eta)]d\ln(A).$

Comparing (6) and (7), it is evident that (6) reduces to (7) when $k = 0$. Thus, Nerlove and Waugh's analysis applies to nontraded goods only.

Both (6) and (7) are consistent in showing that advertising's price-enhancement ability increases as domestic supply or domestic demand becomes less elastic or as consumers become more responsive to the advertising. Direct inspection of (6) indicates

price enhancement is facilitated by a less elastic import supply or export demand curve, as might be expected from Nerlove and Waugh's analysis for the autarky case.

Trade Share and Price Enhancement

Intuitively, one would expect an increase in trade share to diminish advertising's price-enhancement ability when advertising is confined to the domestic market. For example, in the net exporter case, an increase in export share would mean less of the total crop being exposed to the advertising, and thus a weaker price effect. This may be checked by setting $\zeta = \beta/[(1 + k)\epsilon + \eta - ke]$ in (6) and taking the derivative with respect to k to yield:

$$\partial\zeta/\partial k = \beta(e - \epsilon)/[k(\epsilon - e) + \epsilon + \eta]^2.$$

For the net exporter case ($k > 0$ and $e < 0$), $\partial\zeta/\partial k$ is negative, which means an increase in export share always diminishes advertising's price-enhancement ability when advertising occurs in the domestic market. Thus, intuition is confirmed in the net exporter case.

For the net importer case ($k < 0$ and $e > 0$), the effect of trade share on advertising's price-enhancement ability hinges on the relative magnitudes of the supply elasticities. For example, if import and domestic supply are equally elastic ($e = \epsilon$), $\partial\zeta/\partial k = 0$, and import share is irrelevant. Conversely, if import supply is more elastic than domestic supply ($e > \epsilon$), the usual case given small-trader effects and the inelasticity of domestic supply response for most agricultural products, then $\partial\zeta/\partial k > 0$. The positive derivative in this case implies that a decrease in imports increases advertising's price-enhancement ability.

This result accords with intuition as well, but for a different reason than given for the net exporter case. In particular, in the net importer case, supply response, not advertising exposure, is the causal mechanism. This can be seen by noting that as import share declines, so too does the portion of total supply that comes from the more elastic source when $\epsilon < e$. With less quantity coming from the more elastic source, supply response is attenuated and this enhances advertising's price effect.[4]

Fundamental Returns Equation for Traded Goods

The effect of a change in advertising expenditure on industry profit is obtained by substituting (6) into (5'), which yields:

(8) $$\delta R/\delta A = \alpha/[(1 + k)\epsilon + \eta - ke] - \Omega\phi,$$

where $\alpha = \beta p q_S/A$, an expression that is loosely interpreted as "the marginal gross revenue from increased advertising expenditures, *holding prices constant* [sic]" (Nerlove

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[4] A caveat in interpreting the foregoing analysis is that it assumes that e and k are independent. Although this assumption is plausible for small changes in trade share, for large changes in trade share there is reason to believe that the absolute values of e and k are inversely related (Houck, p. 39), in which case the relationships discussed above would be weakened. Still, for small changes, which are required to interpret the derivative, the relationships hold without qualification.

and Waugh, p. 819).[5] [If $q_S = q_D$ (autarky), α reduces to $p \partial q_D / \partial A$, in which case the interpretation is exact.] Equation (8) indicates the net effect of a small change in advertising expenditure on net producer surplus, taking into account (*a*) supply response in the domestic market, (*b*) equilibriating adjustments in the domestic and foreign markets in response to the demand increase in the domestic market, and (*c*) advertising cost shifting and sharing. It is a *net* measure of marginal returns in that it takes into account the incremental cost of the advertising [see equation (5′)].

From (8) it is apparent that the net marginal return (profit) is positive, zero, or negative, depending on the relative magnitude of the marginal cost term $\Omega \phi$, as the first term is nonnegative by assumption. Because the first term, $\alpha / [(1 + k)\epsilon + \eta - ke]$, in essence reflects advertising's price-enhancement ability, the previously discussed factors that determine price enhancement also determine profitability.

Small, Open-Economy Problem

Consider now the issue raised by Alston, Carman, and Chalfant with respect to advertising in a small, open economy. A small, open-economy situation occurs when trade barriers are absent and the crop represented by the promotion entity is too small in relation to the total volume traded to affect price. This situation arises most particularly (but not exclusively) in the case of state-based promotion efforts. For example, California producers fund a wide variety of promotion programs through marketing orders and state commissions (Carman, Cook, and Sexton, p. 140), some of which are state-specific. The point made by Alston, Carman, and Chalfant is that such programs may be futile because price enhancement is problematic.

The reason why price enhancement is problematic in a small, open-economy situation is that the excess supply or demand curve is horizontal. That is, the *e* parameter in (8) is negative infinity in the net exporter case and positive infinity in the net importer case. In either case, (8) reduces to

$$\delta R / \delta A = -\Omega \phi,$$

which means that the industry suffers a marginal loss equal to the incidence parameter (adjusted for cost sharing with foreign producers, where applicable).[6] And this is true regardless of the demand shift associated with the advertising, i.e., the magnitude of β, a fact that highlights the dangers of single-equation modeling of advertising returns.

Potential Biases from Ignoring Trade

What else can be learned from (8)? Consider a situation in which trade flows are modest, i.e., domestic supply and demand are nearly in balance so that $q_T \approx 0$. One might think from (8) that it would then be safe to ignore the trade relation, as the ke term would be

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[5] Technically, (8) is a *partial total* derivative (Chiang, p. 202) in that it holds constant the quantity-dependent parameters k, α, and ϕ at their initial equilibrium levels. To highlight this distinction, d in (5′) is replaced by δ in (8).

[6] As noted by a reviewer, this result stems from the law of one price, which implicitly assumes that domestic and foreign products are perfect substitutes. If this is not the case, then it may be possible to raise producer price through promotion. (For an example of a differentiated-good model, see Goddard and Conboy.)

close to zero. However, this conjecture assumes that k and e are independent. In fact, as noted by Houck (p. 39), $|k|$ and $|e|$ are inversely related. In particular, the excess demand curve facing the net exporter becomes more elastic as exports decrease and, in the limit, becomes perfectly elastic as k approaches zero (unless domestic production is large relative to total volume traded). A parallel argument applies to the net importer case. The upshot is that ignoring the trade relation is liable to prejudice the analysis in favor of the advertising program—and this is true whether trade shares are large or small.

Optimal Advertising Expenditure for Traded Goods

Industry profits from advertising are maximized when marginal net returns are zero, i.e., $\delta R/\delta A = 0$ in equation (8). However, as noted by Nerlove and Waugh, an optimum expenditure level computed in this manner is likely to overstate the true optimum in that it ignores opportunity cost. The opportunity cost of advertising funds can be incorporated into the analysis by defining a parameter ρ that represents the marginal return on the next-best use of advertising funds (e.g., production research; see Wohlgenant 1993). In this case, industry profit is maximized when

$$\delta R/\delta A = \rho.$$

Substituting (8) into this expression and solving for A (recalling that $\alpha = \beta p q_S/A$) yields:

$$(9) \qquad A^* = p q_S \beta / \left[\left((1 + k)\epsilon + \eta - ke \right)(\Omega \phi + \rho) \right],$$

where A^* represents the advertising expenditure that maximizes net producer surplus, taking into account opportunity cost. The optimal expenditure level varies directly with the factors that increase advertising's price-enhancement ability (e.g., less elastic demand or supply) and that lower the effective cost of the advertising to the domestic industry (lower opportunity cost, levy share, or incidence). Incidence is determined by supply and demand elasticities as follows:

$$(10) \qquad \Omega = \acute{\eta}/(\acute{\epsilon} + \acute{\eta}),$$

where $\acute{\eta}$ is the absolute value of the effective demand elasticity, and $\acute{\epsilon}$ is the effective supply elasticity.

The effective demand and supply elasticities depend on trade status (see appendix). For the net importer case,

$$\acute{\eta} = \eta,$$
$$\acute{\epsilon} = \tau[(1 + k)\epsilon - ke_S];$$

and for the net exporter case,

$$\acute{\eta} = (1 + k)^{-1}\eta + (1 + k)^{-1}k|e_D|,$$
$$\acute{\epsilon} = \tau\epsilon,$$

where $\tau = p/(p - t)$, and t is the per unit levy. Substitution of these expressions into (10) yields the following:

(10a)   Incidence for net exporter:

$$\Omega_X = [\eta + k|e_D|]/[\eta + k|e_D| + (1 + k)\tau\epsilon];$$

(10b)   Incidence for net importer, imports taxed:

$$\Omega_M = \eta/[\eta + (1 + k)\tau\epsilon - k\tau e_S];$$

and

(10c)   Incidence for net importer, imports not taxed:

$$\Omega_M' = [\eta - k\tau e_S]/[\eta + (1 + k)\tau\epsilon - k\tau e_S].$$

In essence, trade enlarges the supply or demand elasticity facing the industry, and this affects incidence. In a closed economy ($k = 0$), the situation examined by Chang and Kinnucan, $\acute{\eta} = \eta$ and $\acute{\epsilon} = \tau\epsilon$, and producer incidence is always 100% ($\Omega_X = \Omega_M = \Omega_M' = 1.00$) when supply is fixed ($\epsilon = 0$). However, this is not necessarily true in an open economy ($k \neq 0$). In particular, as can be seen by comparing equations (10a)–(10c), producer incidence is 100% with fixed *domestic* supply only if the industry is a net exporter.

Under the net importer case, a portion of supply comes from foreign producers, and as long as this supply is not fixed, the effective supply elasticity is positive. Consequently, a portion of the advertising tax is always shifted to consumers given downward-sloping demand. One implication is that, ceteris paribus, a net importer situation may provide a more favorable environment in which to promote than a net exporter situation, at least from a cost-shifting perspective. An exception to this statement occurs when imports are not taxed, in which case the domestic producer incidence approaches one as $\epsilon \to 0$ [see (10c)]. Thus, a strong incentive exists to tax imports to prevent free riding, because by doing so the industry acquires a larger budget and shifts a larger portion of the advertising cost onto consumers.

Equation (9) may be compared to Nerlove and Waugh's optimality condition (p. 822) for a nontraded good, which in our notation is:

(11) $A^*|_{N\text{-}W} = pq_S\beta/[(\epsilon + \eta)(1 + \rho)],$

where $A^*|_{N\text{-}W}$ is optimal advertising expenditure as defined by Nerlove and Waugh. Equation (9) reduces to (11) when there is no trade and producers bear the full incidence of the promotion levy, i.e., $k = 0$, and $\Omega = \phi = 1$. Thus, equations (9) and (10) represent a generalization of Nerlove and Waugh's theory of cooperative (generic) advertising.[7]

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[7] In fact, Nerlove and Waugh's result understates the optimum in that if $\Omega = 1.0$ and demand is downward sloping, then supply must be fixed, i.e., the ϵ in equation (11) must vanish. (For further discussion of incidence in the closed-economy case, see Alston, Carman, and Chalfant, pp. 159–60.)

Comparison with Dorfman-Steiner Theorem

The foregoing results may be compared to Dorfman and Steiner's result for a monopolist who chooses advertising and price simultaneously to maximize profit:

$$(12) \qquad\qquad \theta^*|_M = \beta/\eta,$$

where $\theta^*|_M$ is optimal advertising intensity (advertising expenditure divided by revenue) for a monopolist with fixed output. The corresponding condition for a competitive industry without trade may be obtained from (11) by replacing $1 + \rho$ with $\Omega + \rho$ (to account for tax shifting) and substituting (10) to yield:

$$(13) \qquad\qquad \theta^*|_C = \beta/[\eta + \rho(\epsilon + \eta)],$$

where $\theta^*|_C$ is optimal advertising intensity for a competitive industry under autarky.

Comparing (12) and (13), it can be seen that the Nerlove-Waugh condition reduces to the Dorfman-Steiner theorem when opportunity cost is zero and allowance is made for tax shifting. Identical results were obtained by Alston, Carman, and Chalfant (pp. 156–60) from a model that shifts the demand and supply curves simultaneously in response to a combined increase in the advertising levy and advertising expenditure. Thus, treating advertising expenditures as exogenous has no effect on the optimality conditions provided tax incidence is taken into account.

The fact that the Nerlove-Waugh theorem reduces to the Dorfman-Steiner theorem when tax shifting is taken into account suggests that the Dorfman-Steiner theorem is quite general. Becker and Murphy caution, however, that the Dorfman-Steiner condition can be misleading since the theorem implicitly assumes that β and η are independent. But when comparing the behavior of an oligopoly firm to that of a monopoly, β and η are both expected to be larger for the oligopoly firm than for the monopoly, since the oligopoly firm faces closer substitutes and can generate a larger advertising response due to its ability to attract customers from closely competing firms. In this instance, it is incorrect to infer from the Dorfman-Steiner theorem that a monopoly has a stronger incentive to advertise than an oligopoly firm, since β and η are not independent across industry structures.

A more subtle point has to do with Nerlove and Waugh's observation:

> Since payments must generally be approved by a majority of producers, rates must
> be kept low enough to continue to attract majority support. Any purely economic
> theory of cooperative advertising can thus set only an upper bound to optimal
> expenditures (p. 820).

Both the Dorfman-Steiner theorem, and the corresponding condition for a traded good [equations (9) and (10)], fail to take into account the collective-good aspects of cooperative advertising (Hardin) and thus the incentive to free ride. For this reason, it is unlikely that generic advertising will be socially excessive in the sense described by Tremblay and Tremblay, unless generic advertising generates negative externalities (e.g., poorer diet). That is, free-rider incentives reduce the ability to fund collective advertising at the economic optimum.

Application

To illustrate how the theory works and to highlight the key qualitative results, we performed some simulations using baseline data and parameters for the California egg industry, as detailed in table 1. The California Egg Commission's (CEC's) promotion program is of interest because the ads appear strictly in California, which has characteristics of a small, open economy with respect to the egg trade. Specifically, California accounts for less than 10% of national egg production, and eggs are free to move across state lines in response to changes in local supply or demand conditions. California is a modest net importer of table eggs (10.2% average import share between 1993 and 1995), which provides an opportunity to assess the importance of accounting for trade even when trade is apparently unimportant.

Parameterization

The demand and "domestic" (California) supply elasticities were selected to be consistent with estimates in the literature (see notes to table 1). Since no estimates were available for the import supply elasticity, and intuition suggests this parameter should be quite elastic owing to small-trader effects, e was set alternatively to 3, 6, and 12 to gauge the importance of this parameter on the simulation results. To distinguish between returns over different time horizons, simulations are provided with ϵ set alternatively to zero, 0.20, and 0.942. The latter two values correspond, respectively, to Chavas and Johnson's estimate (pp. 331–32) of the short-run (one year) and long-run (six years) supply response in the U.S. egg industry. Setting $\epsilon = 0$ provides a measure of returns for a time horizon when California egg production is fixed, say three months or less.

Because the central purpose of this simulation exercise is to determine the biases that can arise when trade is ignored, we also simulated returns using Nerlove and Waugh's counterpart to equation (8). The N-W relationship (p. 822) is obtained by substituting (7) into (5'):

$$(14) \qquad \delta R/\delta A|_{N\text{-}W} = \alpha/(\epsilon + \eta) - \Omega\phi.$$

Comparing (14) and (8), the main difference between the two measures is that Nerlove and Waugh's formula implicitly assumes a closed economy, which is not true for the California egg market. Thus, a comparison of the returns computed from (8) and (14) provides a basis for assessing the importance of accounting for trade.[8]

In the baseline simulation, we set $\phi = 0.898$ (table 1), as California-produced eggs accounted for 89.8% of California consumption over the evaluation period, and imports are assessed at the same rate as California-produced eggs (Pierre). In the final simulations, ϕ is increased and decreased to assess the impact of cost sharing on marginal returns. Incidence is modeled using (10b), the appropriate equation when imports are assessed at the same rate as domestic production. The baseline values for

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[8] Technically, in Nerlove and Waugh's equation, $\Omega = \phi = 1$, as they did not consider advertising tax shifting or cost sharing. Because the purpose of (14) is to isolate the effects of ignoring trade, we retain the Ω and ϕ parameters.

Table 1. Baseline Values and Parameters for the California Egg Industry, 1993–95

Item	Definition	Value
Q_S	National production of table eggs (mil.)[a]	188,012
q_S	California production of table eggs (mil.)[b]	17,867
q_S/Q_S	California share of national production	0.095
q_D	California consumption of table eggs (mil.)[b]	19,864
q_T	California imports of table eggs (mil.)[b]	−1,997
k	California trade share (q_T/q_D)	−0.102
p	California farm price of eggs ($/doz.)[c]	0.494
v	Farm value $(= pq_S/12)$ ($ mil.)	736
A	CEC advertising expenditures ($ mil.)[b]	10.05
θ	Advertising intensity $(= A/v)$	0.0137
ϕ	Share of A paid by California producers $(= 1 + k)$[b]	0.898
τ	Ratio of market price to net price $(= p/(p - t))$[b]	1.015
β	California advertising elasticity[d]	0.019, 0.042
η	California demand elasticity (absolute value)[e]	0.15, 0.33
ϵ	California supply elasticity[f]	0.00, 0.20, 0.942
e	California import supply elasticity	3, 6, 12

[a] Source: U.S. Department of Agriculture/Economic Research Service, *Poultry Yearbook*, table 27 (updated March 1997).

[b] Source: Robert D. Pierre, CEO, California Egg Commission.

[c] Simple average of Large Egg price and Blend Egg price; source: Don Bell, poultry specialist, University of California, Irvine.

[d] Derived from Schmit, Reberte, and Kaiser's parameter estimates (contact author for details).

[e] Values from Wohlgenant (1989), and Chavas and Johnson, respectively.

[f] Source for latter two values: Chavas and Johnson.

the demand and advertising elasticities are $\eta = 0.15$ and $\beta = 0.019$. The elasticities are increased to 0.33 and 0.042, respectively, in the sensitivity analysis to reveal how a more elastic demand or a more effective advertising campaign affects marginal returns.

Simulation

Results indicate that marginal net returns are positive for the baseline parameter values, but sensitive to trade, especially if domestic supply is fixed (table 2). Although measured marginal returns without trade in all cases are higher than the corresponding returns with trade, when domestic supply is fixed the upward bias from ignoring trade is especially severe, on the order of 204% to 815% (simulation 1). Longer-run returns show less bias (simulations 2 and 3), but in no case is the upward bias from ignoring

Table 2. Net Marginal Returns to Increased Generic Advertising With and Without Accounting for Trade, California Egg Industry, 1993–95

Simulations [a]	Calif. Cost Share (ϕ)	Levy Incidence (Ω)		Marginal Return [b]		Ratio [c]
		With Trade	W/O Trade	With Trade	W/O Trade	
No. 1: ($\epsilon = 0.00$; $\eta = 0.15$; $\beta = 0.019$; $k = -0.102$)						
$e = 3$	0.898	0.33	1.00	2.75	8.35	3.04
$e = 6$	0.898	0.19	1.00	1.65	8.35	5.07
$e = 12$	0.898	0.11	1.00	0.91	8.35	9.15
No. 2: ($\epsilon = 0.20$; $\eta = 0.15$; $\beta = 0.019$; $k = -0.102$)						
$e = 3$	0.898	0.23	0.42	1.97	3.58	1.82
$e = 6$	0.898	0.16	0.42	1.33	3.58	2.69
$e = 12$	0.898	0.10	0.42	0.81	3.58	4.44
No. 3: ($\epsilon = 0.942$; $\eta = 0.15$; $\beta = 0.019$; $k = -0.102$)						
$e = 3$	0.898	0.11	0.14	0.96	1.15	1.19
$e = 6$	0.898	0.09	0.14	0.78	1.15	1.47
$e = 12$	0.898	0.07	0.14	0.56	1.15	2.03
No. 4: ($\epsilon = 0.942$; $\eta = 0.33$; $\beta = 0.019$; $k = -0.102$)						
$e = 3$	0.898	0.22	0.26	0.74	0.86	1.16
$e = 6$	0.898	0.18	0.26	0.61	0.86	1.41
$e = 12$	0.898	0.14	0.26	0.46	0.86	1.89
No. 5: ($\epsilon = 0.942$; $\eta = 0.15$; $\beta = 0.042$; $k = -0.102$)						
$e = 3$	0.898	0.11	0.14	2.25	2.69	1.19
$e = 6$	0.898	0.09	0.14	1.82	2.69	1.47
$e = 12$	0.898	0.07	0.14	1.32	2.69	2.03
No. 6: ($\epsilon = 0.942$; $\eta = 0.15$; $\beta = 0.019$; $k = -0.102$)						
$e = 3$	0.898	1.00	1.00	0.17	0.37	2.22
$e = 6$	0.898	1.00	1.00	-0.04	0.37	-10.49
$e = 12$	0.898	1.00	1.00	-0.27	0.37	-1.36
No. 7: ($\epsilon = 0.00$; $\eta = 0.15$; $\beta = 0.019$; $k = -0.020$)						
$e = 3$	0.980	0.71	1.00	5.91	8.27	1.40
$e = 6$	0.980	0.55	1.00	4.60	8.27	1.80
$e = 12$	0.980	0.38	1.00	3.18	8.27	2.60
No. 8: ($\epsilon = 0.00$; $\eta = 0.15$; $\beta = 0.019$; $k = -0.148$)						
$e = 3$	0.852	0.26	1.00	2.19	8.39	3.84
$e = 6$	0.852	0.15	1.00	1.26	8.39	6.67
$e = 12$	0.852	0.08	1.00	0.68	8.39	12.34

[a] Definitions of terms are as follows: ϵ = domestic (California) supply elasticity, η = domestic demand elasticity (absolute value), β = advertising elasticity, e = import supply elasticity, and k = import share.

[b] Returns with trade were computed from text equations (8) and (10b); returns without trade were computed from (14) and (10b).

[c] Ratio = marginal return w/o trade divided by marginal return w/trade.

trade less than 19% for the baseline parameter values. The attenuation of bias in the longer-run returns is largely due to less bias in the measured incidence, as the values for Ω in the trade and autarky scenarios converge as ϵ becomes larger (e.g., compare Ω in simulations 1 and 3). Unless indicated otherwise, the remaining discussion focuses on long-run returns, i.e., results for $\epsilon = 0.942$.

Long-run returns are relatively insensitive to the demand and import supply elasticities, but quite sensitive to the advertising elasticity (simulations 3–5, table 2). Holding the import supply elasticity constant at $e = 6$, if consumers are relatively price sensitive so that $\eta = 0.33$, marginal returns drop from $0.78 to $0.61 (simulation 3 versus simulation 4), and if consumers are relatively responsive to promotion so that $\beta = 0.042$, marginal returns increase from $0.78 to $1.82 (simulation 3 versus simulation 5). Increasing the import supply elasticity from 3 to 12 causes marginal returns for baseline parameters to drop from $0.96 to $0.56 (simulation 3). Overall, for the hypothesized parameter values, bias is less sensitive to elasticity values than returns, especially for long-run simulations.

Tax shifting exerts its greatest influence in the long run. Specifically, as supply becomes more elastic relative to demand, a greater portion of the promotion levy is shifted to consumers. This serves to counteract the dampening effect of supply response on producer profit. The importance of tax shifting is evidenced by the values of the incidence parameter in table 2: in the short run, producers bear between 10% and 23% of the incremental advertising cost depending on the import supply elasticity (simulation 2); in the long run, producer incidence for the same parameter values declines to between 7% and 11% (simulation 3). The low producer incidence is due to the combination of an inelastic demand and a highly elastic supply response due to small-trader effects. That California producers can escape much of the advertising costs through tax shifting may explain their willingness to invest in advertising despite the a priori modest effect on price.

Suppose that the CEC is unaware of tax shifting, i.e., management believes that the full cost of the adverting levy is borne by producers. Under this condition, a "perceived" return can be computed from (8) by setting $\Omega = 1$. The most interesting results are for long-run returns (table 2), because the differences between the actual and perceived incidences are the largest. In this case, the model produces marginal returns of between -0.27 and 0.17 for the baseline elasticities (simulation 6). The fact that these returns go through zero suggests that the industry may be operating near its long-run *perceived* optimum, as profits are maximized, ignoring opportunity cost, when $\delta R/\delta A = 0$.

Returning to the bias issue (the main point of this exercise), suppose that import share was reduced from 10.2% to 2.0%, the 1993 value. What then would be the bias from ignoring trade? We present results for fixed supply (table 2), as they illustrate the point most forcefully. The bias is between 40% and 160%, smaller than when the import share is 10.2% (compare simulations 1 and 7), but still substantial. Moreover, simulation 7 probably understates the bias, as the with-trade returns assume that the import supply elasticity is constant when in fact it is likely to increase as the trade share approaches zero (Houck, p. 39). Thus, significant biases can result from ignoring trade, even if trade share is tiny.

Finally, consider the effect of trade on profit (table 2). In simulation 8, we retain the supply and demand elasticities used in simulation 7 and increase the import share to 14.8%, the 1995 value. Even with this relatively modest increase in import share over

Table 3. Effect of Import Levy, Opportunity Cost, and Trade Share on Optimal Advertising Intensity, California Egg Industry, 1993–95

Opportunity Cost (ρ) / Trade Share (k)	Optimal Intensity (θ^*)		Ratio[c]
	With Import Levy[a]	W/O Import Levy[b]	
$\rho = 0.10$			
$k = -0.05$	0.0691	0.0326	0.47
$k = -0.10$	0.0649	0.0209	0.32
$k = -0.15$	0.0611	0.0154	0.25
$k = -0.20$	0.0578	0.0122	0.21
$\rho = 0.20$			
$k = -0.05$	0.0464	0.0265	0.57
$k = -0.10$	0.0420	0.0178	0.42
$k = -0.15$	0.0383	0.0134	0.35
$k = -0.20$	0.0352	0.0107	0.30

[a] Computed from text equations (9) and (10b) with elasticities set to $\epsilon = 0.942$, $\eta = 0.15$, $\beta = 0.019$, and $e = 6$; actual intensity is 0.0137.

[b] Computed from text equations (9) and (10c) using the same elasticities as indicated in footnote a.

[c] Ratio = "W/O Import Levy" column divided by "With Import Levy" column.

baseline, profit drops sharply. For example, if the import supply elasticity is 6, our "best guess" value, an isolated increase in import share from 2% to 14.8% causes the marginal return to fall from $4.60 to $1.26. And this reduction in profitability occurs despite the higher cost sharing with non-California producers that occurs as imports increase. The apparent sensitivity of returns to trade share is a new result in the commodity promotion literature. It may help explain the recent failures of the U.S. wool and cut-flower promotion referendums, as both of these industries face strong competition from imports.

Optimal Intensity

By way of summary, and to illustrate the importance of the import levy on promotion incentives, we computed the optimal advertising intensity using the baseline parameters, equation (9), and the appropriate incidence relation (table 3). Specifically, for the "with import levy" scenario, optimal intensity is computed from (9) and (10b); for the "without import levy" scenario, (9) and (10c) are used. For each scenario, the opportunity-cost parameter ρ is set alternatively to 0.10 and 0.20. These values are not meant to be exhaustive, but rather to indicate sensitivity of optimal advertising decisions to opportunity cost. Since trade effects are the primary focus of this research, the simulations in table 3 consider the optimal intensity for values of k ranging from −0.05 to −0.20, values that represent the recent trend in import shares in the California egg market.

Results indicate that the optimal intensity declines as trade share increases, but the decline is attenuated by the import levy (table 3). For example, when $\rho = 0.10$, optimal intensity declines from 0.0691 to 0.0578 as import share increases from 5% to 20% with the import levy; the corresponding decrease without the import levy is from 0.0326 to 0.0122. The reason for the attenuation is that the import levy permits cost sharing with non-California producers to increase in conjunction with imports. This situation mitigates the negative effect on profits of the increased supply response associated with the larger import share. The sharp reduction in optimal intensity when the import levy is removed (e.g., from 0.0649 to 0.0209 when $k = -0.10$ and $\rho = 0.10$) hints at the importance of the import levy for garnering California producer support for the program.

Increasing the opportunity cost to 0.20 attenuates the incentives provided by the import levy, but not substantially so (table 3). Overall, the optimal intensities for the "with import levy" scenario range from 0.0578 to 0.0691 when opportunity cost is 0.10, and from 0.0352 to 0.0464 when opportunity cost is 0.20. Thus, results are sensitive to opportunity cost. That the optimal intensities exceed the observed intensity of 0.0137 is consistent with Nerlove and Waugh's observation cited earlier that cooperative advertising is likely to be underfunded due to free-rider effects.

Concluding Remarks

The major contribution of this research is theory development. In particular, our analysis extends Nerlove and Waugh's theory of cooperative (generic) advertising to the case of traded goods where the advertising cost is shared with consumers through tax shifting and, where applicable, with foreign producers through advertising import levies. It builds on the work of Alston, Carman, and Chalfant by putting their graphical analysis into mathematical form and by extending their analysis to the net importer case. The net importer case has some unique aspects, not the least of which is the expanded role for supply response as a determinant of generic advertising effectiveness.

A caveat in interpreting our simulations is that they are meant to be illustrative of the principles involved, and not to provide a benefit-cost analysis of the California egg promotion program per se. To do that would require inter alia econometric estimation of the import supply elasticity, which is beyond the scope of this research. Then, too, the analysis ignores demand interrelationships, which may cause returns to be overstated (Kinnucan 1996). Bearing in mind these caveats, one might conjecture based on our simulations that the California egg promotion program has been profitable for California egg producers. Even so, there is no assurance that this situation will continue since California is rapidly becoming a major egg importer, and theory indicates an inverse relationship between import share and advertising profitability when import supply is more elastic than domestic supply.

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Appendix:
Derivation of Incidence Relationships

For simplicity, consider the linear model:

(A1) $q_D = a - bp$ (domestic demand),

(A2) $q_S = c + dp_S$ (domestic supply),

(A3) $p_S = p - t$ (net price),

(A4a) $q_X = e - fp$ (export demand),

(A4b) $q_M = g + hp_S$ (import supply with import levy),

(A4c) $q_M = g + hp$ (import supply without import levy),

(A5a) $q_X = q_S - q_D$ (market clearing/net exporter case),

(A5b) $q_M = q_D - q_S$ (market clearing/net importer case),

where the slope parameters b, f, and h are positive, and d is nonnegative to permit fixed domestic supply. In the above model, we abstract from advertising and focus on the effect of the per unit levy t on net price p_S.

Net Exporter Case

For the net exporter case, substitute (A1)–(A4a) into (A5a) and solve for p_S to yield:

(A6) $p_S^* = \kappa_1 - [(b + f)/(b + f + d)]t,$

where κ_1 is a constant term of no direct relevance to the analysis, and p_S^* is the net price in competitive equilibrium. Taking the derivative of (A6) with respect to t gives the comparative-static result:

(A7) $\partial p_S^*/\partial t = -(b + f)/(b + f + d),$

which may be used to analyze producer incidence. Since b and f are positive, and d is nonnegative by assumption, (A7) is negative, i.e., an increase in the levy always reduces the equilibrium net price. Incidence depends on the relative magnitudes of b, d, and f. In particular, if domestic supply is fixed ($d = 0$) or export demand perfectly elastic ($f = \infty$), then $\partial p_S^*/\partial t = -1$, and producers bear the full incidence, as expected. For other permissible parameter values, $0 < |\partial p_S^*/\partial t| \leq 1$, i.e., producer incidence is bounded between zero and one.

To express (A7) in terms of producer incidence and elasticities, let $\Omega_X = |\partial p_S^*/\partial t|$ and define:

(A8a) $$\eta = bp/q_D \quad \text{(recalling that } \eta \text{ is defined as absolute value)},$$

(A8b) $$\epsilon = dp_S/q_S,$$

(A8c) $$|e_D| = fp/q_X.$$

Substituting Ω_X and (A8a)–(A8c) into (A7) yields:

$$\Omega_X = [(q_D/q_S)\eta + (q_X/q_S)|e_D|]/[(q_D/q_S)\eta + (q_X/q_S)|e_D| + (p/p_S)\epsilon].$$

Substituting the identities $k = q_X/q_D$, $(1 + k) = q_S/q_D$, and $\tau = p/p_S$ into the above expression and simplifying yields:

(A9) $$\Omega_X = [\eta + k|e_D|]/[\eta + k|e_D| + (1 + k)\tau\epsilon],$$

which is identical to text equation (10a).

Net Importer Case

For the net importer case, two sub-cases need to be considered: one in which imports are taxed to prevent free riding, and one in which imports are exempted. For the taxed case, (A4b) is applicable, and we substitute this equation and (A1)–(A3) into (A5b) to yield:

(A10) $$p_S^* = \kappa_2 - [b/(b + d + h)]t,$$

which gives the comparative-static derivative:

(A11) $$\partial p_S^*/\partial t = -b/(b + d + h).$$

From (A11), producers never bear the full incidence when both domestic production and imports are taxed. In fact, if $h = \infty$ (small-trader case), $\partial p_S^*/\partial t = 0$, and producer incidence is zero.

If imports are exempted, imports respond to p, which is higher than p_S, the net price to domestic producers. In this case (A4c) is applicable, and we substitute this equation and (A1)–(A3) into (A5b) to yield:

(A12) $$p_S^* = \kappa_2 - [(b + h)/(b + h + d)]t,$$

which gives the comparative-static derivative:

(A13) $$\partial p_S^*/\partial t = -(b + h)/(b + h + d).$$

Comparing (A11) and (A13), it can be seen that (domestic) producer incidence rises when imports are not taxed. In fact, if domestic supply is fixed ($d = 0$), or if import supply is perfectly elastic ($h = \infty$), then $\partial p_S^*/\partial t = -1$, and domestic producers bear the full incidence. Thus, a strong incentive exists to tax imports to prevent free riding.

To express (A11) and (A13) in terms of producer incidence and elasticities, define:

(A8d) $$e_S = hp_S/q_M \quad \text{(with import levy)},$$

(A8e) $$e_S = hp/q_M \quad \text{(without import levy)}.$$

Substituting these expressions and (A8a) and (A8b) into (A11) and (A13) yields:

$$\Omega_M = \eta/[\eta + (q_S/q_D)(p/p_S)\epsilon + (q_M/q_D)(p/p_S)e_S]$$

and

$$\Omega'_M = [\eta + (q_M/q_D)(p/p_S)e_S]/[\eta + (q_S/q_D)(p/p_S)\epsilon + (q_M/q_D)(p/p_S)e_S],$$

where $\Omega_M = |\partial p_S^*/\partial t|$ corresponds to producer incidence when imports are taxed [equation (A11)], and $\Omega'_M = |\partial p_S^*/\partial t|$ corresponds to producer incidence when imports are not taxed [equation (A13)]. Substituting the identities $k = -q_M/q_D$, $(1 + k) = q_S/q_D$, and $\tau = p/p_S$ into the foregoing expressions yields:

(A14a)
$$\Omega_M = \eta/[\eta + (1 + k)\tau\epsilon - k\tau e_S]$$

and

(A14b)
$$\Omega'_M = [\eta - k\tau e_S]/[\eta + (1 + k)\tau\epsilon - k\tau e_S],$$

which are identical to text equations (10b) and (10c).   Q.E.D.