A Benefit-Cost Analysis of U.S. Agricultural Trade Promotion

Henry W. Kinnucan and Hailong Cai

Subsidies for nonprice export promotion can harm domestic consumers by increasing price in the domestic market and by diverting funds from domestic market promotion. Taking these consumer impacts into account, we find that federal expenditures for nonprice export promotion of farm products may be too high.

Key words: benefit-cost analysis, export promotion, international trade, subsidy.

JEL classification: D61, F14, Q11.

Most governments of developed countries encourage industry to develop or expand foreign markets through nonprice promotion activities. For example, a 2002 survey of 29 countries found that total expenditures for nonprice export promotion of agricultural, forestry, and fishery products exceeded $1.5 billion, of which $465 million, or 30%, represented government monies (Thompson 2004). In the United States, the federal government has subsidized nonprice export promotion of farm products since 1955, with outlays in recent years exceeding $130 million. These monies are matched by some $230 million in industry dollars, most of which come from levies on farm output. Promotion intensity, defined as the ratio of export promotion expenditures to the farm value of exports, increased from 0.11% prior to 1985 to 0.65% in the more recent period (table 1).

At issue is whether government expenditures for nonprice export promotion are welfare increasing when the effect of the subsidy on domestic consumers is taken into account. Domestic consumers are affected by the subsidy in two ways. First, a subsidy-induced increase in export demand diverts quantity from the domestic market, which implies a higher price in the domestic market. Since promotion directed at foreign consumers confers no benefit to domestic consumers, the price increase represents an unambiguous welfare loss for domestic consumers.

The second, and more subtle, way in which the subsidy harms domestic consumers is through its impact on domestic market promotion. In the United States, the subsidies are provided through two programs operated by the USDA: the Foreign Market Development Program (FMD) and the Market Access Program (MAP). MAP funds are aimed at processed foods and "high value" farm products (e.g., almonds, raisins, salmon, wine) and require dollar-for-dollar matching. FMD funds are directed at bulk products (e.g., corn, cotton, soybeans, wheat) and require as little as one dollar of industry money per nine dollars of government money. To the extent that the extra demand in the export market does not enlarge the promotion budget, or does so insufficiently to compensate for the added industry dollars spent on export promotion, demand in the domestic market is reduced as industry dollars are diverted from domestic market promotion to capture the subsidy. This "cannibalization effect" increases with the generosity of the subsidy, and thus is particularly strong for the FMD program. If promotion enhances product image or provides useful information, any reduction in spending in the domestic market induced by the subsidy will lower domestic consumer welfare (Tremblay and Tremblay 1995). Moreover, since increased

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Table 1. Export Value, Market Share, and Promotion Intensity, U.S. Agricultural Products, Five-Year Intervals, 1975–2004

Years	U.S. Export Value	U.S. Market Share (MS)	Industry Promotion Expenditures (A_x)	Government Promotion Expenditures (A_G)	Total Expenditures ($\tilde{A}_x$)	Promotion Intensity[a]
1975–79	26,513	0.247	15	15	30	0.0011
1980–84	39,021	0.260	25	18	43	0.0011
1985–89	32,231	0.210	61	104	165	0.0050
1990–94	42,254	0.219	94	180	274	0.0065
1995–99	54,795	0.205	127	118	245	0.0046
2000–04	55,781	0.199	232	131	363	0.0065

Note: All values are in million dollars, undeflated. Letters in parentheses are variable names used in the text.
[a]Total promotion expenditures divided by U.S. export value.
Source: See supplementary appendix available online.

export demand associated with the subsidy must be counterbalanced against the induced reduction in domestic demand, measures of producer impact that fail to take into account the cannibalization effect will be overstated.

A large and growing body of scholarly research exists on the economics of nonprice promotion of farm products (e.g., see Kaiser et al. 2005 and the references therein). Among the studies that evaluate the economic effects of export promotion, the only one known to address consumer impacts is Zhao, Anderson, and Wittwer's (2003) analysis of Australia's wine promotion program.[1] In that study it was found that "domestic consumers lose substantially from the price-raising effect of the promotion abroad and its impact on reducing supplies on the domestic market" (p. 199). In addition to not addressing consumer impacts, the export promotion literature is silent on the cannibalization effect.[2] As such, existing estimates of economic impact are incomplete, overstated, or both.

The purpose of this research is to determine whether the benefits of the nonprice export promotion programs operated by the USDA exceed costs when the consumer impact of the programs is taken into account. The United States represents a useful case study in that the subsidy rate (39%) is comparable to the world average (30%) identified by Thompson (2004). Hence, results should be of interest to policymakers in other countries, such as Australia, Brazil, Canada, Chile, France, Ireland, South Korea, Spain, and the United Kingdom, where subsidies are important. Most farm production in the United States is sold in the home market, which increases the likelihood that consumer losses might outweigh producer gains. Between 2004 and 2008, government expenditures for nonprice export promotion of farm products increased 44% (personal communication, Michael Dwyer, USDA Foreign Agriculture Service, April 26, 2010), which, in light of the cannibalization effect, raises the question of whether the current level of spending might be too high.

We begin with a graphical analysis of the problem. Next, the model is presented and an export demand curve is estimated. The model is then calibrated and simulated to indicate welfare effects. The paper concludes with a summary of key findings.

Graphical Analysis

The basic economics of nonprice export promotion in a partial equilibrium setting are indicated in figure 1. In this diagram we abstract from complexities such as product

[1] As explained by Alston et al. (2007, p. 43), studies ignore consumer impacts for two basic reasons: "authorizing legislation [that] specifies that the program objective is to enhance producer welfare" and "a lack of definitive results in the literature on the appropriate way to measure consumer welfare impacts." The first reason has less force in the case of export promotion in that government subsidies are involved. On the second reason, we adopt the viewpoint taken by Zhao, Anderson, and Wittwer (2003, p. 198, fn. 11), to wit: "There seems to be a consensus that consumers gain welfare from advertising . . . because [either] their knowledge about a product has changed (thus, product characteristics have changed that are objects in their decision functions) or their taste ordering has changed (thus, parameters in the decision functions have changed)." They cite Dixit and Norman (1979). A formula for measuring consumer impacts consistent with this viewpoint, but also with the qualifications raised by Tremblay and Tremblay (1995), is provided later.

[2] For a related literature on export promotion of industrial products, see the study by Williamson, Cramer, and Myrden (2009) and the references therein. The larger issue of the optimum government subsidy is not addressed in this research. A framework for determining the latter is given in Gardner (1987).

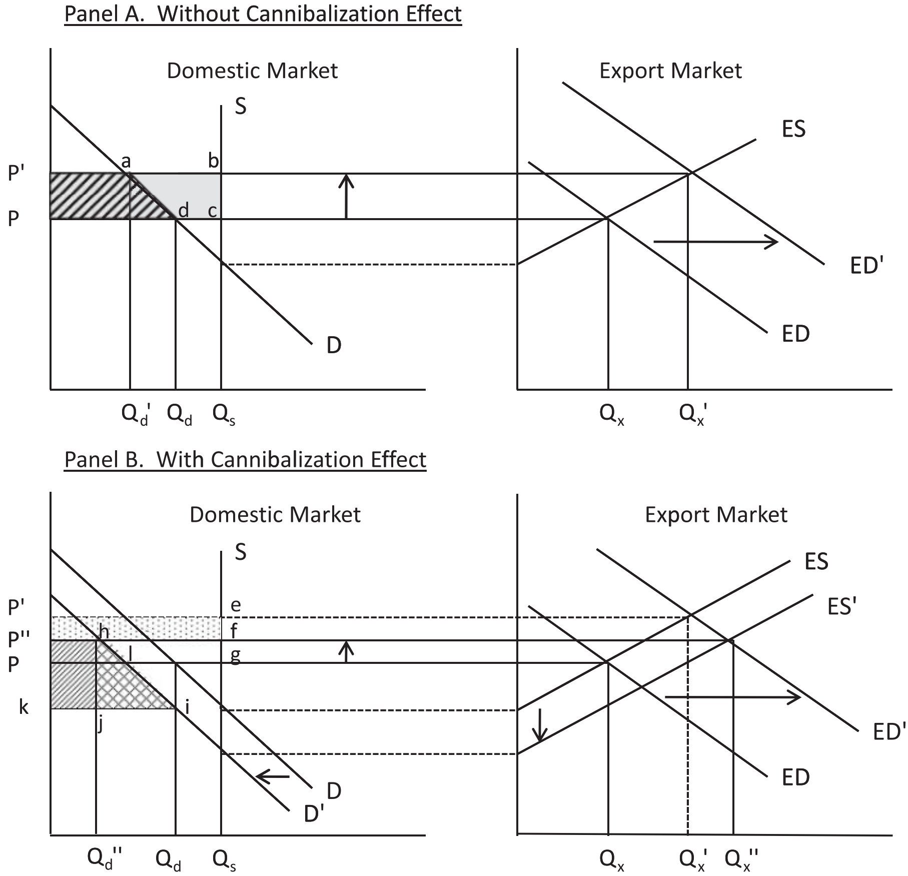

Figure 1. Domestic welfare effects of nonprice export promotion

hetereogeneity, imperfect competition, price wedges due to tariffs or other trade restrictions, and domestic farm programs. The country in question is assumed to account for a sufficiently large portion of world trade to affect price, i.e., it faces a downward- sloping excess demand (*ED*) curve. To keep the diagram simple, we assume that domestic production is fixed, i.e., the domestic supply curve (*S*) is vertical. This assumption, which is relaxed in the model to follow, has no effect on the basic analytics of the problem.

Panel A shows the effects of a promotion-induced increase in export demand on national welfare when the cannibalization effect is ignored. The shift in the excess demand curve from *ED* to *ED′* causes equilibrium price to increase from *P* to *P′*. The higher price confers a welfare gain to producers equal to the shaded area *P′bcP* and a welfare loss to domestic consumers equal to the hatched area *P′adP*. Because the shaded area exceeds the hatched area, there is an unambiguous *gross* national welfare gain equal to the trapezoid *abcd*. Whether the *net* national welfare gain is positive depends on the cost of the promotion, but also on the fraction of industry output that is exported, as the size of trapezoid *abcd* is an increasing function of export share.

Panel B shows the effects of a promotion-induced increase in export demand on national welfare when the cannibalization effect is taken into account. The domestic demand curve shifts to the left (from *D* to *D′*) as levy-constrained industry dollars are diverted from domestic to export market promotion to meet the cost-share requirement of the subsidy. This causes the excess supply curve to shift out from *ES* to *ES′*. The intersection of *ES′* and *ED′* produces an equilibrium price *P″* that is below the equilibrium price *P′* that occurs when the cannibalization effect is ignored. With a smaller price effect, the producer welfare gain dwindles (compare rectangle *P′bcP* in panel A with rectangle *P″fgP* in panel B).

The implications of the cannibalization effect for consumer welfare depend on whether promotion is persuasive or informative or alters product image (Tremblay and Tremblay 1995). The maximal consumer impact occurs when promotion enhances product image (or signals product quality), in which case the consumer welfare loss from the subsidy-induced reduction in domestic demand is equal to area $P''hik$ in panel B. In this instance the gain to society is ambiguous, as there is no assurance that the area representing the producer gain in panel B exceeds the area representing the consumer loss.

The minimal consumer impact occurs when promotion is persuasive. In this instance the consumer loss in panel B is restricted to the price increase associated with heightened export demand, which is equal to area $P''hlP$. But even in this extreme case, ignoring the cannibalization effect is not innocuous, as the producer impact is overstated by an amount equal to the dotted rectangle $P'efP''$.

The Model

Consider the following partial-equilibrium model of the market for an agricultural commodity:

(1) $Q_d = D(P, A_d)$

(2) $Q_x = X(P, \tilde{A}_x)$

(3) $Q_s = S(P_s)$

(4) $P_s = P - T$

(5) $A_d + A_x = A_I$

(6) $A_I = T \cdot Q_s$

(7) $\tilde{A}_x = A_x + A_G$

(8) $\tilde{A}_x = f(A_G)$

(9) $Q_s = Q_d + Q_x$

where Q_d is quantity consumed in the domestic market; Q_x is the quantity exported; Q_s is domestic production; P is price inclusive of the per unit marketing fee T, hereafter "demand price"; P_s is price exclusive of the marketing fee, hereafter "supply price"; A_I is industry funding for promotion raised from the marketing fee; A_d is industry expenditure for domestic market promotion; A_x is expenditure for export market promotion exclusive of the subsidy; $\tilde{A}_x$ is expenditure for export market promotion inclusive of the subsidy; and A_G is government expenditure for export promotion, or "subsidy."

In this model, we relax the assumption of fixed domestic supply but otherwise maintain the same assumptions as used in the graphical analysis. The model contains nine endogenous variables (Q_d, Q_x, Q_s, P, P_s, A_d, A_x, $\tilde{A}_x$, A_I) and two exogenous variables (T, A_G). Exogenous variables that affect supply and demand other than the marketing fee and the subsidy are suppressed. Demand for the industry's output can be increased in two ways: industry can enlarge the total promotion budget by voting to increase T, or government can enlarge the total funds spent on export promotion by electing to increase A_G. (For a good overview of how commodity promotion programs in the United States work, including voting procedures on the assessment, see Forker and Ward 1993; for a recent overview of the subsidy program, see Herrick 2010 and the references therein.) At issue in this study is the effect of an increase in A_G on domestic producer and consumer surplus when the feedback effect of the subsidy on domestic market promotion is taken into account. In the benefit-cost literature, it is common to treat $\tilde{A}_x$ (not A_G) as exogenous. However, as we shall show, the same principles apply regardless of which variable is considered exogenous.

To begin, we substitute equation (7) into equation (5) to eliminate A_x. Then, converting the model to percentage changes yields:

(10) $Q_d^* = \eta_d P^* + \alpha_d A_d^*$

(11) $Q_x^* = \eta_x P^* + \alpha_x \tilde{A}_x^*$

(12) $Q_s^* = \varepsilon P_s^*$

(13) $P^* = (1-\tau)P_s^* + \tau T^*$

(14) $\theta_d A_d^* + \theta_x \tilde{A}_x^* = \theta_I A_I^* + \theta_G A_G^*$

(15) $A_I^* = T^* + Q_s^*$

(16) $\tilde{A}_x^* = \varphi_x A_G^*$

(17) $Q_s^* = k_d Q_d^* + k_x Q_x^*$.

In equations (10)–(17) the asterisked variables indicate relative changes (e.g., $Q_d^* = dQ_d/Q_d$); η_d (<0) and η_x (<0) are domestic and export demand elasticities; α_d (>0) and α_x (>0) are domestic and export promotion elasticities; ε (≥0) is the domestic supply elasticity; $\tau = T/P < 1$ is the marketing fee expressed as a fraction of the demand price; $\theta_d = A_d/A$, $\theta_x =$

$\tilde{A}_x/A$, $\theta_I = A_I/A$, and $\theta_G = A_G/A$ are promotion shares, where $A = A_I + A_G$ is the total promotion budget; φ_x (>0) is an elasticity that indicates the sensitivity of total spending on export promotion to the subsidy, hereafter referred to as the "budget-diversion elasticity"; $k_d = Q_d/Q_s$ is the share of domestic production sold in the home market; and $k_x = Q_x/Q_s$ is the share of domestic production sold in the export market.

The first task is to determine the effect of an increase in promotion on the net price received by producers. For this purpose, we delete equations (14)–(16) (to treat A_d, $\tilde{A}_x$, and A_I as temporarily exogenous), set $T^* = 0$ (since we are not interested in the effect of the marketing fee per se), and solve the remaining equations simultaneously to yield:

$$P_s^* = \left(\frac{k_d\alpha_d}{\varepsilon - (1-\tau)\eta}\right) A_d^* + \left(\frac{k_x\alpha_x}{\varepsilon - (1-\tau)\eta}\right) \tilde{A}_x^* \quad (18)$$

where $\eta = k_d\eta_d + k_x\eta_x$ is the overall demand elasticity. Export promotion's ability to raise the supply price is inversely related to the supply and demand elasticities for the commodity, and directly related to the export promotion elasticity and the export quantity share. A similar interpretation applies to domestic market promotion.

For promotion to increase producer welfare, it must increase the net price received by producers. Thus, if the United States were a small-nation trader such that $\eta_x = -\infty$, then $P_s^*/A_d^* = P_s^*/A_x^* = 0$ and increased promotion would have no effect on producer welfare. Although this situation might occur for state-based promotion efforts (Alston, Carman, and Chalfant 1994; Kinnucan 1999), at the national level the United States accounts for a sufficiently large portion of world trade in farm products (20% in the last five years of our sample) to influence price. Hence, the "small, open-economy problem" is not an issue in the present analysis.

Cannibalization Effect

An analytical expression for the cannibalization effect can be obtained by dividing equation (18) through by A_G^* and substituting equation (16) to yield:

$$\frac{P_s^*}{A_G^*} = \left(\frac{k_d\alpha_d}{\varepsilon - (1-\tau)\eta}\right) \varphi_d + \left(\frac{k_x\alpha_x}{\varepsilon - (1-\tau)\eta}\right) \varphi_x \quad (19)$$

where $\varphi_d = A_d^*/A_G^*$ is the "cannibalization elasticity." Since the cannibalization elasticity is expected to be negative in sign, while the budget-diversion elasticity φ_x is positive, the sign of equation (19) is ambiguous. The ambiguity stems from the fact that an increase in government expenditures for export promotion causes a decrease in demand for the commodity in the domestic market as promotion funds are diverted to capture the subsidy. Depending upon the relative magnitude of the induced "backshift" in the domestic demand curve, the effect of an increase in subsidy on the net producer price could be perverse.

A similar result is obtained if $\tilde{A}_x$ rather than A_G is treated as exogenous. In this instance the price effect is:

$$\frac{P_s^*}{\tilde{A}_x^*} = \frac{k_d\alpha_d(\varphi_d/\varphi_x) + k_x\alpha_x}{\varepsilon - (1-\tau)\eta}. \quad (19a)$$

With the maintained hypothesis that the cannibalization elasticity is negative ($\varphi_d < 0$), the effect of an increase in total expenditures for export promotion on the supply price is uncertain. Thus, benefit-cost ratios that fail to take into account the effect of increased expenditures for export promotion on domestic market promotion will tend to overstate producer impact.

Returning to equation (19), the breakeven condition for a positive price effect is:

$$\alpha_x > \left(\frac{-k_d\varphi_d}{k_x\varphi_x}\right) \alpha_d. \quad (20)$$

Intuitive insight into inequality (20) can be obtained by developing an expression for the cannibalization elasticity in terms of model parameters. For this purpose, first rewrite the budget equation as

$$A_d = A_I + A_G - \tilde{A}_x. \quad (21)$$

Taking the derivative of equation (21) with respect to A_G yields:

$$(22) \quad \partial A_d/\partial A_G = \partial A_I/\partial A_G + 1 - \partial \tilde{A}_x/\partial A_G.$$

The effect of an increase in the subsidy on domestic market promotion depends on two opposing forces: a budget-expansion effect as measured by $\partial A_I/\partial A_G$, and a budget- diversion effect as measured by $\partial \tilde{A}_x/\partial A_G$. The budget-diversion effect increases with the generosity of the subsidy, while the budget-expansion effect increases with the size of the price response to promotion and the supply elasticity.

To quantify equation (22), we estimated the budget-diversion effect by regressing the logarithm of total export promotion expenditures on the logarithm of government expenditures using annual data for 1975–2004 as shown in the supplementary appendix available online. Evaluating the resulting elasticity $\hat{\varphi}_x = 0.92$ at mean data points for the last five years of the sample yields $\partial \tilde{A}_x/\partial A_G = 2.58$. (The mean value of $\partial \tilde{A}_x/\partial A_G$ over the entire sample is 1.94, with a standard deviation of 0.47.) This estimate implies that at the margin, a \$1 increase in subsidy increases total expenditure for export promotion by \$2.58. Inserting this estimate into equation (22) and setting $\partial A_I/\partial A_G = 0$ (to indicate a short-run effect when supply is fixed) yields \$1.58. This estimate implies that a \$1 increase in subsidy reduces domestic market promotion by \$1.58, *ignoring the budget-expansion effect*.

Converting equation (22) to an elasticity and making use of equation (15) (noting that $T^* = 0$) yields:

$$(23) \quad \varphi_d = \frac{\theta_G}{\theta_d} + \frac{\theta_I}{\theta_d}\varphi_I - \frac{\theta_x}{\theta_d}\varphi_x.$$

where $\varphi_I = A_I^*/A_G^* = Q_s^*/A_G^* = \varepsilon(P_s^*/A_G^*)$ is the "budget-expansion elasticity." The cannibalization elasticity equals a positive constant plus a weighted average of the budget-expansion and budget-diversion elasticities, with the constant and weights functions of budget shares. If government expenditure in the initial equilibrium is zero and supply is fixed, equation (23) reduces to $\varphi_d = -(\theta_x/\theta_d)\varphi_x$. In this instance, the posited negative sign for the cannibalization elasticity always holds. The reason is that with supply fixed, the promotion budget is not affected by the demand shift. With no ability to enlarge the total promotion budget, an increase in subsidy has a clear negative effect on domestic market promotion. In general, however, the sign of the cannibalization elasticity is an empirical issue.

In the last five years of our sample, 13% of the total promotion budget represented government monies for export promotion, and 64% of the budget was spent on domestic market promotion. Inserting $\theta_G = 0.13$, $\theta_d = 0.64$, $\theta_x = 0.36$, and $\hat{\varphi}_x = 0.92$ into equation (23) yields $\hat{\hat{\varphi}}_d = -0.31$. This suggests that a 1% increase in government expenditures for export promotion would decrease expenditures on domestic market promotion by 0.31%, *holding constant industry output*.

Over the same period, 75% of U.S. farm output was sold in the domestic market. Inserting $k_d = 0.75$, $k_x = 0.25$, $\hat{\varphi}_x = 0.92$, and $\hat{\hat{\varphi}}_d = -0.31$ into inequality (20) yields $\alpha_x \geq 0.98\ \alpha_d$. This suggests that for U.S. agricultural producers to benefit from increased government spending on export promotion, the export market must be at least as responsive to promotion as the domestic market. This (necessary) condition may be overly stringent, as the budget-expansion effect is ignored.

Whether the cannibalization effect is indeed negative after allowance is made for supply response is determined as a by-product of the benefit-cost analysis based on model simulations. To simulate the model, it must be calibrated. The first step in the calibration process involves obtaining an empirical estimate of the export market response to promotion.

Export Demand Estimation

The only known estimates of the aggregate demand shift associated with USDA-sponsored nonprice export promotion programs are from an unpublished study by Dwyer (1994) and two consulting reports (Global Insight 2007; IHS Global Insight 2010). Dwyer's analysis focused on high-value agricultural products and obtained an estimated long-run promotion elasticity of $\hat{\alpha}_x = 0.15$. The consulting reports expanded Dwyer's analysis to include bulk agricultural products and obtained estimated long-run promotion elasticities of between 0.14 and 0.20. A potential shortcoming of these studies is that price variables are not included in the estimating equations, and promotion expenditures are treated as exogenous. Because theory indicates that promotion expenditures are endogenous and prices are relevant variables in the demand equation, we estimated an export demand curve that addresses these issues.

Following Senhadji and Montenegro (1999), a lagged dependent variable model in constant elasticity form is specified. Senhadji and Montenegro note that while a lagged dependent variable introduces econometric issues, Pesaran and Shin (2001) show that the autoregressive specification retains its usual properties even in a cointegration framework.

Suppressing the error term and time subscripts, the basic specification is:

$$(24)\quad \ln(MS) = \beta_0 + \beta_P \ln(P) + \beta_{PS} \ln(PS) + \beta_{XR} \ln(XR) + \beta_Y \ln(Y) + \beta_A \ln(GW) + \beta_{LAG} \ln(MS_{-1})$$

where $M = PQ_x/Y$ is the share of foreign income spent on U.S. exports; Q_x is the quantity of U.S. farm products exported; P is the U.S. export price; PS is the price of substitutes; Y is foreign income; XR is an exchange rate that converts U.S. dollars into a representative foreign currency; and GW is the goodwill created by U.S. export promotion expenditures.[3] The goodwill specification follows Nerlove and Arrow (1962), who suggested that advertising is a demand-generating asset that depreciates over time (a precise empirical definition is given later). The XR variable is included to test whether foreign buyers' response to exchange-rate movements differs from their response to price movements, as suggested by Chambers and Just (1981).

The lagged dependent variable accounts for inertia. For example, the response of market share to a change in price might take longer than one year due to contractual obligations of importers, buyer habits, or uncertainty about whether the observed price change is temporary or permanent. Inertia is modeled using Nerlove's partial-adjustment model $MS/MS_{-1} = \left(\overline{MS}/MS_{-1}\right)^{\zeta}$, where $0 < \zeta = (1 - \beta_{LAG}) \leq 1$ is the "elasticity of adjustment" (Nerlove 1958, p. 309). If $\zeta = 1$, adjustment is instantaneous in the sense that market share approaches its long-run equilibrium level $\overline{MS}$ in one year. In this case, $\beta_{LAG} = 0$ and the model reduces to a static specification. If $\zeta < 1$, adjustment is delayed, and the coefficients in equation (24) are interpreted as short-run (one year) elasticities. Long-run elasticities are obtained by dividing the short-run elasticities by $(1 - \beta_{LAG})$.

Adding a trend variable and error term to equation (24), the empirical model estimated is:

$$(25)\quad \ln(X_t^{US}/X_t^W) = \beta_0 + \beta_P \ln(P_t^{US}/DEFL_t) + \beta_{PS} \ln(P_t^C) + \beta_{XR} \ln(XR_t) + \beta_Y \ln(X_t^W/DEFL_t) + \beta_A \ln GW_t + \beta_T TREND_t + \beta_{LAG} \ln(X_{t-1}^{US}/X_{t-1}^W) + \mu_t$$

where X_t^{US} is the nominal value of U.S. agricultural exports in year t in U.S. dollars; X_t^W is the nominal value of world imports of agricultural products in year t in U.S. dollars; P_t^{US} is the unit value of U.S. bulk agricultural exports in year t in U.S. dollars; $DEFL_t$ is a GNP deflator for the world less the United States; P_t^C is a Stone index of real trade-weighted exchange rates for U.S. competitors' agricultural exports; XR_t is a world U.S. agricultural trade-weighted real exchange rate; $TREND_t$ is a linear trend variable; and μ_t is a random disturbance term.

The trend variable is included in equation (25) to account for gradual changes in tastes and preferences for U.S. farm exports that may have occurred over the sample period, and other time-related omitted variables. The unit value of U.S. bulk farm exports serves as a proxy for the U.S. price, and an exchange rate index reflecting competitors' agricultural export prices serves as a proxy for the substitute price. Replacing foreign income with world import expenditures on farm products in essence converts the model to a conditional demand specification. Specifically, world demand for farm exports is implicitly assumed to be weakly separable from all other goods. This assumption, coupled with the two-stage budgeting hypothesis, implies that the price and income elasticities estimated from equation (25) are properly interpreted as conditional elasticities (Phlips 1990, pp. 71–77).

[3] Time series data on competitors' promotion expenditures are unavailable and thus this variable is not included in the model. Because U.S. expenditures in 2002 represented only 21% of the total amount spent among 29 surveyed countries (Thompson 2004), a reviewer noted that the omission of competitors' expenditures could be serious. For example, if competitors' expenditures decrease the demand for U.S. agricultural products, and competitors increase their expenditures in response to an increase in U.S. expenditures (an upward-sloping reaction function), the estimated promotion response from a model that excludes competitors' expenditures would be biased downward. The opposite would be true if the reaction function were downward sloping. This caveat must be borne in mind when interpreting results.

The goodwill variable in equation (25) is defined as $GW_t = AD_t + \delta AD_{t-1} + \delta^2 AD_{t-2}$, where $AD_t = \tilde{A}_{x,t} \cdot SDR_t/DEFL_t$is real total U.S. export promotion expenditures in year t, and SDR_t (for Special Drawing Rights) is the value of the U.S. dollar in relation to a market basket of five world currencies as computed by the International Monetary Fund. In this study, the retention parameter δ, which indicates the contribution of past flows of advertising to the current stock of goodwill, is set to 0.33.[4] Following Dwyer (1994), promotion expenditures are multiplied by an exchange rate to account for the increased purchasing power of U.S. promotion dollars as the currency strengthens. A precise definition of all variables in the model, including sources, is given in a supplementary appendix available online.

Labeling equation (25) "Model A," three restrictive forms were estimated to assess the sensitivity of parameter estimates to economic hypotheses:

$$\text{Model B}: \quad \beta_P = \beta_{XR}$$
(complete exchange rate pass-through)

$$\text{Model C}: \quad \beta_Y = 0$$
(homothetic preferences)

$$\text{Model D}: \quad \beta_Y = \beta_P = 0$$
(homothetic preferences and unitary demand elasticity)

In testing the restrictive forms, Model A is treated as the maintained hypothesis. The model was estimated using annual data for the period 1975–2004. Two observations are lost due to the goodwill specification, so the effective sample period is 1977–2004.

Estimation Procedure and Results

Augmented Dickey–Fuller tests showed all variables to be nonstationary in levels but stationary in first differences at the 5% level or better. The Johansen test indicated that the $I(1)$ variables are cointegrated.[5] Based on these results, equation (25) was estimated using the Fully Modified estimator of Phillips and Hansen (1990) and Hansen (1992). The FM estimator accounts for unit roots, serial correlation, and endogenous right-hand-side variables.[6] In addition to price, export promotion expenditures are endogenous because they depend on the size of the total promotion budget, which varies with the subsidy and output-altering demand shifts.

Estimation results are satisfactory in that the estimated coefficients have the correct signs, and most are significant (table 2). The estimated coefficient of the lagged dependent variable is significant in all models (t-ratio > 7.0), implying rejection of the static specification. A chi-square test rejects Model B at almost no probability of a type I error ($p = 0.0005$). Hence, the hypothesis of complete exchange rate pass-through is firmly rejected. That is, the Chambers–Just hypothesis that agents' responses to price movements differ from their responses to exchange-rate movements is affirmed. The chi-square test, however, fails to reject Models C and D (table 2, last row). The hypothesis of homothetic preferences, a central feature of Armington's (1969) trade model, is compatible with our data, at least from a short-run perspective. Since Models A and D are statistically equivalent, and the estimated coefficients are similar, the remaining discussion will focus on the simpler specification.

In Model D, market share is invariant to U.S. price, which means that the short-run own-price elasticity of export demand is −1. Dividing this coefficient by one minus the estimated coefficient of the lagged dependent variable (0.72) yields a long-run export demand elasticity of −3.57. Hence, export demand for U.S. farm products appears to be price elastic. The estimated short-run exchange rate elasticity is −0.67 (t-ratio = −5.0), which implies a long-run elasticity of −2.39. Thus, export demand with respect to exchange rate is also elastic, but less so than for price. (The null hypothesis that the long-run exchange rate and own-price elasticities are equal is rejected at the $p = 0.062$ level based on a Wald test.) The estimated short-run cross-price elasticity is 0.34 (t-ratio =

[4] The exponential specification implies that goodwill depreciates at a constant rate. Experimentation with alternative specifications of the goodwill variable, including a simple three-year moving average of the AD variable akin to Nerlove and Waugh's (1961) specification, and the Cobb-Douglas form proposed by Doganoglu and Klapper (2006), indicated that parameter estimates are not much affected by the choice of the decay function. Setting the retention parameter to 0.33 implies that advertising expenditures older than two years contribute less than 11% to the current stock of goodwill.

[5] Test results can be found in a supplementary appendix available online.

[6] Estimation is done using the econometric software EViews, version 7 (Quantitative Micro Software, Irvine, CA).

Table 2. Fully Modified Least Squares Estimates of the Market-Share Equation for U.S. Agricultural Exports

Variable/Statistic	Parameter	Model A	Model B	Model C	Model D
Goodwill	β_A	0.0686	0.0711	0.0642	0.0534
		(2.76)[a]	(2.73)	(3.28)	(3.38)
Own Price	β_P	−0.025	−0.119	−0.005	—
		(−0.45)	(−2.42)	(−0.11)	
Substitute Price	β_{PS}	0.226	0.069	0.300	0.238
		(3.16)	(1.32)	(3.59)	(3.61)
Exchange Rate	β_{XR}	−0.576	—	−0.654	−0.668
		(−3.49)		(−5.19)	(−5.04)
Income	β_Y	0.085	0.294	—	—
		(0.77)	(3.17)		
Trend	β_T	−0.0111	−0.0153	−0.0084	−0.0083
		(−2.85)	(−4.00)	(−4.70)	(−4.61)
Lagged Dep. Variable	β_{LAG}	0.728	0.786	0.720	0.717
		(7.14)	(7.47)	(7.90)	(8.01)
Constant	β_0	−0.244	−3.112	0.908	0.941
		(−0.16)	(−2.62)	(2.13)	(2.67)
SE of regression	—	0.0603	0.0604	0.0590	0.0448
Computed chi-square for Model A vs. alternative	—	—	12.170	0.586	0.597
Significance level	—	—	0.0005	0.444	0.742

Note: Model A refers to text equation (25). Models B, C, and D restrict Model A as follows: Model B: $\beta_P = \beta_{XR}$, Model C: $\beta_Y = 0$, and Model D: $\beta_Y = \beta_P = 0$.
[a] Asymptotic *t*-ratios in parentheses.

3.6), which implies a long-run elasticity of 1.21. Thus, domestic and foreign farm products are substitutes in international trade.

The invariance of market share to the value of world imports of farm products means that the short-run expenditure elasticity is one. The implied long-run expenditure elasticity is 3.57, which suggests that U.S. farm products are a superior good in international trade. This finding is consistent with the growing importance of high-value products, which, over our sample period, increased from 28% to 68% of total export value.

The estimated coefficient of the trend variable is −0.0083 (*t*-ratio = −4.6). This suggests that in the absence of changes in relative prices, exchange rates, income, and promotion, U.S. market share would have declined at an annual rate of 0.83%. The actual average annual rate of decline over the sample period was 0.24%. This suggests that demand growth associated with the economic variables in the model largely offsets the negative effects of omitted trend-related factors.

Promotion Effect

Turning to promotion, this study's key policy variable, the estimated short-run elasticity, is 0.053 (*t*-ratio = 3.4), which implies a long-run elasticity of 0.189. Although this estimate is within the range of the estimates obtained by Dwyer (1994) and the more recent consulting reports, the estimates are not directly comparable owing to differences in variable definition, model specification, and estimation procedure. This caveat notwithstanding, the congruence in the estimates suggests that the export response to promotion is stable and that a 1% increase in export promotion expenditures causes the export demand curve to shift in the quantity direction by approximately 0.19% in the long run.

Simulation

Welfare Formulas

With parallel demand shifts, the welfare effects of increased subsidy can be approximated using the following formulas (Wohlgenant 1993):

$$(26) \quad \Delta PS = P_s^o Q_s^o P_s^*(1 + 0.5Q_s^*)$$

$$(27) \quad \Delta CS = P^o Q_d^o(\omega V_d - P^*)(1 + 0.5Q_d^*)$$

where ΔPS and ΔCS are the changes in domestic producer and consumer surplus associated with the subsidy increment; $P_s^o Q_s^o$ is farm revenue (net of the marketing fee) in the initial equilibrium, i.e., before the demand shift; $P^o Q_d^o$

is domestic consumer expenditures in the initial equilibrium; P_s^* and P^* are the relative changes in the supply and demand prices associated with the subsidy increment; Q_s^* and Q_d^* are the associated relative changes in domestic production and consumption; $V_d < 0$ is the relative vertical shift in the domestic demand curve induced by the subsidy increment; and ω is a weighting parameter.

The vertical shift parameter is obtained by solving equation (10) for P^* with Q_d^* set to zero to yield $\widehat{P}^* = -(\alpha_d/\eta_d)A_d^*$, where $\widehat{P}^* = V_d$ is the relative change in the demand price when domestic consumption is fixed. Specifically, $|V_d|$ measures the relative vertical distance between D and D' in figure 1, panel B (details can be found in the supplementary appendix available online). Multiplying the right side of this equation by A_G^*/A_G^* yields:

$$(28)\qquad V_d = -\,(\alpha_d \varphi_d/\eta_d)\,A_G^*$$

where φ_d is the cannibalization elasticity as defined in equation (23).

Tremblay and Tremblay (1995) show that the consumer impact of advertising depends on whether it persuades, informs, or alters product image. Advertising that "merely" persuades may have no effect on consumer welfare, while advertising that enhances product image is tantamount to an improvement in product quality and thus has its maximum impact. In Tremblay and Tremblay's scheme, $\Delta CS_{PERS} \le \Delta CS_{INFO} \le \Delta CS_{IMAGE}$. Accordingly, we adjusted the demand shift in equation (27) by setting ω alternatively to zero, 0.5, and 1.0 to represent the lower-, middle-, and upper-bound impacts, respectively, suggested by the inequality. Setting $\omega = 1$ reproduces Wohlgenant's (1993, p. 645, equation (11)) measure of consumer impact.

Setting $A_G^* = 0.01$ and inserting simulated values for the endogenous variables from the economic model (equations (10)–(17)) into equations (26) and (27) give the surplus changes for a 1% increase in the subsidy. Summing these changes yields the total welfare impact:

$$(29)\qquad \Delta TS = \Delta PS + \Delta CS.$$

Government funds are assumed to be raised via a lump-sum tax on the representative consumer. Hence, the national benefit from the subsidy is maximized when $\Delta TS/\Delta A_G = \rho$, where ρ represents the societal rate of return on the next-best use of the incremental taxpayer dollar. In this study we set $\rho = 0$, which implies that the opportunity cost of government funds invested in nonprice export promotion of farm products at the margin is zero. To the extent $\rho > 0$, the national benefit implied by model simulations is overstated.

Model Calibration

Initial equilibrium values for price, quantity, and promotion are set to their average annual averages for 2000–04, as indicated in table 3. The average annual promotion budget was \$1.023 billion, with 13% coming from the federal government to support export promotion expenditures totaling \$363 million. Accordingly, the budget share parameters in the model were set to $\theta_G = 0.13$, $\theta_I = 0.87$, $\theta_d = 0.64$, and $\theta_x = 0.36$.

For the time period in question, the average annual gross value of U.S. farm production was \$221 billion, of which \$56 billion was exported. Based on these figures, the quantity shares were set to $k_d = 0.75$ and $k_x = 0.25$. Dividing industry monies for promotion ($T \cdot Q_s = \$892$ million) by the total gross value of farm output yields 0.0040. Hence, the marketing fee in the model was set to $\tau = T/P = 0.004$. Based on this "tax" rate and the aforementioned quantity share parameters, in the welfare formulas we set the net farm value to $P_s^o Q_s^o = \$220.108$ billion and domestic consumer expenditures to $P^o Q_d^o = \$165$ billion.

The domestic demand and supply elasticities were set to $\eta_d = -0.50$ and $\varepsilon = 0.60$, our "best bet" estimates of these parameters. The domestic promotion elasticity is assumed to lie on the closed interval $\alpha_d \in [0.01, 0.10]$. This range is consistent with empirical estimates for dairy, beef, pork, and cotton, commodities that constitute the bulk of promotion spending in the domestic market (Kinnucan and Zheng 2005). In the simulations to follow, 0.05 is deemed the best-bet value for the domestic market response to promotion; the cannibalization effect is "turned off" by setting $\alpha_d = 0$. The export demand and promotion elasticities are set to $\eta_x = -3.57$ and $\alpha_x = 0.189$, the values estimated in this study.

Results

Reduced-form elasticities indicate that the budget-expansion effect is unimportant (table 4). Specifically, with the domestic promotion and supply elasticites set to 0.05

Table 3. Baseline Values for Model Parameters

Item	Definition	Value
A_G	Government expenditures for export promotion, mil. dol.[a]	131
$A_I = TQ_s$	Industry monies for promotion [a]	892
A_d	Total expenditures for domestic market promotion, mil. dol.[a]	660
$\tilde{A}_x$	Total expenditures for export promotion, mil. dol.[a]	363
A	Total promotion expenditures $= A_G + A_I = A_d + \tilde{A}_x$	1,023
$P^o Q_s^o$	Gross farm value of U.S. production, million dollars [a]	221,000
$P_s^o Q_s^o$	Net farm value of U.S. production $= (P^o - T)Q_s^o$	220,108
$P^o Q_x^o$	Value of U.S. farm exports, million dollars[a]	56,000
$P^o Q_d^o$	Value of domestic consumption $(= P^o Q_s^o - P^o Q_x^o)$	165,000
θ_G	Government share $= A_G/A$	0.13
θ_I	Industry share $= A_I/A$	0.87
θ_d	Domestic promotion share $= A_d/A$	0.64
θ_x	Export promotion share $= A_x/A$	0.36
τ	Industry marketing fee or "tax" $= TQ_s/P^o Q_s^o$	0.004
k_d	Domestic quantity share $= P^o Q_d^o/P^o Q_s^o$	0.75
k_x	Export quantity share $= (1 - k_d)$	0.25
ε	Domestic supply elasticity	Zero or 0.60
η_d	Domestic demand elasticity	−0.50
η_x	Export demand elasticity	−3.57
α_d	Domestic promotion elasticity	Zero to 0.10
α_x	Export promotion elasticity	0.189
φ_x	Budget diversion elasticity[b]	0.92

[a]Average annual value for 2000–04. See supplementary appendix online for sources.
[b]See text for details.

Table 4. Reduced-Form Elasticities for Government Expenditure (A_G)

Endogenous Variable	Fixed Supply ($\varepsilon = 0$)			Upward-Sloping Supply ($\varepsilon = 0.60$)		
	$\alpha_d = 0.05$	$\alpha_d = 0$	Ratio	$\alpha_d = 0.05$	$\alpha_d = 0$	Ratio
P	0.0250	0.0343	1.37	0.0150	0.0232	1.55
P_s	0.0251	0.0344	1.37	0.0150	0.0233	1.55
Q_d	−0.0282	−0.0171	0.61	−0.0226	−0.0116	0.51
Q_x	0.0846	0.0514	0.61	0.1039	0.0909	0.88
Q_s	0.0000	0.0000	—	0.0090	0.0140	1.55
A_d	−0.3144	−0.3144	1.00	−0.3021	−0.2953	0.98
$\tilde{A}_x$	0.9200	0.9200	1.00	0.9200	0.9200	1.00
A_I	0.0000	0.0000	—	0.0090	0.0140	1.55

and 0.60, respectively, $\hat{\varphi}_I = 0.009$. This means that a doubling of government expenditures for export promotion would increase industry funds available for promotion a mere 0.9%. As a consequence, the cannibalization elasticity is negative, as expected, and is not much affected by the supply elasticity or the induced shift in the domestic demand curve. Specifically, regardless of whether the domestic supply elasticity is zero or 0.6, or whether the domestic promotion elasticity is zero or 0.05, $\hat{\varphi}_d \approx -0.30$, which means that a 1% increase in government expenditures for export promotion reduces expenditures for domestic market promotion by approximately 0.3%.

Importantly, the *mutatis mutandis* export promotion elasticity is sensitive both to supply response and to the cannibalization effect. With $\varepsilon = 0$ and $\alpha_d = 0.05$, the *mutatis mutandis* export promotion elasticity is 0.085. Turning off the cannibalization effect by setting $\alpha_d = 0$ reduces this elasticity to 0.051, which underscores the importance of price rationing. (With the cannibalization effect turned off, the total demand shift, and thus the price effect, is larger, which reduces the quantity consumed.) Permitting quantity supplied to adjust to price by setting $\varepsilon = 0.6$ increases the *mutatis mutandis* promotion elasticity but does not alter the basic conclusion that ignoring the cannibalization

Table 5. Welfare Effects of a 1% Increase in Government Expenditures for Export Promotion of Farm Products (million US$)

α_d	ΔPS	ΔCS_1	ΔCS_2	ΔCS_3	ΔTS_1	ΔTS_2	ΔTS_3
0	51	−38	−38	−38	13	13	13
0.01	49	−36	−41	−46	12	7	3
0.02	46	−34	−44	−54	12	2	−8
0.03	43	−32	−47	−62	11	−4	−19
0.04	41	−30	−50	−70	10	−9	−29
0.05	38	−28	−53	−78	10	−15	−40
0.06	35	−26	−56	−86	9	−21	−51
0.07	33	−24	−59	−94	8	−27	−62
0.08	30	−22	−62	−102	8	−32	−72
0.09	27	−20	−65	−111	7	−38	−84
0.10	24	−18	−69	−119	6	−44	−95

Note: ΔCS_1, ΔCS_2 and ΔCS_3 represent lower-, intermediate-, and upper-bound estimates, respectively, of the impact of increased export promotion on domestic consumer welfare. For details, see text equation (27) and the attendant discussion.

effect causes the total demand shift to be overstated. For the considered parameter values, the largest *mutatis mutandis* export promotion elasticity is $Q_x^*/A_G^* = 0.10$, which is substantially smaller than the partial elasticity $\hat{\alpha}_x = 0.189$. This discrepancy hints at the potential importance of price and promotion endogeneity in benefit-cost determination.

Indeed, as shown in table 5, the cannibalization effect is pivotal. In this table $\Delta CS_i (i = 1, 2, 3)$ measures the change in consumer surplus when ω is set alternatively to zero, 0.5, and 1.0. For the considered parameter values, regardless of how the consumer impact of the subsidy increment is measured, domestic consumers always lose with program intensification. Focusing on ΔCS_2, our "best-bet" measure of the consumer loss, when the cannibalization effect is ignored, a 1% increase in subsidy causes producer surplus to increase by \$51 million and consumer surplus to decrease by \$38 million, for a net welfare gain of \$13 million. When the cannibalization effect is recognized, the net welfare gain converts to a loss for a value of α_d as low as 0.03. If $\alpha_d = 0.05$, our best-bet value, the producer gain of \$38 million is swamped by the consumer loss of \$53 million, resulting in a national welfare loss of \$15 million. If $\omega = 0$, implying domestic market promotion has no effect on domestic consumer welfare, the \$53 million consumer loss dwindles to \$28 million. In this instance, the measured consumer loss is due strictly to the higher prices that domestic consumers must pay as the result of heightened export demand. That is, taking 0.5 as the most likely value for ω, about half of the measured consumer loss when $\alpha_d = 0.05$ is due to higher prices; the rest is due to reduced spending on domestic market promotion induced by the subsidy. Increasing ω to 1.0, the value used in Wohlgenant's (1993) analysis, intensifies the consumer losses associated with the subsidy increment, and thus serves merely to underscore the importance of the cannibalization effect.

Marginal benefit-cost ratios (MBCRs) are presented in table 6. These were computed by dividing the welfare measurements in table 5 by \$1.31 million, the government outlay corresponding to a 1% increase in expenditure. Without the cannibalization effect, the producer MBCR is 39:1 and the national MBCR is 10:1. Noting that the spending level is optimized (ignoring opportunity cost) when MBCR = 0, these estimates suggest that export promotion is underfunded from both industry and societal perspectives.[7] (The implied social rate of return at the margin is 900%!) With the cannibalization effect, the producer MBCR declines but remains positive for the considered elasticity values. Thus, our results are consistent with most estimates in the literature that suggest that export promotion of farm products is underfunded *from an industry perspective* (e.g., Rusmevichientong and Kaiser 2009 and references therein). However, *from a societal perspective* the underfunding inference is less clear-cut. In particular, as shown in table 6, when consumer impacts are taken into account, the MBCR is not clearly positive. For $\alpha_d = 0.05$, the national MBCR ranges from −30:1 to 7:1

[7] Most studies use MBCR = 1 as the benchmark to indicate whether spending is too high or too low (e.g., see Alston et al. 2005, p. 9). This is appropriate when the price effect is measured inclusive of the per unit marketing fee. When the price effect is measured exclusive of the marketing fee, as in the present study (see equation (26)), the appropriate benchmark is MBCR = 0.

Table 6. Marginal Benefit-Cost Ratios for a 1% Increase in U.S. Government Expenditures for Export Promotion of Farm Products

		Society[a]		
α_d	Producer	$\omega = 0$	$\omega = 0.5$	$\omega = 1.0$
0.00	39	10	10	10
0.01	37	9	6	2
0.02	35	9	1	−6
0.03	33	8	−3	−14
0.04	31	8	−7	−22
0.05	29	7	−12	−30
0.06	27	7	−16	−39
0.07	25	6	−20	−47
0.08	23	6	−25	−55
0.09	21	5	−29	−64
0.10	19	5	−34	−72

[a] The societal MBCR includes the consumer impact, where $\omega = 0$ implies export promotion has no effect on domestic consumer welfare other than that associated with the promotion-induced increase in price, and $\omega = 1$ implies promotion has its maximal effect.

with a median estimate of −12:1 (based on $\omega = 0.5$). Only in the extreme case where domestic market promotion has no effect on consumer welfare ($\omega = 0$) is the national marginal rate of return positive for the considered parameter values.

Concluding Comments

The basic theme of this research is that subsidies for nonprice export promotion benefit domestic producers at the expense of consumers. Domestic consumers are harmed because the heightened export demand raises price in the domestic market, but also because the subsidies divert funds from domestic market promotion. To the extent that promotion provides useful information or enhances product image, a subsidy-induced decrease in domestic demand reduces consumer welfare (Tremblay and Tremblay 1995). Taking these consumer impacts into account, we find that for likely parameter values, USDA expenditures on nonprice export promotion of farm products may be too high. Specifically, the estimated marginal benefit-cost ratio is between −30:1 and 7:1 with a "best-bet" value of −12:1. The corresponding estimate when consumer impacts are ignored is 29:1.

The sharp divergence in producer and national rates of return suggested by the foregoing estimates underscores the importance of a more complete accounting of the costs and benefits of nonprice export promotion. Most benefit-cost studies ignore consumer impacts, in part because the enabling legislation that underlies the collective promotion effort emphasizes producer benefits. However, as the analysis of Alston, Freebairn, and James (2003) suggests, this view is too narrow in that consumers implicitly share in the cost of the promotion effort through incidence shifting of the marketing fee. Moreover, in the case of export promotion where general tax revenues are used to augment industry monies, there is a clear national interest in whether benefits, broadly defined, exceed costs.

A caveat in interpreting our results is that we have not considered treasury savings that might accrue due to reduced outlays for price support. These expenditures over the 2000–04 period covered by our simulations averaged $7.0 billion per year (USDA 2006). Research on cotton, a major recipient of federal subsidies both for export promotion and for price support, indicates substantial marginal gains to the taxpayer from increased expenditures for export promotion (Ding and Kinnucan 1996; Kinnucan, Duffy, and Ackerman 1995). Then, too, we have not considered competitor expenditures, which might increase or decrease the optimum level of spending depending, *inter alia*, on the slope of reaction functions (Alston, Freebairn, and James 2001). Clearly, additional research is needed to sort out these issues. In the meantime, the fact that Love, Porras, and Shumway (2001), using a very different approach, also found national benefit-cost ratios to be less than one for likely elasticity combinations affirms our basic conclusion that program enlargement would provide little in the way of public benefits, although producer benefits, at the margin, might be substantial.

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