Market Allocation Rules for Nonprice Promotion with Farm Programs: U.S. Cotton

Lily Ding and Henry W. Kinnucan

Rules are derived to indicate the optimal allocation of a fixed promotion budget between domestic and export markets when the commodity in question represents a significant portion of world trade and is protected in the domestic market by a deficiency-payment program. Optimal allocation decisions are governed by advertising elasticities in the domestic and export markets and the export market share. Promotion's ability to lower deficiency payments is inversely related to the absolute value of demand elasticities in the domestic and export markets and directly related to advertising elasticities and certain policy parameters. The empirical application suggests subsidies for nonprice export promotion may be efficiency increasing in a second-best sense. That is, the heightened subsidies associated with the Targeted Export Assistance program and the Market Promotion Program appear to have corrected allocative errors that favored domestic market promotion.

Key words: allocative efficiency, nonprice promotion, subsidies

Introduction

Nonprice promotion of food and fiber products by farm groups has become a prominent feature of American agriculture, thanks to federal legislation authorizing nationwide mandatory checkoff programs and increased subsidies for export promotion. In 1989 American farmers spent nearly $700 million on promotion, research, and nutrition education to strengthen the demand for their products in domestic and export markets (Forker and Ward, p. 106). Federal subsidies for nonprice export promotion grew from $20 million in 1982 to $234 million in 1992 before declining to the current (1995) level of $105 million (Kinnucan and Ackerman, p. 123). Yet despite the large investments in domestic and export promotion by industry and government, and growing evidence that promotion can indeed increase demand (Ferrero et al.), scant attention has been paid to decision rules to guide promotion policy.

Early work by Dorfman and Steiner (D-S) and by Nerlove and Waugh (N-W) remains the theoretical foundation for optimal advertising decisions. The D-S and N-W models, however, assume a single market and, thus, are silent on the issue of fund allocation across markets. Goddard, Griffith, and Quilkey extend the D-S and N-W models to multiple-market situations but do not consider the impacts of government programs, the major focus of this article. Kinnucan, Duffy, and Ackerman consider the relative impacts

of price reduction versus promotion in the export market for an industry protected by deficiency payments but do not consider the relative effectiveness of domestic versus export promotion. Discussing commodity promotion from a small open-economy perspective, Alston, Carman, and Chalfant consider farm programs but do not develop specific optimization rules to guide fund allocation decisions.

The purpose of this research is to determine optimal market allocation rules for a commodity that is traded in international markets but is protected in the domestic market by a deficiency-payment scheme. The allocation issue is important because, in a large open-economy situation, promotion affects treasury outlays for deficiency payments. The nexus between deficiency payments and promotion suggests treasury savings are possible if funds are allocated to minimize the combined cost of promotion and protection.

The analysis proceeds by first specifying an equilibrium-displacement model to indicate the price effects of increased promotion in a competitive market protected by a deficiency payment scheme. The model's reduced-form relationships are then incorporated into the first-order conditions of a cost-minimization problem to derive the allocation rules. The allocation rules are applied to the U.S. cotton industry to demonstrate usefulness and to determine whether historic fund allocations are efficient from a cost-minimization perspective.

Basic Model

The basic model assumes competitive market clearing and a single price in the domestic and export markets, that is, the law of one-price is assumed to hold. Quantity demanded in the domestic and export markets is assumed to be a decreasing function of price and an increasing function of promotion. Domestic production, which is entirely allocated to the domestic and export markets through the market mechanism, is assumed to be an increasing function of the "supply-inducing price" (to be defined later). The promoting country is assumed to have sufficient market presence to affect price (large open-economy assumption). Initial equilibrium is described as follows:

(1) $Q_d = f(P, A_d)$ (domestic demand),

(2) $Q_x = g(P, A_x)$ (export demand),

(3) $Q_s = h(P_s)$ (domestic supply),

(4) $Q_s = Q_d + Q_x$ (equilibrium quantity),   and

(5) $P_s = \phi P_T + (1 - \phi)P$ (supply-inducing price),

where Q_d is quantity demanded in the domestic market; Q_x is quantity demanded in the export market; Q_s is the promoting country's total supply; P is the market price of the promoted commodity; P_T is the target price; P_s is the supply-inducing price; A_d is advertising in the domestic market; and A_x is advertising in the export market.

The above system consists of five equations in five endogenous variables: Q_s, P_s, Q_d, Q_x, and P. The target price, P_T, which is set by government, is exogenous. For the purposes of this analysis, following Nerlove and Waugh, we treat advertising as an exogenous variable.[1] The supply-inducing price is defined as a weighted average of the

---

[1] Technically, initial equilibrium is conditioned by exogenous variables not explicitly included in the model (e.g., consumer income in the demand equations and technology in the supply equation). For brevity, these variables are deleted, as they are irrelevant to the analysis.

market price P and the target price P_T. The weighting factor ϕ [see (5)] reflects the proportion of total production eligible for deficiency payments and, thus, is bounded on the unit interval. A maintained hypothesis is that the deficiency-payment program is binding, that is, $P_T > P$.

Changes in quantities can be approximated linearly by substituting (5) into (3) and totally differentiating the resulting equations, which when converted to elasticities and relative changes, yields

(1a) $$d \ln Q_d = -N_d \, d \ln P + B_d \, d \ln A_d,$$

(2a) $$d \ln Q_x = -N_x \, d \ln P + B_x \, d \ln A_x,$$

(3a) $$d \ln Q_s = E\xi \, d \ln P, \quad \text{and}$$

(4a) $$d \ln Q_s = K_d \, d \ln Q_d + K_x \, d \ln Q_x,$$

where $d \ln Z = dZ/Z$ denotes the relative change in variable Z. The parameters N_d and N_x are demand elasticities in the domestic and export markets, respectively; B_d and B_x indicate the percent change in demand in the domestic and export market, respectively, associated with a one percent change in promotion, hereafter referred to as "advertising elasticities." The K_d and K_x parameters represent, respectively, the proportion of total supply allocated to the domestic and export markets.

The E parameter is the supply elasticity for the promoted commodity. It is multiplied by a scaling factor, $\xi = (1 - \phi)P/[\phi P_T + (1 - \phi)P]$, which reflects the effect of program provisions on supply response.[2] In particular, if all acres are eligible for payments and all producers participate in the program, $\phi = 1$. In this case, $\xi = 0$ and supply is unresponsive to price. More generally, some producers elect not to participate and program provisions restrict eligibility, so $0 < \xi < 1$ and supply is responsive to changes in market price.

The reduced-form equation for domestic price is obtained by substituting equations (1a)–(3a) into (4a), which yields

(6) $$d \ln P = (K_d B_d/D)d \ln A_d + (K_x B_x/D) \, d \ln A_x,$$

where $D = (E\xi + K_d N_d + K_x N_x)$. Equation (6) is a reduced-form relationship that indicates the effect of an increase in promotion on price, taking into account supply response and the price-induced feedback effects between the markets. Equation (6) yields the hypothesis that promotion's price-enhancement ability is directly related to the advertising elasticities in the two markets and inversely related to the absolute value of the demand elasticities, the supply elasticity, and policy parameters affecting eligibility and program participation. For example, if program participation is complete and all production is eligible for deficiency payments, $\xi = 0$ and increased promotion has a relatively large impact on market price. The inverse relationship between demand elasticities and promotion effectiveness is consistent with the Dorfman-Steiner theorem and the Nerlove-Waugh model. Under the stated assumptions, $D > 0$; thus, increases in domestic or export

---

[2] To derive ξ, first take the total differential of equation (5): $dP_s = (1 - \phi) \, dP + \phi \, dP_T$. Setting $dP_T = 0$ (P_T is exogenous), this equation can be reexpressed as $(dP_s/P_s)P_s = (1 - \phi)P(dP/P)$. Dividing both sides by P_s and writing the resulting expression in logarithmic form gives $d \ln P_s = (1 - \phi)(P/P_s) \, d \ln P$. Substituting (5) for P_s yields $d \ln P_s = \xi \, d \ln P$, where $\xi = (1 - \phi)P/[\phi \, P_T + (1 - \phi)P]$.

promotion always increase price, assuming that promotion does indeed shift the respective demand curve, that is, $B_d > 0$ and $B_x > 0$.

The reduced-form equation for quantity is obtained by substituting equation (6) into (3a), which yields

$$(7) \qquad d \ln Q_s = (E\xi K_d B_d/D) \, d \ln A_d + (E\xi K_x B_x/D) \, d \ln A_x.$$

Equation (7) yields the hypothesis that as long as supply is upward sloping, and some production remains outside the program, increases in promotion always increase quantity. However, if all production is covered by deficiency payments and $P_T > P$, as assumed, increases in promotion affect price but not quantity.

Allocation Rules

With the necessary reduced-form expressions in hand, it is now possible to derive optimality conditions to guide promotion allocation decisions. In so doing, we assume that the goal is to minimize the combined cost of promotion and protection. Cost minimization is compatible with rent maximization under a variety of conditions (Kinnucan, Duffy, and Ding). Moreover, if the deficiency-payment program is binding, a maintained hypothesis in this study, the primary beneficiary of promotion is the taxpayer. Producer benefits are nil (see footnote 11) if the market price remains below the target price following an increase in promotion. In this case, a sensible goal is to find the allocation that maximizes taxpayer welfare.[3]

The objective is to choose A_d, A_x, and λ such that the following function is minimized:

$$(8) \qquad L = \phi(P_T - \tau P)Q_s + A_d + A_x + \lambda(A_T^0 - A_d - A_x),$$

where L is the Lagrange function; A_T^0 is the promotion budget, inclusive of the subsidy for export promotion; λ is the Lagrange multiplier; and τ is a "fudge" factor (less than one) used in the calculation of the per-unit deficiency payment.[4] The first term in (8) reflects direct treasury outlays for deficiency payments; the second and third terms (A_d and A_x) reflect combined industry and treasury outlays of promotion; and the fourth term expresses the budget constraint. (Treasury outlays for promotion, which are restricted to the export market, appear in the A_x term.)

The allocation of A_T^0 that minimizes the combined cost of protection and promotion is determined by partially differentiating (8) with respect to the three choice variables and setting each derivative to zero (the second-order sufficiency conditions are derived in the appendix):

---

[3] A more encompassing objective would take into account the welfare impacts of increased promotion on consumers and foreign producers. To keep things simple and to highlight the interplay between promotion and protection, we chose to limit the analysis to taxpayer impacts.

[4] The fudge factor is specified to account for the fact that the market price for cotton reported by the USDA is generally higher than the market price used to calculate the per-unit deficiency payment. The differences apparently stem from "seasonal adjustment" procedures applied to the market price for deficiency-payment purposes.

(9)
$$\frac{\partial L}{\partial A_d} = -\phi\tau\frac{\partial P}{\partial A_d}Q_s + \phi(P_T - \tau P)\frac{\partial Q_s}{\partial A_d} + 1 - \lambda = 0,$$

(10)
$$\frac{\partial L}{\partial A_x} = -\phi\tau\frac{\partial P}{\partial A_x}Q_s + \phi(P_T - \tau P)\frac{\partial Q_s}{\partial A_x} + 1 - \lambda = 0,$$

and

(11)
$$\frac{\partial L}{\partial \lambda} = A_T - A_d - A_x = 0.$$

Expressing (9) in elasticity form yields

$$(1 - \lambda)\frac{A_d}{Q_s} = \phi\tau P\frac{d\ln P}{d\ln A_d} - \phi(P_T - \tau P)\frac{d\ln Q_s}{d\ln A_d}.$$

Substituting equations (6) and (7) into the above equation yields

(12)
$$(1 - \lambda)V_d = \phi\frac{K_d B_d}{D}C,$$

where $V_d = A_d/(Q_s P)$ is the domestic advertising intensity, and $C = \tau - E\xi(P_T - \tau P)/P$. Similar manipulation of (10) yields

(13)
$$(1 - \lambda)V_x = \phi\frac{K_x B_x}{D}C,$$

where $V_x = A_x/(Q_s P)$ is export advertising intensity.

Substituting (12) and (13) into (11) yields

(14)
$$(1 - \lambda)V_T = \phi\frac{K_d B_d + K_x B_x}{D}C,$$

where $V_T = V_d + V_x = (A_d + A_x)/(Q_s P)$ is total advertising intensity.

In fact, dividing (12) and (13) by (14), the optimality conditions for A_d and A_x can be simplified to:

(15a) $A_d^* = A_T^0 K_d B_d/(K_d B_d + K_x B_x),$ and

(15b) $A_x^* = A_T^0 K_x B_x/(K_d B_d + K_x B_x),$

where A_d^* is the optimal allocation to the domestic market and A_x^* is the optimal allocation to the export market. Equations (15a) and (15b) indicate the allocation of a fixed promotion budget (A_T^0) that minimizes the combined cost of promotion and protection for an industry protected by deficiency payments.

The rules indicate that allocations are independent of supply response, demand elasticities, and policy parameters. All that matters in allocation decisions is the relative size of the advertising elasticities in the two markets and the export share. Assuming equal market shares, the market that is more responsive to promotion receives the larger al-

location. Conversely, if both markets are equally responsive to promotion, the larger market gets the larger allocation.[5]

Demand and supply elasticities and policy parameters, however, are relevant in determining the marginal effectiveness of promotion. To see this, substitute (12) and (13) into (14) and solve for λ:

(15c) $$\lambda^* = \phi(\xi E\psi - \tau)\delta/[V_T^0(\xi E + \zeta)] + 1,$$

where λ^* is the Lagrange multiplier in cost-minimizing equilibrium, $\psi = (P_T - \tau P)/P$, $\delta = (K_d B_d + K_x B_x)$, and $\zeta = (K_d N_d + K_x N_x)$. λ^* indicates the *net* effect on deficiency payments and promotion outlays of a small increase in the promotion budget, *assuming the budget increment is allocated to the two markets optimally,* that is, in accordance with (15a) and (15b).[6] Inspection of (15c) yields the hypothesis that the marginal effectiveness of increased promotion is directly related to the advertising elasticities and inversely related to the absolute value of the export and domestic demand elasticities. The effect of policy parameters on marginal effectiveness depends on program participation and eligibility restrictions. For example, if all producers participate in the program and all production is eligible for payments $\phi = 1$, which implies $\xi = 0$. In this case, the ψ term drops out of (15c) and marginal effectiveness is invariant to the target price. In general, the more generous the program provisions, the lower the marginal effectiveness of promotion.[7] The conclusion is consistent with Kinnucan, Duffy, and Ding's analysis which suggests that protection reduces the incentive to promote.

Application

The allocation rules are applied to cotton to illustrate usefulness and to determine whether historic allocations are consistent with the cost-minimizing solution. The cotton industry represents a suitable case study because it is protected by a deficiency-payment program; the industry invests substantial funds in domestic and export promotion; and the target price in general has stayed well above the market price. Average annual government outlays for cotton price support between 1989 and 1993 was $1.1 billion (see table 1

---

[5] A reviewer questioned how the allocation rules would change if (a) the trade status of the commodity changed, or (b) the instrument of protection changed. If the trade status changed from a large to a small open-economy situation, promotion would have no effect on the market price, in which case the best solution is not to promote at all (Alston, Carman, and Chalfant, pp. 149–52). If the instrument of protection changed such that the target price was no longer binding (free-market situation), equations (15a) and (15b) are still applicable, provided the large, open-economy assumption is valid and producers wish to maximize quasi-rent (Kinnucan and Christian). Yet a third scenario is when the law of one-price fails to hold. This might occur, for example, if the marketing authority has monopoly power and practices price discrimination. In this case, the Dorfman-Steiner theorem applies, and the demand elasticity enters the decision calculus. In particular, the more elastic market, ceteris paribus, receives the larger allocation (De Boer, pp. 133–34).

[6] As pointed out by a reviewer, $\partial L^*/\partial A_T^0 = 1 + \lambda^*$, so the Lagrange multiplier is interpreted as the *net* effect of a budget increment on deficiency payments, that is, net of the incremental cost of the additional promotion outlay. In this sense, λ^* measures the "pure" gain (or loss) associated with a small increase in the promotion budget. As long as $\lambda^* < 0$ and $|\lambda^*| > 1$, a unit increase in the promotion budget results in a pure economic gain.

[7] Owing to space limitations, a complete analysis to support this statement is not possible here. However, it is instructive to consider the effect of the fudge factor, that is, $\partial\lambda^*/\partial\tau$, for the case when $\phi = 1$. In this case, (15c) reduces to $\lambda^* = (V_T^0 \zeta - \tau\delta)/(V_T^0\zeta)$. Then, $\partial\lambda^*/\partial\tau = -\delta/(V_T^0\zeta)$, which is negative by assumption. Thus, as the fudge factor increases from a small positive fraction to its upper bound of one (implying an increasingly less generous deficiency payment), the marginal effectiveness increases, as claimed. Next, consider the conditions required for an increase in promotion to decrease the combined cost of protection and promotion. Here we find that $\lambda^* < 0$ only if $\tau\delta > V_T^0\zeta$, which upon substitution and rearranging, yields $V_T^0 < \tau (K_d B_d + K_x B_x)/(K_d N_d + K_x N_x)$. This expression can be made more intelligible by noting that if $\tau = K_d = 1$, then $V_T^0 < B_d/N_d$. The right-hand side of this expression is the Dorfman-Steiner theorem. Thus, marginal returns are positive as long as the promotion intensity is less than would be indicated as optimal by the D-S theorem.

Table 1. Model Parameters and Baseline Values, U.S. Cotton Industry

Item[a]	Definition	Value
P	Domestic market price ($/lb.)	0.611
P_T	Target price ($/lb.)	0.729
τ	Domestic price correction factor ($\tau = (P_T - DP)/P$)	0.979
Q_s	Domestic production (mil. lbs.)	7,450
ϕ	Proportion of production eligible for deficiency payments[b]	0.85
ξ	Supply response scaling factor ($\xi = (1 - \phi)P/[(\phi P_T + (1 - \phi)P])$	0.1304
G	Govt. outlays for price-support deficiency payments ($ mil.)[c]	1,089
K_d	Domestic share (Q_d/Q_s)[d]	0.57
K_x	Export share (Q_x/Q_s)[d]	0.43
A_d	Total outlays for domestic promotion ($ mil.)[e]	35.7
A_I	U.S. industry outlays for export promotion ($ mil.)[f]	5.2
A_{TP}	Foreign third-party outlays for export promotion ($ mil.)[f]	28.1
A_g	Govt. outlays for export promotion ($ mil.)[f]	17.1
A_x	Total outlays for export promotion ($A_1 + A_{TP} + A_g$)	50.4
A_T^0	Promotion budget ($A_d + A_x$)	86.1
N_d	Domestic demand elasticity	0.30
N_x	Export demand elasticity	1.00, 2.00
B_d	Domestic advertising elasticity	?
B_x	Export advertising elasticity	0.120
E	Domestic supply elasticity	0.30, 0.92

[a] Prices and quantity data refer to average values for the 1989/90–1993/94 crop years. Source: USDA/ERS 1995.
[b] Estimated based on crop yields and actual deficiency payments as reported in USDA/ERS, April 1995 (tables 17 and 35).
[c] Average for 1989/90–1993/94. Source: USDA/ERS, April 1995 (p. 50, table 35).
[d] Average values for 1984–93.
[e] 1992 value. Source: *AD $ Summary*.
[f] 1992 value. Source: Cotton Council International.

outlays for cotton price support between 1989 and 1993 was $1.1 billion (see table 1 footnotes for sources). This represents 24% of gross farm revenue (exclusive of the production subsidy). Promotion expenditures in 1992 totaled $86.1 million, with $35.7 million going to domestic promotion and $50.4 million to export promotion. The export promotion expenditures include a federal subsidy of $17.1 million.

The United States is considered a large cotton exporter because its average share of the world cotton market between 1960 and 1993 was 27% [U.S. Department of Agriculture (USDA), *World Cotton Situation*]. Thus, promotion-induced changes in the demand for U.S. cotton are likely to increase the market price. The higher market price stimulates local production by nonprogram producers and may encourage raw fiber imports, which would undercut the profitability of the promotion investment. The import response, however, is likely to be negligible owing to the insulating effects of the deficiency-payment program.

To implement (15), the model parameters and baseline values must be assigned numerical values. The baseline values for domestic price, domestic quantity, export quantity, export share, and the policy parameters (P_T, τ, ϕ) are based on USDA data for the 1989–93 crop years as indicated in table 1. The baseline values for promotion in the domestic market ($35.7 million) and the export market ($50.4 million) pertain to 1992.

The export-market expenditure includes the subsidy ($17.1 million) and funds provided by foreign third-party cooperators ($28.1 million).

Values for the demand and supply elasticities and the export advertising elasticity are available from past research. The derived demand elasticity for cotton in the domestic market is set to 0.30, Wohlgenant's estimate, which is confirmed in our work to be discussed later. The export demand elasticity is set to two alternative values, 1.00 and 2.00. These estimates bound the "total" export demand elasticities for U.S. cotton obtained by Duffy, Wohlgenant, and Richardson. The domestic supply elasticity is set to 0.30, an estimate of the "short-run" response used by Duffy and Wohlgenant in their study of export price subsidies. To gauge the longer-run impacts of supply response on marginal returns, the domestic supply elasticity is set alternatively to 0.92, a recent estimate obtained by Duffy, Shalishali, and Kinnucan. The export advertising elasticity is set to 0.12, the estimate obtained by Solomon and Kinnucan for U.S. cotton promotion in the Pacific Rim. No empirical estimates exist for the domestic advertising elasticity.

Estimation

Model

The domestic promotion elasticity was estimated using an augmented version of Wohlgenant's derived demand model. The basic specification is

$$(16) \quad \ln Q_{dt} = a_0 + a_1 \ln P_{t-4} + a_2 \ln P^R_{t-4} + a_3 \ln P^P_{t-4} + a_4 \ln P^I_t + a_5 \ln(E_t/P^*_t)$$
$$+ a_6 \ln A_{dt-2} + a_7 \ln Q_{dt-1} + \Sigma^3_{j=1} b_j D_{jt} + u_t,$$

where $t = 5, 6, \ldots, 72$ (1977.I–1993.IV); Q_{dt} denotes per capita mill consumption of cotton in period t; P_{t-4} denotes the domestic farm price of cotton in period $t - 4$; P^R_{t-4} is the wholesale price of rayon in period $t - 4$; P^P_{t-4} is the wholesale price of polyester in period $t - 4$; P^I_t denotes the wholesale price of imported textiles in period t; E_t denotes per capita total expenditure on cotton, rayon, polyester, and imported textiles in period t; P^*_t denotes the Stone's price index, that is, $\ln P^*_t = w_1 \ln P_t + w_2 \ln P^R_t + w_3 \ln P^P_t + w_4 \ln P^I_t$, where w_j are expenditure weights such that $\Sigma^4_{j=1} w_j = 1$; A_{dt-2} denotes total expenditures on cotton promotion in the domestic market in period $t - 2$; D_{jt} are quarterly dummy variables specified to take the value of one in the specified calendar quarter and zero otherwise; and u_t is a random disturbance term. In this model, prices and advertising are expressed in real terms through deflation by the consumer price index (1982–84 equals 100).

Equation (16) differs from Wohlgenant's (annual) model in that a lagged dependent variable is added to account for advertising carryover (Clarke; Lee and Brown); dummy variables are included to test for seasonality in mill demand; and advertising is added as a shift variable. In addition, rayon price is added to confirm Lowenstein's earlier finding that rayon is a substitute for cotton.

Following Wohlgenant, we specified the price variables for cotton, rayon, and polyester with a four-quarter lag to account for forward contracts between mills and fiber suppliers. Thus, the first four observations are lost and estimation is based on 68 observations. The

textile price and total expenditures, which reflect demand conditions at retail, are specified contemporaneously. Preliminary testing indicated a delayed advertising response. In particular, t-tests indicated that advertising did not "take hold" until the second quarter following the initial expenditure. Accordingly, the advertising variable is specified with a two-period lag. The double-log specification permits advertising to display diminishing marginal returns (Simon and Arndt).

Advertising's specification as a shift variable in (16) is consistent with Stigler and Becker's hypothesis that advertising acts as an input in the household production function. An alternative view is that advertising is a "taste shifter" that affects marginal utility (Theil). The latter view implies that advertising should be specified as an interaction term with income or price (Quilkey; Chang and Kinnucan). To test whether advertising has caused the demand curve to rotate, we specified the own-price coefficient in (16) as a linear function of advertising:

(17) $$a_1 = c_1 + c_2 \ln A_{dt-2}.$$

Substituting (17) into (16):

(18) $$\ln Q_{dt} = c_0 + c_1 \ln P_{t-4} + c_2 \ln A_{dt-2} \cdot \ln P_{t-4} + c_3 \ln P^R_{t-4} + c_4 \ln P^P_{t-4} + c_5 \ln P^I_t$$

$$+ c_6 \ln(E/P^*) + c_7 \ln A_{dt-2} + c_8 \ln Q_{dt-1} + \Sigma^3_{j=1} d_j D_{jt} + v_t.$$

The validity of the structural-change hypothesis is tested by forming the hypothesis:

(19a) $$H_N : c_2 = 0, \quad \text{and}$$

(19b) $$H_A : c_2 \neq 0.$$

Hypothesis (19) represents a two-tailed test that can be implemented with a standard t-statistic.

Data

The price and quantity data for cotton, rayon, and polyester were obtained from tables 15, 26, 7, 23, and 27 of USDA's *Cotton and Wool: Situation and Outlook Report.*[8] The price data are raw fiber-equivalent prices. Price data for imported textiles were obtained from table 3 of the U.S. Department of Commerce's *Survey of Current Business.* Population data and the consumer price index were obtained from tables b-59 and b-22 of the various issues of the *Economic Report of the President* (Council of Economic Advisers).

The advertising data were obtained from Leading National Advertisers (*AD $ Summary*), a commercial service that tracks advertising expenditures in ten principal media for major brand advertisers. The advertising data pertain to quarterly expenditures listed under Cotton Incorporated, the industry marketing organization responsible for domestic promotion. Because data from commercial tracking services are prone to measurement error (Kinnucan and Belleza), preliminary analysis was performed to determine whether a correlation exists between A_d and equation (16)'s error term. The Hausman test (Kmenta, pp. 365–66), using advertising lagged one and two periods and quarterly dummy

---

[8] The quantity data for polyester are adjusted by its share in the noncellulosic category (Ding). Polyester market share data were obtained from table 5 of the article "World Textile Trade and Production Trends" (Anson and Simpson).

variables as instruments, failed to detect measurement error. A data appendix with additional explanatory detail is available in Ding.

Results

The t-value for structural change was -1.367, which is not large enough to reject hypothesis (19a) at the 5% level. This constitutes evidence in favor of the simple-shift hypothesis implied by Stigler and Becker's theory of advertising, so (16) was selected as the appropriate specification.

Owing to the use of quarterly data, we tested for both first- and fourth-order autocorrelation using the Durbin m-test, the preferred test statistic in the presence of a lagged dependent variable (Kmenta, p. 333). The test failed to detect first-order autocorrelation; however, there was evidence of fourth-order autocorrelation. Cochrane-Orcutt's method for higher-order autocorrelation (Greene, pp. 276–77) was used to obtain generalized least squares estimates. Equation (16) was estimated with (Model A) and without (Model B) the seasonal dummy variables to test whether mill demand is seasonal.

The models show good explanatory power ($R^2 = 0.95$) and most of the estimated coefficients are significant and agree in sign with economic theory (table 2). The estimated coefficient of the lagged dependent variable is highly significant (t-ratio of eight) and is between zero and one, as required to satisfy stability conditions. The estimated long-run own-price elasticity, which is calculated by dividing the estimated cotton price coefficient by one minus the estimated coefficient of the lagged dependent variable, is -0.30 for Model A and -0.29 for Model B. The close correspondence between these estimates and Wohlgenant's earlier estimate of -0.30 suggests that the derived demand for cotton is inelastic and stable over time. (Because Wohlgenant's estimate is based on annual data, and no lag structures were specified, it may be interpreted as a long-run elasticity.)

The estimated coefficient for rayon price is positive, which suggests rayon is a substitute for cotton. This result is consistent with Lowenstein's finding. The estimated coefficient for polyester price is negative, signifying that polyester is a complement. Wohlgenant, by contrast, found polyester to be a substitute. The difference may be due to the omission of rayon price in the earlier specification.[9] Consistent with Wohlgenant's findings, the estimated elasticities for textile price and group expenditures are positive, which suggests that an increase in the price of imported textiles or consumer income increases the derived demand for U.S. cotton fiber.

The estimated long-run advertising elasticity, the key parameter of interest in this study, is 0.062 in Model A and 0.066 in Model B. Based on a one-tailed t-test, the estimated advertising elasticity is significant at the 10% level in Model A and the 0.005% level in Model B. Because cotton advertising varies seasonally, the lack of precision in Model A's estimate may be due to multicollinearity. To test this, we removed the dummy variables and conducted an F-test to determine if the reduced model differs from the full model. As indicated in table 2, the computed F-value was 2.08, which is not large enough to reject the null hypothesis that the seasonal dummy variables' coefficients are jointly

---

[9] A reviewer suggested that because cotton is a more dominant fiber now than in the past and that cotton-polyester blends are common, the relationship between polyester and cotton may have changed from competitive to complementary.

Table 2. GLS Estimates (Corrected for Fourth-Order Autocorrelation) of Domestic Mill Demand for Cotton, 1976–93 Quarterly Data

Variable	Model A	Model B
Advertising	0.01967	0.02395
	(1.32)	(3.16)
	[0.062]	[0.066]
Cotton price	−0.0952	−0.1055
	(2.51)	(2.77)
	[−0.30]	[−0.29]
Rayon price	0.2236	0.2518
	(2.39)	(2.66)
Polyester price	−0.2686	−0.3053
	(2.78)	(3.19)
Imported textile price	0.1372	0.1595
	(2.72)	(3.15)
Expenditure	0.1124	0.1295
	(2.11)	(2.41)
Lagged dependent variable	0.6843	0.6390
	(8.66)	(8.70)
Constant	0.23683	0.28003
	(0.97)	(1.14)
Spring	0.0311	—
	(1.94)	
Summer	−0.0009	—
	(0.051)	
Fall	0.00149	—
	(0.076)	
R^2	0.955	0.950
Durbin *m*-test for serial correlation:		
First order	0.778	0.218
Fourth order	−2.232	−2.027
F-test: Model A vs. B	—	2.0832[a]

Notes: Figures in parentheses are absolute values of *t*-ratios. Figures in brackets are long-run elasticities.
[a] The probability for 3 and 57 degrees of freedom is 0.1125, which means that Models A and B are statistically equivalent.

zero. This result, coupled with the uniformly higher *t*-values in Model B, lead us to accept the reduced model as the preferred specification.

The advertising elasticity from Model B of 0.066 may be compared with Solomon and Kinnucan's estimate of 0.12 for the export market and to Dewbre, Richardson, and Beare's estimate of 0.086 for Australian wool promotion in the United States.

Optimal Budget Allocations for Cotton

With the missing elasticity estimated, the optimal budget allocations and marginal returns to increased cotton promotion can now be determined using equations (15a)–(15c). To determine the optimal budget allocations, we set $B_d = 0.066$, $B_x = 0.12$, and "simulated"

Table 3. Optimal versus Actual Allocation of Cotton Promotion Budget (A_T) to the Domestic (A_d) and Export (A_x) Markets, 1984–93

Year	A_T	Domestic Allocation (A_d)			A_g[b]	Export Allocation (A_x)		
		Optimal ($ mil.)	Actual ($ mil.)	Ratio[a] (%)		Optimal ($ mil.)	Actual ($ mil.)	Ratio[a] (%)
1984	12.7	4.2	7.5	180	1.6	8.5	5.2	61
1985[c]	14.9	5.3	8.4	158	1.7	9.6	6.5	68
1986	16.3	6.2	9.6	154	1.8	10.0	6.7	66
1987	25.8	10.1	11.0	108	7.1	15.7	14.8	94
1988	44.2	18.7	26.6	146	8.6	26.0	17.6	68
1989	27.7	10.6	11.0	104	8.8	17.1	16.7	98
1990	56.0	21.4	19.2	90	15.6	34.6	36.8	106
1991	68.5	25.0	18.5	74	18.7	43.6	50.0	114
1992	86.1	44.4	35.7	80	17.1	41.6	50.4	121
1993	77.8	36.0	32.4	90	15.2	41.8	45.4	108

[a] Actual divided by optimal.
[b] Government subsidy for export promotion.
[c] Owing to an unusually small export share in this year ($K_x = 0.23$), the optimal allocation is based on the average export share for 1984 and 1986 ($K_x = 0.50$).

(15a) and (15b) using export share data for the period 1984–93. This 10-year period is of interest because federal subsidies for cotton export promotion increased nine-fold as indicated in table 3. The first increase occurred in 1987 following the implementation of the Targeted Export Assistance program (TEA). The replacement of TEA with the Market Promotion Program (MPP) in 1990 coincided with a second round of subsidy increases so that by 1992 cotton was receiving $17.1 million to support export promotion.

The heightened subsidies are reflected in the budget allocations (table 3). In particular, prior to TEA, the industry overinvested (relative to the optimum) in the domestic market at the expense of the export market. Following TEA, budget allocations began to shift in favor of the export market. With the inception of MPP in 1990 and the new round of subsidy increases, budget allocations reversed their earlier pattern to such an extent that the industry was overinvesting (relative to the optimum) in the export market. The allocative errors favoring the export market (6%–21%), however, are less severe than the earlier (pre-TEA) allocative errors favoring the domestic market (54%–80%). Thus, one might argue that the increased subsidies were efficiency increasing in the sense that they encouraged industry to allocate its marketing resources in a more cost-effective manner.

That industry tends to underinvest in export promotion when export promotion subsidies are low can be explained by the free-rider problem. The free-rider problem, as explained by Goddard and Conboy, arises when the promoted product is viewed by importing countries as homogenous across import sources. In this case, if one country's promotion program increases demand, all importing sources experience a demand increase and thus benefit from the promotion without incurring the cost. The inability to capture the full benefit of export promotion may act as a disincentive to invest in export promotion, especially if the promoting country's trade share is modest. (Recall that the U.S. average trade share for cotton is 27%.)

Given the large increases in promotional spending (from $12.7 million in 1984 to

Table 4. Benefit-Cost Ratios for Increased Cotton Promotion under Alternative Assumptions about the Export Demand Elasticity (N_x), the Export Advertising Elasticity (B_x), and the Domestic Supply Elasticity (E), United States, 1992

	$B_x = 0.120$		$B_x = 0.066$	
Length of Run	$N_x = 2.00$	$N_x = 1.00$	$N_x = 2.00$	$N_x = 1.00$
Short run $(E = 0.30)$	2.63	5.07	1.69	3.49
Long run $(E = 0.92)$	2.32	4.31	1.46	2.92

Note: The B-C ratio indicates the net reduction in government outlays for deficiency payments and promotion per dollar increase in the promotion budget, assuming that the budget increment is allocated to the domestic and export markets optimally, that is, in accordance with text equations (15a) and (15b).

$86.1 million in 1992), the question arises whether industry (and, by implication, government) is overinvesting in cotton promotion. To answer this question, we evaluated the Lagrange multiplier [equation (15c)] at the higher expenditure level ($A_T^0 = 86.1$) for the parameter values given in table 1. Results indicate that even at the higher investment level, the budget is suboptimal from the standpoint of minimizing the combined cost of protection and promotion. In particular, for the baseline values of the export advertising elasticity ($B_x = 0.12$), export demand elasticity ($N_x = 2.00$), and supply elasticity ($E = 0.30$), the absolute value of the Lagrange multiplier is 2.63. This means that if the promotion budget (A_T) was relaxed by one dollar, *and if the budget increment was allocated to the domestic and export markets optimally, that is, in accordance with (15a) and (15b)*, the extra demand associated with the $1 budget increment would cause the *combined* outlays for deficiency payments and promotion to decline by $2.63. This implies, for example, that an increase in subsidies for export promotion would be self-financing in that net treasury outlays for price support and promotion would decline by more than the cost of the increased subsidy.

Sensitivity analysis indicates that the Lagrange multiplier is sensitive to assumed values for the demand and advertising elasticities but relatively insensitive to the supply elasticity (table 4). The smallest value for λ^* is obtained when export demand and domestic supply are relatively elastic and the export market is relatively unresponsive to promotion. For example, if the export-promotion elasticity is reduced to 0.066, the elasticity estimated for the domestic market, N_x remains at 2.00, and $E = 0.92$, the Lagrange multiplier in absolute value is 1.46, which still supports the underinvestment hypothesis. Reducing the export demand elasticity to 1.00 increases the Lagrange multiplier to between 2.92 and 3.49 if the export market is relatively unresponsive to promotion and to between 4.31 and 5.07 if the market is relatively responsive. Thus, it appears that increases in cotton promotion can be justified on economic grounds, provided that funds are allocated efficiently and the current program provisions remain intact.[10]

---

[10] Elimination of program provisions called for in the 1996 farm bill makes subsidies for export promotion difficult to

Concluding Comments

A basic theme of this article is that nonprice promotion interacts with government programs to shape treasury exposure and that welfare gains can be achieved (in a second-best sense) if promotion funds are allocated efficiently. Allocation rules derived for a "large" exporting industry protected by deficiency payments indicate that optimal market allocations are governed by just two basic parameters: the advertising elasticities in the domestic and export markets and the export market share. This finding is important because it indicates that promotion managers need not concern themselves with policy parameters, demand elasticities, or supply response in making "good" decisions about fund allocations. The required information is limited to parameters that are readily observed (export shares) or that can be obtained as a by-product of program evaluation (advertising elasticities).

Protection through deficiency payments implies that producer benefits from promotion are nil unless promotion increases demand sufficiently to push the market price above the target price.[11] Under these conditions, the major beneficiary of promotion, aside from any potential gains or losses to consumers and foreign producers, is the American taxpayer. Thus, the public has a stake in program effectiveness, which leads naturally to the cost-minimization framework adopted in this study. Besides rules to guide allocation decisions, the framework provides information that should be useful to industry and government in determining how much to invest in promotion. The investment decision is more complex than the allocation decision in that policy parameters, demand elasticities, advertising elasticities, export shares, and supply response must be taken into account simultaneously.

Subsidies for export promotion provide incentives for industry to divert funds from domestic market promotion, which will diminish the overall economic impacts of the program if the subsidies encourage industry to overinvest in the export market. In the case of cotton, however, it appears that subsidies for export promotion may be efficiency increasing in that market allocations when subsidies are high more nearly match the cost-minimizing allocation than when subsidies are low. Still, subsidies of any type promote inefficiencies unless market failures or negative externalities are attenuated. A full accounting of the social welfare implications of promotion subsidies must await additional research.

[*Received October 1995; final version received July 1996.*]

References

AD $ Summary. New York: Leading National Advertiser Inc. Various issues, 1975–93.

Alston, J. M., H. F. Carman, and J. A. Chalfant. "Evaluating Primary Product Promotion: Returns to Generic Advertising by a Producer Cooperative in a Small, Open Economy." In *Promotion in the Marketing Mix:*

---

justify in that there is no corresponding benefit to taxpayers in terms of reduced outlays for deficiency payments. Whether the total budget is too large or too small can be determined from the Nerlove-Waugh theorem. The allocation rules, however, are unaffected.

[11] This statement is strictly true only if all producers participate in the program and all production is eligible for deficiency payments. If some production is not covered by deficiency payments, promotion-induced increases in market price will benefit this production, provided the price increase is sufficient to offset the per-unit promotion cost for producers outside the program.

What Works, Where, and Why, eds., W. Goddard and D. S. Taylor, pp. 145–67. Guelph: University of Guelph, Canada, 1994.

Anson, R., and P. Simpson. "World Textile Trade and Production Trends." In *Textile Outlook International,* eds., R. Anson, A. Baxton, and B. Taylor, pp. 10–49. Cheshire United Kingdom: Textile Intelligence Limited, January 1995.

Chang, H.-S., and H. W. Kinnucan. "Advertising, Information, and Product Quality: The Case of Butter." *Amer. J. Agr. Econ.* 73(1991):1195–203.

Clarke, D. G. "Econometric Measurement of the Duration of Advertising Effect on Sales." *J. Mktg. Res.* 13(1976):345–57.

Council of Economic Advisors. *Economic Report of the President.* Washington DC: Government Printing Office. Various issues, 1976–94.

De Boer, A. J. "Rural Product Promotion: Economic Aspects of Promotability, Organization and Public Assistance." *Rev. Mktg. and Agr. Econ.* 43,4(1977):121–45.

Dewbre, J., R. Richardson, and S. Beare. "Returns from Wool Promotion in the United States." Occ. Pap. No. 100. Australian Bureau of Ag. and Res. Econ. Canberra: Australia Government Publishing Service, 1987.

Ding, L. *Optimal Static Decision Rules for Allocating Advertising Funds between Domestic and Export Markets: The Case of Cotton.* Unpub. master's thesis, Auburn University, March 1996.

Dorfman, R., and P. O. Steiner. "Optimal Advertising and Optimal Policy." *Amer. Econ. Rev.* 44(1954):826–36.

Duffy, P. A., K. Shalishali, and H. W. Kinnucan. "Acreage Response under Farm Programs for Major Southeastern Field Crops." *J. Agr. and Appl. Econ.* 26(1994):367–78.

Duffy, P. A., and M. K. Wohlgenant. "Effects of an Export Subsidy on the U.S. Cotton Industry." *S. J. Ag. Econ.* 23(1991):1–7.

Duffy, P. A., J. W. Wohlgenant, and J. W. Richardson. "The Elasticity of Export Demand for U.S. Cotton." *Amer. J. Agr. Econ.* 72(1990):468–73.

Ferrero, J., L. Boon, H. M. Kaiser, and O. D. Forker. "Annotated Bibliography of Generic Commodity Promotion Research" (revised). Res. Bull. No. 96-03, National Institute for Commodity Promotion Research and Evaluation, Cornell University, February 1996.

Forker, O. D., and R. W. Ward. *Commodity Advertising: The Economics and Measurement of Generic Programs.* New York: Lexington Books, 1993.

Goddard, E., and P. Conboy. "Optimal International Promotion Expenditure for Differentiated Products." *Rev. Mktg. and Agr. Econ.* 61(1993):49–61.

Goddard, E. W., G. R. Griffith, and J. J. Quilkey. "Optimal Advertising Investment Decisions." Res. Bull. No. 94/01, Dept. of Agr. Econ. and Bus., University of Guelph, Canada, December 1994.

Greene, W. H. *LIMDEP User's Manual and Reference Guide,* Version 6.0. Bellport NY: Econometric Software, Inc., 1991.

Kinnucan, H. W., and K. Z. Ackerman. "Public Funding of Foreign Market Development Programs." In *Public Policy in Foreign and Domestic Market Development,* ed., D. I. Padberg, pp. 121–34. College Station: Texas A&M University, 1995.

Kinnucan, H. W., and E. Belleza. "Advertising Evaluation and Measurement Error: The Case of Fluid Milk in Ontario." *Can. J. Agr. Econ.* 39(1991):283–97.

Kinnucan, H. W., and J. E. Christian. "Effectiveness of Pacific Rim Almond Promotion: A Reappraisal." Unpub. ms, Dept. of Agr. Econ. and Rur. Soc., Auburn University, December 1995.

Kinnucan, H. W., P. A. Duffy, and K. Z. Ackerman. "Effects of Price Versus Non-price Export Promotion: The Case of Cotton." *Rev. Agr. Econ.* 17(1995):91–100.

Kinnucan, H. W., P. A. Duffy, and L. Ding. "Optimal Promotion in Protected Industries." Sem. Pap., Cornell University, August 1995.

Kmenta, J. *Elements of Econometrics,* 2nd ed. New York: Macmillan Publishing Company, 1986.

Lee, J.-Y., and M. G. Brown. "Lag Structures in Commodity Advertising Research." *Agribusiness* 8(1992): 143–54.

Lowenstein, F. "Factors Affecting the Domestic Mill Consumption of Cotton." *Agr. Econ. Res.* 4(1952):44–51.

Nerlove, M., and F. Waugh. "Advertising without Supply Control: Some Implications of a Study of the Advertising of Oranges." *J. Farm Econ.* 43(1961):813–37.

Quilkey, J. "Promotion of Primary Products—A View from the Cloister." *Aust. J. Agr. Econ.* 30(1986): 38–52.

Simon, J. L., and J. Arndt. "The Shape of the Advertising Response Function." *J. Advertising Res.* 4(1980): 11–28.

Solomon, H., and H. W. Kinnucan. "Effects of Non-price Promotion: Some Evidence for Cotton." *Aust. J. Agr. Econ.* 37(1993):1–15.

Stigler, G. J., and G. S. Becker. *"De Gustibus non est Disputandum."* *Amer. Econ. Rev.* 67(1977):76–90.

Theil, H. *System-Wide Explorations in International Economics, Input-Output Analysis, and Marketing Research,* Vol. 2. Amsterdam: North-Holland Publishing Co., 1980.

U.S. Department of Agriculture, Economic Research Service (USDA/ERS). *Agricultural Outlook.* Pub. No. AO-217. Washington DC: Government Printing Office, April 1995.

———. *Cotton and Wool: Situation and Outlook.* Washington DC: Government Printing Office. Various issues, 1976–95.

———. *World Cotton Situation.* Circ. Series. Pub. No. FC6-91. Various issues, 1960–94.

U.S. Department of Commerce (USDC). *Survey of Current Business.* Washington DC: Bureau of Economic Analysis. Various issues, 1976–94.

Wohlgenant, M. K. "Impact of an Export Subsidy on the Domestic Cotton Industry." Texas Agr. Exp. Sta. Bull. No. B-1529, Texas A&M University, College Station, April 1986.

Appendix: Second-Order Sufficiency Conditions

The second-order sufficiency conditions for a minimum of the Lagrange function [equation (8)] require that the determinant of the bordered Hessian matrix H^* be negative in sign, that is,

(A1)
$$|H^*| = \begin{vmatrix} 0 & 1 & 1 \\ 1 & L_{aa} & L_{ab} \\ 1 & L_{ba} & L_{bb} \end{vmatrix} < 0,$$

where L_{ij} is the second-order partial derivative of equation (8) with respect to domestic ($i, j = a$) and export ($i, j = b$) promotion (e.g., $L_{ab} = (\partial^2 L/(\partial A_d \, \partial A_x))$). Performing the indicated mathematical operations on (A1), the sufficient condition in algebraic form is

(A2)
$$-L_{aa} + L_{ab} + L_{bao} - L_{bb} < 0.$$

Direct application of inequality (A2) to (8) results in an expression that is too cumbersome to evaluate. However, insight into the problem can be obtained by considering the case in which all production is eligible for deficiency payments ($\phi = 1$) and (for notational convenience) the unadjusted market price is used to compute the deficiency payment ($\tau = 1$). In this case, the Lagrangian function reduces to

(A3)
$$L = (P_T - P)Q^0 + A_d + A_x + \lambda(A_T^0 - A_d - A_x),$$

where Q^0 is the (fixed) level of domestic production elicited by target price P_T. For notational convenience, let P_{ij} denote first- and second-order partials, respectively, of price with respect to domestic and export promotion [e.g., $P_{ab} = (\partial^2 P/(\partial A_d \, \partial A_x)]$. Utilizing this notation, $L_{ij} = -P_{ij}Q^0$ (e.g., $L_{ab} = -P_{ab}Q^0$). Substituting these relationships into (A2) and dividing through by Q^0 yields

(A4)
$$P_{aa} - P_{ab} - P_{ba} + P_{bb} < 0.$$

Whether inequality (A4) is true depends on how promotion's price-enhancement ability is affected by (*a*) the level of promotion in the own market as indicated by the signs of P_{aa} and P_{bb} and (*b*) the level of promotion in the cross market as indicated by the signs

of P_{ab} and P_{ba}. The own-market effects in essence are governed by the shape of the sales-response function, which is characterized by diminishing marginal returns (e.g., Simon and Arndt). Thus, a plausible hypothesis is that P_{aa} and P_{bb} are negative.

The cross-market effects depend on complementarities between domestic and export promotion. One possibility is that domestic consumers also see advertisements for U.S. cotton in foreign countries (e.g., Canada), and this increases their responsiveness to the domestic promotion. In this case, $P_{ab} > 0$. However, given the geographic separation between the domestic market and major export markets [Pacific Rim countries historically have accounted for the bulk of U.S. cotton exports and promotional spending (Solomon and Kinnucan)], a more plausible hypothesis is that advertising effects across markets are independent, that is, $P_{ab} = P_{ba} = 0$. In this case, $P_{aa} + P_{bb} < 0$, and diminishing returns in the separate markets are sufficient to ensure that the market allocation rules given in (15a) and (15b) do indeed minimize the combined outlays for promotion and protection.