Dynamic Complementarity in Export Promotion:
The Market Access Program in Fruits and Vegetables

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Abstract: To justify public subsidies for export promotion, export markets must fail to provide incentives for exporters to recognize the benefits of spillover or long-term benefits of promotion. This paper tests for these failures in dynamic dual models of horticultural export supply. Results show significant spillover and dynamic effects.

Introduction

During debate over the 1996 Food and Agriculture Improvement and Reform Act (FAIR), subsidized export promotion under what was then known as the Market Promotion Program (MPP) came under sharp criticism as a prime example of "corporate welfare." Critics maintain that if such promotion is economically viable, then there is no need for government assistance. However, in the presence of certain market failures, a case for public support of export promotion can be made.

At least two market failures could cause firms to under promote their product in foreign markets, thereby leading to lower exports overall, and lower national welfare. First, uncertainty over the level and extent of funding may cause firms to adopt a short-term planning perspective, even though the effects of their promotion may last for many years (Dhalla). With this myopic perspective, the net present value of any promotion investment will be lower than if a long-term perspective were adopted. Second, advertising may create positive externalities if promoting one good causes exports of another to rise. Typically, growers of the promoted commodity do not include these "halo effects" in their decision to promote (Dwyer).

This study develops a method of testing for these market failures using a dynamic dual model of export sales. In this framework promotion expenditures are treated as an exporter's investment in establishing and maintaining a product's image in a foreign market, herein called "product equity." The notion of product equity is akin to Nerlove and Arrow's idea of advertising contributing to the "goodwill" associated with a product. With this approach, promotion investments not only impact sales of an exporter's own product, but also products closely associated with the exporters. This may arise in U.S. export promotions that emphasize the products' U.S. origin. The effectiveness of the promotion investment is likely to decline over time, though. The next section develops the dynamic promotion model used in this analysis.

An Adjustment Cost Model of Export Supply and Promotion

Existing analyses of the effectiveness of export promotion consider its role in expanding foreign consumers' import demand for the promoted commodity (Comeau, Mittelhammer, and Wahl; Solomon and Kinnucan; and many others). Although this approach has proven popular and valuable in quantifying the impact of promotion on demand, there are a few reasons why it is not the only way to model trade in agricultural products. First, the decision to enter export markets is not usually made directly in response to demand from foreign consumers, but rather originates from a perception among growers that domestic production has outgrown the domestic market's ability to maintain acceptable price levels (Elwell). Second, treating promotion as an argument of consumers' utility functions is not necessarily universally accepted (Stigler and Becker). Third, considering the vast number of products that consumers are expected to maintain specific knowledge of, describing the dynamics of promotion in terms of a firm's investment in a depreciating capital stock of goodwill, product equity, or reputation (Nerlove and Arrow) is at least as plausible as including it in a consumer's utility function. Finally, many goods are demanded not by foreign consumers, but by firms as intermediate inputs in the production of final goods (Davis and Jensen). Consequently, this study offers an alternative approach by treating export promotion as an input to U.S. producers' export supply decision.

Other studies also look at promotion from a firm, rather than consumer perspective. Ehrlich and Fisher treat promotion expenditure explicitly as an input to production, where the stock of product equity depreciates over time. Thus, the demand for promotion arises as a derived demand within a dynamic profit maximization problem. Their approach, though, does not allow for adjustment costs, which are likely to be significant in establishing and maintaining product equity. With adjustment costs, the demand for promotion is more appropriately considered, as Little suggests, as the demand for a quasi-fixed input to production (Mortensen, Treadway, Howard and Shumway 1988). Treating product equity as a quasi-fixed input offers an explanation for promotion dynamics that is well grounded in firm optimizing behavior.

Beyond these nice conceptual features, this approach also provides a natural framework within which to test the quasi-fixity of promotion, the significance of spillovers from promoting one commodity to another (or the halo effect), and the direct effect of promoting a commodity on its own sales. First, estimates of the adjustment rate of each commodity's stock of product equity are obtained directly by specifying the cost-of-adjustment model in terms of a multivariate flexible accelerator (MVFA). If product equity does not adjust to its steady-state instantaneously (within one period), then single-period planning horizons for promotion expenditure are sub-optimal. Second, the MVFA adjustment-rate parameters show not only the proportion each quasi-fixed input adjusts towards its steady-state level given deviations from its own long-run level, but also the effect of disequilibria among all other quasi-fixed inputs (Mortensen). Epstein and Denny define dynamic complementarity as the case where a deficient stock of one quasi-fixed input causes a reduction in the rate of adjusting another. The logic in this case is reasonably intuitive -- if the marginal value product of one input rises in the level of a second, insufficient stocks of the latter cause demand for the first to fall. In addition to these potential long-run spillover effects, the model estimates short-run interactions by including all cross-promotion variables in each supply equation.

The demand for promotion and the supply of exports are derived using the dynamic dual framework of Epstein as applied to agricultural investment by Howard and Shumway (1988) or to investment in the food processing industry by Morrison. With this approach, if firms maximize the present value of future profits subject to a single-period production constraint and a dynamic constraint on the rate of adjusting quasi-fixed inputs, then the maximized objective function of the firm can be written in terms of a dual value function. The dual value function expresses the present value of the firm as a function of input prices, output prices, rental rates of quasi-fixed inputs and current quasi-fixed input stocks. Applying a dynamic analogue of Hotelling's Lemma to a value function of a specific functional form generates estimable input demand, output supply, and investment demand equations.

In terms of the export promotion decision, however, it is common to consider input quantities as predetermined (Lawrence). Therefore, the problem facing exporters (primarily private firms) is to choose their own promotion expenditure levels and, subject to export promotion program regulations, the amount of support to apply for from the Foreign Agricultural Service (FAS) in order to maximize grower revenue net of promotion costs. Conceptually, this means that the relevant objective function is neither a profit nor a cost function, but a net revenue function instead. Further, the fact that product equity is costly to adjust in foreign countries means that the revenue function is constrained by the process governing the change in equity over time. An exporter's objective is, therefore, to maximize the present value of net export revenue -- net of the cost of adjusting the stock of product equity. The dynamic dual arguments made by Epstein apply equally to the dual revenue function as to the dual profit or cost functions more common to the literature, provided that the equivalent regularity conditions are satisfied. One potential problem in the empirical estimation of this model is obtaining separate data on commodities bought for export (inputs) and the amounts actually exported (outputs). By assuming current period exports are composed of pre-determined levels of production, however, current output is a function of last period's input endowment. Given this argument, the dual value function, assuming the decision maker maximizes the present value of future export net revenue over an infinite horizon, can be written as:

(1)
$$
\begin{aligned}
J(\boldsymbol{p},\boldsymbol{q},\boldsymbol{x},\boldsymbol{z}) &= \max_{\boldsymbol{I_j},\boldsymbol{y}} \int_0^\infty e^{-rt}[\boldsymbol{p}'\boldsymbol{y}(\boldsymbol{x},\boldsymbol{z}) - C(\boldsymbol{I}) - \boldsymbol{q}'\boldsymbol{z}]\,dt \\
s.t.\quad \dot{z}_j &= I_j - \delta z_j,\; z(0) = z_o,\; z(t) > 0 \;\forall\; t, \\
J(\boldsymbol{p},\boldsymbol{q},\boldsymbol{x},\boldsymbol{z}) &\leq \int_0^\infty e^{-rt}(\boldsymbol{p}_L\boldsymbol{y}_L)\,dt;
\end{aligned}
$$

where J is the optimal present value of net export revenues, q_j is the rental rate of quasi-fixed input z_j, r is a real interest rate, $\boldsymbol{p}$ is a vector of output prices, $\boldsymbol{y}$ is a vector of export quantities, $\boldsymbol{x}$ is a vector of input endowments, I_j is the gross rate of investing in quasi-fixed input j, and δ is a constant rate of depreciation. In order for J to meet the regularity conditions required for dynamic duality (Epstein), the value function must, among other conditions, be homogeneous and convex in output prices, output supply monotonically increasing in output price, and the shadow value of $\boldsymbol{z}$ must be non-negative for positive adjustments (investment), and non-positive for disinvestments. Solving this optimization problem yields a system of export supply and investment demand equations.[1] The empirical form of these equations depends on the selection of an appropriate functional form for the value function, which is presented next.

[1] A complete derivation of this model is available from the authors.

Empirical Model of Export Supply

One plausible functional form for the value function is the Generalized Leontief (GL) of Diewert. This functional form is widely used in empirical dynamic dual studies because it is inherently homogeneous in prices, is a second-order approximation to an arbitrary technology, and is affine in the state variables. In terms of the variables in this application, the value function is written:

(2)

$$J(\boldsymbol{p},\boldsymbol{q},\boldsymbol{x},\boldsymbol{z}) = \boldsymbol{p}'\boldsymbol{A}_{\boldsymbol{pz}}\boldsymbol{z} + \boldsymbol{q}'\boldsymbol{B}_{\boldsymbol{qz}}^{-1}\boldsymbol{z} + \boldsymbol{p}^{1/2\prime}\boldsymbol{C}_{\boldsymbol{pq}}\boldsymbol{q}^{1/2} + \boldsymbol{q}^{1/2\prime}\boldsymbol{D}_{\boldsymbol{qq}}\boldsymbol{q}^{1/2} + \boldsymbol{p}^{1/2\prime}\boldsymbol{E}_{\boldsymbol{pp}}\boldsymbol{p}^{1/2} + [\boldsymbol{p}' \ \boldsymbol{q}'] \begin{bmatrix} \boldsymbol{F}_{\boldsymbol{px}} \\ \boldsymbol{F}_{\boldsymbol{qx}} \end{bmatrix} \boldsymbol{x},$$

where ***p*** and ***q*** are output and quasi-fixed input prices (rental rates), respectively, ***A***, ***B***, ***C***, ***D***, ***E***, and ***F*** are conformable parameter matrices, and ***z*** is a vector of stocks of product equity. This specification generates estimable output supply and investment demand equations:

(3)

$$y_i(\boldsymbol{p},\boldsymbol{q},\boldsymbol{x},\boldsymbol{z}) = \sum_j A_{ij}\ (r z_{t,j} - \dot{z}_j) + r\left(\sum_{k\neq i} E_{ki} \left(\frac{p_k}{p_i}\right)^{1/2} + E_{ii}\right) + (r/2) \sum_j C_{ij} \left(\frac{q_j}{p_i}\right)^{1/2} + \sum_l F_{il} x_l$$

and:

(4)

$$\dot{z}_j(\boldsymbol{p},\boldsymbol{q},\boldsymbol{x},\boldsymbol{z}) = r\ z_{t,j} + \sum_m B_{jm}\ [z_{t,m} + \sum_l F_{jl} x_l + (r/2)\left(\sum_i C_{im}\left(\frac{p_i}{q_m}\right)^{1/2} + 2\sum_{m\neq j}(D_{jm}\left(\frac{q_j}{q_m}\right)^{1/2} + D_{mm})\right)].$$

In a model of dynamic adjustment, both long and short-run elasticities are of interest. For current purposes, short-run elasticities are defined as conditional on existing levels of each quasi-fixed input so they are, in effect, fixed inputs. In the long-run, on the other hand, steady-state quasi-fixed input stocks respond to changes in prices, promotion, or other elements of the $\boldsymbol{x}$ vector in (4). Long run elasticities, therefore, take into account the effects of price changes on both current supply and future changes in supply induced by changes in quasi-fixed input stocks.[2] Equation (3) can be used to differentiate between the long- and short-run effects of promotion. Whereas sales respond directly to promotion in the current period as shown by the $\boldsymbol{A}$ parameter matrix, estimates of the long-run effect take into account both sluggish adjustment of accumulated promotion stocks and interactions with stocks of other commodities' goodwill. These effects are shown in the speed-of-adjustment parameters in $\boldsymbol{B}$. Indeed, the parameters of $\boldsymbol{B}$ provide a means of testing the degree of complementarity or substitutability between commodity-promotion programs.

Data and Methods

Export shipments of apples, almonds, grapes, and wine were considered in this analysis. Data on export shipments were obtained from *Foreign Agricultural Trade of the United States* (*FATUS*). Export prices were calculated as unit value indices using the reported export values and quantities. Annual data on promotion expenditures were obtained from the Foreign Agricultural Service. However, these data were only available for the period 1984 through 1995. To generate sufficient degrees of freedom to estimate the model, it was necessary to pool the data over a cross-section of importers, which included Mexico, Sweden, Norway, Finland, United

[2] The derivation of the price and promotion elasticities is available from the authors.

Kingdom, France, Germany, Malaysia, Singapore, the Philippines, and Japan. While the data to this point are commonly used in export promotion studies, calculating different rental prices (q_j) for each commodity's stock of product equity is a problem unique to a dynamic-dual approach.

Ehrlich and Fisher's approach for measuring the rental price and estimating the depreciation rate for product equity, δ, is adopted in this study. With their method, estimates of the depreciation rate are obtained using a maximum likelihood grid-search procedure.[3] Searching over increments of size 0.001 provides an optimal depreciation rate of 0.921, implying a relatively rapid decay of product equity. This depreciation rate is maintained while testing both the regularity conditions for duality and hypotheses regarding the effectiveness, durability, and spillovers associated with export promotion expenditure.

Results and Discussion

The estimated parameters from equations (3) and (4) showed that the dynamic export supply specification is consistent with both convexity and symmetry of the value function, so these theoretical conditions are maintained while testing for instantaneous and independent quasi-fixed input adjustment.[4] In both commodity-by-commodity and joint tests of instantaneous adjustment, the null hypothesis is rejected. Rejecting instantaneous adjustment means that investments in product equity through promotion expenditure have multi-period effects that would be ignored by adopting a single-period promotion planning horizon. These findings support the possibility of a dynamic externality to export promotion. The results also suggest rejecting hypotheses of

[3] The depreciation rate cannot be estimated simultaneously with the rest of the system parameters because net investment is unobservable when the depreciation rate is unknown. As in Ehrlich and Fisher, therefore, this grid search procedure estimates both the unobservable stock of product equity and the investment-demand parameters.

[4] The estimated parameters are not reported here, but are available from the authors.

independent adjustment for each quasi-fixed input. This means that the establishment of a reputation for one product may help to build product equity in other products with characteristics common to the first. Because promoters of the first product are not likely to take these spillovers into account, a case may be made for external effects to commodity promotion.

The effects of promotion on export sales are presented in the form of elasticities in table 1. These elasticities combine the direct effect of promotion on exports and the indirect effect on exports working through the interaction of equity-stocks discussed above. The short-run elasticities show that the direct effect may be an important factor in determining export sales, with two of the four own-promotion elasticities greater than one. In these two cases, apples and wine, a 1% increase in export promotion expenditure causes a 5% and a 3% increase in exports, respectively. In the short-run, the spillover effects from other commodities promotion can exert as great an influence as own-commodity promotion. For example, a 1% rise in apple promotion causes almond sales to rise by 0.22% -- albeit a small effect, it is nonetheless greater than almonds' own-promotion elasticity. Promoting almonds, grapes, and wine also has a strong effect on apple exports, with two of the four cross-promotion elasticities greater than 1.0. Combining the direct effect of promotion with its indirect effect on the productivity of other goods' promotion is accomplished by estimating long-run elasticities.

As other dynamic-dual studies find (Howard and Shumway 1988, Vasavada and Ball, Weersink and Howard), these long-run elasticity estimates are consistent with the L'Chatelier-Samuelson principle, namely that long-run promotion elasticities are larger in absolute value than their short-run counterparts. This arises because of the durability of promotion investments.

Promotion effects may persist for several periods, thereby causing promotion elasticities to be many times larger in the long-run than in the short-run.

The effect of grape promotions on apples sales illustrates an important distinction between the short-run (direct) and long-run effect of promotion. Grape promotions increase apple sales in the short-run, but decrease apple sales in the long-run. This arises because grapes and apples were found to be dynamic substitutes. Increases in grape promotions, decrease the effectiveness of apple promotions. Thus, the longer term effects come to dominate the short-run or direct effects. Such negative promotion-externalities argue against subsidizing the promotion of products that extend a negative image to associated products. This is the case for a few other commodity pairs: wine supply with respect to apple promotion, and almond supply with respect to apple and wine promotion.

Table 1 also presents the short- and long-run price elasticities. Perhaps as expected due to the model's consistency with the curvature conditions required for dynamic duality, all long-run elasticities of supply are positive and significantly different from zero. These estimates suggest that all exports are inelastic in supply, ranging from 0.534 for wine to 0.027 for almonds. Although there are no elasticities in the literature with which we can compare these results, they appear to be reasonable given the relative importance of institutional, infrastructure, and domestic market constraints on the amount traded. Similarly, the short-run elasticities appear reasonable due to a practical inability to increase export supplies within one year, but considerably more latitude to divert supplies from the domestic market given sufficient time to adjust.

Although individual exporters of these relatively diverse products seem to have little ability to influence the supply of the other products, market development efforts for many commodities often occur together due to economic or institutional changes in the importing country. Further, the fact that decisions regarding promotion are often made through trade associations, multi-product cooperatives, and the FAS itself creates the likelihood for significant interactions in supply. Indeed, in the majority of cases, the cross-elasticity of supply is both numerically small and statistically insignificant, but some notable exceptions arise. In particular, apples and almonds appear to be substitutes in supply and grapes substitute for apples. However, the relationship between apples and grapes is not symmetric as increasing apple prices cause grape export supplies to rise, so these products are joint, or complements in supply.

Implications

Given that this study provides evidence of positive externalities to export promotion both over time and across commodities, questions of how to make most efficient use of the limited funds available from either public or private sources becomes the primary issue. This research provides at least tentative support for public interest in export promotion, but does not necessarily suggest that the most efficient solution is a continuation of current means of providing this support. Subsidies for export promotion are but one way in which exporters can be made to internalize the benefits over time and to other commodities of their promotion efforts. Arising in the private sector, greater coordination between trade associations and individual commodity groups may help exporters realize the synergies available from developing specific foreign markets for complementary products in tandem. In fact, removing the “policy uncertainty” that surrounds refunding federal export promotion programs each year may serve to reduce the dynamic externality found herein. However, as is the case with any government program, rent-seeking activities by potential beneficiaries may serve to usurp all potential benefits to society.

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Table 1. Elasticities of Supply and Promotion Response: Apple, Almond, Grape, and Wine Exports: 1984-1994.

		Price Change in:				Promotion Expenditure for:			
Response in:		Apple	Almond	Grape	Wine	Apple	Almond	Grape	Wine
Apple	Short Run:	0.016*	-0.017*	0.000	-0.001	5.011*	1.028*	0.647*	1.128*
		(2.026)	(-2.230)	(-0.130)	(-0.246)	(56.541)	(40.626)	(33.186)	(38.081)
	Long Run:	0.321*	-0.008*	-0.013*	-0.009	23.949*	3.775*	-4.258*	14.133*
		(5.681)	(-1.688)	(-1.981)	(-0.104)	(29.955)	(26.294)	(-7.661)	(14.902)
Almond	Short Run:	-0.006*	0.007	-0.001	-0.000	0.221*	0.052*	0.029*	0.045*
		(-2.231)	(1.263)	(-0.214)	(-0.006)	(2.762)	(3.024)	(3.091)	(2.741)
	Long Run:	-0.064*	0.027*	0.001	0.002	-2.310*	0.387*	0.198*	-1.769*
		(-4.356)	(1.679)	(0.583)	(0.086)	(-2.411)	(2.805)	(2.857)	(-2.737)
Grape	Short Run:	-0.002	-0.003	0.004	-0.000	0.362*	0.706*	0.467*	0.853*
		(-0.130)	(-0.214)	(0.297)	(-0.003)	(48.869)	(31.191)	(29.876)	(34.579)
	Long Run:	0.481*	-0.003	0.320*	0.001	5.414*	4.898*	0.778*	80.848
		(5.242)	(-0.057)	(5.272)	(0.230)	(37.829)	(3.132)	(38.086)	(0.120)
Wine	Short Run:	-0.008	-0.000	-0.000	0.001	0.603*	-0.062*	0.067*	2.096*
		(-0.245)	(-0.006)	(-0.003)	(0.307)	(12.045)	(-7.606)	(10.098)	(22.093)
	Long Run:	0.056	-0.001	0.004	0.534*	-0.369*	0.027*	0.019*	2.736*
		(0.852)	(-0.115)	(0.380)	(5.366)	(-8.694)	(5.019)	(10.441)	(19.437)

A single asterisk indicates significance at the 5% level.