Revenue Impacts of MPP Branded Funds: A Firm-Level Analysis

Paul M. Jakus, Kimberly L. Jensen, and George C. Davis

The USDA's Market Access Program (formerly Market Promotion Program) recently underwent a major change to redirect all branded products export promotion funds to small domestic firms and cooperatives. The redirection responded to criticisms by the General Accounting Office of past allocations of branded products export promotion funds to large, experienced exporters. This study uses a firm-level analysis to examine whether firm size and export experience matter in how effectively firms use the promotion funds to increase their revenues. The results support neither the GAO criticisms nor the recent program redirection.

Key Words: export promotion programs, export sales, Market Promotion Program

One of the U.S. Department of Agriculture's (USDA's) most visible export promotion programs is the Market Access Program (MAP), formerly known as the Market Promotion Program (MPP). The MAP uses funds from the Commodity Credit Corporation (CCC) to assist U.S. firms by cost-sharing promotional activities abroad for U.S. agricultural products. An overall objective of the MPP/MAP program throughout its history has been to increase export sales. Another objective of the MPP/MAP has been to give special priority to firms that face undue trade barriers for their products, necessitating more intense promotional efforts.

In 1998, Agriculture Secretary Dan Glickman announced that *all* MAP funds for export promotion of branded products would be allocated to cooperatives and small domestic companies (USDA, 1998).[1]

The MAP is now exclusively targeted at small firms, firms relatively new to exporting, and firms facing consumer awareness and import restriction problems in foreign markets. The redirection of MAP funds exclusively to small domestic firms and cooperatives represents a major departure from the priorities originally set out for the program.

The program funds redirection was, in part, a response to criticisms of the program by the U.S. Congress and the General Accounting Office (GAO) throughout the 1990s (U.S. GAO 1993a,b, 1995, 1997, 1998, 1999). GAO reports alleged that MPP funds have not been targeted at firms most in need of export assistance. Because small and/or "new-to-export" firms may have more difficulty accessing international markets than larger or more export-experienced firms, the GAO has argued that smaller and less export-experienced firms should receive the greatest share of MPP/MAP funds.

Closely related to this "equity" criticism is an "efficiency" criticism. The GAO contended large firms would simply substitute CCC-provided MPP funds for private promotional expenditures, thus resulting in a negligible impact on large firms' export sales. MPP funding allocated to small firms and/or "new-to-export" firms would result in greater export sales per dollar funding than would allocations to larger, more experienced firms.

Response to these criticisms began with the Omnibus Budget Reconciliation Act of 1993, placing

---

Paul M. Jakus is associate professor, Department of Economics, Utah State University; Kimberly L. Jensen is professor, Department of Agricultural Economics and Rural Sociology, University of Tennessee; and George C. Davis is associate professor, Department of Agricultural Economics, Texas A&M University.

We thank, without implicating, Ju-Chin Huang for helpful comments on this manuscript. We also thank participants at the NEC-63 Spring 2000 meeting held in Denver, CO, especially Henry Kinnucan, Shida Henneberry, and Tim Richards. This study was funded in part by The University of Tennessee Agricultural Experiment Station and the USDA National Research Initiative Program. The views expressed here do not necessarily reflect those of the funding institutions.

[1] Secretary Glickman stated, "For the first time ... all MAP funds for promotion of branded products will be allocated to cooperatives and small U.S. companies to help them *expand their sales* in the international market place" [emphasis added].

greater program emphasis on providing MPP/MAP funds to small firms facing exporting problems.[2] The response culminated in 1998, with the total redirection of program funds under Secretary Glickman's administration.

The program redirection was initiated despite the absence of strong empirical evidence that smaller, less export-experienced firms are more effective than larger, more experienced firms in converting MPP/ MAP funds into export sales. While several studies have considered the overall effectiveness of the Market Promotion Program by analyzing aggregate market data, none of these studies have directly addressed these GAO criticisms.[3] In fact, aggregate market data cannot be used to answer this question. Analysis to support or refute the Congressional/ GAO criticisms and the ensuing program redirection can be empirically addressed only if firm-level data are used.

This analysis attempts to answer the question central to the GAO's criticisms and the program redirection: whether firm size and export experience matter in the conversion of MPP/MAP branded funds into firm sales. The study provides the first firm-level analysis of the impacts of MPP/MAP branded funds on firm sales. The empirical results are then directly linked to the GAO criticisms regarding firm size and export experience using estimates of marginal revenue and average revenue resulting from MPP funds.

This study also makes a methodological contribution by developing an econometric model that integrates two different approaches to estimate the revenues added by MPP/MAP funds. Integrating these approaches within the same econometric model produces qualitatively identical results, yet also yields more efficient parameter estimates. The modeling procedure should prove useful when designing similar surveys and analyzing the responses.

[2] Most of this legislation is found in the Omnibus Budget and Reconciliation Act of 1993, the FAIR Act of 1996, the Agricultural, Rural Development, Food and Drug Administration, and related Agencies Appropriation Act of 1996, and the Government Performance and Results Act of 1993.

[3] Examples of this literature include Halliburton and Henneberry (1995); Weiss, Green, and Havenner (1996); Kinnucan and Christian (1997); Richards, Van Ispelen, and Kagan (1997); and Richards and Patterson (1997). Each of the studies provides important information regarding the aggregate market impacts by examining industry returns and/or spillover effects from export promotion. The market-level data used by these researchers permits evaluation of the MPP/MAP program only in the aggregate, and GAO concerns are not directly addressed.

An Initial Model Relating Export Sales to MPP Funding

In this section we develop a reduced-form model of export sales as a function of MPP expenditures and other factors. The motivation for working with the reduced form is that the MPP program has a matching-funds requirement, and MPP funds will likely also influence nonsubsidized promotion expenditures.

Specifically, let export sales (*ES*) be written as a function of total promotion expenditures (*TPE*) and a vector of other variables $\mathbf{X}_1$, or $ES = f(TPE, \mathbf{X}_1)$. Now *TPE* can be considered the sum of MPP funds, matching funds (*MF*), and nonsubsidized promotion expenditures (*NPE*). However, by definition, the level of matching funds depends on the MPP allocation, so $MF = g(MPP)$, and the level of *NPE* will depend on MPP funds, in addition to other variables $\mathbf{X}_2$, or $NPE = h(MPP, \mathbf{X}_2)$. Substitution leads to the general reduced form $ES = f(MPP, \mathbf{X}_1, \mathbf{X}_2)$. The reduced form will therefore capture the *total effect* of MPP, or:

$$(1)\quad \frac{\partial ES}{\partial MPP} = \frac{\partial ES}{\partial MPP}\bigg|_{dMF = dNSE = 0} + \frac{\partial ES}{\partial MF}\frac{\partial MF}{\partial MPP} + \frac{\partial ES}{\partial NSE}\frac{\partial NSE}{\partial MPP},$$

where the first term is the *partial effect*, and the second and third terms are *indirect effects*.[4]

For estimation, an ordinary least squares (OLS) model could be written as:

$$ES = \mathbf{X}\boldsymbol{\beta} + \mathbf{Z}\boldsymbol{\gamma} + \varepsilon,$$

where $\mathbf{X}$ is a vector of factors influencing export total sales, and $\mathbf{Z}$ is a vector of all MPP variables (e.g., linear, quadratic, or interaction variables) which influence export sales. Having obtained OLS estimates of $\boldsymbol{\beta}$ and $\boldsymbol{\gamma}$, one could then estimate the marginal impact of the MPP funding by simply taking the derivative of the export sales model with respect to the $\mathbf{Z}$ variables associated with the MPP funding, $\partial ES/\partial \mathbf{Z} = g(\boldsymbol{\gamma}, \mathbf{Z})$. The notation reflects the fact that the marginal effect may be a function of $\mathbf{Z}$ and $\boldsymbol{\gamma}$.

[4] We thank an anonymous reviewer for suggesting this interpretation of the model. It should also be pointed out that the reduced-form model is the relevant model for policy considerations because the reduced form accounts for all feedback effects or multiplier effects. This is for the same reason that multipliers are so important in macroeconomics and input-output models; they measure total impacts. There is also a close connection between this approach and the approaches pursued by Thurman and Wohlgenant (1989), and Smith (1993) in estimating general equilibrium demand curves, which are partial reduced forms.

The OLS approach, however, ignores the practical difficulties involved with collecting primary data at the firm level. Survey practitioners have long noted the reluctance of households to reveal their income to interviewers (Dillman, 1978, pp. 105–106). To minimize item nonresponse to a question about income, income data are often collected for intervals (e.g., \$0–\$9,999, \$10,000–\$20,000, etc.), where the respondent is asked to indicate the interval into which household income falls.

Similarly, firms—particularly those whose shares are not publicly traded—may be reluctant to reveal total sales information. Thus, one might wish to collect such data using the interval format. This procedure presents only a minor complication for the econometric model because one may use a "completely censored" or "grouped data" approach to modeling these data (see Stewart, 1983; or Greene, 2000). The model is similar to a tobit model, except the data are censored from below and above, i.e., by the limits which define each sales interval. A maximum-likelihood approach estimates the *probability* that a firm with characteristics (**X**, **Z**) would have sales within any given sales interval.

The parameters obtained from this model could be used to calculate export sales according to:

$$(2) \qquad ES = \mathbf{X}\boldsymbol{\beta} + \mathbf{Z}\boldsymbol{\gamma} + \sigma\lambda(MPP),$$

where $\boldsymbol{\beta}$ and $\boldsymbol{\gamma}$ are estimated coefficients, σ is the estimated standard deviation of sales, and λ is an adjustment factor (similar to an inverse Mill's ratio) accounting for lower and upper censoring inherent in the interval data.[5] The variable λ is a function of all variables and estimated coefficients, but the above notation makes explicit its functional dependence on the MPP funding. The marginal impact of MPP funding on firm sales can be estimated by taking the derivative of this function with respect to **Z**, including the λ term.

Survey Design and Data, Part 1

Participants in the 1994 MPP program were surveyed for this study. This year was selected because the GAO's criticisms of the program funds allocation were presented in 1993, and the Budget Reconciliation Act and related legislation were passed in 1993. USDA/Foreign Agricultural Service (FAS) records were used to compile a mailing list of the population of 764 U.S. firms that participated in the MPP 1994 program year (branded portion). During the year in which this study was conducted, the export promotion program was still called the Market Promotion Program, so henceforth we refer to the MPP exclusively.

With the exception of focus group participants and a pre-test sample of 25 firms, the survey was mailed to all firms participating in the branded MPP program in 1994, following a modified Dillman approach. These firms included those applying through trade associations, such as the Western United States Agricultural Trade Association (WUSATA).[6] Approximately one week after the initial mailing, a follow-up postcard was sent to nonrespondents and about two weeks later, a second mailing was sent to all remaining nonrespondents. In conjunction with the second mailing, reminder phone calls were placed to nonrespondents. Of the 225 firms responding to the survey (representing a 31% response rate), 150 provided usable responses to all survey questions needed for this analysis.

Several questions elicited the information needed to estimate the impact of firm-level MPP funding on firm-level export sales according to the econometric specification outlined in equation (1). Firms were asked the interval into which their *total sales* fell in 1994 (e.g., between \$0 and \$100,000, between \$100,000 and \$249,000, etc.). The total sales question was expressed as an interval question because of the proprietary nature of sales figures for many firms. The actual level of MPP funds received by each firm was available from FAS records. The survey also requested information about firm characteristics important to answering the GAO criticisms, such as firm size (number of employees) and export experience (number of years exporting).

Estimating the Initial Total Sales Model

Relating Total Sales to Export Sales

A key requirement of completely censored models is that the "limits" used in eliciting the data must be used in the empirical estimation. Thus, we must use

---

[5] For this model, the inverse Mill's type correction factor takes the following form:

$$\left[\phi\left(\frac{L-\mathbf{X}\boldsymbol{\beta}-\mathbf{Z}\gamma}{\sigma}\right)-\phi\left(\frac{U-\mathbf{X}\boldsymbol{\beta}-\mathbf{Z}\gamma}{\sigma}\right)\right]\div \left[\Phi\left(\frac{U-\mathbf{X}\boldsymbol{\beta}-\mathbf{Z}\gamma}{\sigma}\right)-\Phi\left(\frac{L-\mathbf{X}\boldsymbol{\beta}-\mathbf{Z}\gamma}{\sigma}\right)\right],$$

where U and L represent the upper and lower truncation limits, respectively, and ϕ and Φ are the normal density and cumulative distribution functions, respectively.

[6] We assume trade associations act as simple "pass-through" organizations having no impact on the ability of firms to convert MPP dollars into export sales.

Table 1. Variable Definitions and Summary Statistics (*N* = 150)

Variable Name	Definition	Units	Percent or Mean
TS	Interval measure of total sales in \$10,000s, percent of sample in category	1 if *TS* ≤ 10	0.66%
		2 if 10 ≤ *TS* ≤ 24.9	6.00%
		3 if 25 ≤ *TS* ≤ 49.9	3.33%
		4 if 50 ≤ *TS* ≤ 99.9	4.67%
		5 if 100 ≤ *TS* ≤ 199.9	7.33%
		6 if 200 ≤ *TS* ≤ 499.9	16.67%
		7 if 500 ≤ *TS* ≤ 999.9	14.00%
		8 if 1,000 ≤ *TS* ≤ 4,999.9	22.67%
		9 if 5,000 ≤ *TS* ≤ 9,999.9	12.00%
		10 if *TS* ≥ 10,000	12.67%
e	Share of total sales from exports	Share (.01 to 1)	0.327
k	Proportion by which exports would have changed if firm had not received MPP funds	Proportion (−4 to +4)	−0.119
MPP Funds	Value of 1994 program year MPP allocation from FAS, in \$10,000s	Dollars/10,000	4.269
Small Firm	Fewer than 500 employees	1 if fewer than 500 employees, 0 otherwise	0.847
New to Export	Exporting 5 years or less	1 if exporting 5 years or less, 0 otherwise	0.433
Years in Business	Years in business	Years/10	3.249
Employees	Number of full-time employees, in 100s	Employees/100	3.408

the limits from the question about "total sales" because export sales were not elicited in the interval approach. This does not present a major complication, however, because MPP funds are restricted to use on export activities. Noting that total sales (*TS*) is the sum of domestic sales (*DS*) and export sales (*ES*), then *TS* = *DS* + *ES*(**Z**), or

$$TS = DS + \mathbf{X}\boldsymbol{\beta} + \mathbf{Z}\boldsymbol{\gamma} + \sigma\lambda(MPP).$$

If there are no production constraints relating export sales to domestic sales, *DS* is independent of **Z**, and the impact of MPP funding on export sales can be estimated using a model based on total sales.

Specification Issues

The goal of the empirical model is to estimate the impact of MPP funding on firm sales, but—as is the rule rather than the exception—the exact specification is unknown. With respect to explanatory variables, the controversy surrounding the MPP program suggested that important variables would be a direct measure of the MPP funds received by the firm: firm size and "newness to exporting." The level of MPP funding was clearly part of the **Z** vector, as were variables which interact MPP funds with the firm size and "newness-to-export" variables. The interaction terms allow the model to disentangle the effects of MPP funding by key firm characteristics.

Empirically, firm size was measured two ways: with a dummy variable, and by directly including the number of employees. The dummy variable *Small Firm* represents the size cutoff (less than 500 employees) for Small Business Assistance for most firms in the eligible industries. *New to Export* denotes firms that had exported for five years or less. Another factor expected to influence firm sales was business experience, so a measure of experience was also included (*Years in Business*). Business experience, firm size, and newness to export were hypothesized to influence firm sales regardless of the level of MPP funding (these variables formed the core of the **X** vector). Summary statistics for these data are provided in table 1.

With respect to functional form issues, models that were both linear and nonlinear in variables were estimated. Nonlinearity of a quadratic form was introduced by using the square root of the continuous right-hand-side variables.[7]

[7] This form was used as a simple way to allow for nonlinear MPP effects. Alternatively, one could use a squared term or take the natural log, but economic theory provides no guidance on the exact specification. It is, ultimately, an empirical question. For example, similar to the usual quadratic relationship given by the presence of a squared term, a positive (negative) coefficient on the linear term and a negative (positive) sign on the square root term yields a U-shaped (inverted U-shaped) function.

Total Sales Model Results

The initial total sales models represent a simple grouped data regression of the MPP funds (and other variables) on total sales. Unlike an OLS approach, the coefficients from such a model do not have a simple interpretation (Greene, 2000). The marginal effect on total sales for a change in, say, the **X** variables is (as derived in the appendix):

$$\frac{\partial TS}{\partial \mathbf{X}} = \boldsymbol{\beta} + \boldsymbol{\beta}\left[\frac{(\alpha_L \phi_L - \alpha_U \phi_U)}{\sigma(\Phi_U - \Phi_L)} - \lambda^2\right],$$

where the elements of the bracketed term are defined in the appendix. The derivative with respect to the **Z** variables would have a similar form. The important point is that the bracketed term is a nonlinear function of *all* the parameters and the levels of *all* variables in the model. Thus, one must calculate the marginal effect for each firm evaluated at firm-specific levels of (**X**, **Z**); one cannot simply use the sign of a given coefficient to draw conclusions regarding the marginal impact. In reporting the results of the total sales model, we simply comment on the sign and statistical significance of each coefficient and refrain from discussing marginal effects until a later section.

The four models reported in table 2 differed with respect to explanatory variables and functional form. The final three models (Models 2–4) were restricted versions of the Model 1 specification reported in the first column. In all models, the **Z** vector was composed of *MPP Funds*, the square root of *MPP Funds*, and the interactions between the funding level and a firm size dummy variable (*MPP Funds* × *Small Firm*), and the funding level and *New to Export* (*MPP Funds* × *New to Export*).

In Model 1, *Small Firm* and *New to Export* were in the **X** vector, along with linear and square root terms for *Years in Business* and *Employees*. All **X** vector variables were statistically significant except the nonlinear term for business experience and the dummy variable *New to Export*. The **Z** vector was composed of linear and square root terms for *MPP Funds*, and two terms that interact *MPP Funds* with *Small Firm* and *New to Export*. Two of these terms were statistically significant: *MPP Funds* and the interaction between *MPP Funds* and *Small Firm*.

The second specification (Model 2) kept the **X** vector in its most simple form: a linear term for years in business and dummy variables for firm size (*Small Firm*) and exporting experience of five years or less (*New to Export*). Several variables were significant in Model 2: *Years in Business*, *Small Firm*, *MPP Funds*, and the interaction term between *MPP Funds* and *Small Firm* were all significant at conventional levels (*P*-values of less than 0.10). The estimate of the standard deviation of firm sales, *Sigma*(*Total Sales*), was also significant.

Model 3 used a continuous measure of firm size (the number of employees divided by 100) in the **X** vector. Both linear and quadratic terms for employment were used, each of which was statistically significant in explaining firm sales. *Years in Business* and the interaction between *MPP Funds* and *Small Firm* were also significant. Model 4 introduced nonlinearity in *Years in Business*, with the remainder of the specification identical to Model 3. The new nonlinear term was insignificant, and had little effect on the coefficients and standard errors of the remaining variables, with the exception of the linear term for *Years in Business*.

The grouped data models were encouraging from the perspective of explaining the impact of *MPP Funds* on firm sales. In all models, the interaction term between the MPP funding level and firm size was statistically significant, whereas the linear term for *MPP Funds* was significant in only two specifications. These statistically significant coefficients represent only six of the 16 MPP parameters, however. Additional information provided by firms on the impact of MPP on firm sales could improve the statistical analysis.

Survey Design and Data, Part 2

In addition to the "total sales" approach described above, another method to evaluate the impact of MPP funding on export sales was simply to ask firm managers a direct question:

> *In 1994, the value of my firm's export sales WITHOUT MPP funds would have been:* (*a*) *less by* [$$] *percent,* (*b*) *about the same,* (*c*) *greater by* [$$] *percent, or* (*d*) *zero* (*no export sales*).

In addition, an anonymous referee suggested the model should allow for different destination or country effects. Though certainly legitimate, we did not pursue that approach because the interest here is in aggregate effects, or effects across countries. If country effects are included in the model but the interest is in the effects across all countries (the aggregate effects), then the effects across all countries would have to be aggregated in some fashion. It is not clear how this should be done, because by definition the regression equation that includes country effects is conditional on those country effects. The heart of the issue is an old one: In estimating an aggregate relationship, is it better to estimate and then aggregate? or aggregate and then estimate? There does not appear to be any clear-cut answer in the literature (e.g., see Grunfield and Griliches, 1960), but here we aggregate and then estimate.

Table 2. Grouped Data Models

Variable	Model 1	Model 2	Model 3	Model 4
Intercept	3,295.170	8,181.763**	!1,648.687*	708.633
	(2,190.936)	(1,599.887)	(915.154)	(1,696.937)
X Variables:				
Years in Business	831.221*	520.360**	166.119*	865.645*
	(433.625)	(92.029)	(89.592)	(435.880)
Square Root of *Years in Business*	!2,515.509			!2,809.864
	(1,711.793)			(1,713.732)
Small Firm	!2,704.496*	!8,876.656**		
	(1,457.041)	(1,204.357)		
Employees	!412.401**		!406.845**	!442.342**
	(68.864)		(64.195)	(67.374)
Square Root of *Employees*	4,376.669**		4,669.231**	4,979.496**
	(620.361)		(502.899)	(534.689)
New to Export	114.228	!159.133	495.049	185.215
	(621.707)	(688.262)	(601.328)	(623.219)
Z Variables:				
MPP Funds	!500.426**	!859.751**	!283.066	!278.495
	(239.415)	(270.322)	(211.873)	(209.736)
Square Root of *MPP Funds*	!265.053	993.149	!208.494	!362.843
	(829.075)	(943.081)	(835.400)	(832.228)
MPP Funds × *Small Firm*	622.001**	736.362**	383.944**	409.788**
	(171.350)	(193.443)	(128.309)	(128.011)
MPP Funds × *New to Export*	!21.399	!15.611	!34.049	!29.147
	(93.054)	(108.358)	(94.635)	(93.714)
Sigma(*Total Sales*)	2,383.376**	2,817.042**	2,429.638**	2,402.381**
	(162.399)	(189.481)	(163.928)	(162.399)
Log Likelihood	!390.066	!412.521	!393.145	!391.813

Notes: * and ** denote statistical significance at $\alpha = 0.10$ and 0.05, respectively. Numbers in parentheses are asymptotic standard errors.

This type of question is of a "contingent" nature; that is, "contingent on your firm not receiving MPP funding, what would your export sales have been?"

In the parlance of the literature, the survey elicited a "contingent response." Such questions have been used by economists for over 30 years, generally to analyze markets for new products, transportation alternatives, or to value nonmarket (environmental) commodities. In recent years, a burgeoning literature has linked contingent response data to "traditional" data associated with observable responses. While the majority of such studies have focused on environmental goods or new products, recent studies have extended the analysis to farmer adoption of best management agricultural practices (Cooper, 1997) and adoption of new agricultural technologies (Hubbell, Marra, and Carlson, 2000).[8]

Opponents of a contingent response approach often argue that answers to these types of questions are, at best, uninformative (high variance) or, at worst, biased. Such concerns can be well-founded for a number of different reasons. Those most germane to this application include scenarios where: (*a*) respondents must evaluate an unfamiliar product or situation, i.e., the MPP program; (*b*) responses do not reflect economic constraints, i.e., the cost to producers, in terms of matching funds and completing program paperwork; and (*c*) there is an incentive to provide a strategic response. Each of these issues is addressed below in turn.

First, the questionnaire was sent only to firms who had received MPP funding, and was completed by managers who were responsible for administering

[8] In addition to the papers described in the text, the applications in which the different types of data are combined are growing rapidly. A small selection of recent research would include Haener, Boxall, and Adamowicz (2001) for an application to recreational site choice; Earnhart (2001) for residential amenities; and Brownstone, Bunch, and Train (2000) for the demand for alternative fuel vehicles. For a thorough review of the econometric advantages and complications associated with combining data, see Hensher, Louviere, and Swait (1999).

the MPP funds. Thus, respondents were very familiar with the MPP program and its effects. With respect to the second concern, the focus group work and questions on the survey indicated respondents were keenly aware of the constraints imposed by program participation. For example, 31.2% reported that the matching funds requirement made compliance for reimbursement difficult, while nearly 66% said the paperwork and procedures required for compliance were difficult. Some 55% of respondents agreed or strongly agreed with the following statement: "Overall, complying with the program requirements to receive reimbursement was difficult." These results suggest responses to the contingent response question were made with full knowledge of the constraints imposed by program participation.

Finally, we must deal with the incentive for strategic response, i.e., will respondents systematically bias their answers regarding the effect of MPP funding on firm sales? First, MPP funding was *not* allocated on the basis of self-reports of past export performance of MPP funds. Rather, firms were asked to provide information about promotional budgets (including MPP funding) in the previous two years. Further, the vast bulk of the eight-page application form gathered information about the *proposed* marketing plan under which the *requested* MPP funds would be used. At no point does the application request information regarding the effectiveness of promotion funds a firm may have received in the past.[9]

Second, 42% of responding firms reported export sales would *not* fall (or would have increased) if MPP funds were not available. It is difficult to see how these results suggest a systematic bias in one direction or the other. Even if bias were present, however, it is likely to be relatively small, and could be adjusted by combining different sources of data and imposing parameter restrictions, as described in the next section.

Linking the Additional Information to the Total Sales Model

Firms' contingent response to loss of MPP funding could be used to calculate a second estimate of the impact of MPP funds on revenues. However, the contingent response approach can be linked to the total sales model so that joint estimation of the two models will yield a single, more efficient estimate of the impact of MPP funding on firm sales.

Specifically, whereas the total sales model relates *total* sales to *total* MPP funding, the contingent response model relates *changes* in sales to *changes* in MPP funding. The links between the two models can be exploited to gain efficiency in estimation. The approach is similar in spirit to estimating a cost function and factor demand functions simultaneously, where the first derivative or change of the cost function yields the factor demands via Shephard's lemma. Similarly, joint estimation of two different models is increasingly common in the economics literature, where the theoretical links underlying the two approaches are exploited in the estimation process.

The goal is to connect the total sales model to the contingent response model, where the contingent response, k, measures the proportional change in firm-level export sales due to loss of MPP funds. First, note that total sales without MPP can be written as $TS(No\ MPP) = \mathbf{X}\boldsymbol{\beta} + \sigma\lambda(No\ MPP)$. The total impact of MPP can then be derived from the grouped data model of equation (1) using the relation:

$$(3)\quad \Delta TS\ '\ TS(MPP)\ \&\ TS(No\ MPP),$$

where the censoring adjustment $\lambda(\cdot)$ in the "No MPP" case is evaluated with $\mathbf{Z} = 0$. By definition, total sales is equal to domestic sales plus export sales (i.e., $TS = DS + ES$). Again, by law, MPP funds cannot be used on domestic sales. Thus, if there are no production constraints relating domestic and export sales, then

$$\begin{aligned}(4)\quad \Delta TS & \\ &'\ TS(MPP)\ \&\ TS(No\ MPP) \\ &'\ [ES(MPP)\ \%\ DS]\ \&\ [ES(No\ MPP)\ \%\ DS] \\ &'\ ES(MPP)\ \&\ ES(No\ MPP).\end{aligned}$$

Also, by definition, export sales are equal to the proportion of total sales from exports (e) times total sales, or $ES(MPP) = e \times TS(MPP)$.

Another equation relating firm-level export sales with and without MPP funds can be obtained by noting the respondents' subjective evaluation of the proportional change in export sales due to the MPP, k, is by definition:

$$(5)\quad k\ '\ [ES(No\ MPP)\ \&\ ES(MPP)] \div ES(MPP).$$

Substituting (3) into (5) then yields

$$k\ '\ \&\Delta TS \div [e \times TS(MPP)],$$

[9] A copy of the application is available from the authors upon request.

or in terms of equation (2),

$$(6)\quad k = -\{\mathbf{Z}\boldsymbol{\gamma} + \sigma[\lambda(No\ MPP) - \lambda(MPP)]\} \div \{e \times [\mathbf{X}\boldsymbol{\beta} + \mathbf{Z}\boldsymbol{\gamma} + \lambda(MPP)]\}.$$

By exploiting the internal consistency requirements implied by equations (2) and (6), the most efficient model to estimate is a full-information maximum-likelihood model for equations (2) and (6). However, the likelihood function must adjust for complications due to (*a*) the doubly censored nature of the total firm sales (*TS*) data, and (*b*) firms' sales (*TS*) and the proportional change in sales due to MPP (*k*) may be distributed according to a bivariate distribution, with correlation between *TS* and *k*.

Let the bivariate density of *TS* and *k* be represented by $\phi_2(TS, k)$, where the scale and correlation parameters are temporarily suppressed. The bivariate density can be rewritten in terms of its univariate marginal and conditional densities (Tsokos, 1972):

$$\phi_2(TS, k) = \phi(k) \times \phi(TS|k).$$

Introducing the scale and correlation parameters, σ^2_{TS}, σ^2_k, and ρ, which denote the variances of *TS*, *k*, and the correlation between the two, respectively, then the marginal and conditional densities are given by (7) and (8):

$$(7)\quad \phi(k) = \frac{1}{\sqrt{2\pi\sigma^2_k}} \exp\left[-\frac{1}{2}\left(\frac{k - f(\mathbf{X}\boldsymbol{\beta}, \mathbf{Z}\boldsymbol{\gamma})}{\sigma_k}\right)\right]^2,$$

$$(8)\quad \phi(TS|k) = \frac{1}{\sqrt{2\pi\sigma^2_{TS}(1-\rho^2)}} \times \exp\left[-\frac{1}{2}\left\{\left(\frac{TS - \mathbf{X}\boldsymbol{\beta} - \mathbf{Z}\boldsymbol{\gamma}}{\sigma_{TS}}\right)\frac{1}{\sqrt{(1-\rho^2)}} - \rho\sigma_{TS}\frac{\left([k - f(\mathbf{X}\boldsymbol{\beta}, \mathbf{Z}\boldsymbol{\gamma})]/\sigma_k\right)}{\sqrt{\sigma^2_{TS}(1-\rho^2)}}\right\}^2\right],$$

where $f(\mathbf{X}\boldsymbol{\beta}, \mathbf{Z}\boldsymbol{\gamma})$ is the right-hand side of (6).

The upper (*U*) and lower (*L*) limits for the interval variable *TS* are known. Integrating the conditional density function (8) from $-\infty$ to *U* gives the conditional probability of being below the upper limit, $\Phi(TS < U|k)$, and integrating from $-\infty$ to *L* gives the conditional probability of being below the lower limit, $\Phi(TS < L|k)$. The difference between the two gives the probability of being between the two limits, conditional on the value of *k*:

$$\Phi(L < TS < U|k) = \Phi(TS < U|k) - \Phi(TS < L|k).$$

The likelihood function for the model then becomes

$$L = \Pi_i\, \phi_i(k) \times \Phi_i(L < TS < U|k),$$

where *i* denotes the firm. Note the likelihood function estimates $\boldsymbol{\beta}$, $\boldsymbol{\gamma}$, the scale parameters, and the correlation coefficient such that the total impact of MPP (as implied by *k*) and the marginal impact of MPP (as implied by the derivative of *TS* with respect to **Z**) are consistent with each other.[10]

Empirical Results from the Linked Model

The "linked" bivariate approach was applied to the same specifications used for the grouped data models (table 3).[11] Relative to the grouped data results reported in table 2, very few of the coefficients in the linked model changed in either order of magnitude or sign. Indeed, only two of the 34 estimates of **X** and **Z** coefficients changed by an order of magnitude; only one of these (*Small Firm* in Model 1) was statistically significant in the initial grouped data model. Seven of the 34 **X** and **Z** coefficients changed sign, but none of these parameters were statistically significant under either estimation method. In short, the parameter estimates were remarkably stable across the two modeling approaches. The parameter stability also suggests that any potential bias associated with the contingent response is minimal.

Second, the additional information used in the combined model did achieve the primary goal: more efficient parameter estimates. Relative to the grouped data model, the standard errors were smaller for all coefficients in all specifications of the linked model. Because we are interested in the impact of MPP funding on sales, we pay particular attention to the **Z** coefficient estimates. Of the 16 potential parameters, nine were significant in the bivariate model, whereas only six were significant in the grouped data model. Thus, the linked model which takes advantage of the additional information on the impact of MPP allows more precise estimation of the key parameters.

[10] This likelihood function is very similar to that presented in Maddala (1983, pp. 266–267). The only difference is that Maddala's first term adjusts for truncation, a problem not found in our data. It is also similar to the generalized Tobit models discussed in Amemiya (1985).

[11] Due to scaling problems in the maximum-likelihood estimation, the empirical version of the bivariate model used $k \times e \times TS$ as the dependent variable rather than *k*. This transformation can be achieved by multiplying both sides of equation (6) by the denominator on the right-hand side.

Table 3. Bivariate Models

Variable	Model 1	Model 2	Model 3	Model 4
Intercept	!1,460.740	5,208.660**	!1,817.573**	!1,484.500
	(1,813.851)	(627.764)	(659.177)	(1,509.505)
X Variables:				
Years in Business	367.145	543.595**	261.041**	367.671
	(414.146)	(80.919)	(65.665)	(412.968)
Square Root of *Years in Business*	!419.473			!423.237
	(1,620.832)			(1,612.721)
Small Firm	!23.353	!5,559.341**		
	(767.860)	(606.453)		
Employees	!308.610**		!304.538**	!309.150**
	(60.243)		(45.647)	(46.074)
Square Root of *Employees*	3,621.135**		3,590.947**	3,629.656**
	(591.728)		(401.175)	(406.788)
New to Export	!56.396	!166.548	!10.409	!56.221
	(479.262)	(432.570)	(411.726)	(478.675)
Z Variables:				
MPP Funds	!115.495*	!185.531**	!115.264*	!115.285*
	(67.580)	(88.568)	(66.047)	(66.075)
Square Root of *MPP Funds*	324.953	551.792**	323.703	324.497
	(208.339)	(274.667)	(206.789)	(207.378)
MPP Funds × *Small Firm*	89.678*	107.745*	89.394*	89.616*
	(51.391)	(56.228)	(47.784)	(47.638)
MPP Funds × *New to Export*	!10.288	12.259	!10.306	!10.381
	(38.141)	(45.109)	(38.167)	(38.104)
Rho	!0.250	!0.167	!0.254*	!0.250
	(0.172)	(0.191)	(0.151)	(0.168)
Sigma(*Total Sales*)	2,296.217**	2,650.071**	2,298.933**	2,296.191**
	(155.044)	(170.277)	(141.695)	(149.024)
Sigma(*k* × *e* × *Total Sales*)	201.639**	200.923**	201.391**	201.649**
	(5.696)	(7.610)	(5.552)	(5.548)
Log Likelihood	!1,267.326	!1,289.449	!1,267.363	!1,267.326

Notes: * and ** denote statistical significance at $\alpha = 0.10$ and 0.05, respectively. Numbers in parentheses are asymptotic standard errors.

The additional information used by the bivariate model provided a more "stable" story regarding the relationship between *MPP Funds* and firm sales. In general, the key variables that were statistically significant in one specification were significant in all specifications. The linear term for *MPP Funds* was negative and significant in all models, whereas the interaction term between *MPP Funds* and *Small Firm* was positive and significant in all models. The interaction between *MPP Funds* and *New to Export* was never significant.

In the **X** vector, both the linear and quadratic terms for the number of employees were statistically significant in all the models in which these terms appeared. *Years in Business* was significant in the second two models, but not in the first and last, perhaps because these models also included a quadratic term for *Years in Business*.

The linked modeling strategy also provided parameter estimates for the standard deviation of the grouped data [*Sigma*(*Total Sales*)] and the standard deviation of the model of respondents' subjective evaluations [*Sigma*(*k* × *e* × *Total Sales*)]. In all models, these parameter estimates were positive (as required by statistical theory) and significant. The correlation parameter, *Rho*, measures the error correlation between the two models. A statistically significant parameter would imply that the omitted effects of one model (say, the grouped data model) were correlated with the omitted effects of the other (the contingent response model). The estimate for *Rho* did fall in the [!1, 1] interval as required by statistical theory, but was significant in only one model (Model 3).

Marginal and Average Revenue Analysis

As previously noted, one cannot simply look at the sign of a parameter to predict what would happen to firm sales as that variable changes (i.e., we did not state that firm sales were negatively related to *MPP Funds*, only that the sign was negative). Instead, the impact of MPP on firm sales must be calculated for each firm.

We do this in two ways. First, the marginal effect of the MPP funding was calculated by evaluating the derivative of the total sales function at the exact value of each firm's characteristics. Thus, this directly measures the marginal revenue (MR) generated by the last dollar of MPP funding. Recalling equation (1), however, this is a "reduced" form of the marginal effect, capturing the effects of the MPP allocation as well as possible changes in matching funds and nonsubsidized promotion expenditures. Second, an average revenue (AR) measure can be constructed by comparing the change in total sales, with and without MPP, to the MPP funds.[12]

For any given firm, AR per dollar of MPP funding was specified as:

$$[TS(MPP)\ \&\ TS(No\ MPP)]/MPP\ Funds,$$

where total sales were estimated at the value of the explanatory variables for each firm. The first term in the numerator used the actual MPP funding received by the firm, whereas the second term assumed this funding was zero (i.e., no MPP funds). All other variables were held constant. The estimated mean MR and AR measures are reported in table 4. Because of the statistical superiority of the linked model, all MR and AR results were calculated using results from the bivariate model.

Confidence intervals (CIs) were estimated for both measures using the bootstrap technique developed by Krinsky and Robb (1986). The Krinsky-Robb method was used because the measures of interest—namely, marginal revenue and average revenue of MPP funding—were nonlinear functions of random variables (i.e., the maximum-likelihood estimates). This technique uses information about the parameter estimates contained in the variance-covariance matrix to develop an empirical distribution for the marginal and total effects of MPP.

The Krinsky-Robb approach uses a random draw from the multivariate normal distribution implied by the variance-covariance matrix to generate parameter estimates which are "reasonably likely" alternatives to the original estimates, given the standard errors and covariance terms of the estimated variance-covariance matrix. MR and AR are calculated for each firm at the new parameter vector implied by a given random draw, and the mean for the sample calculated. If this is done a sufficiently large number of times (5,000 in this case), an empirical distribution for the measure of interest can be generated (i.e., 5,000 estimates of the mean marginal effect). After ordering the empirical distribution from smallest to largest, the 95% confidence interval can be established by finding the cutoff points for the top and bottom 2.5%.

The largest MR effects of MPP funding were produced by estimates from the most restrictive model (Model 2), with the marginal dollar of MPP funding being worth, on average, about $7.14 in additional export sales. The marginal dollar of MPP funding had an impact of $7.40 in additional export sales for small firms (with 95% CI between $0.31 and $14.75), whereas MPP had an estimated MR for large firms of $5.73 (95% CI between $2.28 and $9.44). The MR estimates for the other model specifications were slightly smaller than those calculated for Model 2.

For all specifications, the mean and confidence interval estimates for AR followed the same general pattern as for the MR measure. The largest AR estimate for the full sample, $23.81, also came from Model 2. This finding indicates, on average, every dollar of MPP funding generated $23.81 in export sales. The corresponding 95% CI was between $2.01 and $46.22. The mean AR varied by firm size, where firms with more than 500 employees had an estimated mean AR of $16.81, while smaller firms had a mean AR of $25.08.

Other specifications yielded smaller estimates of AR, but followed the same pattern as the first specification. An important aspect of Models 1, 3, and 4 concerns the confidence intervals. In general, the 95% CI for small firms was much wider than that for large firms, indicating there was much more variation in the MPP revenue impacts for small firms than for large firms. In fact, the CI for small firms included a negative lower bound for all specifications except the second. This finding means the estimated AR for small firms was statistically equal to zero for all specifications except the second.

In contrast, the 95% CI for large firms was not only strictly greater than zero, it was strictly greater than one. This finding shows that large firms generated more than $1 in export sales for every dollar

[12] Recall, by equation (4), the change in total sales due to MPP funding is equivalent to the change in export sales.

Table 4. Impact of MPP Funding on Total Sales ($)

Model	Mean $MTS/MMPP$	Marginal Revenue (95% CI)[a]	Mean $\Delta TS/\Delta MPP$	Average Revenue (95% CI)[a]
Model 1:				
Overall (n = 150)	6.35	(0.13 – 12.65)	18.68	(! 1.68 – 38.69)
Firms with $ 500 employees (n = 23)	5.54	(2.12 – 9.03)	13.84	(2.32 – 25.61)
Firms with < 500 employees (n = 127)	6.50	(! 0.46 – 13.43)	19.55	(! 2.42 – 41.02)
Model 2:				
Overall (n = 150)	7.14	(0.76 – 13.80)	23.81	(2.01 – 46.22)
Firms with $ 500 employees (n = 23)	5.73	(2.28 – 9.44)	16.81	(3.77 – 30.46)
Firms with < 500 employees (n = 127)	7.40	(0.31 – 14.75)	25.08	(1.61 – 49.08)
Model 3:				
Overall (n = 150)	6.21	(0.43 – 11.98)	18.28	(! 1.29 – 7.29)
Firms with $ 500 employees (n = 23)	5.42	(2.14 – 8.75)	13.51	(2.55 – 24.66)
Firms with < 500 employees (n = 127)	6.35	(! 0.10 – 12.75)	19.15	(! 2.09 – 39.83)
Model 4:				
Overall (n = 150)	6.25	(0.25 – 12.14)	18.31	(! 1.40 – 37.13)
Firms with $ 500 employees (n = 23)	5.47	(2.02 – 8.98)	13.59	(2.50 – 24.81)
Firms with < 500 employees (n = 127)	6.39	(! 0.37 – 13.04)	19.17	(! 2.01 – 39.39)

[a] The 95% confidence interval was calculated using the Krinsky-Robb bootstrap technique with 5,000 random draws.

of MPP funding. The size of the confidence intervals is not due to the differing sample sizes for each group (i.e., 23 large firms and 127 small firms), but rather to relatively greater variation in the characteristics of small firms.[13] A referee also noted the relative inexperience of small firms in exporting may have resulted in greater variability in the impact of MPP funds on export sales.

Conclusions

This study has attempted to answer the question of whether firm size and export experience matter in the effectiveness of converting MPP funds into revenues. The results do not support the contention of the U.S. General Accounting Office (GAO) that larger, more export-experienced firms were less effective than small firms in using export promotion funds to increase firms' export sales. Regardless of model specification, MPP funds provided a positive marginal impact on large firms' export revenues.

Further, the confidence intervals for both marginal revenue and average revenue generated by MPP funding allow us to conclude with great confidence that large firms have a greater than one-to-one revenue payoff for each dollar of MPP funding. The same cannot be said of small firms. While it was true the point estimate of the MPP revenue payoff for small firms (both MR and AR) was larger than the corresponding point estimate for large firms, the confidence interval surrounding these point estimates included the value of zero for three of the four specifications. Consequently, it cannot be stated with great confidence that, on average, MPP funding aided small firms in increasing export sales. Thus, the recent programmatic change requiring distribution of all MPP funds to small firms and cooperatives (based on the efficiency argument of the GAO) was not supported by our data.

Furthermore, the fact that the average overall and small firm effects (except for one model) were insignificant suggests moving program preferences toward small firms will make the revenue effects even more insignificant, on average. Of course, the reported measures are each the mean of a distribution, and each distribution has firms in either the left tail or the right tail of the distribution. This phenomenon may help explain, in part, why there is so much disagreement about whether export promotion is effective in increasing sales, and for whom.

The relatively large variation in AR for small firms compared with large firms suggests that other screening criteria for the Market Access Program, such as viability of an export marketing plan, may be more critical for small firms than for large firms to ensure effective use of the funds. The results also

[13] Indeed, the 95% confidence intervals were each based on 5,000 random draws, with each draw representing an empirical estimate of the mean effect.

point to the importance of calculating confidence intervals for any measure of program effectiveness, which is usually not done in the promotion evaluation literature. It should be noted that just reporting the mean MR and AR effects would have given a misleading impression of significance when, statistically, most MR and AR estimates for small firms were not significantly different from zero.

Another GAO hypothesis was that new-to-export firms (those firms with exporting experience of five years or less) would use MPP funds more effectively than export-experienced firms to increase export sales. Based on our analysis, the measure for export experience was never significant in any model, indicating inexperienced firms are no more or less effective than experienced firms in converting MPP funds into increased export revenues.

We note a few final caveats of the study. First, this study is a cross-sectional snapshot in time, but promotion effects can have distributed lag effects. Hence, the effects as measured in this study would be expected to underestimate the longer-term effects. It may be conjectured that these distributed lag effects would tend to shift the distribution of the marginal effects and benefit/cost measures toward more positive values. However, verification of this conjecture would require time-series firm-level data of the type used here. To date, these types of data are not publicly available or collected, making quantification of firm-level distributed lag effects infeasible at this point in time.

Second, we have not investigated the potential for differing revenue effects across different countries (as discussed in footnote 7). If, for example, our sample represented firms which exported disproportionately to countries with relatively low revenue effects (or relatively high revenue effects), the econometric model would have reflected these effects.

Third, our estimate of "marginal" revenue effects is a reduced form of the revenue effect that includes possible firm responses such as changing nonsubsidized export expenditures. Fully investigating these effects would yield a more accurate measure of the net impact of MPP funding.

Finally, although Congress and other federal agencies are interested in the sales enhancement effects of MPP funding, a more theoretically sound test of the social desirability of the MPP program would assess the benefits and costs of the program as measured by changes in consumer and producer surplus, applying a potential Pareto criterion in the analysis.

References

Amemiya, T. (1985). *Advanced Econometrics*. Cambridge, MA: Harvard University Press.

Brownstone, D., D. S. Bunch, and K. E. Train. (2000). "Joint Mixed Logit Models of Stated and Revealed Preferences for Alternative Fuel Vehicles." *Transportation Research: Part B: Methodological* 34, 315–338.

Cooper, J. C. (1997, July). "Combining Actual and Contingent Behavior Data to Model Farmer Adoption of Water Quality Protection Practices." *Journal of Agricultural and Resource Economics* 22, 30–43.

Dillman, D. A. (1978). *Mail and Telephone Surveys—The Total Design Method.* New York: John Wiley and Sons, Inc.

Earnhart, D. (2001). "Combining Revealed and Stated Preference Methods to Value Environmental Amenities at Residential Locations." *Land Economics* 77, 12–29.

Greene, W. H. (2000). *Econometric Analysis*, 4th edition. New York: Macmillan Publishing Co.

Grunfield, Y., and Z. Griliches. (1960, February). "Is Aggregation Necessarily Bad?" *Review of Economics and Statistics* XLII(1), 1–13.

Haener, M. K., P. C. Boxall, and W. L. Adamowicz. (2001). "Modeling Recreation Site Choice: Do Hypothetical Choices Reflect Actual Behavior?" *American Journal of Agricultural Economics* 83, 629–642.

Halliburton, K., and S. R. Henneberry. (1995, July). "The Effectiveness of U.S. Nonprice Promotion of Almonds in the Pacific Rim." *Journal of Agricultural and Resource Economics* 20, 108–121.

Hensher, D., J. Louviere, and J. Swait. (1999). "Combining Sources of Preference Data." *Journal of Econometrics* 89, 197–221.

Hubbell, B. J., M. C. Marra, and G. A. Carlson. (2000). "Estimating the Demand for a New Technology: Bt Cotton and Insecticide Policies." *American Journal of Agricultural Economics* 82, 118–132.

Kinnucan, H., and J. Christian. (1997, July). "A Method for Measuring Nonprice Export Promotion with Application to Almonds." *Journal of Agricultural and Resource Economics* 22, 120–132.

Krinsky, I., and A. L. Robb. (1986). "On Approximating the Statistical Properties of Elasticities." *Review of Economics and Statistics* 68, 715–719.

Maddala, G. S. (1983). *Limited Dependent and Qualitative Variables in Econometrics.* New York: Cambridge University Press.

Richards, T., and P. Patterson. (1997, December). "Dynamic Complementarity in Export Promotion: The Market Access Program in Fruits and Vegetables." *Journal of Agricultural and Resource Economics* 23, 319–337.

Richards, T., P. Van Ispelen, and A. Kagan. (1997). "A Two-Stage Analysis of the Effectiveness of Market Promotion Programs for U.S. Apples." *American Journal of Agricultural Economics* 79, 825–837.

Smith, V. (1993, May). "Welfare Effects, Omitted Variables, and the Extent of the Market." *Land Economics* 69(2), 121–131.

Stewart, M. B. (1983). "On Least Squares Estimation when the Dependent Variable Is Grouped." *Review of Economic Studies* 50, 737–753.

Thurman, W., and M. Wohlgenant. (1989, November). "Consistent Estimation of General Equilibrium Welfare Effects." *American Journal of Agricultural Economics* 71, 1041–1045.

Tsokos, C. (1972). *Probability Distributions: An Introduction to Probability Theory with Applications.* Belmont, CA: Duxbury Press.

U.S. Department of Agriculture, Foreign Agricultural Service. (1998). "Market Access Program." USDA/FAS, Washington, DC. Online. Available at http://www.fas.gov.usda/mos/mapprog.html. [Retrieved February 8, 1999.]

U.S. General Accounting Office. (1993a, June). "International Trade: Effectiveness of Market Promotion Program Remains Unclear." Report No. GAO/NSLAD-93-103, Washington, DC.

———. (1993b, July). "International Trade: Changes Needed to Improve the Effectiveness of the Market Promotion Program." Report No. GAO/GGD-93-12, report to Congressional requesters, Washington, DC.

———. (1995, May). "Export Promotion: Rationale For and Against Government Programs and Expenditures." Pub. No. GAO/T-GGD-95-169, Testimony to Congress, Washington, DC.

———. (1997, September). "U.S. Agricultural Exports: Strong Growth Likely, but U.S. Export Assistance Programs' Contribution Uncertain." Pub. No. GAO/NSIAD-97-260, Testimony to Congress, Washington, DC.

———. (1998). "Export Promotion: Issues for Assessing the Government-wide Strategy." Pub. No. GAO/T-NSIAD-98-105, Testimony to Congress, Washington, DC.

———. (1999, April). "Agricultural Trade: Changes Made to Market Access Program, but Questions Remain on Economic Impact." Letter Report No. GAO/NSIAD-99-38, Washington, DC.

Weiss, K., R. Green, and A. Havenner. (1996). "Walnuts in Japan: A Case Study of Generic Promotion Under the USDA's Market Promotion Program." In J. Ferraro, K. Ackerman, and J. Nichols (eds.), *Agricultural Promotion Policies and Programs in the Global Agri-Food System* (pp. 47–80). Ithaca, NY: National Institute for Commodity Research and Evaluation, Cornell University.

Appendix: Marginal Effects for Continuous Variables in Total Sales Equation

Following Maddala (1983, pp. 366–368), let

$$\alpha_L = L - \mathbf{X\beta} - \mathbf{Z\gamma},$$

$$\alpha_U = U - \mathbf{X\beta} - \mathbf{Z\gamma}.$$

Then define from text footnote 5:

$$\lambda = \frac{\phi\left(\frac{\alpha_L}{\sigma}\right) - \phi\left(\frac{\alpha_U}{\sigma}\right)}{\Phi\left(\frac{\alpha_U}{\sigma}\right) - \Phi\left(\frac{\alpha_L}{\sigma}\right)} = \frac{\phi_L - \phi_U}{\Phi_U - \Phi_L} = \frac{Numerator\ (N)}{Denominator\ (D)}.$$

Question: What is $\frac{\partial\lambda}{\partial\mathbf{X}}$? $\frac{\partial\lambda}{\partial\mathbf{Z}}$?

Answer: Working backwards using rules of calculus:

$$\text{(A1)}\quad \frac{\partial\lambda}{\partial\mathbf{X}} = \frac{\frac{\partial N}{\partial\mathbf{X}}D - \frac{\partial D}{\partial\mathbf{X}}N}{D^2}.$$

Working on numerator (N) first:

$$\text{(A2)}\quad \frac{\partial N}{\partial\mathbf{X}} = \frac{\partial\phi_L}{\partial\mathbf{X}} - \frac{\partial\phi_U}{\partial\mathbf{X}},$$

$$\text{(A3)}\quad \frac{\partial\phi_i}{\partial\mathbf{X}} = \frac{\partial\phi_i}{\partial\alpha_i}\frac{\partial\alpha_i}{\partial\mathbf{X}}, \qquad i = L, U,$$

$$\text{(A4)}\quad \frac{\partial\phi_i}{\partial\alpha_i} = -\frac{\alpha_i}{\sigma^2}\phi_i, \qquad i = L, U \text{ (Maddala, p. 368)},$$

$$\text{(A5)}\quad \frac{\partial\alpha_i}{\partial\mathbf{X}} = -\boldsymbol{\beta}, \qquad i = L, U \text{ (note, this is a vector, not a scalar)}.$$

Next, working on denominator (D):

$$\text{(A6)}\quad \frac{\partial D}{\partial\mathbf{X}} = \frac{\partial\Phi_U}{\partial\mathbf{X}} - \frac{\partial\Phi_L}{\partial\mathbf{X}},$$

$$\text{(A7)}\quad \frac{\partial\Phi_i}{\partial\mathbf{X}} = \frac{\partial\Phi_i}{\partial\alpha_i}\frac{\partial\alpha_i}{\partial\mathbf{X}}, \qquad i = L, U,$$

$$\text{(A8)}\quad \frac{\partial\Phi_i}{\partial\alpha_i} = \frac{1}{\sigma}\phi_i, \qquad i = L, U \text{ (Maddala, p. 367)},$$

$$\text{(A9)}\quad \frac{\partial\alpha_i}{\partial\mathbf{X}} = -\boldsymbol{\beta}.$$

Substituting (A9) and (A8) into (A7) and into (A6) yields:

$$\text{(A6.1)}\quad \frac{\partial D}{\partial\mathbf{X}} = -\frac{\boldsymbol{\beta}}{\sigma}(\phi_U - \phi_L) = \frac{\boldsymbol{\beta}}{\sigma}(\phi_L - \phi_U).$$

Substituting (A5) and (A4) into (A3) and into (A2) yields:

$$\text{(A2.1)}\quad \frac{\partial N}{\partial\mathbf{X}} = \frac{\boldsymbol{\beta}}{\sigma^2}(\alpha_L\phi_L - \alpha_U\phi_U).$$

Substituting (A6.1) and (A2.1) into (A1) yields:

$$\text{(A1.1)}\quad \frac{\partial\lambda}{\partial\mathbf{X}} = \frac{\frac{\boldsymbol{\beta}}{\sigma^2}(\alpha_L\phi_L - \alpha_U\phi_U)\times[\Phi_U - \Phi_L] - \frac{\boldsymbol{\beta}}{\sigma}(\phi_L - \phi_U)^2}{(\Phi_U - \Phi_L)^2}$$

$$= \frac{\boldsymbol{\beta}}{\sigma^2}\frac{(\alpha_L\phi_L - \alpha_U\phi_U)}{\Phi_U - \Phi_L} - \frac{\boldsymbol{\beta}}{\sigma}\left(\frac{\phi_L - \phi_U}{\Phi_U - \Phi_L}\right)^2$$

$$= \frac{\boldsymbol{\beta}}{\sigma}\left[\frac{(\alpha_L\phi_L - \alpha_U\phi_U)}{\sigma(\Phi_U - \Phi_L)} - \lambda^2\right].$$

Now the model is written from the text as follows:

$$TS = DS + \mathbf{X}\boldsymbol{\beta} + \mathbf{Z}\boldsymbol{\gamma} + \sigma\lambda(\mathbf{X}, \mathbf{Z}).$$

Thus, the marginal effect of **X** on *TS* is as shown in the text:

$$\text{(A10)} \quad \frac{\partial TS}{\partial \mathbf{X}} = \boldsymbol{\beta} + \sigma \frac{\partial \lambda}{\partial \mathbf{X}} = \boldsymbol{\beta} + \boldsymbol{\beta}\left[\frac{(\alpha_L \phi_L - \alpha_U \phi_U)}{\sigma(\Phi_U - \Phi_L)} - \lambda^2\right].$$

The derivation with respect to **Z** variables would proceed in a similar fashion.