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# IMPACTS OF WHEAT EXPORT STRATEGIES ON MARKET SHARES

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## *Highlights*

*This paper analyzes impacts of strategies used by wheat exporting countries on the cross-sectional variability in market shares. A logically consistent market share model is used to explain impacts of credit guarantees, long-term agreements, PL480, and export bonuses. Results provide measures of the effects of strategies on major wheat exporting countries' market shares. Specific conclusions are:*

- *Export credit guarantees were important determinants of market shares in the early 1980s, particularly for the United States and Canada.*

- *The marginal effect of strategies varies with the size of the exporting countries' market share and with the distribution of competitor countries' market shares. In markets in which the United States has a small market share or that it dominates, the marginal effects of EEP or credit are negligible.*

- *Elasticities for PL480 and LTAs frequently did not differ significantly from zero. In the period before 1985, a number of the own-credit elasticities were significant, particularly those for the United States and Canada. However, values of these, and for the cross-credit elasticities varied greatly, indicating that otherwise similar programs had varying degrees of effectiveness.*

- *Elasticities varied greatly through time. Most important was that in the period following introduction of EEP, credit elasticities were reduced in absolute value. Structurally, EEP had the impact of increasing U.S. market shares and mitigating effects of other strategies including that of the U.S. credit programs. EEP also had a negative impact on competitor countries' market shares, primarily on Canada and Argentina. However, the effect of EEP on EC market shares was never significant.*

*A number of important policy implications can be discerned from these results. First, simply introducing and using a strategy does not necessarily increase market shares. Strategies replicated by competitors, either or with identical or other strategies, essentially reduce the impacts of a strategy on the distribution of market shares. Second, the marginal effect of strategies in terms of market share all have a saturation effect--i.e., a point is reached at which the marginal effect is maximum, beyond which it diminishes to zero. This has important strategic implications for export policy administration, particularly when budget constraints force allocation decisions across importing countries. Third, these results clearly indicate that the marginal effects of credit (the only program which each of the exporting countries has used) varies across exporting countries. This suggests that the programs must have important features, which vary and/or are administered more strategically in some countries than others.*

# IMPACTS OF WHEAT EXPORT STRATEGIES ON MARKET SHARES*

William W. Wilson and Seung-Ryong Yang**

Competition among exporting countries in the international wheat market has intensified since the late 1970s; and, in response, the composition of export strategies has changed. All major wheat exporting countries have increased their use of export strategies, many of which are differentiated across importing countries. During the mid to late 1970s, the primary export strategies were PL480 for the United States and long-term agreements (LTAs) and credit guarantees for some competitor countries. During the early 1980s, the United States, Australia, and European countries expanded their use of credit guarantees with only infrequent credit sales by Argentina. In the late 1980s, price subsidies escalated; and other strategies diminished in relative importance, though they have been maintained.[1]

Fundamental objectives of most export strategies are to increase total imports and/or to alter the distribution of market shares among exporting countries. However, their impact on the distribution of market shares depends on the composition and effectiveness of competitor countries' programs. As program administrators and policymakers review export strategies, their comparative effectiveness on sales must be evaluated across programs.[2]

The purpose of this paper is to determine impacts of export strategies for wheat on the cross-sectional variation in market shares. A *logically consistent* market share model is specified and estimated, and results are compared through time, across export strategies, and across exporting countries. Comparisons of elasticities of different export strategies through time and across instruments to those of competitor countries yield conclusions about relative impacts on market shares. Critical to administration of any export strategy is its impact on market shares; estimated elasticities are a prerequisite to optimally adjusting the level and use of an export strategy. The results provide an understanding of the spatial distribution of shares, especially that component attributable to use of specific strategies that would be of interest to traders and policy administrators.

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[1]See Grisby and Dixit; Harris; International Wheat Council (1990); U.S. Department of Agriculture(1990); and Smith for discussions on use and operations of these programs.

[2]With the escalated use of credit programs, their operations and effectiveness have come under scrutiny. Harris compares the U.S. credit programs to that of competitor countries, and Sorenson et al. (p. 73) suggests that the E.C. "may begin diversifying use of export policy instruments including export credits...."

Impacts of alternative policies can be examined and assessed only if concurrent impacts of other export strategies are included. Past studies evaluating impacts of policies on trade flow include Anania, Bohman, and Carter and Koo, Golz, and Yang using spatial equilibrium models. Koo and Karemera used pooled data with a supply/demand equilibrium specification to determine factors impacting trade flows. Fleming used pooled data to evaluate impacts of export strategies on the cross-sectional distribution of rice flows. This study goes beyond past approaches by analyzing multicompetitive interactions of export strategies used by principal exporting countries on market shares.

This paper is organized as follows. In the second section, we analytically demonstrate impacts of selected export strategies on market shares in a two-country model. This simple, theoretical framework provides insight about why each exporting country provides (or adapts) a specific trade strategy and how these trade policies affect the distribution of market shares. The third section develops a logically consistent market share model used in this study for empirical analysis. Estimation procedures and data sources are presented in the fourth and fifth sections. The sixth section contains the empirical results, followed by the conclusions.

## Export Strategies and Market Shares

In this section, we demonstrate analytically the impact of each export strategy on the buyer's import allocation decisions and the distribution of market shares, assuming *ceteris paribus*. For analytical simplicity and clarity, we consider an import market with two exporting countries; and the good is weakly separable from all other goods in the commodity bundle. A base model is developed first, and expected market shares are derived. These results are compared to expected market shares stemming from introduction of individual export strategies. Each export strategy impacts the distribution of market shares. However, competitors' matching strategies of similarly administered programs mitigates impacts of other strategies.

**Base Model** Let $X=\{x_1,x_2,..,x_n\}'$ be a vector of goods and $P=\{p_1,p_2,..,p_n\}'$ be the corresponding world price vector an importing country faces. The country imports $x_1$ from two sources A and B and the two goods, $x_1^A$ and $x_1^B$ (or products in Armington's terminology), are assumed perfect substitutes. With a constrained budget Y, the buyer's problem is to

$$[1] \quad \text{maximize } U = U(X) \quad \text{subject to } Y = P'X.$$

Since $x_1$ is weakly separable from all other goods, the utility function can be rewritten as

$$[2] \quad U = U(x_1(x_1^A,x_1^B),x_2,..,x_n),$$

where $x_1=x_1^A+x_1^B$ because the goods are perfect substitutes by assumption.

A separable utility function enables two-stage budgeting. From the first order condition of [1] with [2], the importer first determines the optimal level of each good, $x_i^*=x_i(P,Y)$, i=1,..,n. At the second stage, the levels of $x_1^A$ and $x_1^B$ are determined by minimizing total expenditures on imports:

$$[3] \quad \text{minimize } M = p_1x_1^A + p_1x_1^B \quad \text{subject to } x_1(p_1,p_2,..,p_n,Y) = x_1^A + x_1^B.$$

Because the subutility $x_1$ is linear and homogenous, $p_1$ is independent of $x_1$ and, together with Euler's theorem, $M=p_1x_1$ (Armington). This implies that the cost minimizing curve is identical to the indifference curve with infinite combinations of solutions for $x_1^A$ and $x_1^B$.

This result is obvious from the assumption that the two products are homogeneous and have equal prices. Since these products are undifferentiated, the expected import from each source would be the same; $E(x_1^A) = E(x_1^B) = x_1(p_1,p_2,..,p_n,Y)/2$ and the expected market share of each exporting country, $E(S^A)= E(S^B)= 0.5$.[3]

**Export Subsidies** The importer's decision problem changes if country A offers a direct price subsidy, $b^A>0$. Specifically, the buyer's budget allocation in [3] becomes

$$[4] \quad \text{minimize } M = (p_1-b^A)x_1^A + p_1x_1^B \quad \text{subject to } x_1(p_1-b^A,p_2,..,p_n,Y) = x_1^A + x_1^B,$$

where the optimal level of $x_1$ changes at the first stage because of the introduction of $b^A$. Showing that the optimal solution for $(x_1^A\ x_1^B)$ would be $(x_1^*\ 0)$ is straight forward. The $E(S^A)$ increases to 1.0, capturing the whole market. Further, since the total market size for $x_1$ is larger than without the subsidy, i.e., $x_1(p_1-b^A,p_2,..,p_n,Y) > x_1(p_1,p_2,..,p_n,Y)$, the expected increase in A's exports would be $x_1(p_1-b^A,p_2,..,p_n,Y) - x_1(p_1,p_2,..,p_n,Y)/2$.

If country B also provides a direct price subsidy, $b^B = b^A$, the $E(S^A)= E(S^B)= 0.5$ as in the base model since the minimum cost line would coincide with the indifference curve. However, the export quantity for each country increases because of market expansion. If $b^A<b^B$, then the optimal solution is reversed; and $x_1^A=0$ and $x_1^B=x_1^*$. Thus, exporting countries' use of direct subsidies has the effect of attracting buyer's imports or to negate impacts of a rival country's subsidy.

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[3]If the two products are not perfect substitutes, a linearly homogeneous but nonlinear subutility function (e.g., Cobb-Douglas function) could be assumed and a unique solution could be derived. In the case where $x_1=(x_1^A)^{\alpha}(x_1^B)^{1-\alpha}$, the market share for A would be $\alpha$ while that for B would be $1-\alpha$. However, this requires *a priori* knowledge about the functional form. Further, analytical solutions under the perfect substitutability assumption are analogous to those under any homogeneous subutility.

**Long-Term Agreements (LTA)** Long-term agreements are mechanisms to guarantee minimum trade flows.[4] In the case of wheat, importing countries use LTAs to varying degrees, but are a primary export strategy of Canada. Suppose the importing country agrees to import $lx_1^A$ from country A under an LTA. The importer's problem becomes

$$[5] \quad \text{minimize } M = p_1x_1^A + p_1x_1^B \quad \text{subject to } x_1(p_1,p_2,..,p_n,Y) = x_1^A + x_1^B \text{ and } x_1^A \geq lx_1^A.$$

The feasible solution for $x_1^A$ and $x_1^B$ would be $lx_1^A \leq x_1^A \leq x_1$ and $0 \leq x_1^B \leq x_1 - lx_1^A$, $E(x_1^A)=lx_1^A+(x_1-lx_1^A)/2$, and $E(x_1^B)=(x_1-lx_1^A)/2$. The LTA between the importing country and A increases the expected market share for A by $lx_1^A/2x_1$ and decreases that for B by the same proportion. The market size is unchanged under LTAs.

**Export Credit Programs** Export credit programs (including guarantees and direct credits) for $x_1$ expand the importing country's budget constraint.[5] This allows the importer to spend the released foreign exchange to increase imports. Let $c^A$ be the credit A provides to purchase $x_1^A$. Without considering the dynamic nature of repayment, the buyer's problem at the first stage is

$$[6] \quad \text{maximize } U=U(x_1(x_1^A,x_1^B),x_2,..,x_n) \quad \text{subject to } Y=p_1x_{1s}+p_2x_2+...+p_nx_n \text{ and } c^A=p_1x_{1c},$$

where $x_{1c}$ is $x_1$ purchased under credit and $x_{1s}$ is $x_1$ purchased with cash. As long as $x_1(p_1,p_2,..,p_n,Y)>0$ (i.e., no corner solution), $x_1(p_1,p_2,..,p_n,Y+c^A)>x_1(p_1,p_2,..,p_n,Y)$, the two exporters face an expanded market. The buyer's allocation problem becomes

$$[7] \quad \text{minimize } M=p_1x_1^A + p_1x_1^B \quad \text{subject to } x_1(p_1,p_2,..,p_n,Y+c^A)=x_1^A+x_1^B \text{ and } x_1^A=x_{1s}^A+x_{1c}^A,$$

where $x_{1s}^A$ is the cash purchase of $x_1$ from A and the credit purchase of $x_1$, $x_{1c}^A=c^A/p_1$. The feasible solution for $x_1^A$ and $x_1^B$ would be $x_{1c}^A \leq x_1^A \leq x_1$ and $0 \leq x_1^B \leq x_1 - x_{1c}^A$. Expected exports from the two countries are $E(x_1^A)=x_{1c}^A+(x_1-x_{1c}^A)/2$ and $E(x_1^B)=(x_1-x_{1c}^A)/2$. Export credits given by A expands the market size for $x_1$, increases $E(S^A)$ by $x_{1c}^A/2x_1$, and decreases $E(S^B)$ by the same proportion.

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[4]Of particular importance in the case of wheat are bilateral agreements, which "are merely supply arrangements whereby the exporting country assures itself of a firm customer for its grain over a period and the importing country safeguards its source of supply" (Sewell, p. 96). As such, LTAs could be interpreted similar to vertical relationships in the industrial organization literature (Vickers and Waterson).

[5]For a detailed description of uses of credit programs in international trade, see Harris; Yang and Wilson; International Wheat Council.

Thus far, we have analytically demonstrated the *ceteris paribus* impact of each export strategy on buyer's import allocation decisions. In practice, more than two exporting countries exist whose products may not be perfectly substitutable and each operates a different mix of export strategies. In this case, analytical solutions would be extremely complicated, if not impossible. The marginal effect of each export strategy in a multicompetitive framework can be analyzed empirically with a market share model as developed in the next section.

## Market Share Theory: The Attraction Model

An exporting country's market share is an indicator of sales performance in a particular market. Market share analysis is used to assess impacts of export strategies that influence purchase decisions.[6] Exporting countries use strategies to increase their products' "attractiveness" and, in turn, shares in particular markets. The impact of a country's export strategy depends on the effectiveness of its own programs and composition and effectiveness of competitor countries' programs. However, strategies used to change the distribution of market shares have the impact of mitigating effectiveness of other strategies, own and competitor.

We specify an attraction model (Bell, Keeney and Little; Kotler; Karnani; Kuehn, McGuire, and Weiss; Lilien and Kotler) to empirically analyze the impact of each strategy on exporting countries' market shares. In this model, each product has its own attraction to the importing country which is determined by characteristics and attributes. Relative attractiveness determines the distribution of market shares.[7]

Let $S_i$ be the market share of product i, i=1,...,m, in an importing country and $A_i$ be product i's attraction, which buyers have toward each competing product. With four axioms, Bell, Keeney and Little show that the market share of product i can be expressed as the attraction model:

$$[8] \qquad S_i = A_i/\Sigma_j A_j.$$

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[6]The marketing literature refers to this as the marketing mix, comprised of price discounts, advertising etc.

[7]This model is used extensively in marketing research to assess impacts of firm marketing efforts on shares. Other studies using market share models include Wilson and Gallagher; that Houck and Ryan; Sowter, Gator, and Granger. However, we are not aware of any studies which have explicitly incorporated export strategies in a *logically consistent* market share model derivable from purchaser behavior to analyze their impacts on the distribution of market shares.

This model also can be derived from Kotler's fundamental market share theorem with an assumption that the attraction of product i depends on the product's marketing mix:

$$[9] \quad A_i = f(Z_i;\beta_i),$$

where $Z_i$ is the vector of marketing effort and $\beta_i$ is the corresponding vector of responsiveness.

Among alternatives, two functional forms are used extensively in the literature. The first is the multiplicative competitive interaction model (MCI model) in which $f(\cdot)$ is multiplicative in variables. The other is the multinomial logit model (MNL model) in which variables are exponentially transformed in the MCI model. Gruca and Sudharshan show that the MCI model is more useful in equilibrium analyses. However, if data for marketing variables contain zeros, i.e., no marketing effort for some periods or regions, the MNL model is more appropriate. This study uses the MNL model since values for some export strategies are zero.

Following Cooper and Nakanishi, we specify a fully extended model in which attraction for product i and, therefore, market share is a function of its own strategies and those of all other exporting countries. The fully extended MNL attraction model is

$$[10] \quad A_i = \exp(\beta_{0i} + \Sigma_j\Sigma_k\beta_{kij}Z_{kj} + \varepsilon_i), \text{ and}$$
$$S_i = A_i/\Sigma_j A_j,$$

where $Z_{kj}$ is the $k^{th}$ strategy variable in $Z_j$ and $\beta_{kij}$ is the corresponding parameter for $Z_{kj}$ in $S_i$. The intercept $\beta_{0i}$ is product-specific and denotes the attraction of the product, which is independent of export strategies. $\varepsilon_i$ is the disturbance term.

The market share, by definition, should be non-negative, sum to one (adding up), and fall within the interval [0,1]. These conditions are referred to as "logical consistency" (Naert and Bultez). The attraction model in [10] automatically satisfies these conditions. Since $A_i$ is strictly positive, so is
$S_i$ and $\Sigma_i S_i = \Sigma_i(A_i/\Sigma_j A_j) = 1$.

The marginal effect of each export policy on market shares is obtained by

$$[11] \quad \partial S_i/\partial Z_{kj} = ((1-S_i)\beta_{kij} - S_j\beta_{kjj} - \Sigma_{h\neq i,j}S_h\beta_{khj})S_i$$

The first term on the right-hand side, $(1-S_i)\beta_{kij}$, is the direct effect of $Z_{kj}$ on $S_i$, while the remaining two terms indicate the sum of indirect effects through other market shares. When i=j, [11] indicates the own effect. In what follows, even if $\beta_{kii}$ is negligible, the overall effect can be sizable through the sum of indirect effects on other market shares. Note also that $\partial S_i/\partial Z_{kj}$ may differ in sign from $\beta_{kij}$ if $\beta_{kij}$ is nearly zero and $S_j\beta_{kjj}$ is smaller than $\Sigma_{h\neq i,j}S_h\beta_{khj}$. In other words, if product i is relatively isolated so that the effect of $Z_{kj}$ is negligible on $S_i$ but

is larger on the markets other than $S_j$, then $Z_{kj}$ may have an opposite effect on $S_i$. As such, the fully extended attraction model captures complicated intercountry effects of strategies on international wheat market shares.

The sum of marginal effects of $Z_{kj}$ on all market shares is zero. This implies that an increase(s) in market share(s) from a change in export strategy is necessarily drawn from competitors'. This follows the definition that the market shares sum to one before or after the change.

The model is analogous to random utility theory and explicitly accounts for impacts of strategies on utility and, therefore, purchase behavior and market shares. The functional form is appealing because it allows for a saturation effect to emerge for each export strategy. Specifically, the marginal effect, $\partial S_i/\partial Z_{kj}$ and, therefore, the elasticity increases with increases in market share, reaches a maximum, and then decreases with additional increases in market share. However, the relative importance of this effect is determined empirically.

## Model Estimation and Specification

The attraction model in [10] is inherently nonlinear in parameters, which may compound estimation problems. However, Cooper and Nakanishi developed a procedure to estimate the model through a log-centering transformation. With this transformation, the attraction model in [10] can be rewritten as

$$[12] \quad \log(s_i^*) = \beta_{0i}^* + \Sigma_k\Sigma_j\beta_{kij}^* Z_{kj} + \varepsilon_i^*, \; i=1,...,m,$$

where $s_i^*$ is the log-centered $s_i$, which is $s_i/s_i^g$, where $s_i^g$ is the geometric mean of $s_i$ over i, and $\beta_{oi}^* = \beta_{oi}-\beta_o^a$, $\beta_{kij}^*=\beta_{kij}-\beta_{kj}^a$, $\varepsilon_i^* = \varepsilon_i-\varepsilon^a$ where $\beta^a$, $\beta_{kj}^a$, and $\varepsilon^a$ are arithmetic means of $\beta_{oi}$, $\beta_{kij}$, and $\varepsilon_i$, respectively, calculated over i.

Since each equation has the same independent variables, OLS applied to each individual equation yields the best unbiased linear estimates of $\beta_{kij}$ under standard assumptions on the disturbance term, $\varepsilon_i^*$. The estimated $\beta_{kij}^*$ is not the same as $\beta_{kij}$ but is the difference between $\beta_{kij}$ and its average over i, $\beta_{kij}-\beta_{kj}^a$. Thus, the estimate cannot be directly used to evaluate strategy impacts. However, Cooper and Nakanishi demonstrated that the elasticity, using $\beta_{kij}^*$, is identical to that using $\beta_{kij}$.

Comparing effectiveness of export strategies is convenient with elasticities. In matrix notation, elasticities of market shares with respect to export strategy are

$$[13] \quad E = ZB(I_m-J_mS)',$$

where E is a (km x m) matrix of elasticities, Z is a (km x km) diagonal matrix of strategy variables, B is a (km x m) matrix of parameters, $I_m$ is an (m x m) identity matrix, $J_m$ is an (m x m) matrix of ones, and S is a (m x m) diagonal matrix of market shares.

In this paper we present elasticities of export strategies and test their significance. However, t-values associated with the estimated $\beta_{kij}^*$ do not test the null hypothesis of Ho: $\beta_{kij}=0$ but of Ho: $\beta_{kij}=\beta_{kj}^a$. As an alternative, we test the null hypothesis, Ho: $e_{kij}=0$, where $e_{kij}=0$ is an element of the elasticity matrix E in [12]. The basis for the statistical tests on elasticities is developed in the appendix.

Export strategies are explanatory variables in the attraction model. These include price discounts, credit programs, and long-term agreements. Use of each varies across exporting countries and through time. Variables included for the United States are exports under credit guarantees, PL480, LTAs, and EEP bonuses. Other countries provide price discounts. However, this information is not publicly available for Canada and Australia due to a lack of transparency. Export price subsidies are used extensively for the EC, however, they are equal across importing countries (Sorenson, et al. p. 72). Thus, only credit guarantees and LTAs are included for Canada, Australia, and Argentina and credit for the EC. To capture geographical effects, such as distance and potential intercountry relationships from foreign policies, regional dummy variables were included for Africa, Asia, South America, and Europe.

## Data Description

Market shares for each importing country were derived from wheat shipment data reported in USDA Grain Market News and in annual reports of the International Wheat Council, Australian Wheat Board, and Canadian Wheat Board. Data on wheat export shipments under PL480 were taken from USDA annual reports. The value used for EEP was an annual average of EEP bonus for importing countries and were taken from Foreign Agricultural Service news releases source.

Sales under export credit guarantees from each exporting country to each importing country were taken from various sources. United States shipments under credit guarantees were the sum of sales to each importing country under the GSM-102, GSM-103, and Blended Credit (when used) programs taken from annual reports of the Foreign Agricultural Service. Canadian data were taken from Canadian Wheat Board Annual Reports. Australian and Argentine data were taken from the International Wheat Council (IWC) and supplemented with discussions with program administrators. Aggregate guarantees of all EC exporting countries that the International Wheat Council (IWC) reported were used for the EC. A data series of LTAs was derived from data contained in annual reports of the International Wheat Council and Canadian Wheat Board. For each year, the quantity of wheat under LTA between each importing and exporting country was derived and used in the analysis.

Cross-section data for 114 countries were developed; however, because of missing information, only 97 countries could be used in the analysis. Separate equation systems were estimated for each commodity marketing year from 1979/80 through 1989/90.

Among these export strategies and importing countries comprising our sample, the export strategy the United States used most frequently was PL480. Use of PL480 has increased from 21 countries in 1982 to 34 in 1989. EEP increased from nil prior before 1985 to 15 recipient countries in 1989. Use of credit guarantee programs by the United States has also increased dramatically, from nil in 1979 to 22 in 1989. Other countries have used credit guarantees less frequently. The EC, Canada, and Australia used credit guarantees in 5, 4, and 3 countries, respectively. Canada used LTAs most extensively, followed by Australia and Argentina. The United States used LTAs with only 2 importing countries and the EC with none.

## Results

Fully extended market share models were estimated for each year from 1979 through 1989. Due to the volume of analyses, we present statistical results for 1979, 1982, 1986, and 1989. These years reflect changing model structures (i.e., included export strategies) through time: 1979 having few operative export strategies; 1982 having greater use of credit guarantees; 1986 reflecting incorporation of EEP as an export strategy; and 1989, the last period of the sample data.

**Statistical Estimates** Statistical estimates for each exporting country and year are shown in Table 1. Many of the parameters are statistically significant. Due to the log-centering transformation, the t-ratios are interpreted as a test that $\beta_{kij}=\beta_{kj}^{*}$.[8]

The intercepts directly measure the level of attraction independent of strategies. Technically, if the value of all export strategies were nil, these would be an index of relative attractiveness. These reflect quality differentials and other effects not explicitly included in the model specification.

The intercepts for each importing region were derived for each exporting country (using the dummy variables) and are shown in Table 2 for 1979 and 1989. In 1979, the import markets with the greatest attraction for both the United States and Canada were in Europe. The region with the least attraction for U.S. wheat in both years was Africa. In 1989, South America as a region had the greatest attraction for U.S. and Canadian wheat. Over time, Europe's attraction to U.S. wheat decreased and Canada's increased. Africa was the region with the greatest attraction for EC wheat in both periods. In 1979, the import market with the greatest attraction to Australia was Africa but shifted to Asia in 1989. Similar shifts occurred for Canada's wheat in Asia during this period, but attraction to U.S. wheat in the Asian market decreased.

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[8]Significant t-values in this context indicate that a country's export strategy is more effective than average if positive, as represented by $\beta_{kj}^{*}$.

**Table 1. Statistical Estimates of Export Market Share Models**

| | 1979 | | | | | 1982 | | | | | 1986 | | | | | 1989 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Variable** | **U.S.** | **Canada** | **Aus** | **Arg** | **EC** | **U.S.** | **Canada** | **Aus** | **Arg** | **EC** | **U.S.** | **Canada** | **Aus** | **Arg** | **EC** | **U.S.** | **Canada** | **Aus** | **Arg** | **EC** |
| Intercept | 2.64* | 0.98* | -2.26* | -1.91* | 0.55 | 1.37* | 1.23* | -2.22* | -1.62* | 1.24* | 1.33* | 1.79* | -1.96* | -1.91* | 0.76 | 0.35 | 2.22* | -1.35* | -2.22* | 0.99 |
| | (4.84) | (2.09) | (5.23) | (5.32) | (1.17) | (2.09) | (2.56) | (5.75) | (4.18) | (2.06) | (2.41) | (3.58) | (4.81) | (5.70) | (1.20) | (0.64) | (4.44) | (3.42) | (6.73) | (1.62) |
| Africa | -2.38* | -1.01 | 1.04* | 0.11 | 2.24* | -2.17* | -1.46* | 1.09* | 0.06 | 2.48* | 0.04 | -1.81* | 0.74 | -0.33 | 1.36 | -0.71 | -1.46* | -0.48 | 0.12 | 2.53* |
| | (3.16) | (1.56) | (1.75) | (0.22) | (3.43) | (2.37) | (2.17) | (2.03) | (0.11) | (2.93) | (0.06) | (2.67) | (1.33) | (0.71) | (1.57) | (0.93) | (2.11) | (0.88) | (0.25) | (2.99) |
| Asia | -1.04 | -1.62* | 3.27* | -0.57 | -0.05 | -0.08 | -1.39* | 2.48* | -0.58 | -0.44 | -0.79 | -1.95* | 2.93* | -0.09 | -0.09 | 0.21 | -1.66* | 0.97* | 0.20 | 0.27 |
| | (1.40) | (2.53) | (5.56) | (1.16) | (0.07) | (0.09) | (2.11) | (4.72) | (1.09) | (0.54) | (1.05) | (2.88) | (5.27) | (0.20) | (0.11) | (0.27) | (2.37) | (1.76) | (0.44) | (0.32) |
| S. America | 1.02 | -1.53* | 0.09 | 2.04* | -1.61* | 0.44 | -2.23* | 0.63 | 1.31* | -0.15 | 2.03* | -2.66* | 0.17 | 0.87* | -0.40 | 2.95* | -2.25* | -0.74 | 1.12* | -1.07 |
| | (1.31) | (2.30) | (0.14) | (3.99) | (2.39) | (0.47) | (3.23) | (1.13) | (2.36) | (0.18) | (2.70) | (3.92) | (0.30) | (1.89) | (0.47) | (3.83) | (3.27) | (1.35) | (2.45) | (1.27) |
| Credit: U.S. | | | | | | 0.32* | -0.25* | 0.04 | 0.13 | -0.23 | 0.06 | 0.02 | -0.03 | 0.08 | -0.13 | 0.03 | 0.04 | 0.12 | -0.06 | -0.12 |
| | | | | | | (1.87) | (2.02) | (0.37) | (1.25) | (1.46) | (0.44) | (0.19) | (0.33) | (1.11) | (0.90) | (0.11) | (0.17) | (0.70) | (0.41) | (0.47) |
| Canada | -0.16 | -0.01 | 0.05 | 0.09 | 0.03 | -0.67* | 0.21 | 0.18 | -0.13 | 0.40 | -0.17 | 0.73* | -0.32 | -0.07 | -0.18 | 0.03 | 0.04 | 0.13 | -0.29 | 0.09 |
| | (1.20) | (0.12) | (0.44) | (1.09) | (0.28) | (1.78) | (0.77) | (0.82) | (0.56) | (1.15) | (0.46) | (2.21) | (1.19) | (0.29) | (0.42) | (0.05) | (0.07) | (0.30) | (0.78) | (0.13) |
| Aus | | | | | | 2.39 | -6.23* | 2.55 | 3.65 | -2.36 | -0.40 | -0.48* | 0.39* | 0.17 | 0.31 | -0.06 | 0.02 | 0.62* | 0.30 | -0.28 |
| | | | | | | (0.53) | (1.87) | (0.95) | (1.36) | (0.57) | (1.26) | (1.67) | (1.68) | (0.90) | (0.86) | (0.12) | (0.06) | (1.83) | (1.06) | (0.54) |
| Arg | | | | | | -2.79 | -9.20 | -5.32 | 15.73* | 1.59 | -1.11 | -1.30 | 0.26 | 1.72* | 0.43 | -0.32 | -0.63 | -0.32 | 1.10* | 0.17 |
| | | | | | | (0.25) | (1.12) | (0.80) | (2.36) | (0.15) | (0.70) | (0.91) | (0.22) | (1.79) | (0.24) | (0.54) | (1.17) | (0.76) | (3.11) | (0.26) |
| EC | | | | | | -0.11 | -0.12 | 0.04 | -0.06 | 0.25 | -0.32 | -0.12 | -0.47* | 0.09 | 0.81* | -0.08 | 0.09 | -0.29 | 0.19 | 0.08 |
| | | | | | | (0.15) | (0.23) | (0.09) | (0.14) | (0.37) | (0.88) | (0.36) | (1.75) | (0.43) | (1.95) | (0.27) | (0.33) | (1.37) | (1.11) | (0.25) |
| PL480 | 0.25 | -0.17 | 0.23 | -0.22* | -0.09 | 1.12* | 0.09 | -0.61 | -0.60 | -0.01 | 0.28 | 0.17 | -0.18 | -0.09 | -0.18 | 0.83* | -0.57 | 0.23 | -0.45* | -0.03 |
| | (1.23) | (0.94) | (1.40) | (1.66) | (0.50) | (1.67) | (0.18) | (1.53) | (1.49) | (0.01) | (1.11) | (0.74) | (0.96) | (0.61) | (0.60) | (1.98) | (1.52) | (0.78) | (1.82) | (0.07) |
| LTA: U.S. | 0.01 | 0.03 | -0.01 | 0.04 | -0.08 | 1.31 | -2.54* | 0.78 | 1.37 | -0.92 | 0.11* | 0.06 | -0.09* | -0.01 | -0.08 | 0.10 | 0.05 | -0.05 | -0.01 | -0.10 |
| | (0.82) | (0.64) | (0.21) | (0.89) | (1.40) | (0.73) | (1.91) | (0.73) | (1.28) | (0.55) | (1.70) | (0.96) | (1.74) | (0.14) | (1.03) | (1.46) | (0.82) | (1.02) | (0.17) | (1.25) |
| Canada | 0.09 | 0.23* | -0.04 | -0.07 | -0.22* | 0.16 | 0.20* | -0.18* | -0.11 | -0.07 | -0.12 | -0.29 | 0.02 | 0.19 | 0.20 | 0.01 | -0.13 | -0.05 | -0.01 | 0.18 |
| | (0.62) | (1.79) | (0.30) | (0.67) | (1.71) | (1.03) | (1.81) | (1.96) | (1.25) | (0.50) | (0.50) | (1.36) | (0.14) | (1.33) | (0.71) | (0.01) | (0.35) | (0.17) | (0.03) | (0.40) |
| Aus | | | | | | -4.55 | 8.35* | -2.45 | -4.34 | 3.00 | 0.46 | 0.64* | 0.03 | -0.42* | -0.71 | -0.19 | 0.01 | -0.78 | 0.57 | 0.39 |
| | | | | | | (0.77) | (1.92) | (0.70) | (1.24) | (0.55) | (1.14) | (1.77) | (0.10) | (1.71) | (1.54) | (0.19) | (0.01) | (1.14) | (1.00) | (0.36) |
| Arg | 0.17 | -0.43 | -0.13 | 0.04 | 0.34 | -0.65 | 0.79 | -0.13 | -0.37 | 0.36 | 0.19 | 0.96 | 0.05 | -0.63 | -0.58 | -0.17 | 0.09 | -0.05 | 0.29* | -0.16 |
| | (0.51) | (1.48) | (0.48) | (0.19) | (1.17) | (0.57) | (0.94) | (0.19) | (0.54) | (0.34) | (0.23) | (1.29) | (0.08) | (1.25) | (0.61) | (1.11) | (0.64) | (0.49) | (3.23) | (0.94) |
| EXP | | | | | | | | | | | 0.05* | -0.04* | 0.00 | -0.03* | 0.01 | 0.19* | -0.07 | -0.03 | -0.05 | -0.04 |
| | | | | | | | | | | | (2.57) | (2.17) | (0.09) | (1.99) | (0.47) | (2.06) | (0.88) | (0.50) | (0.84) | (0.39) |
| $R^2$ | 0.22 | 0.15 | 0.36 | 0.32 | 0.32 | 0.21 | 0.27 | 0.31 | 0.30 | 0.23 | 0.29 | 0.25 | 0.40 | 0.27 | 0.18 | 0.35 | 0.22 | 0.32 | 0.35 | 0.26 |

* Indicator significant at the 10% level.

**Table 2. Intercepts Adjusted to Regional Dummies for Each Model: 1979 and 1989**

| | | U.S. | Canada | Australia | Argentina | EC |
|---|---|---|---|---|---|---|
| 1979 | Europe | 2.64 | .98 | -2.26 | -1.91 | .55 |
| | Africa | .26 | -.03 | 1.22 | -1.8 | 2.79 |
| | Asia | 1.6 | -.64 | 1.01 | -2.48 | .50 |
| | So. America | 1.62 | -.55 | -2.17 | .13 | 1.61 |
| 1989 | Europe | .35 | 2.22 | -1.35 | -2.22 | .99 |
| | Africa | -.36 | .76 | -1.83 | -2.1 | 3.52 |
| | Asia | .14 | .56 | -.38 | -2.02 | 1.26 |
| | So. America | 3.30 | -.03 | -2.09 | -1.1 | -.08 |

**Marginal Effects** The marginal effect, $\partial S_i/\partial Z_{kj}$, of an export strategy on market shares provides one way to demonstrate the effects of strategies on market shares. These effects depends on the distribution of competitor country market shares and, therefore, cannot be generalized. For illustration purposes, the empirical relationship between the marginal effect of selected U.S. export strategies and market share are shown in Figures 1 and 2.

The marginal effect of credit guarantees during 1982 and 1989 are shown in Figure 1. Each observation represents particular importing countries. In 1982, the marginal effect was maximum at about 0.06/unit. The effect of credit is greatest for countries in which the U.S. market share is about 55%. For countries in which the U.S. market share differs from about 55%, the marginal effect of credit guarantees diminishes confirming the saturation effect embedded in the empirical model. The difference in marginal effects between observations with similar values of U.S. market shares is attributed to differences in the distribution of $S_j$, for all $j \neq$ U.S. in those markets. In contrast, marginal effects of credit in 1989 are less systematic, and many are close to zero. These illustrate impacts of other strategies, namely EEP, which have the impact of mitigating impacts of other export strategies.

Marginal effects of EEP are calculated for both 1985 and 1989 and shown in Figure 2. In 1985, the marginal effects were generally constant indicating negligible saturation at about 0.15/unit. The marginal effect of EEP in 1989 is more systematic and has a much greater saturation effect. It reached a maximum at about 0.65/unit, with a U.S. market share of about 50%. The marginal effect of EEP diminishes in countries with either larger or smaller U.S. market shares. These graphs illustrate an important feature of the impact of export strategies on market shares. In particular, marginal effects increase from nil as the level of the market share increases, reaches a maximum,[9] and diminishes in markets with shares greater than about 50%.

[9]In a simple effects market share model, the maximum would be precisely at .5. However, in the fully extended model, the maximum is an empirical question, depending on the distribution of competitor country market shares $S_i$, for all $j \neq$ U.S.

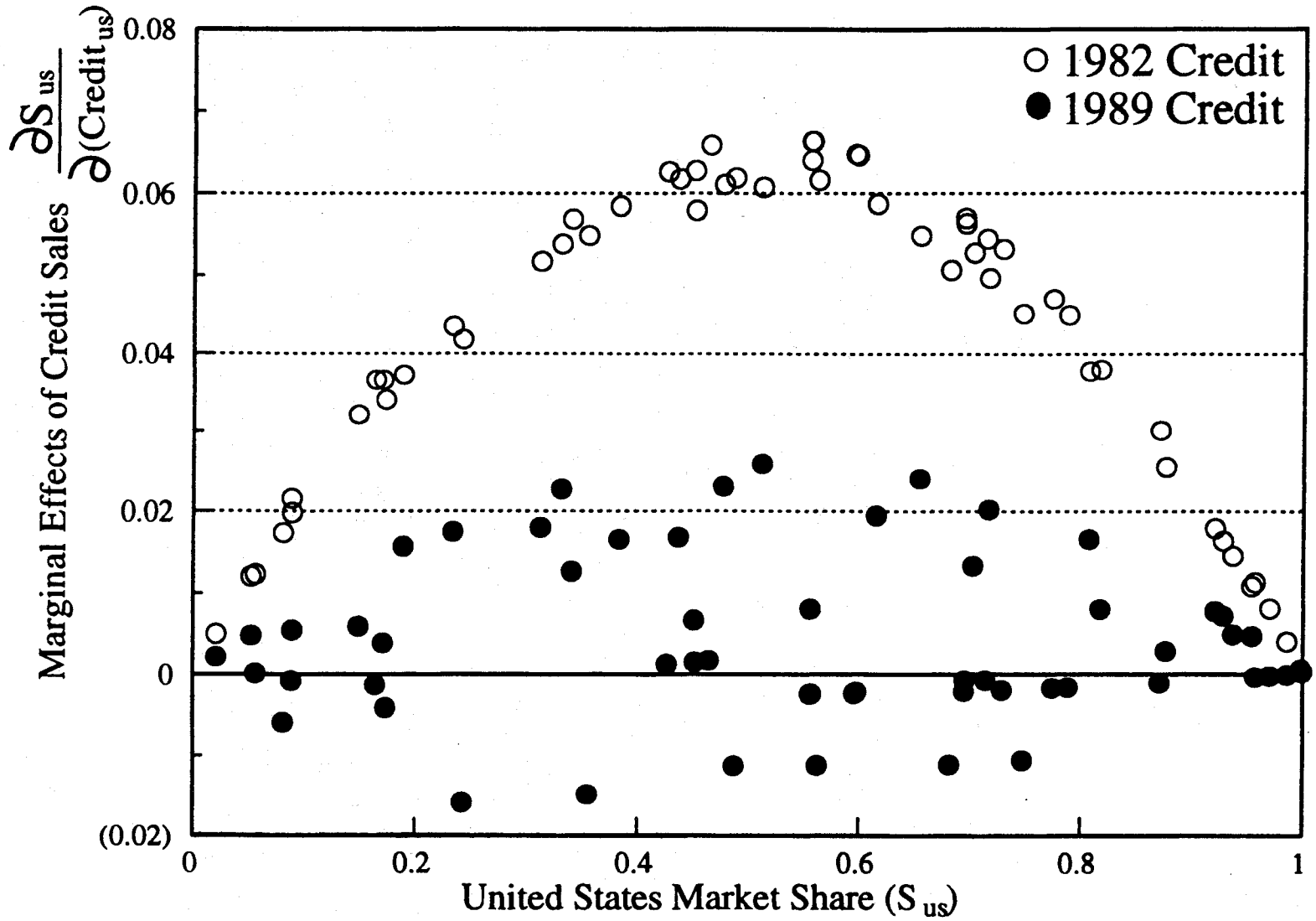


Figure 1. Marginal Effects of Credit Sales on the U.S. Market Share in 1982 and 1989

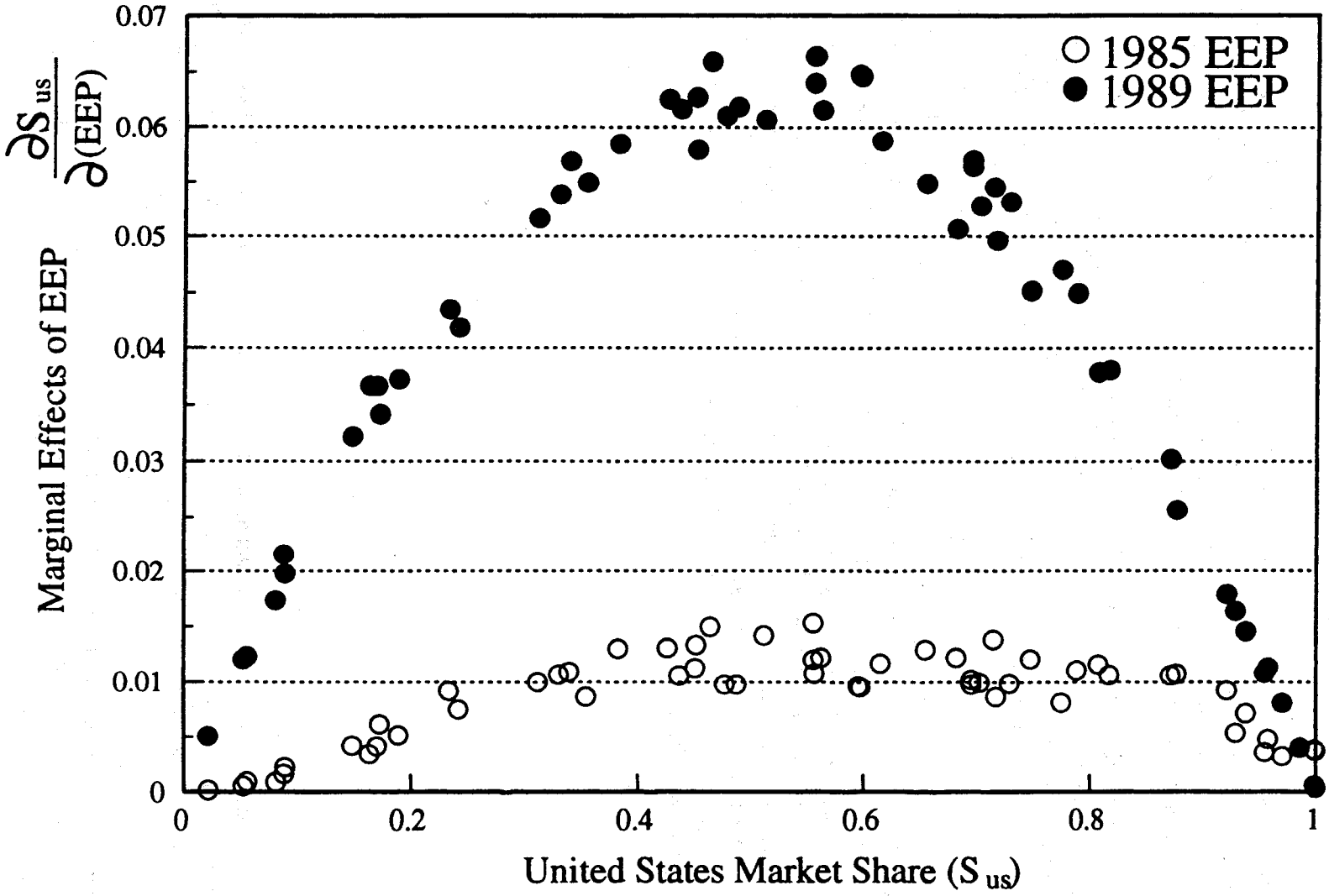


Figure 2. Marginal Effects of EEP on the U.S. Market Share in 1985 and 1989

**Elasticities** were calculated at mean values and are shown in Tables 3 through 6.[10] First, we discuss impacts of specific export strategies and make more general observations across individual exporting countries.

Elasticities for LTAs were generally insignificant.[11] The own-elasticity was significant only for Argentina in 1989. Use of LTAs by all other exporting countries only had periodic significant cross effects. These suggest that, in general, LTAs do not have a great influence on the distribution of export market shares.

The own elasticity for PL480 did not differ significantly from zero in 1979, 1982, or 1986. However, there were important and significant negative cross effects of PL480 on Argentina in three of the years, Canada in one year, and Australia in two years. Though PL480 was normally not significant, it had the greatest negative impact on Argentina.

Canada was the only exporter with an active credit guarantee program in 1979, but that impact was not significant (Table 3). In 1982, own-credit elasticities for the United States, Canada, and Argentina were significant. U.S. credit allocations increased own-market share and reduced that of Canada, but impacts on other countries' market shares were not significant. Cross-credit elasticities differed for these two countries' programs, indicating that Canada's program has a greater negative impact on the U.S. market share than the negative impact that the U.S. program has on Canada's market share. In 1986, all own and cross elasticities were lower in absolute value. The U.S. program did not have a significant impact on the distribution of market shares in 1986. However, for other countries own credit elasticities were significant.

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[10]For comparison, elasticities calculated at the mean of nonzero values of independent variables are larger. Some of these are shown later in the paper for comparison. However, general conclusions made in this study are the same, using elasticities calculated at either point.

[11]Given the operations of the U.S. marketing system, U.S. LTAs would be unlikely to lend themselves as effective compared to those of competitor countries. However, this is not substantiated in these results.

**Table 3. Market Share Elasticities With Respect to Export Strategies: 1979**

| | Market Share | | | | |
|---|---|---|---|---|---|
| | U.S. | Canada | Australia | Argentina | EC |
| Credit: Canada | -0.048 | 0.024 | 0.054 | 0.077 | 0.047 |
| PL480 | 0.050 | -0.088 | 0.042 | -0.107* | -0.063 |
| LTA: U.S. | 0.011 | 0.024 | -0.003 | 0.025 | -0.042 |
| Canada | 0.040 | 0.116 | -0.029 | -0.046 | 0.132 |
| Argentina | 0.016 | -0.106 | -0.045 | -0.010 | 0.052 |

Note: Elasticities were derived at means.
* (**) Indicates significance at a 10% (5%) level.

**Table 4. Market Share Elasticities With Respect to Export Strategies: 1982**

| | Market Share | | | | |
|---|---|---|---|---|---|
| | U.S. | Canada | Australia | Argentina | EC |
| Credit: U.S. | 0.286* | -0.269* | 0.010 | 0.098 | -0.253 |
| Canada | -0.443* | 0.237 | 0.215 | -0.023 | 0.387 |
| Australia | 0.379 | -0.827 | 0.401 | 0.556 | -0.313 |
| Argentina | -0.006 | -0.031 | -0.016 | 0.068* | 0.012 |
| EC | -0.032 | -0.035 | 0.004 | -0.019 | 0.053 |
| PL480 | 0.228 | -0.095 | -0.309* | -0.307* | -0.112 |
| LTA: U.S. | 1.270 | -2.637 | 0.805 | 1.431 | -1.023 |
| Canada | 0.280 | 0.401 | -0.567* | -0.403 | -0.290 |
| Australia | -1.398 | 2.624* | -0.737 | -1.336 | 1.031 |
| Argentina | -0.363 | 0.513 | -0.044 | -0.191 | 0.273 |

Note: Elasticities were derived at means.
* (**) Indicates significance at a 10% (5%) level.

**Table 5. Market Share Elasticities With Respect to Export Strategies: 1986**

| | Market Share | | | | |
|---|---|---|---|---|---|
| | U.S. | Canada | Australia | Argentina | EC |
| Credit: U.S. | 0.055 | 0.024 | -0.021 | 0.079 | -0.112 |
| Canada | -0.028 | 0.183* | -0.065 | -0.004 | -0.034 |
| Australia | -0.098 | -0.126 | 0.193* | 0.112 | 0.162 |
| Argentina | -0.024 | -0.032 | 0.032 | 0.092* | 0.040 |
| EC | -0.062 | -0.024 | -0.090 | 0.160 | 0.155* |
| PL480 | 0.093 | 0.036 | -0.131 | -0.090 | -0.125 |
| LTA: U.S. | 0.064 | 0.020 | -0.093* | -0.030 | -0.086 |
| Canada | -0.157 | -0.497 | 0.125 | 0.455 | 0.475 |
| Australia | 0.113 | 0.172 | -0.028 | -0.173 | -0.272* |
| Argentina | -0.069 | 0.500 | -0.011 | -0.387 | -0.373 |
| EEP | 0.172* | -0.315* | -0.099 | -0.233* | -0.053 |

Note: Elasticities were derived at means.
* (**) Indicates significance at a 10% (5%) level.

**Table 6. Market Share Elasticities With Respect to Export Strategies: 1989**

| | Market Share | | | | |
|---|---|---|---|---|---|
| | U.S. | Canada | Australia | Argentina | EC |
| Credit: U.S. | 0.022 | 0.030 | 0.093 | -0.041 | -0.059 |
| Canada | 0.012 | 0.021 | 0.057 | -0.129 | -0.023 |
| Australia | 0.014 | 0.049 | 0.283* | -0.081 | -0.096 |
| Argentina | -0.005 | -0.033 | -0.004 | 0.057* | 0.018 |
| EC | -0.026 | 0.022 | -0.088 | 0.056 | 0.033 |
| PL480 | 0.194* | -0.258* | -0.002 | -0.219* | -0.068 |
| LTA: U.S. | 0.071 | 0.030 | -0.050 | -0.016 | -0.090 |
| Canada | -0.070 | -0.165 | -0.107 | -0.081 | 0.208 |
| Australia | -0.039 | 0.008 | -0.181 | 0.141 | 0.066 |
| Argentina | -0.015 | 0.172 | 0.072 | 0.321* | -0.129 |
| EEP | 0.276* | -0.215 | -0.137 | -0.164 | -0.168 |

Note: Elasticities were derived at means.
* (**) Indicates significance at a 10% (5%) level.

Own-credit elasticities for the EC were never significant except in 1986. The results also suggest that during 1986, competitor credit programs were administered more strategically than U.S. programs, resulting in greater increases in their own market shares. In general, own-credit elasticities for competitor countries exceeded that of the United States, particularly in 1986 and 1989. These results confirm Harris' allegation that features of competitor programs increase their effectiveness relative to that of the United States. This reflects that different countries' programs, which are otherwise similar, are administered in such a way to have differing degrees of effectiveness (see Harris for a discussion in the case of credit guarantees). In addition, these are in contrast to Skully, who assumed that credit guarantees did not influence market shares.

The change in elasticities through time also reflects the impact of the changing structure of competition, namely introduction of EEP. The impact of this is to mitigate influences of previously existing export strategies. To illustrate, the models were estimated for each year from 1979 to 1989, and elasticities for credit (own credit) and EEP (own and cross effects) were derived at means of the nonzero independent variables (Table 7). United States own credit elasticity was significant and elastic before EEP was introduced in 1985. After 1985, it rapidly declined in value. Credit elasticities for Australia were greater in 1981 than U.S. elasticities, and Canadian elasticities were greater in 1983 and 1984, indicating that in those years, competitor country programs were more effective relative to U.S. credit programs.

**Table 7. Market Share Elasticities of Credit and EEP: 1979-1989**

| | Own Credit | | | EEP | | | | |
|---|---|---|---|---|---|---|---|---|
| | U.S. | Canada | Aust. | U.S. | Canada | Aus | Arg | EC |
| 1979 | | -.31 | | | | | | |
| 1980 | 1.56* | -2.22 | .28 | | | | | |
| 1981 | 1.36 | .69 | 17.68* | | | | | |
| 1982 | 1.44* | 3.79 | 19.28 | | | | | |
| 1983 | 1.21* | 3.63* | .47 | | | | | |
| 1984 | 1.75* | 5.18* | 2.94 | | | | | |
| 1985 | .67 | .95 | 5.04 | 1.25* | -1.39 | -.60 | -1.65* | -.44 |
| 1986 | .31 | 2.21* | 6.23* | 1.37* | -2.54* | -.80 | -1.88* | -.43 |
| 1987 | .07 | 2.11 | 6.56* | 1.41* | -1.97* | -.92 | -1.09* | -.60 |
| 1988 | .51 | 4.84* | 15.77 | 1.51* | -1.19 | -1.65* | -.56 | -1.53 |
| 1989 | .10 | .13 | 9.14* | 1.78* | -1.39 | -.88 | -1.06 | -1.09 |

Note: Elasticities were derived at means of non-zero observations.
* (**) Indicates significance at a 10% (5%) level.

Introduction of EEP in 1985 had several important effects. First, it increased U.S. market share in the importing countries where it was used. Second, it diminished the effects of the U.S. credit program. Third, it had a negative impact on competitor countries' market shares, primarily on Canada and Argentina. Australian market shares were impacted only in 1988. Its effect on EC market shares has been negligible and, in fact, never differed significantly from zero supporting Anania, Bohman, and Carter. The negative impact on competitor elasticities has diminished. For example, the cross elasticity of EEP on Canada's market share was -2.54 and -1.97 and significant in 1986 and 1987 but has decreased in (absolute) value and has become insignificant in 1989. Similar conclusions can be made regarding the impact of EEP on Argentina.

When these results were compared over time, the frequency of use of export strategies increased, and the frequency of their elasticities' being significant increased. Specifically, in 1979 none of trade strategies had significant effects on "own-country" market shares, and only one had a significant cross effect. However, in later years, more strategies were used and, apparently, were being used more strategically as reflected by the greater occurrence of elasticities, which differed significantly from zero.

## Conclusions

All major wheat exporting countries have increased use of export strategies, which are differentiated across importing countries. These include credit guarantees, long-term agreements, PL480, and the U.S. Export Enhancement Program. Most export strategies are administered to increase total imports and/or to change the distribution of market shares among exporting countries. However, their impact on the distribution of market shares depends on the composition and effectiveness of competitor countries' programs. A crucial determinant of any analysis of export strategies is their comparative impact on market shares.

A *logically consistent* market share model is specified and estimated. Specifically, a fully extended attraction model is used to allow explicit introduction of export strategies to impact purchase decisions. Exporting countries use strategies to increase their commodities' attractiveness and market shares. However, impacts of strategies depend on use of other strategies, and composition and effectiveness of competitor countries' strategies. In this model, relative attractiveness determines the distribution of market shares. The specific functional form used allows for a saturation effect of a strategy after some level is achieved.

The intercepts (adjusted for regional effects) measure attraction independent of the export strategies. Comparison of these values indicate some important shifts in relative attraction to exporters by importing regions. Most notable is that over time, the attraction of European markets to U.S. wheat decreased and that of Canada increased. Similarly, Asia's attractiveness to wheat from Canada and Australia increased between 1979 and 1989, but its attraction to U.S. wheat in this market decreased.

The marginal effect of strategies varies with the size of the exporting countries' market share and with the distribution of competitor countries' market shares. In most cases, the marginal effect of export strategies is maximum in countries where the exporting country has a market share of about 50%. In markets in which the United States has a small market share or that it dominates, the marginal effects of EEP or credit are negligible.

Elasticities were derived for each strategy and exporting country. Generally, elasticities for PL480 and LTAs frequently did not differ significantly from zero. In the period before 1985, a number of the own-credit elasticities were significant, particularly those for the United States and Canada. However, values of these, and for the cross-credit elasticities varied greatly, indicating that otherwise similar programs had varying degrees of effectiveness. In addition, these elasticities varied greatly through time. Most important was that in the period following introduction of EEP, credit elasticities were reduced in absolute value. Structurally, EEP had the impact of increasing U.S. market shares and mitigating effects of other strategies including that of the U.S. credit programs. EEP also had a negative impact on competitor countries' market shares, primarily on Canada and Argentina. However, the effect of EEP on EC market shares was never significant.

A number of important policy implications can be discerned from these results. First, simply introducing and using a strategy does not necessarily increase market shares. Strategies replicated by competitors, either or with identical or other strategies, essentially reduce the impacts of a strategy on the distribution of market shares. Second, the marginal effect of strategies in terms of market share all have a saturation effect--i.e., a point is reached at which the marginal effect is maximum, beyond which it diminishes to zero. This has important strategic implications for export policy administration, particularly when budget constraints force allocation decisions across importing countries. Third, these results clearly indicate that the marginal effects of credit (the only program which each of the exporting countries has used) varies across exporting countries. This suggests that the programs must have important features, which vary and/or are administered more strategically in some countries than others.

Export strategy impacts were discussed in terms of the marginal effect of that strategy on market shares, or a related measure, its elasticity. Neither of these measures captures any notion of costs of strategies and, therefore, could not be used strictly alone to make an allocation decision, or to evaluate overall performance of each strategy. Nonetheless, the measures in this paper provide a foundation for estimating the additional market share associated with each strategy, which would be an important element of the policy analysis.

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## Appendix

The mathematical expression in [12] is for an elasticity matrix. The left-hand side is a matrix of random variables. For convenience, we transform the matrix into a vector, using the stacking operator:

[A1] $\text{vec}(E) = \text{vec}(XB(I_m - J_m S)') = [(I_m - J_m S) \otimes X]\text{vec}(B)$,

where $\text{vec}(E) = \text{vec}(e_1\ e_2\ \ldots\ e_m)$ where $e_i$ is the $i^{th}$ column of E and @ denotes the Kronecker product. The covariance matrix of vec(E) is

[A2] $\Sigma_{vec(E)} = [(I_m - J_m S) \otimes X]\Sigma_{vec(B)}[(I_m - J_m S) \otimes X]'$,

where $\Sigma_{vec(B)} = (Z'(\Sigma^{-1} \otimes I_T)Z)^{-1}$ where $\Sigma$ is the covariance matrix of $\varepsilon_i$, i=1,...,m, and $Z = (I_m \otimes Z_i)$ where $Z_i$ is a (T x (km)) matrix of explanatory variables of equation [14], and T is the sample size. The t-values for the elasticities can be obtained through the element division of vec(E) by the square root of the diagonal element of $\Sigma_{vec(E)}$.