An Economic Analysis of U.S. Wheat Export Promotion

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U.S. Wheat Associates (USW) operates foreign market development programs in countries around the world with its primary mission to increase U.S. wheat exports. USW emphasizes the reliability, quality, and value of all six U.S. wheat classes to wheat buyers, millers, bakers, food processors and government officials in more than 100 countries around the world. USW is financed by checkoff dollars from 19 state wheat commissions and cost-share grants from the U.S. Department of Agriculture's (USDA) Foreign Agricultural Service (FAS). The purpose of this study was to measure the economic impacts of the generic export promotion programs operated by USW.

The economic evaluation was based on an econometric model of U.S. wheat import demand in four major "mega-regions" importing U.S. and other country wheat. The mega-regions include: Europe, Asia, Latin America, and Africa-Mid East (combined). This model was estimated using annual data from 1994-2014 for the four mega-regions. The econometric model was then used to simulate the market-wide impacts of alternative scenarios involving the USW export promotion.

More specifically, this study addressed several key questions regarding the impacts and effectiveness of USW and FAS export promotion:

1. What was the responsiveness of the import demand for U.S. wheat in the four mega-regions with respect to USW foreign market development programs (also referred to as "export promotion" in this report)?

2. What would have been the impact on U.S. wheat exports in the four mega-regions had there been a 50% reduction in wheat export promotion conducted by USW?

3. What would have been the impact on U.S. wheat exports in the four mega-regions had there not been any USDA promotion and only USW promotion? And, relatedly, what would have been the impact on U.S. exports had there not been any USW promotion and only USDA promotion?

4. How did the gain in export net revenue due to wheat export promotion compare to the costs of the promotion? That is, what was the benefit-cost ratio of these programs in the four mega-regions?

5. How did the emergence of the Black Sea exporting countries in 2002 impact the promotion effectiveness of USW?

The remainder of this report is organized as follows. In the next (second) section, the conceptual economic methodology is discussed. The third section presents the econometric model and data sources for the study. This is followed by the results for the aggregate model that pools together all four mega-regions. The fifth section presents the results for the regionally disaggregate model that measures the impacts separately for each region. The sixth section examines how the emergence of the Black Sea wheat exporting countries impacted the effectiveness of U.S. wheat export promotion. The last sections summarizes the conclusions of the study.

Economic Methodology

To answer the above questions, this study quantified the relationship between the export promotion effort of USW and FAS, and the export demand[1] for U.S. wheat to foreign markets. The model was based on the economic theory of import demand for U.S. wheat. In theory, one expects that the export promotion activities are beneficial to wheat producers because the promotion increases the import demand of foreign consumers for U.S. wheat, which results in higher U.S. export sales and revenues. However, there are also other factors that affect import demand. In order to distinguish the impact of export promotion on import demand for U.S. wheat from the impacts of other factors, an econometric framework was adopted.

The econometric approach quantifies economic relationships using economic theory and statistical procedures with data. It enables one to simultaneously account for the impact of a variety of factors affecting wheat import demand in the foreign market in question. These demand-determining factors (called "determinants") included the price of U.S. wheat, the price of competing countries wheat, exchange rates, exports from competing countries, income, and the USW and USDA/FAS wheat export promotion expenditures. By casting the export promotion evaluation in this type of framework, we can filter out the effect of other factors and, hence, directly quantify the net impact of USW export promotion activities on U.S. wheat demand of foreign consumers.

To compare the relative importance of each factor on U.S. wheat demand, the results from the statistical (econometric) model were converted into demand "elasticities." A demand elasticity measures the percentage change in U.S. wheat import demand given a one-percent change in a specific demand factor, holding all other factors constant. For example, the computed price elasticity measures the percentage change in the demand for U.S. wheat given a 1% change in price. The computed export promotion elasticity measures the percentage change in the import demand for U.S. wheat given a 1% change in export promotion expenditures, and so on. A comparison of the demand elasticities allows you to see which factors have the largest impact on U.S. wheat demand.

Econometric Model and Data

In this study, the import demand equation for U.S. wheat was estimated with U.S. wheat imports as the dependent variable, which was measured on a tonnage basis for each calendar year. Since we were interested in commercial imports, U.S. government concessional program exports (including Public Law 480, Section 416, Food for Progress, and U.S. A.I.D.) were subtracted from total imports. Two different import demand models for U.S. wheat were estimated: (1) an aggregate model representing four "mega-regions", and (2) a disaggregated model for each mega-region separately.

For the first model, panel data were used to estimate the model, where the data consisted of annual observations from 1994-2014 for four mega-regions importing U.S. wheat: (1) Europe, (2) Asia, (3) Africa-Mid East, and (4) Latin America. The overall coverage by these four mega-regions represents 97% of U.S. wheat trade except for the U.S. and Canada. (The U.S. does not conduct export promotion to Canada). Therefore, this is very good coverage of the overall impact of U.S. wheat export promotion. For the second model, the promotion variable was disaggregated into four separate variables for each mega-region. As a result, the promotion elasticity for each region was separately estimated.

The following import demand determinants were included in both models to ascertain their impacts on import demand for U.S. wheat:

1. Ratio of the price of U.S. wheat imports in dollars per ton, to the price of competing country wheat imports (dollars per ton),

2. Real exchange rate of importing region currency to U.S. $,

[1] This report refers to "export demand" and "import demand" throughout the text. Import demand means the quantity of imports of U.S. wheat in a specific region such as Europe, while export demand refers to the total quantity of wheat exported by the U.S. The econometric model estimated in this study is an import demand model for the four mega-regions which represents approximately 97% of all U.S. wheat exports.

3. Real exchange rate of other competing countries currency to U.S. $,

4. Gross Domestic Product (GDP) for importing regions in U.S. $,

5. Competing import quantities from rest of the world in tons, and

6. U.S. wheat foreign market development and promotion expenditures in U.S. $.

Both the U.S. and competing country prices were computed as unit values, equal to the value of imports in U.S. dollars to the region divided by the quantity of imports, and the data source was Global Trade Information Services. The ratio of the U.S. to competing country import price was used in the demand equation because importers base their demand decision on the relative import prices from the U.S. vs. other exporters of wheat. The U.S. price was expected to be negatively related to U.S. imports, i.e., a lower price would result in higher U.S. import quantity demanded reflecting the law of demand. The import price of all other competitors to the U.S. was included to reflect the price of competitors to U.S wheat. The relationship between the competitors' price and the demand for U.S. wheat was expected to be positive because other country wheat is a close substitute with U.S. wheat.

Each mega-region's Gross Domestic Product (GDP), exchange rate, and Consumer Price Index (CPI) data came from the U.S. Department of Agriculture, Economic Research Service's international macroeconomic data. GDP is expressed in dollars and is the sum of all countries GDP in each region. The exchange rates are agricultural trade adjusted exchange rates computed by USDA. The CPI is a weighted average CPI of all countries in each region. The relationship between importing region real, inflation adjusted GDP and the demand for U.S. wheat was expected to be positive, i.e., as countries become wealthier, the demand for U.S. wheat should increase. The relationship between the demand for U.S. wheat and the importing region currency relative to the U.S. dollar was expected to be negative; as the value of the dollar depreciates, the demand for U.S. wheat increases since it is now cheaper to import U.S. wheat. The relationship between the demand for U.S. wheat and the competing exporters' currency relative to the U.S. dollar was expected to be positive; if the competing exporter's currency declines in value relative to the U.S. dollar, its exports become cheaper and cause U.S. import demand to decline.

Another measure of the impact of competing wheat exporting countries on the demand for U.S. wheat is the import quantity of other countries to the importing region. The sum of wheat imports from the major competing countries for each region was included in the model. This variable was expected to be negatively related with the demand for U.S. wheat since the two are substitutes with one another. This variable was included in the model because past purchasing behavior by importers likely has an impact on imports independent of relative prices. For example, an importer is familiar with the wheat purchased from a specific region, may have personal relationships that come into play, and would be familiar with the purchasing process and logistics. All these factors may impact U.S. import demand in addition to price differences. This data also came from Global Trade Information Services.

Unlike the majority of previous studies, which only considered USDA/FAS expenditures for U.S. foreign market development (export promotion) due to lack of data (see, for example, Dwyer (1995) and Wang (2005)), this analysis combines USDA/FAS MAP and FMDP expenditures with private cooperator expenditures from USW to measure the total export promotion impact and the data source was USW. U.S. wheat export promotion, or foreign market development expenditures, promote U.S. wheat by implementing various promotional programs in importing regions such as technical assistance, public relations, advertising, and trade servicing. In recent years, approximately 70% of expenditures for export promotion have come from USDA/FAS and the remaining 30% have come from wheat producers. For the econometric estimation, only non-administrative demand enhancing expenditures were included for export promotion expenditures. Administrative expenses, which are later included in the calculation of the benefit-cost ratio, were not included in the estimation because they do not directly impact import demand. Wheat export promotion expenditures were deflated by the importing region's Consumer Price Index to account for inflation since 1994. Export promotion generally has a carryover effect, i.e., promotion today

has demand impacts tomorrow. To deal with this, preliminary regressions with one- and two-year lags were performed; however, they resulted in statistically insignificant coefficients for the lagged variables. Hence, the data did not support lagging export promotion. This did not mean that there was no carryover effect for export promotion. Rather, it meant that because annual data was the time frequency being used, the carryover effect was not significant for longer than one year.

Aggregate Mega-Region Model

The import demand model was estimated in logarithmic form with annual data from 1994 through 2014 and the four mega-regions. Hence there were 84 observations (4 x 21) in total. Because autocorrelation was detected[2], an auto-regressive error term (AR1) was appended to the regression so the resulting equation is subsequently free from autocorrelation. The panel data model was estimated using cross-sectional fixed effects, and a generalized least squares seemingly unrelated regression method.[3] The R-squared, which is a measure of how well the demand determinants explain the demand for U.S. wheat, indicated that the demand determinants explained about 84% of the variations in U.S. wheat import demand. The elasticity signs were consistent with economic theory and all estimated coefficients were statistically significant at better than the 10% significance levels. No other econometric problems were encountered. The estimated elasticities are presented in Table 1.

The estimated import demand equation indicated that the prices of U.S. and competing country wheat were marginally important factors in explaining annual variations in demand for U.S. wheat imports. The estimated own-price elasticity was -0.205 indicating that a 1% increase in the U.S. wheat price relative to the wheat price in competing countries resulted in a 0.205% decrease in U.S. wheat imports, holding all other demand determinants constant. Alternatively, a 1% increase in the competing countries wheat price relative to the U.S. wheat price resulted in a 0.205% increase in U.S. wheat imports, holding all other demand determinants constant. This coefficient was marginally statistically significant with a p-value < 0.12. While this estimate was more inelastic than expected, the two exchange rate variables probably capture part of the price effect for importers.

Table 1. Estimated Elasticities for U.S. Wheat Import Demand.*

Demand Factor	Elasticity	p-value**
U.S. price/competing country price	-0.205	0.117
Importing country exchange rate vs. U.S. dollar	-0.750	0.009
U.S. export competitors exchange rate vs. U.S. dollar	0.462	0.004
Importing regions' Gross Domestic Product	1.245	0.075
Competing country export quantity	-0.418	0.007
U.S. export promotion	0.168	0.005
R-square	0.84	

*A demand elasticity measures the percentage change in U.S. wheat imports given a 1% change in each demand factor, holding constant all other demand factors. For instance, the estimated U.S. price elasticity in this table means a 1% increase in the U.S. wheat price relative to the wheat price in competing countries leads to a 0.205% decrease in U.S. wheat imports to all mega-regions.

[2] Autocorrelation, or serial correlation as it is sometimes called, is a statistical problem related to a variable not displaying randomness over time, but rather a pattern. In statistical models, randomness is a central assumption in determining if a univariate statistical process is in control. If autocorrelation is detected, then an AR correction term needs to be appended to the error term in the model, which was done here.

[3] The fixed effect estimator is useful for looking at the impact of export promotion on U.S. wheat demand over time within each region. Generalized seemingly unrelated regression is a statistical technique that is more efficient than its counterpart, ordinary least squares, and was used for this reason.

**A p-value is a measure of the statistical significance level for the estimated elasticity and can range in value from 0 to 1. The lower the p-value, the more statistically significant the elasticity is from zero. Generally, an elasticity with a p-value that is less than 0.1 is considered statistically significant.

Both U.S. and competing exporting countries' exchange rates were important factors impacting the demand for U.S. wheat. The value of the U.S. dollar was negatively associated with U.S. import demand and was highly statistically significant. The estimated elasticity was -0.75, indicating a 1% increase in the value of the U.S. dollar relative to the importing region's currency led to a 0.75% decrease in U.S. wheat imports, holding all other demand determinants constant. Relatedly, the exchange rate between competing countries and the U.S. dollar was a statistically significant factor impacting U.S. wheat imports. The estimated elasticity was 0.462 implying that a 1% increase in the value of competing countries' currency value increased U.S. wheat imports by 0.462%, holding all other import demand factors constant.

GDP in importing regions was positively related with U.S. wheat import demand and was the most important demand factor influencing U.S. wheat imports. The estimated income elasticity was 1.245 and statistically significant, i.e., a 1% increase in these countries' GDP resulted in a 1.245% increase in U.S. wheat imports, holding all other factors constant. Hence, the demand for U.S. wheat is what economists refer to as a "normal good;" demand increases as consumer income increases.

The quantity of imports from competing country had a negative and statistically significant impact on U.S. imports, indicating a substitute relationship between U.S. and other country wheat. A 1% increase in competing country exports resulted in a 0.418% decrease in U.S. imports, holding all other demand determinants constant.

Finally, and most importantly for this analysis, U.S. wheat export promotion had a positive and statistically significant impact on U.S. wheat import demand. The statistical evidence supports the notion that U.S wheat export promotion programs, which are funded by public-private contributions, have the effect of increasing the import demand for U.S. wheat. The estimated export promotion elasticity was 0.168. That is, holding all other demand factors constant, a 1% increase in U.S. wheat export promotion expenditures (recall that these do not include the administrative expenses since they are not demand enhancing) resulted in a 0.168% increase in U.S. imports. Based on the last 5 years of data, this promotion elasticity implies that a 1% increase in U.S. wheat export promotion would increase wheat exports by 48,137 tons per year with a total (gross) value of $14.8 million per year.[4]

The estimated promotion elasticity of 0.168 was within the range of other estimates for U.S. export promotion. Table 2 presents the results from previous export promotion evaluation studies in the row labeled "Estimated promotion elasticities." There were 39 U.S. export promotion elasticities reported in this table for various commodities and various importing countries. These estimates range from a low of 0.014 to a high of 0.98, and the median elasticity (half the values lie below the median and half lie above it) was 0.09. Therefore, the estimated U.S. wheat export promotion elasticity in this current study was about 1.9 times larger than the median estimates for 39 promotion elasticities.

In 2009, a similar study was conducted on the economic effectiveness of U.S. wheat export promotion by Kaiser. In the 2009 study, Kaiser found the U.S. wheat export promotion elasticity to be 0.295, which is higher than the current estimate of 0.168. However, these results are not directly comparable since a different data set (FAOSTAT) was used and an export demand model rather than import demand model was estimated.

[4] This calculation is based on multiplying 0.00168 times 28.65 million tons, which was the average level of imports to these four regions in the last four years.

Simulation and Benefit-Cost Analysis of Aggregate Mega-Region Model

According to the metric results, it is clear that wheat export promotion expenditures

Table 2. Key results from economic impact studies on U.S. export promotion.

	California raisins	US orange juice	US orange juice	US fresh grapefruit	US apples	US apples
Study	Kaiser (2010)	Lee and Brown (1986)	Armah and Epperson (1997)	Fuller, Bello, and Capps (1992)	Rosson, Hammig, and Jones (1986)	Richards and Patterson (1997)
Activities evaluated	Industry and FAS programs	Three Party program	Industry and FAS programs	FAS Three Party and TEA programs	Industry and FAS programs	Industry and FAS programs
US export promotion in:	12 countries	13 European countries	France, UK, Germany, Japan Netherlands	Japan, Canada, France, and Netherlands	All countries US has programs in	Singapore and UK
Period of estimation	1996-2008	1973-82 (panel data)	1984-92 (panel data)	1969-88 quarterly	1972-81	1962-93
Type of model	Import demand	Import demand, single equations	Export demand, single equation	Import demand, single equations	Export demand single equations	Import demand, LES/AIDS demand systems
Estimated promotion elasticities	0.204	Promotion elastitcities not given	France=0.014 Germany=0.044* Japan=0.014 Netherlands=0.302* UK=0.014*	Japan=0.109* Netherlands=0.153* France=0.234*	Apples=0.51*	Singapore=0.055* UK=0.016*
Estimated benefit-cost ratio	Overall ABCR=3.49	For all countries, MBCR=5.51	MBCRs: France=7.44 Germany=37.10 Japan=5.61 Netherlands=51.92 UK=7.64	MBCR:Japan=5.02 Netherlands=6.65 France=4.13 Canada=no promotions	MBCR=60.0	NA
Assumed no promotion price impact	Yes	Yes	Yes	Yes	Yes	NA

Notes: ABCR means average benefit-cost ratio; MBCR means marginal benefit-cost ratio. * Means statistically significant at conventional significance levels, i.e., at least the 10% level.

Table 2. Key results from economic impact studies on U.S. export promotion.

	CA table grapes	US frozen potatoes	US pecans	US walnuts	US almonds	US cotton
Study	Alston et al. (1997)	Lanclos, Devodoss, and Guenthner (1997)	Onunkwo and Epperson (2000)	Weiss, Green, and Havenner (1996)	Halliburton and Henneberry (1995)	Solomon and Kinnucan (1993)
Activities evaluated	Industry and FAS programs	Industry and FAS programs	Industry and FAS programs	Industry and FAS programs	FAS FMD and MPP programs	FAS programs
US export promotion in:	Asian countries	Japan, Mexico, Philippines, Thailand	Asia and EU	Japan	Japan, Taiwan, Hong Kong, Singapore, South Korea	6 countries in the Pacific Rim
Period of estimation	1976-94	1978-93	1986-96 (panel data)	1986-96 (monthly data)	1986-92 (panel data)	1965-85
Type of model	Single equation, export demand	Import demand, single equations	Export demand, single equation	Event analysis	Import demand, single equations	Armington trade model
Estimated promotion elasticities	0.21*	Third Party: Japan=0.03* Philippines=0.53* Thailand=0.87*	Asia=0.98* EU=0.06*	$1000 in promotion increased exports by 4.5 tons	3 models range from -0.2788 to 0.85	Japan=0.53* South Korea=0.045* Hong Kong=0.21* Philippines=0.26* Thailand=0.045 Taiwan=-0.54
Estimated benefit-cost ratio	ABCR: 4.1-9.4 MBCR: 4.1-4.2	Third Party MBCRs: Japan=1.29 Philippines=11.77 Thailand=16.36	Asia: MBCR=6.45 EU: MBCR=6.75	MBCR=5.85	MBCRs: Japan=4.95 Taiwan=5.94 Hong Kong=3.69	NA
Assumed no promotion price impact	No	Yes	Yes	Yes	Yes	NA

Notes: ABCR means average gross benefit-cost ratio; MBCR means marginal gross benefit-cost ratio.
* means statistically significant at conventional significance levels, i.e., at least the 10% level.

Table 2. Key results from economic impact studies on U.S. export promotion.

	US red meat	US red meat	US soybeans	All US food exports
Study	Le, Kaiser, and Tomek (1998)	Comeau, Mittelhammer, and Wahl (1997)	Williams et al. (1998)	Dwyer (1995)
Activities evaluated	FAS FMD and TEA programs	FAS MPP and TEA programs	Industry and FAS programs	FAS programs
US export promotion in:	S. Korea, Taiwan, Hong Kong, Singapore	Japan	EU, Japan, and Rest of the World	World
Period of estimation	1984-94 (panel data)	1973-94	1969-96	1975-92
Type of model	Import demand, single equations	Inverse Almost Ideal Demand System	SOYMOD world market model	Armington trade model
Estimated promotion elasticities	Korea=0.598* HK=-0.019 Taiwan=0.047 Singapore=0.034	Japan price flexibilities wrt promotion ranged from 0.11* to 0.128*	Soybeans:EU=0.0234* Japan=0.0367* ROW=0.068* Soymeal:EU=0.0445* Japan=0.0733* ROW=0.0516* Soyoil:EU=0.0446* Japan=0.0323* ROW=0.0156*	Short-run=0.0135* Long-run=0.15*
Estimated benefit-cost ratio	MBCR=15.62 to 47.32 for all 4 countries	MBCR for beef ranged from 15.56 to 18.11	ABCR:13.5 (1978-89) 5.3 (1990-94) 11.3 (1978-94)	ABCR=16.0
Assumed no promotion price impact	Yes	Yes	No	Yes

Notes: ABCR means average gross benefit-cost ratio; MBCR means marginal gross benefit-cost ratio.

- means statistically significant at conventional significance levels, i.e., at least the 10% level.

Table 2. Key results from economic impact studies on U.S. export promotion.

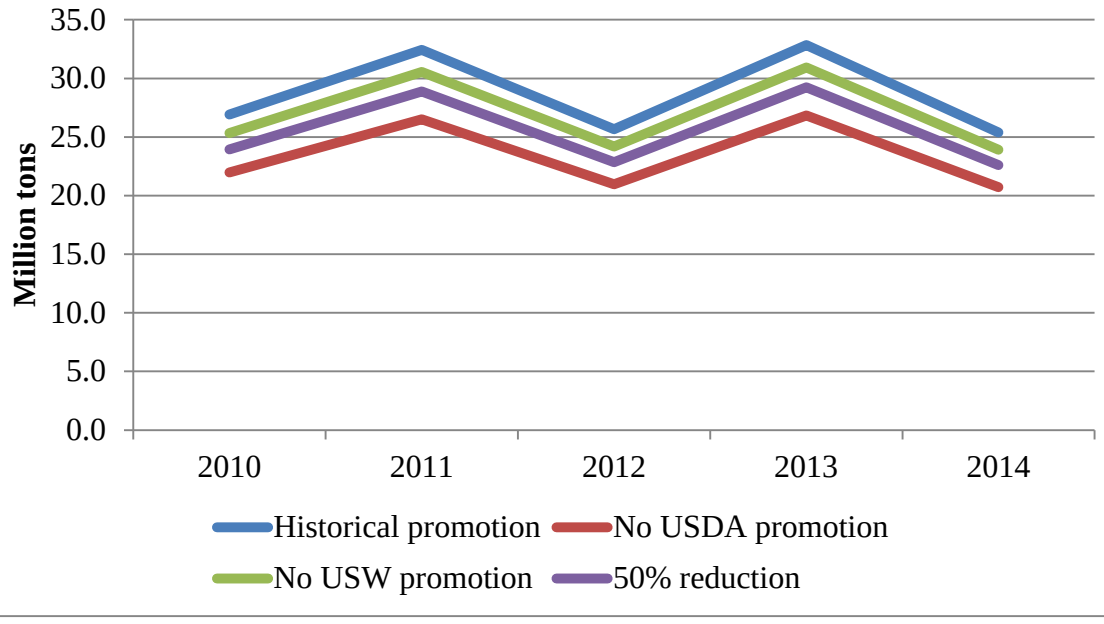
	US Beef	US pork	US frozen potatoes	All US food	US Wheat
Study	Kaiser (2014)	Kaiser (2012)	Richards and Kaiser (2012)	Global Insight (2010)	Kaiser (2009)
Activities evaluated	FAS FMD and MAP programs	FAS MAP and FMD programs	Industry and FAS programs	All FAS programs	USW and FAS export programs
US export promotion in:	World	World	Seven importing regions	World	World
Period of estimation	1985-2013	1984-2010	2007-2011	1975-2010	1975-2007
Type of model	Export demand, single equations	Export demand, single equations	Export demand, single equations	Armington trade model	Export demand, single equation
Estimated promotion elasticities	0.167*	0.302*	0.063*	0.186* high valued products 0.192* bulk products	0.295
Estimated benefit-cost ratio	MBCR=14.2	MBCR=19.1	MBCR=4.93	ABCR=14.6	ABCR=12.29 (average)
Assumed no promotion price impact	No	No	No	No	No

Notes: ABCR means average gross benefit-cost ratio; MBCR means marginal gross benefit-cost ratio.
* means statistically significant at conventional significance levels, i.e., at least the 10% level.

had a positive and statistically significant impact on U.S. wheat imports to the four mega-regions considered in this analysis. Next, the estimated import demand equation was simulated for several alternative U.S. export promotion expenditure levels to address the second and third set of research questions. Specifically, four scenarios were simulated: (1) a baseline scenario in which export promotion programs were in effect, and expenditures on U.S. export promotion were set at actual levels; (2) a counterfactual scenario, where U.S. wheat export promotion expenditures were set at 50% of their actual levels, (3) a counterfactual scenario, where USDA wheat export promotion expenditures were eliminated, but USW expenditures were not, and (4) a counterfactual scenario, where USW wheat export promotion expenditures were eliminated, but USDA expenditures were not.[5] The difference between the first and second scenarios provided a measure of the impact of a 50% reduction in export promotion expenditures on the demand for U.S. wheat imports. The difference between the first and the third (or the fourth) scenario provided a measure of the impact of USDA (or USW) export expenditures on the import demand for U.S. wheat. The model was simulated for the more recent 5-year period of 2010 through 2014.

Figure 1 presents the simulation results for these four alternative export promotion expenditure scenarios. The 50% reduction in U.S. wheat export promotion expenditures would have decreased U.S. wheat imports by a total volume of 15.8 million tons from 2010 through 2014, or an average of 3.2 million tons per year. In percentage terms, this represented a reduction of 11% over this period. Therefore, U.S. wheat export promotion has had a very large impact on total U.S. wheat imports.

Figure 1. U.S. Wheat Exports Under Alternative Export Promotion Expenditure Scenarios.



Had there not been any USW export promotion for wheat over this period, but USDA funding, U.S. wheat exports would have averaged 8.3 million tons lower over this entire period, or an average of 1.7 million tons per year. In percentage terms, this is a 5.8% reduction in imports. Had there not been USDA export promotion for wheat over this period, but USW funding, U.S. wheat exports would have averaged 26.3

[5] The last two scenarios are based on the assumption that USDA provided 70% of total export promotion expenditures and USW 30% over this period. In other words, the no-USDA scenario is simulated as a 70% reduction in export promotion expenditures and the no-USW scenario is simulated as a 30% reduction in export promotion expenditures.

million tons lower over this period, or an average of 5.3 million tons lower per year. In percentage terms, this is an 18.3% reduction in imports.

Benefit-cost analysis: While the above results indicated a positive impact of export promotion on U.S. wheat imports to the four mega-regions, the impact that export promotion has on wheat producer net revenue compared with its cost was a more important question to be addressed. That is, a benefit-cost ratio (BCR) should be computed. The benefit of export promotion is the additional net revenue to the wheat producer due to higher U.S. exports and price. The cost of export promotion is the cost of conducting export promotion programs.

The increase in U.S. wheat import demand due to promotion just described assumed that all other demand determinants, including price, remained constant. However, an increase in demand generally will cause price to increase as well, provided that the demand increase is not perfectly offset by an increase in quantity supplied. Hence, to properly evaluate the full effect of U.S. wheat export promotion programs on quantity and price, an export supply response for U.S. wheat must be incorporated into the model.

To do this, an approach similar to the one used by Alston et al. was used in the simulation. In this approach, the export supply response was incorporated using a constant elasticity form and equated with predicted export demand quantities. Changes in export demand due to U.S. wheat export promotion then affected the level of production and price. The change in net benefits due to export promotion programs were computed for each year (2010 through 2014) as the difference in net revenue (ΔNR) between the two scenarios defined below, which mathematically equals

$$\Delta NR_t = (P_tQ_t - P_t'Q_t')\, M_t,$$

where P_tQ_t represents total revenue for the scenario with 100% export promotion expenditures and $P_t'Q_t'$ represents total revenue for the scenario with 99% export promotion expenditures[6], and M_t represents a net margin factor for U.S. wheat imports which transforms total into net revenue.[7]

By equating the equations for export supply and import demand and solving for world market equilibrium, the actual U.S. prices and predicted quantities were obtained (from the import demand model) using the actual values for the explanatory variables. The counterfactual scenario was then simulated assuming a 1% reduction in export promotion expenditures by setting the values at 99% of their actual levels in each year. Five assumed values for export supply elasticities were used, which ranged from 1.0 to 3.0 in order to examine a broad range of elasticities. The Economic Research Service of USDA has an estimate of 1.6 for the export supply elasticity (price). That is, they compute that a 1% increase (decrease) in the wheat price would result in a 1.6% increase (decrease) in export quantity supplied, holding all other supply factors constant. The marginal BCR was then computed for each export supply elasticity as:

$$BCR = \Delta NR/\Delta COST, \text{ where}$$

ΔCOST is the difference in non-administrative and administrative costs of USW export promotion programs for the 99% and 100% funding scenarios. Note that unlike the econometric estimation of the model, the calculation of the BCR includes administrative costs of export promotion.

Table 3 presents average annual impacts and marginal BCRs for U.S. wheat export promotion efforts over the various assumed own-price elasticities of export supply using the import demand results. This table gives a measure of how prices, net revenue, and BCRs would change based on a 1% change in U.S. wheat export promotion expenditures. For example, the average increase in price ranged from 1.28 cents per bushel, in the case of the most inelastic supply response (1), to 0.42 cents per bushel per ton,

[6] The resulting BCR based on the difference in net revenue and costs for this very small (marginal) 1% change here is referred to as a marginal BCR. Marginal BCRs are a very popular way to measure the incremental benefits vs. costs of promotion programs (e.g., the majority of BCRs reported in Table 2 are marginal BCRs.

[7] Following the same procedure Kaiser (2009) used, it was assumed that the net margin factor was equal to 10%, which is based on 2008 USDA data. Specifically, the average baseline wheat price by USDA/AMS for 2009/10 was $4.85 per bushel (http://www.usda.gov/oce/commodity/wasde/latest.pdf). In 2008, the national average operating and ownership costs for wheat was $4.24 per bushel. The $0.61 per bushel margin as a percent of the 2009/10 baseline U.S. wheat import price ($6.50) is 9.4%, which is very close to the 10% net margin used in this study. The net margin factor was also set to 5% and 1% and the results are reported after the 10% results.

in the case of the most elastic supply response (3). The magnitude of price impacts declined as the assumed supply response became larger because producers under larger supply responses further dampened the positive price impacts of the promotion-induced increased demand by increasing the quantity supplied to the world market relative to smaller supply response scenarios. That is, the more elastic export supply, the larger the "rent dissipation" effect, i.e., longer term gains in net revenue due to effective promotion results in increased production and consequently a dampening of the increase in price. For [illegible] (not shown in Table 3), which was the ERS reported elasticity, the increase in price was 0.80 cents per ton.

U.S. wheat export promotion also had a positive impact on net revenue over this period. The marginal increase in wheat producer net revenue due to a 1% increase in wheat export promotion ranged from $2.96 million per year in the case of the least elastic supply response ([illegible]) to $1.98 million per year in the case of the most elastic supply response ([illegible] = 3). The same elasticities and net revenue occurred, i.e., the more elastic the supply elasticity, the smaller the increase in net revenue due to promotion. For [illegible] = 1.6, the increase in net revenue was $2.4 million per year. It is clear that U.S. export promotion has had a significant and positive impact on wheat producer net revenue over this time period.

Table 3. Average Annual Marginal Impacts and Marginal Benefit-Cost Ratios due to 1% Change in U.S. Wheat Export Promotion, 2010-14.

Export supply elasticity =>	1.0	1.5	2.0	2.5	3.0
Change in producer price (cents/bu)	1.28	0.86	0.64	0.52	0.42
Change in producer net revenue ($1,000)	2,961	2,469	2,222	2,074	1,975
Change in promotion costs ($1,000)	166	166	166	166	166
Marginal benefit-cost ratio	17.89	14.91	13.42	12.53	11.93

How did the gain in wheat producer net revenue compare with the costs of export promotion? To answer that question, a marginal BCR was computed (see the bottom row of Table 3). The marginal BCR exceeded 1.0 for every supply response considered in the simulation. For the least elastic supply response ([illegible] = 1), the marginal BCR was 17.89. This implies that, on average over the period 2010-2014, an extra $1.00 spent on U.S. export promotion programs would have returned $17.89 in incremental net revenue to U.S. wheat growers. At the opposite end of the spectrum in supply response ([illegible] = 3), the marginal BCR was 11.93. For [illegible] = 1.6, the BCR was 13.64. Clearly, U.S. wheat export promotion has a large and beneficial impact for the wheat sector.

Because wheat producers pay for roughly 30% of the export promotion programs (USDA/FAS pays for the other 70%), the BCR to wheat producers is actually about three times higher than those reported in Table 3. Clearly, U.S. wheat export promotion has a large and beneficial impact for the economy.

Sensitivity Analysis on the Net Margin Factor: To determine how sensitive the average BCRs were to the assumed net margin factor, the model was resolved using 5% and 1% factors instead of the original 10% factor. The results are presented in Table 4. When a 5% net margin factor is assumed, BCRs are still well above 1.0 for all assumed supply responses, ranging from a high of 8.94 ([illegible] = 1) to a low of 5.97 ([illegible] = 3). When a 1% net margin is assumed, the BCRs are still above 1.0 for all assumed supply responses, ranging from a high of 1.79 ([illegible] = 1) to a low of 1.19 ([illegible] = 3). Even if margins shrink from 10% all the way down to 1%, U.S. wheat export promotion is still profitable for wheat producers.

Table 4. Benefit-Cost Ratios for Models 1 and 2 with Net Margin Factors of 5% and 1%.

Assumed supply elasticity =>	1.0	1.5	2.0	2.5	3.0
Benefit-cost ratio (0.05)	8.94	7.46	6.71	6.27	5.97
Benefit-cost ratio (0.01)	1.79	1.49	1.34	1.25	1.19

Disaggregated Mega-Region Model

It is clear from the above analysis that U.S. wheat export promotion had a statistically significant impact on U.S. wheat imports for all four mega-regions combined for the period 1994-2014. In order to see how the export promotion elasticity varied over the four regions, the previous aggregate import demand model above was re-estimated by disaggregating the export promotion variable into four variables representing each mega-region. This was accomplished by including four slope dummy variables for each region interacted with export promotion expenditures. All the other demand drivers from the previous model were also included as well.

The disaggregated regional import demand model was estimated in logarithmic form with annual data from 1994 through 2014. Because autocorrelation was detected, an auto-regressive error term (AR2) was appended to the regression so the resulting equation is subsequently free from autocorrelation. Unlike the aggregate model, which used a fixed effects estimator, the disaggregated model did not use a fixed effects model because we were interested in each region's promotion elasticity. The R-squared indicated that the equation explained about 88% of the variations in U.S. wheat import demand. The elasticity signs were consistent with economic theory and all estimated coefficients (except price) were statistically significant at better than the 10% significance levels. No other econometric problems were encountered. The estimated elasticities are presented in Table 5.

The prices of U.S. and competing country wheat were not statistically significant in this model. The estimated own-price elasticity was -0.067 indicating that a 1% increase in the U.S. wheat price relative to the wheat price in competing countries resulted in a 0.067% decrease in U.S. wheat imports, holding all other demand determinants constant. Alternatively, a 1% increase in the competing countries wheat price relative to the U.S. wheat price resulted in a 0.067% increase in U.S. wheat imports, holding all other demand determinants constant. One explanation for the insignificance of this variable is that the two exchange rate variables are probably capturing most of the price effect for importers.

Indeed both U.S. and competing exporting countries' exchange rates were the two most important factors impacting the demand for U.S. wheat. The value of the U.S. dollar was negatively associated with U.S. import demand and was highly statistically significant. The estimated elasticity was -1.016, indicating a 1% increase in the value of the U.S. dollar relative to the importing region's currency led to a 1.016% decrease in U.S. wheat imports, holding all other demand determinants constant. Relatedly, the exchange rate between competing countries and the U.S. dollar was a statistically significant factor impacting U.S. wheat imports. The estimated elasticity was 0.779 implying that a 1% increase in the value of competing countries' currency value increased U.S. wheat imports by 0.779% holding all other import demand factors constant.

GDP in importing regions was positively related with U.S. wheat import demand. The estimated income elasticity was 0.643 and statistically significant, i.e., a 1% increase in these countries' GDP resulted in a 0.643% increase in U.S. wheat imports, holding all other factors constant.

The quantity of imports from competing country had a negative and statistically significant impact on U.S. imports, indicating a substitute relationship between U.S. and other country wheat. A 1% increase in competing country exports resulted in a 0.507% decrease in U.S. imports, holding all other demand determinants constant.

Table 5. Estimated Elasticities for the Regionally Disaggregated U.S. Wheat Import Demand.*

Demand Factor	Elasticity	p-value
U.S. price/competing country price	-0.067	0.038
Importing country exchange rate vs. U.S. dollar	-1.016	0.000
U.S. export competitors exchange rate vs. U.S. dollar	0.779	0.004
Importing regions' Gross Domestic Product	0.643	0.004
Competing country export quantity	-0.507	0.000
U.S. export promotion to Latin America	0.206	0.140
U.S export promotion to Africa-Mid East	0.244	0.075
U.S. export promotion to Asia	0.278	0.004
U.S export promotion to Europe	0.060	0.390
R-square	0.88	

Finally, and most importantly for this analysis, U.S. wheat export promotion had a positive and statistically significant impact on U.S. wheat import demand. An F-test was conducted to determine whether the combined impact of all four regional export promotion elasticities had a significant impact on U.S. wheat imports to the four mega-regions. The F-test was highly statistically significant (critical value of 6.387, which is significant at better than the 0.001 level) indicating that promotion had a significant impact on U.S. imports. These results are consistent with the previous, aggregated model. However, the elasticities were not the same for each region. Specifically, U.S. wheat export promotion had its largest impact in Asia and smallest impact in Europe. The ranking of magnitudes of the export promotion elasticities—Asia, Africa-Mideast, Latin America, and Europe—may be explained by the amount of export promotion spent in each market. For instance, for the entire period 1994-2014, Asia had the most combined USW and FAS spending on promotion ($6.075 million per year on average) followed by Africa-Mideast ($4.549 million per year on average). While Latin America had a higher elasticity than Europe, Europe had similar but slightly higher promotion expenditures ($1.8 million for Europe vs. $1.5 million for Latin America) than Latin America.

An important caveat on this model needs to be acknowledged regarding the estimated promotion elasticity in Africa-Mideast. Around 2002 with the emergence of the Black Sea wheat exporters, there was a significant decline in U.S. imports to this region. USW responded to this by sharply decreasing its export promotion expenditures in this market. There is an obvious positive correlation between the decline in U.S. imports in this region and the resulting decrease in U.S. wheat export promotion expenditures. However, while there is a positive correlation, it is not likely that the change in promotion is causing the change in imports. It is equally likely that the reverse is true, i.e., USW decreased its promotion expenditures because of the decline in imports, and the decline in imports was likely the result of another factor, namely the emergence of the Black Sea exporters who took market share away from the U.S. by selling at lower prices. As a result, the estimated promotion elasticity for the Africa-Mideast region may be problematic, and one should use caution in making any implications about its magnitude. The other three regions do not have this problem.

Marginal BCRs for each mega-region were computed using the same simulation procedures as before for the case of an export supply elasticity equaling 3.0 (Table 6). The marginal BCRs were above 1 for every region indicating that the benefits to USW export
promotion exceeded the costs in each region. However, the results varied significantly across the four mega-regions.

The largest return was from Latin America, where an extra dollar invested in U.S. wheat export promotion returned $24.36 in net revenue. At the opposite extreme was Europe, where an extra dollar returned $1.18.

Impact of the Black Sea Wheat Exporters on U.S. Wheat Promotion Effectiveness

The final question addressed in this report is did the emergence of the Black Sea wheat exporting countries in the early 2000s reduce the effectiveness of U.S. wheat export promotion? USW's promotional strategy has been built around the idea that the five classes of U.S. wheat each have unique qualities that makes it suitable for specific types of products. By helping U.S. wheat importers to optimize the use of the wheat to make those products, USW in many cases was able to convince importers that U.S. wheat was worth a modest premium over wheat from other origins. As a result, U.S. wheat was not only the largest single country exporter throughout nearly all of the time period, but also was the most expensive when comparing each class with its closest competitor.

Table 6. Marginal BCRs for Each Mega-Region based on Export Supply Elasticity of 3.0.

Region	BCR
Asia	11.35
Europe	1.18
Africa-Mideast	10.83
Latin America	24.36

The emergence of Black Sea exporters undermined that strategy in several ways. For one thing, Black Sea exporters often have been willing to sell at substantially lower prices compared to what comparable wheat was offered for. There are various reasons for that, including how farmers (often corporations) acquired the land for very low cost and the lack of financing and storage that would allow growers to market their wheat more effectively. About one-third of the total world trade in wheat is imported by countries around the Mediterranean and in the Mideast. Thus, the Black Sea exporters were uniquely positioned to offer shipments in small volumes (often river going barges) with very quick delivery times. This further minimizes costs for importers since they do not have to buy far in advance and do not have to finance large shipments. These cost advantages exceeded any interest these markets had in paying a little extra for quality wheat. Those developments have pretty well shut the U.S. out of a large part of the world wheat trade and a part of the world, which previously had been important to U.S. wheat exports.

The Black Sea exporters also significantly expanded world trade in wheat by greatly expanding shipments of feed wheat. A large share of Black Sea wheat, especially from the Ukraine, but also Russia at times, has been imported as feed. Most of the expansion in world trade since 2004 has been taken by the Black Sea exporters. U.S. exports have varied from year, but the overall trend has been pretty flat. Some of these Black Sea cost and logistical advantages also took some market share in Europe as well, but there were other developments there that have had an effect. The Europeans have traditionally bought U.S. and Canadian spring wheat to improve (increase the protein level) their own bread wheat. However, their wheat has improved over the last ten years or so, which has reduced their need for high protein imports. They also can sometimes get similar quality spring wheat from Kazakhstan (with the same Black Sea advantages discussed above) though Kazakh wheat is not always available. Another big factor likely has been the long economic downturn in Europe, which has encouraged them to make do with domestic wheat if at all possible rather than paying something extra for imports.

To measure whether the emergence of the Black Sea exporters weakened the effectiveness of USW promotion, the aggregate model was re-estimated by including a "Black Sea exporter" dummy variable. Specifically, the variable applied to the two mega-regions it became a force in, Europe and Africa-Mid East, and was equal to 0 in those regions for 1994-2001 and equal to 1 for 2002-2014. This dummy variable was interacted with the promotion variable. It was hypothesized, based on the reasoning above, that the coefficient on this variable would be negative, which would indicate that USW promotion effectiveness was weakened due to the emergence of the Black Sea exporters.

The results indicate that the emergence of the Black Sea exporters did, in fact, lower the export promotion elasticity for U.S. wheat. Specifically, regression results indicated that the promotion elasticity was 12.4% lower after the emergence of the Black Sea exporters than it was for the period 1994-2001. This result was statistically significant at the 0.001 significance level.

Conclusions

The purpose of this study was to measure the economic impacts of the generic export promotion programs operated by USW. USW operates foreign market development programs in countries around the world with its primary mission to increase U.S. wheat exports, and is financed by checkoff dollars from 19 state wheat commissions and cost-share grants from the USDA's Foreign Agricultural Service. The economic evaluation was based on an econometric model of U.S. wheat import demand in Europe, Asia, Latin America, and Africa-Mid East combined for the time period 1994-2014. The econometric model was then used to simulate the market-wide impacts of alternative export expenditure scenarios involving the USW export promotion. Specifically, the following key questions were addressed:

1. What is the responsiveness of the import demand for U.S. wheat in the world market and the four mega-regions with respect to USW foreign market development programs?

2. What would U.S. wheat exports have been in the four mega-regions had there been a 50% reduction in wheat export promotion conducted by USW?

3. What would have been the impact on U.S. exports had there not been any USDA promotion and only USW promotion? Relatedly, what would have been the impact on U.S. exports had there not been any USW promotion and only USDA promotion?

4. How does the gain in export net revenue due to wheat export promotion compare to the costs of the promotion? That is, what is the benefit-cost ratio of these programs in total and in each of the four mega-regions?

5. How did the emergence of the Black Sea exporting countries in 2002 impact the promotion effectiveness of USW?

Regarding the first question, it was found that U.S wheat imports in each mega-region and in total were highly responsive to USW export promotion. An import demand promotion elasticity of 0.168 was estimated for overall imports in the four mega-regions, and it was highly statistically significantly different from zero, indicating that increasing U.S. wheat export promotion (non-administrative expenditures) by 1% would increase import demand for U.S. wheat by 0.168%, holding constant all other factors affecting the demand for U.S. wheat. In terms of the four mega-regions, Asia had the highest promotion elasticity (0.278) followed by Africa-Mideast (0.244), Latin America (0.206), and Europe (0.06). However, caution was advised in interpreting the estimated promotion elasticity for Africa-Mideast because of the emergence of the Black Sea wheat exporters in 2002, and USW's subsequent decision to sharply decrease export promotion in this region as a result. Consequently, while there was a positive correlation between export promotion and U.S. wheat imports in Africa-Mideast, it was not certain which factor was cause and which one was effect unlike the other three regions.

In terms of the second and third question posed in this research, the econometric model was simulated for the alternative export spending scenarios and the results indicated that a 50% reduction in U.S. wheat export promotion expenditures would have decreased U.S. wheat imports by a total volume of 15.8 million tons from 2010 through 2014, or an average of 3.2 million tons per year. In percentage terms, this represented a reduction of 11% over this period. Therefore, U.S. wheat export promotion has had a very large impact on total U.S. wheat imports. Had there not been any USW export promotion for wheat over this period, but USDA funding, U.S. wheat exports would have averaged 8.3 million tons lower over this entire period, or an average of 1.7 million tons per year. In percentage terms, this is a 5.8% reduction in imports. Had there not been USDA export promotion for wheat over this period, but USW funding, U.S.

wheat exports would have averaged 26.3 million tons lower over this period, or an average of 5.3 million tons lower per year. In percentage terms, this is a 18.3% reduction in imports.

Perhaps the most important question addressed in this research was the fourth regarding the benefits vs. costs of U.S. wheat export promotion. A marginal BCR was computed, which was equal to the average change in benefits due to a 1% change in export promotion divided by the 1% change in annual costs. The marginal BCR exceeded 1.0 for every supply response considered in the simulation. For the least elastic supply response (= 1), the margin
period 2010-2014, an extra $1.00 spent on U.S. export promotion programs would have returned $17.89 in incremental net revenue to U.S. wheat growers. At the opposite end of the spectrum in supply response (= 3), the margina
export promotion has a large and beneficial impact for the wheat sector.

Because wheat producers pay for roughly 30% of the export promotion programs (USDA/FAS pays for the other 70%), the actual BCR to wheat producers was actually about three times higher than those reported in Table 3. Clearly, U.S. wheat export promotion has a large and beneficial impact for the economy. The highest marginal BCR was for Latin America (24.36), followed by Asia (11.35), Africa-Mideast (10.83), and Europe (1.18). Again, the same caveat applies to the result for the Africa-Mideast mega-region.

The final question addressed in this report was did the emergence of the Black Sea wheat exporting countries in the early 2000s reduce the effectiveness of U.S. wheat export promotion? To measure whether the emergence of the Black Sea exporters weakened the effectiveness of USW promotion, the aggregate model was re-estimated by including a “Black Sea exporter” dummy variable. Specifically, the variable applied to the two mega-regions it became a force in, Europe and Africa-Mid East, and was equal to 0 in those regions for 1994-2001 and equal to 1 for 2002-2014. This dummy variable was interacted with the promotion variable. It was hypothesized, based on the reasoning above, that the coefficient on this variable would be negative, which would indicate that USW promotion effectiveness was weakened due to the emergence of the Black Sea exporters. The results indicated that the emergence of the Black Sea exporters did, in fact, lower the export promotion elasticity for U.S. wheat. Specifically, regression results indicate that the promotion elasticity was 12.4% lower after the emergence of the Black Sea exporters than it was for the period 1994-2001. This result was statistically significant at the 0.001 significance level.

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