Abstract

"Export Demand for U.S. Wheat." Carlos A. Arnade and Cecil W. Davison (ERS, USDA)

A 19-equation econometric analysis of demand for U.S. wheat exports, 1961-83, indicated importers' wheat production, importers' income, and the U.S. wheat price were major demand determinants. Average 1-year price, income, and exchange rate elasticities were inelastic; -.2 to -.4, .4 to .5, and -.06 to -.24, respectively.

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EXPORT DEMAND FOR U.S. WHEAT

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Since U.S. agricultural exports soared in the early 1970's, the nation's agricultural sector has become increasingly dependent on foreign markets. During the past 10 years, agricultural exports ranged from nearly $23 billion (fiscal 1976) to almost $44 billion (fiscal 1981), and are receding to below $28 billion in fiscal 1986. Within that time, 59 percent of domestic wheat production was shipped abroad.

Declining export values in 3 of the last 4 years exposed agriculture's dependence on foreign markets, and falling farm income triggered large Federal outlays in producer support payments. Farmers and policymakers interested in reversing the recent trend of declining exports need to know how to accomplish this mission. Consequently, the objectives of our study were to identify the major factors affecting the demand for U.S. exports of wheat, and quantify and rank those factors in order of importance.

Econometric Approach Preferred

Debate has intensified over the price elasticity of demand for U.S. agricultural exports. In Gardiner and Dixit's review, published estimates of price elasticities of U.S. wheat exports range from -6.72 to -0.14 (pp. 14-15). Each elasticity is contingent upon the method used, the time period of estimation, the type of data (monthly, quarterly, annual) and the quality of data available to researchers. Gardiner and Dixit noted that much of the

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past work, such as that of Tweeten (1967); Johnson (1977); Bredahl, Meyers, and Collins (1979); Dunmore and Longmire (1984), and Holland and Sharples (1984), has used the concept of excess foreign demand and domestic elasticities to calculate price elasticities of import demand. We think inconsistent estimates of domestic elasticities and problems providing an economic rationale for price transmissions hamper this approach.

Recent availability of long time series of worldwide macroeconomic data has enabled direct econometric estimation of elasticities. The advantage of this approach lies in isolating the impact of price and other variables on exports. For example, with one equation it is possible to obtain income, price, cross-price, and exchange rate elasticities. A further advantage of this approach is that all elasticities can be obtained using a consistent methodology over similar time periods, which is frequently not done with other methods. The econometric approach also allows researchers to test for changing elasticities. A major disadvantage of the econometric approach is the intense data requirements necessary to achieve useful estimates.

We econometrically estimated 19 country-specific and rest-of-world export demand equations for U.S. wheat using annual data from 1961 to 1983. Approximately 80 percent of U.S. wheat exports are captured by the 18 country-specific equations.

Results

Variables explaining or representing components of foreign demand for U.S. exports are ranked, according to their impact on U.S. exports, in table 1 if they were significant at the 10-percent level. Wheat production in importing countries emerged as the most important determinant of foreign demand for U.S. wheat. Income was second, followed by U.S. and Australian wheat prices and

Table 1--Ranking of foreign demand determinants by average annual impact on U.S. wheat exports, 1961-83

Market	Market share 1/	Ranking share 2/
Japan	.115	
Production		178
Freight rates		3/77
Soviet Union 4/	.109	
Production		2887
Population		1371
U.S. wheat price, Gulf		1165
EC	.088	
Production		192
Livestock		151
Exchange rate		3/98
China (variables not significant)	.083	
Egypt	.060	
U.S. wheat price, Gulf		105
Nominal GNP		62
Dummy variable for 1967 war		42
Brazil	.053	
Production		309
Real GNP		138
P.L. 480		49
India	.044	
Stocks of rice		977
Australian wheat price		673
U.S. wheat price, Portland		454
Production		406
Foreign exchange reserves		405
Korea	.042	
Real GNP		139
Exchange rate		81
Production		65
Venezuela	.025	
Freight rates		3/59
Nigeria	.022	
Average price of U.S. and Thai rice		283
Freight rates		3/84
Philippines	.022	
Nominal GNP		120
Exchange rate		29
Mexico	.020	
Production		358
Real GNP		101

Table 1--Ranking of foreign demand determinants by average annual impact on U.S. wheat exports, 1961-83--Continued

Market	Market share 1/	Ranking share 2/
Taiwan	.020	
U.S. wheat price, Portland		314
Real GNP		77
Exchange rate		15
Peru	.018	
Argentine wheat price		3/131
U.S. wheat price, Gulf		3/112
Foreign exchange reserves		67
P.L. 480		29
Chile	.014	
P.L. 480		61
Foreign exchange reserves		55
Freight rates		3/40
Dummy for Allende regime		12
Stocks of wheat		1
Portugal	.013	
Exchange rate		3/122
Morocco	.010	
P.L. 480		156
Production		3/112
Exchange rate		3/84
Foreign exchange reserves		76
Freight rates		42
U.S. wheat price, Gulf		3/36
Rest of world	.242	
Production		516
Foreign exchange reserves		262
Exchange rate		232
Dummy for 1980 USSR grain embargo		74
	1.000	

Total, excluding USSR	Right sign only	All signs included	Absolute values
Production	2024	1912	2136
Income (Real or nominal GNP or foreign exchange reserves)	1502	1502	1502
U.S. wheat price (Gulf or Portland)	873	725	1021
Australian wheat price	673	673	673
Exchange rate	357	53	661
P.L. 480	295	295	295
Livestock	151	151	151
Freight rates	42	218	302
Argentine wheat price		-131	131

1/ Average share of U.S. export market, 1961-83. 2/ The annual average variation in exports (1000 metric tons) associated with the annual average variation in the respective demand determinants (all significant at the 10% level). 3/ Wrong sign. 4/ From model of total wheat imports.

exchange rates. Elasticities are reported in tables 2 and 3. Our elasticities measure the average annual percentage change in exports from a one-percent change in the variable of interest, over 1961-83.

Customers' Wheat Production Largest Demand Determinant

Our results indicate that the most important variable affecting U.S. wheat exports was wheat production in importing countries, particularly in the Soviet Union, India, Mexico, and Brazil.

Foreign Income Ranked Second

Rising incomes, whether measured as real GNP or foreign exchange reserves, were the second major factor affecting U.S. exports of wheat from 1961 to 1983. In some countries, the impact comes not from high elasticities but from high rates of income growth.

We got low and insignificant income elasticities for the EC and Japan, both high income regions (table 2). This may support the theory of diminishing marginal propensity to consume food items, or concave Engel curves. Future increases of U.S. wheat exports to these regions will likely be due to factors other than rising incomes.

High income elasticities were estimated for Mexico, the Philippines, and Brazil, countries with fast-growing populations. Recent declines in real incomes in these countries may explain some recent declines in U.S. exports. Equations with lower income elasticities (Peru, Chile, Morocco, and the Rest of the World) were estimated using a foreign reserves variable. Such a measure may be more constrained than GNP, producing smaller elasticity estimates. Or, poor countries may be more aware of their income constraints and less likely to spend new income outside their countries. Debt

Table 2--Price, income and exchange rate elasticities for U.S. wheat exports, 1961-83

Market	Elasticities 1/			Market share 2/	Weighted elasticities 3/		
	Price	Income	Exchange rate		Price	Income	Exchange rate
Japan	4/.08 (.02)	.32 (.54)	-.17 (-.85)	.115	.009	.037	-.019
Soviet Union	-1.04 (-1.82)*	--	--	.109	-.113*	--	--
EC	-.17 (-1.12)	.21 (1.23)	4/1.01 (2.29)	.088	-.015	.018	.089
China	(model not significant)			.083	--	--	--
Egypt	-.54 (-1.98)*	.37 (2.95)*	4/.45 (.98)	.060	-.033*	.022*	.027
Brazil	-.16 (-.24)	1.50 (3.85)*	-.04 (-1.05)	.053	-.008	.080*	-.002
India	-1.28 (-1.55)*	.68 (2.63)*	-.69 (-.30)	.044	-.056*	.030*	-.030
Korea 5/	4/.54 (.59)	1.15 (5.28)*	--	.042	.022	.048*	--
Venezuela	-3.60 (-.62)	.92 (.88)	-.75 (-.98)	.025	-.090	.023	-.018
Nigeria	-.02 (-.01)	.62 (.32)	-.15 (-.50)	.022	-.0004	.014	-.003
Philippines	-.004 (-.03)	1.65 (6.80)*	-.67 (-3.30)*	.022	-.0001	.036*	-.014*
Mexico	-1.15 (-.18)	1.95 (1.71)*	4/.16 (.73)	.020	-.023	.039*	.003
Taiwan	-.61 (-1.35)*	.96 6/(large)*	-2.80 (-1.54)*	.020	-.012*	.019*	-.055*
Peru	4/2.03 (1.67)	.41 (3.21)*	-.56 (-.10)	.018	.036	.007*	-.010
Chile	4/1.20 (.46)	.46 (1.73)*	--	.014	.017	.006*	--
Portugal	4/.12 (.25)	.88 (.67)	4/3.33 (1.48)	.013	.002	.011	.043
Morocco	4/1.12 (1.81)	.69 (1.97)*	4/1.19 (3.71)	.010	.011	.007*	.012
Rest of world	-.12 (-.98)	.35 (2.43)*	-.37 (-1.76)*	.242 1.000	-.029	.084*	-.088*
World total, right sign, significant at 10% level (*)					-.21	.38	-.16
World total, right sign					-.38	.48	-.24
World total, all					-.28	.48	-.06

-- = data not available. 1/ T-statistics in parentheses. 2/ Average share of U.S. export market, 1961-83. 3/ Elasticities times market share. 4/ Wrong sign. 5/ After 1978. 6/ Denominator of T-statistic extremely small.

Table 3--Cross-price elasticities for U.S. wheat exports, 1961-83

Competitor/ market	Competitor's wheat price	T-statistic	Market share 1/
Argentine wheat			
Brazil	0.006	0.01	.053
Mexico	1.39	1.19	.020
Peru	2/-1.70	-1.38	.018
Australian wheat			
Japan	.06	.22	.115
Korea	.27	.71	.042
India	1.50	2.11*	.044
Philippines	2/-.32	-.46	.022
Canadian wheat			
Taiwan	.11	.11	.020

* = significant at 10% level. 1/ Average share of U.S. export market, 1961-83. 2/ Wrong sign.

service payments may limit income available for imports. Neither foreign reserves nor GNP accurately measures disposable income, for which we had no data.

The significance of changing production (which shifts short run supply curves) and changing income (which shifts domestic demand curves) means these variables can go a long way in explaining future wheat imports of many countries. In the short run, governments in these countries may set retail sale targets to achieve specific goals, predict domestic production, and then import the rest. In the longer run, governments can use price incentives or input subsidies to increase domestic production.

U.S. Wheat Price Ranked Third

Countries' immediate response to U.S. wheat price changes vary greatly but are usually small. Models of India, the USSR, Taiwan, and Egypt produced

statistically significant elasticities (table 2). The first two countries show elastic short run price response and have in common large investments in agriculture and volatile relations with supplying countries. Thus, these two importers may have viewed world markets as auction markets over our estimation period, with price a major determinant of the source of wheat purchases. The inelastic response of Taiwan and Egypt may reflect greater bilateral trade commitments.

In contrast, price elasticity estimates are inelastic and not significant for Japan, the Philippines, the EC, Brazil, and Korea which are countries with stable relationships with the United States and where wheat purchases are a relatively small component of bilateral trade flows. These countries may view purchases of U.S. wheat as investments in an economic relationship they want to maintain to assure supplies and provide a market for their exports.

Exchange Rates Ranked Fifth

Our exchange rate elasticities are often low, insignificant, or the wrong sign (table 2). Our country equations use nominal exchange rates in individual country currencies. A real exchange variable may have performed differently. A real exchange rate variable may be more appropriate when exchange rates are fixed and a nominal exchange rate variable when rates are flexible. Our models were estimated over periods of both fixed and variable exchange rates. However, movement in relative consumer price indices mostly occurs during the period of flexible exchange rates after 1972. Our use of a nominal exchange rate variable over the period of fixed exchange rates (1961-72) when inflation was relatively low should introduce little distortion in our elasticity estimates.

Some Policy Implications

An aggregate inelastic price elasticity indicates that U.S. exporters could not increase revenues with price cuts in the short run. Long run responses might differ as importers and competing exporters have time to adjust production and import and export policies. For example, preliminary estimates of short and long-run price elasticities for 1974-83 for the Soviet Union are -.44 and -.85, respectively, and for Japan, -.24 and -.26. The long-run elasticity is the cumulative effect, over the period, of a sustained price change in 1974. The Soviet Union model shows that the longer run elasticity is considerably larger than the short run.

Policymakers need accurate estimates of current elasticities, not just historical averages. With the use of dummy variables, we found no significant change in the 1-year price elasticities from 1961-79 to 1979-83, indicating that current elasticities may not be significantly different from those we calculated.

U.S. agricultural policymakers have little control over the two largest demand determinants in the models, foreign production and income (represented as GNP or foreign exchange reserves). However, one may argue that U.S. policies which weaken foreign income growth, such as quotas and tariffs on U.S. imports, would adversely affect U.S. farm exports even where U.S. producers have a comparative advantage. This is particularly true for U.S. policies which affect countries with high marginal propensities of consumption for food such as Mexico and Brazil. Thus, decisions on management of foreign debt, which can affect foreign disposable income and foreign reserves, may affect U.S. agricultural exports.

U.S. policymakers have even less direct control over foreign production. U.S. policy could encourage high cost foreign wheat producers to shift towards crops where they have a comparative or absolute advantage. However, foreign willingness to do so depends upon: (1) guaranteed access to export markets for the substitute crops, and (2) an assured and stable supply of U.S. wheat. U.S. quotas and tariffs on imports and U.S. restrictions on commodity exports (embargoes) could likely limit foreign shifts out of wheat production and diminish U.S. wheat export potential.

Foreign Production Response to Price

Foreign wheat production is partially influenced by domestic costs (including foregone revenues of producing other crops) and expected U.S. prices. In the short run, importers who are sensitive to high U.S. wheat prices can respond by: (1) allowing or forcing consumers to forego wheat consumption, or (2) substituting other imported wheat for U.S. wheat.

In the long run, a third option exists, replace U.S. wheat with domestically grown wheat or a substitute food grain. In a country where wheat is not grown and start-up costs are high, the expected price in the distant future must be considered carefully. Foreign decisionmakers may have mental, informal probability distributions of U.S. prices, or formal models. The mean (the expected price) and variance (the risk factor) of this distribution are likely to be highly sensitive to U.S. agricultural and trade policy. A relatively high expected price of future world wheat could encourage foreign wheat production even in countries with no current absolute advantage in growing wheat. A U.S. policy of stable supplies and relatively low prices would surely reduce world price risk and reduce increases in foreign wheat production, compared with a policy of stable supplies at higher supported

prices. Assets fixed in agriculture have few alternative uses outside of agriculture, which slows production reduction in any country. Thus, production may not respond as quickly to a fall in price as to a rise.

Limitations of Study

Estimation of models can reflect two approaches. The first approach is to theoretically derive properties of functions which are used to restrict econometric estimation. The second approach does not impose theory on the data; instead it uses the data as an input into determining theory. This second approach is typical of other sciences. However, other sciences often obtain data through controlled experiments. Testing to determine if imposing restrictions significantly improves models is the closest economics can come to controlled experiments. When theory is not well developed, as in the case of trade which typically is presented as buying and selling of residuals (after domestic needs are met), the second approach may be more useful. This study leans towards the second approach, although theory was used to specify equations.

Economics often invokes theory to infer causality between variables. Although the econometric approach provides many advantages, significant estimators derived thereby indicate only a correlation between exogenous and endogenous variables. Causality tests exist, but debate on their usefulness continues.

Generally, economic models are never completely specified. Some variables may serve as a proxies for unknown or missing variables. Missing variables result in biased estimators which in badly specified models can significantly alter results. For example, our Soviet wheat equations do not contain information on the U.S.-Soviet grain agreements, wherein corn may be

substituted for wheat (the Soviets feed wheat extensively to their livestock). When we subtracted the target level of wheat imports in the agreement from the dependent variable, the new equation differed from our reported results in one respect: the price elasticity was not significant at even the 10 percent level. Whether the price is serving as a proxy for a grain agreement variable is difficult to determine.

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