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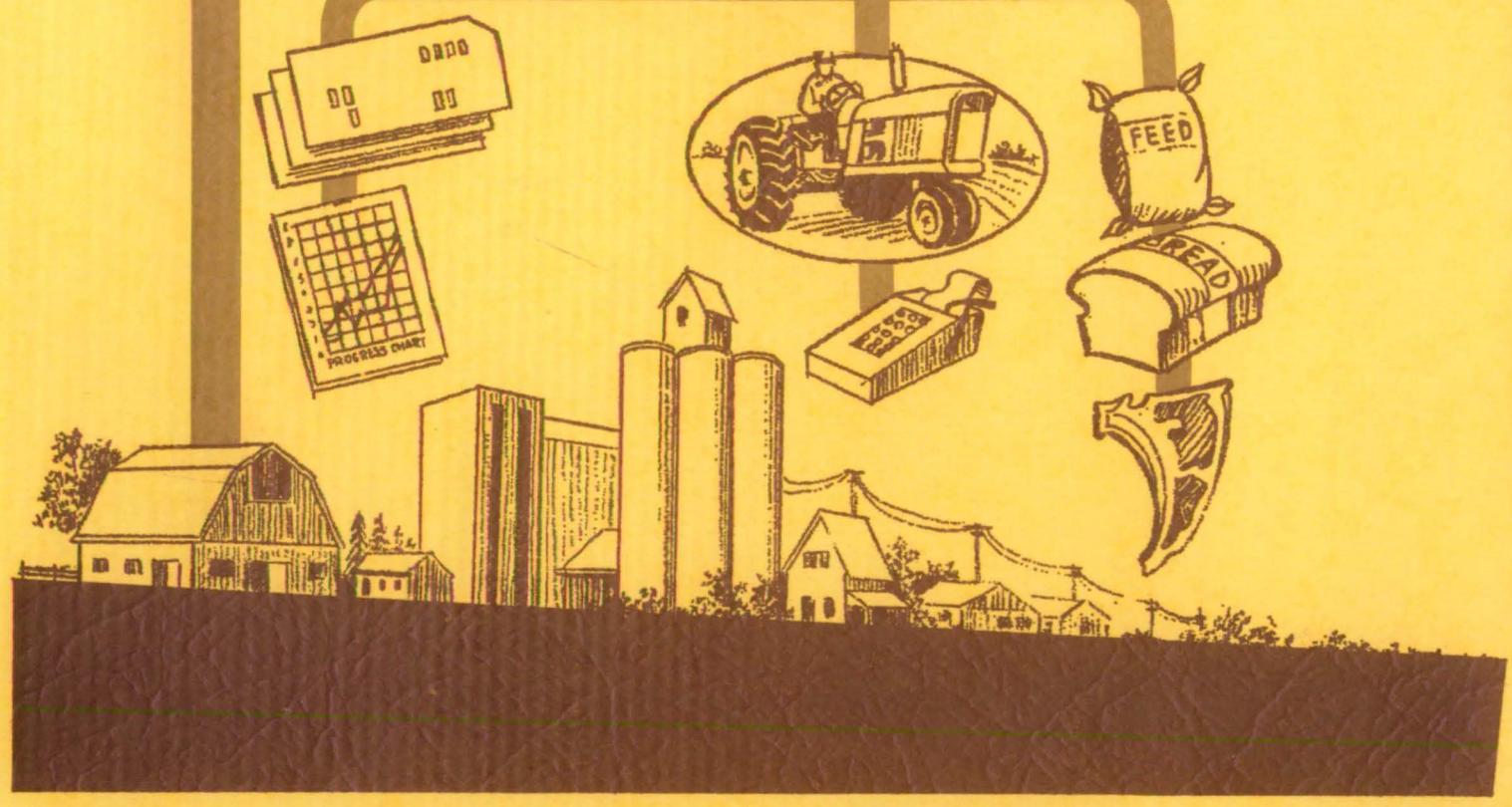

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SOUTH AMERICAN COUNTRIES DEMAND FOR WHEAT IMPORTS AND U.S. MARKET SHARE: SETS OF DISTURBANCE RELATED FUNCTIONS

by
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Abstract

Import demand functions for wheat were estimated for seven South American countries in a set of SUR equations. United States shares were estimated by another set. Kravis-Heston-Summers RGDP series adjusted for purchasing power parities were used as income proxies, and border price deflators were designed to reflect changes in consumer prices and exchange rates. Countries were found to respond to border price, income, and exchange rate changes. Price and income coefficients were tested for equality across countries, failure of the test suggested that regional aggregation may be improper. Since exchange rates were highly elastic, recommendations were made to reactivate local currency sales and to increase exports under barter.

South American Countries Demand for Wheat Imports and U.S. Market Share: Sets of Disturbance Related Functions

During the decade of the seventies, our agricultural sector expanded rapidly to meet the needs of growing world markets and the U.S. share of world trade in grains increased significantly. In the eighties, U.S. share of global wheat exports dropped substantially from 48% in 1981-82 to 41% in 1982-83 then, to 38% in 1983-84. In 1980-81 and 1981-82, wheat exports almost doubled domestic disappearance, and the impact of wheat exports on wheat producers and general farm income was obvious. Research on wheat trade with specific importing countries has been neglected in favor of total aggregation of the world market or of particular regions. The general objective of this paper is to estimate the import demand functions of seven South American Countries which were, and still are, consistent importers of U.S. wheat. The time frame extends from 1963 to 1982 annually for July - June international wheat year. Specific objectives are to obtain estimates of each country's wheat import elasticities with respect to price, income, and exchange rate and to quantify their response to U.S. export prices.

The Conceptual Framework:

The problem of import demand function specification has long attracted economists' attention because of its theoretical and empirical challenges. An appropriate specification for import demand is defined as one that is theoretically sound and yields unbiased - or at least consistent - and efficient elasticity estimates (Thursby et al. 1984). The most appropriate form was found to be the Houthakker-Magee

specification:

$Q_t = f(P_t * P_{t-1}, Y_t * Y_{t-1}, Q_{t-1})$ followed by the more conventional demand function specification in a Nerlovian context.

$Q_t = f(P_t, Y_t, Q_{t-1})$

where, Q_t = imports, P_t = Real price and Y_t = Real Gross Domestic Product.

Results of the multiplicative forms were more acceptable than the additive forms for most specifications. Using dummy variables to allow for structural shifts in the early seventies - rise in oil prices or drop in value of the dollar - improved the results in some countries. The underlying assumptions for such models are: 1) Supply elasticity of imports is infinite at the level given by world price, in other words importing countries are price takers, 2) Import demand is not affected by variables excluded from the model (Capel et al., 1974). The second assumption could easily be relaxed in single functions if they were to be estimated in a set of disturbance related equations.

Conversion of gross domestic products of different countries via exchange rates does not provide income proxies that can be compared with each other, because it tends to underestimate income in poor countries (Kravis et al, 1978). In response to the problem of international comparison of income between countries at different stages of development, Kravis, Heston and Summers developed a method to measure real GDP adjusted for purchasing power parities. USDA published their estimates which are used in this paper.

Error terms for each country's import function reflect factors which are not specified in the model. Such factors may influence the entire wheat trade in addition to a particular country's specific effect. Anticipating that all countries would have some common pattern in response to those factors, error terms would probably be correlated across countries. Seemingly unrelated regression (SUR) was selected as an appropriate estimation tool because it yields efficient estimates (Zellner et al. 1962). Furthermore, SUR provides for possible joint testing of hypotheses across countries with more degrees of freedom. For a complete treatment of SUR and tests of hypotheses see (Judge et al. 1982).

Ocean shipping costs proved to be a major contributor to grain trade instability (Binkley, 1983) which gave rise to the importance of using the border prices in trade models. The border price concept was originally developed to include all international marketing costs (Schmitz et al. 1973). In this model, however only maritime freight for grains was considered, in other words a border price is defined as cost and freight.

The Empirical Model:

Importing countries are: Brazil, Venezuela, Chile, Peru, Colombia, Ecuador and Bolivia. All are wheat producing countries except Venezuela. Almost all wheat exports to these countries were from the U.S., Canada, Argentina and Australia. Variable postulated to influence per capita imports are; real border price of wheat, per capita real GDP, real border price of rice imports, per capita domestic production, lagged dependent variable and dummy variables

representing structural shifts. U.S. export share as a percentage of total exports for each country is believed to be a function of lagged share and U.S. border price as a percentage of world border price to the country. Houthakker-Magee specification was used in the share analysis, because ratios are expected to be volatile over time (Houthakker et al. 1969). Nominal border prices were deflated by an index of the importing country's exchange rate along with its CPI to reflect the effect of exchange rate changes on purchasing power. It follows that the elasticity of imports with respect to exchange rates is equal to the elasticity of imports with respect to border price of wheat minus the elasticity of imports with respect to Real Gross Domestic product adjusted (RGDP) (Konandreas et al. 1978). RGDP series are already adjusted for purchasing power parity.

Signs of the coefficients are expected to be negative for border price of wheat and domestic production, positive for RGDP and the price of rice. Signs for the lagged dependent variable and the dummy variables cannot be deduced a priori.

Specification and Data Sources:

(A) The demand for wheat imports (a set of seven equations):

$$Ln(QMW)_{it} = f[Ln\left(\frac{WPW}{CPI * ER}\right)_{it}, Ln\left(\frac{RGDP}{POP}\right)_{it}, Ln\left(\frac{PR}{CPI * ER}\right)_{it},$$

$$Ln(QMW)_{it-1}, Ln(WDP)_{it}, D_{1971/72}, D_{1973/74}] \quad (1)$$

(B) U.S. share for wheat exports (a set of seven equations):

$$Ln(QRP)_{it} = f[\{Ln(PRP)_{it} + Ln(PRP)_{it-1}\}, Ln\{QRP\}_{it-1}] \quad (2)$$

where: wheat is defined as wheat and wheat flour in wheat equivalent.

i = importing country (1, . ., 7); j = exporting country (1, . ., 4)

QMW_{it} = per capita imports of wheat for country i from all sources in grams (Source: International Wheat Council)

WPW_{it} = world border price of wheat for country i $/M.t.

$$= \sum_{j=1}^{4} \{[PW_{ijt} + (s_{ij} * F_{jt})] * [QE_{ijt} / \sum_{j=1}^{4} QE_{ijt}]\}$$

PW_{ijt} = price of wheat exported from j to country i FOB country j ports. $/M.t.

if j = U.S., the price is country specific (Source: U.S. Foreign Agricultural Trade Fiscal year and U.S. Exports: Commodity by country.)

if j = Canada, the price is an average of St. Lawrence and Pacific port prices of No. 1 Canada western red spring 13.5% protein (Source: IWC)

if j = Argentina, price of Trigo Pan (Source: IWC)

if j = Australia, price of Australia Standard Wheat (Source: IWC)

S_{ij} = distance between countries j and i in 1000 nautical miles, at one port of delivery for each importing country: Rio de Janeiro, Brazil; Maiquetia, Venezuela; Valparaiso, Chile; Callao, Peru; Buenaventora, Colombia; Guaquil, Ecuador; Arica, Bolivia. (Source: Prentice-Hall's Great International Atlas)

F_{jt} = maritime freight cost of grains exported from source j $/M.t/1000 nautical miles (Source: Food and Agricultural Organization).

QE_{ijt} = quantity of wheat exported from j to i, M.t. (Source: IWC)

CPI_t = consumer price index in i, 1975 = 1 (Source: International Monetary Fund)

ER_{it} = exchange rate; i the country's currency per 1 \$, 1975 = 1 (Source: IMF)

$RGDP_{it}$ = real gross domestic product in millions of dollars K-H-S series. (Source: Vollrath et al. 1984) USDA data were available until 1977 only, the following function was used to complete 4 observations of RGDP adjusted for each country from 1978 to 1981: $Ln(RGDP)_i = f[Ln(GDP)_i, (Ln(GDP_i))^2, T, D]$ where: GDP = exchange rate converted real gross domestic product, (Source: IMF) t = time, d = dummy beginning in 1974. Estimated by SUR set of 7 equations for the period 1963 to 1977. Estimated coefficients were then used, along with GDP to complete the series.

POP_{it} = population in millions (Source: IMF)

PR_{it} = border price of rice \$/M.t. = $[PRUS + (S_{ius} * F_{ius})]_t$

PRUS = U.S. price of rice FOB New Orleans \$/M.t. (Source: IMF)

S_{ius} = distance from U.S. to country i

WDP_{it} = per capita domestic production of wheat in country i in grams (Source: IWC) Series for Peru and Colombia were not complete, FAO estimates were used to complete missing observations.

D = dummy variable beginning in indicated wheat year

QRP_{it} = percentage of U.S. wheat exports to total world exports to country i

$$= QE_{iust} * 100/\sum_{j=1}^{4} QE_{ijt}$$

PRP_{it} = percentage for U.S. border price of wheat to world border price of wheat for country i = $[PW_{ius} + S_{ius} * F_{ius})] * 100/WPW_{it}$

PW_{ius} = PW_{ij} when j = U.S.

Per capita wheat production in both Bolivia and Ecuador was suppressed from their equations because data on production in both countries were unreliable. In the case of Chile's CPI, the IMF series was found to be uncomparable, so western hemisphere CPI was used instead.

Results:

Estimated equations for the demand for wheat imports are given in Table 1 and the U.S. market share results are given in Table 2. All significant coefficients for price of wheat, income and price of rice were in agreement with economic theory and a priori hypothesis, with the exception of the positive wheat price coefficients for two countries. Ranges of the correct sign for price and income coefficient were surprisingly wide, -.45 to -.99 in wheat price and .64 to 3.29 in income. Coefficients with negative sign for wheat price were tested for equality across countries using a global nested F-test. The estimated value of F* = 3.265 compared to the critical value of F = 2.51 at the 5% level of significance, which lead to rejection of the null hypothesis. The same procedure was used to test equality of income coefficients for all countries except Colombia. The estimated value of F * = 6.371 compared to the critical value of F = 2.35. The null hypothesis was also rejected at the 5% level. Both test results could discount the credibility of deriving policy implications on the bases of aggregate estimates for regional or world demand.

Table No. 1: South American Countries Demand for Wheat Imports

	Constant	Lagged Per Capita Imports	Effective Border Price	Effective Per Capita Income	Border Price of Rice	Dummy 1973/74	Dummy 1971/72	Per Capita Domestic Production
Brazil	8.572	-.208	-.451	.642	.556	.419	-.368	-.202
	(3.896)	(-3.590)	(-3.795)	(2.021)	(4.574)	(2.335)	(-2.669)	(-5.753)
Venezuela	2.725	.092	-.999	1.804	.638	.809	-.342	
	(-.503)	(.656	(-8.599)	(2.065	(3.763)	(5.335)	(-2.999)	
Chile	-1.024	.412	-.970	1.752	1.001	.745	.133	-.710
	(-.145)	(4.597)	(-3.953)	(1.691)	(4.298)	(2.299)	(.481)	(2.951)
Peru	4.605	-.695	.292	1.640	.038	-.502	.110	.096
	(1.975	(1.47)	(1.472)	(4.236)	(.179)	(-4.227)	(1.174)	(.939)
Colombia	11.531	.252	-.813	-.736	.920	.254	.123	-.128
	(1.853)	2.847)	(-3.895)	(-.863)	(3.573)	(.974)	(.628)	(-.843)
Ecuador	6.796	-.856	-.743	2.090	.029	1.112	.478	
	(8.734)	(-11.359)	(-6.570)	(15.218)	(.200)	(7.882)	(4.240)	
Bolivia	-2.849	-.802	.595	3.297	-.184	-1.098	-.153	
	(-1.061)	(-15.598)	(4.660)	(7.594)	(-.886)	(-4.645)	(-.747)	

R^2 between observed and predicted: Brazil =.63, Venezuela =.40, Chile =.70, Peru =.43, Colombia =.48, Ecuador =.89 and Bolivia =.47

A Set of Seven Equations: SUR Estimates. (n = 18 for each equation)
Depenedent variable: Per Capita Wheat Imports in grams (Time Span: 1963/64 - 1980/81)
System R^2 =1, Chi-square = 5S1414.39, Log of Likelihood Function = 277.39

Figures in parenthesis are asymptotic t values.

Table No. 2: U.S. Share of Wheat Exports

	Constant	Lagged Percentage Exports	Percentage Border Prices	R^2 Between Observed & Predicted
Brazil	10.093 (5.084)	-.500 (-2.942)	-.464 (-2.454)	.23
Venezuela	5.627 (2.725)	.456 (4.382)	-.345 (-1.502)	.48
Chile	40.119 (4.810)	.490 (4.058)	-4.072 (-4.635)	.53
Peru	15.822 (2.297)	.523 (4.003)	-1.519 (-2.055)	.52
Colombia	20.875 (8.218)	-.665 (-4.238)	-1.444 (-6.724)	.53
Ecuador	6.262 (.471)	.671 (3.711)	-.518 (-.339)	.83
Bolivia	3.482 (.713)	.111 (.539)	-.014 (-.028)	.10

A Set of Seven Equations: SUR Estimates.

Time Span: 1963/64 - 1981/82, n = 19

Dependent Variable: Percentage U.S. Wheat Exports To Total Wheat Exports
System R^2 = .9877, Chi-Square = 83.607, Log of Likelihood Function = 10.719

Figures in parenthesis are asymptotic t values.

Production coefficients were significant with correct signs in Brazil and Chile and insignificant in Colombia and Peru. The structural dummy variables for 1973/74 were positive and highly significant in Venezuela and Ecuador, both oil exporting countries. They were also positive and significant for Brazil and Chile (indicating greater demand for imports), but negative and significant for Peru and Bolivia (indicating less ability to import). The coefficient of the structural dummy variable for 1971/72 was negative and significant for Venezuela, although its currency appreciated relative to the dollar in the seventies. The country experienced a drop in per capita RGDP in the same period. The coefficient was negative and significant for Brazil whose currency depreciated relative to the dollar while per capita RGDP was increasing. Finally, it was positive and significant for Ecuador whose currency was pegged to the dollar at constant rate from 1970 to 1981, while per capita income was rising rapidly.

The price coefficients for the U.S. share model (Table 2) were negative and significant for five countries, demonstrating that the majority of wheat importing countries in South America are responsive to border price changes in making their decisions to import wheat and from which source.

The criterion that imports flow through one port for each country may involve over simplification. It could be the reason for the positive sign for the Bolivia price coefficient. Bolivia does not have coastal borders, and the delivery of imports through Arica was not consistent during the time frame of this study. Obviously many countries use more than one port for delivery. If the criterion of

one port was dropped, a probabilistic estimates for flows through several points should have been developed, which was not the intent of this study.

Sets of disturbance related equations may experience serial correlation. In SUR, serial correlation could occur within and/or across equations. In other words, current disturbances for a given equation depend not only on the recent disturbance for that equation but also on recent disturbances in other equations. Two methods have been developed to treat this problem, namely, the Parks method and the Guilky and Schmidt method. Neither of them was used in this study because there's little Monte Carlo evidence on small sample properties of various estimators obtained by either method.

Conclusions:

The results suggest that the majority of these countries respond to price changes. Wheat import elasticity with respect to income and also with respect to exchange rates larger than one. Almost all countries in our sample exhibit substitution (in imports) between wheat and rice.

Failure of the test of equality of coefficients across countries points to the importance of quantifying responses on the country level rather than regional aggregates. The results are in general agreement with previous research (Chambers, 1981) and (Konandreas, 1978). However, we suggest that for those countries with highly elastic exchange rate response, U.S. could reactivate the local currency sales which was used prior to 1971 under public Law 480 Title I. On the other hand for countries with low response to price in both the import

demand and the share models, the Barter sales or Blended-Credit program could be used.

In general, sets of disturbance related equations proved to be useful in avoiding the specification error problem, and to provide more efficient and consistent estimates.

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