1-1980

The Effect of Price-Insulating Poll Policies on Exchange Rate Analysis

William H. Meyers
Iowa State University

Elizabeth J. Gerer
ESCS

Maury E. Bredahl
University of Missouri–Columbia

The Effect of Price-Insulating Poll Policies on Exchange Rate Analysis

Abstract

A model derived to compute exchange rate effects on trade uses foreign internal demand elasticities and price transmission elasticities which account for government price-insulating policies Appreciation of the Japanese yen relative to the dollar is analyzed for impacts on Japanese imports of U S wheat, feed grains, and soybeans.

Keywords

Exchange rate, Government price policy

Disciplines

Agricultural Economics | Economic Policy | International Economics

Comments

This article is from *Agricultural Economics Research* 32 (1980): 25–30.

THE EFFECT OF PRICE-INSULATING POLL POLICIES ON EXCHANGE RATE ANALYSIS

By William H. Meyers, Elizabeth J. Gerber, and Maury E. Bredahl*

A model derived to compute exchange rate effects on trade uses foreign internal demand elasticities and price transmission elasticities which account for government price-insulating policies. Appreciation of the Japanese yen relative to the dollar is analyzed for impacts on Japanese imports of U.S. wheat, feed grains, and soybeans.

Keywords

Exchange rate
Government price policies

The relationship between exchange rate fluctuations and U.S. agricultural exports has been a topic of considerable interest to policymakers and economists since the currency adjustments of the early seventies. The recent weakening of the U.S. dollar has intensified the debate on the nature and magnitude of exchange rate impacts. Schuh postulated that the currency realignment of the early seventies had a major effect on subsequent crop price increases (*7*).[1] Kost proposed some theoretical reasons why the impact should be small (*6*). Bredahl and Gallagher extended Kost's analysis by developing conditions under which export impacts could be large or small in a free trade model (*3*). Bredahl and Womack compared free trade and restricted trade cases in the context of the European Economic Community (EC) trade policies for grains (*1*). Johnson, Grennes, and Thursby tested Schuh's hypothesis for wheat, using derived price elasticities, and concluded that foreign government policies were more important than exchange rates in explaining the wheat price surge in 1973/74 (*5*). Yandle, using a commodity equilibrium approach to analyze exchange rate effects on the wheat market for the 1971 to 1974 period, found that exchange rates were a minor factor in explaining the price and export changes (*10*).

The size of the U.S. export demand elasticities colors much of the debate over the magnitude of exchange rate impacts. Schuh (*8*) pointed to foreign demand elasticity computations by Tweeten (*9*), which were large. Bredahl, Meyers, and Collins later showed that omitting the effects of price insulating policies in trading countries leads to serious overstatements of U.S. export demand elasticities (*2*). These internal price policies are therefore an important factor in the analysis of exchange rate effects.

We develop a model of shortrun exchange rate effects which uses price transmission elasticities to account for price-insulating policies. The model derives the commodity equilibrium impacts on U.S. price and exports as a weighted summation of effects in individual countries. We demonstrate the price transmission effects by a partial equilibrium application to Japan.

THE ANALYTICAL MODEL

The impact of the exchange rate on U.S. agricultural exports can be divided into two components (see figure). A devaluation of U.S. currency rotates import demand (ID) to the right.[2] Exports increase from M_0 to M_1 at the initial export price P_0 — this is the maximum impact on exports. Equilibrium price rises to P_2 if export supply is not perfectly elastic, and the net increase in exports is reduced to M_2-M_0. Given the elasticities of export supply (η_{es}) and import demand (η_{ed}) and the relative shift in import demand at $P_0(\hat{M})$,[3] the relative changes in equilibrium price ($\hat{P}$) and exports ($\hat{X}$) can be determined by

$$\hat{P} = \frac{1}{\eta_{es} - \eta_{ed}} (\hat{M}) \qquad (1)$$

$$\hat{X} = \frac{\eta_{es}}{\eta_{es} - \eta_{ed}} (\hat{M}) \qquad (2)$$

Countries must be treated individually, because exchange rates behave differently in each country. The shift in the import demand at $P_0(d\hat{M})$ can be separated into shifts in demand (dD) and supply (dS) by country:

$$dM = \sum_i (dD_i - dS_i) \qquad (3)$$

*Assistant professor of economics with Iowa State University, formerly international economist with the National Economics Division, ESCS, and assistant professor of agricultural economics with the University of Missouri-Columbia.

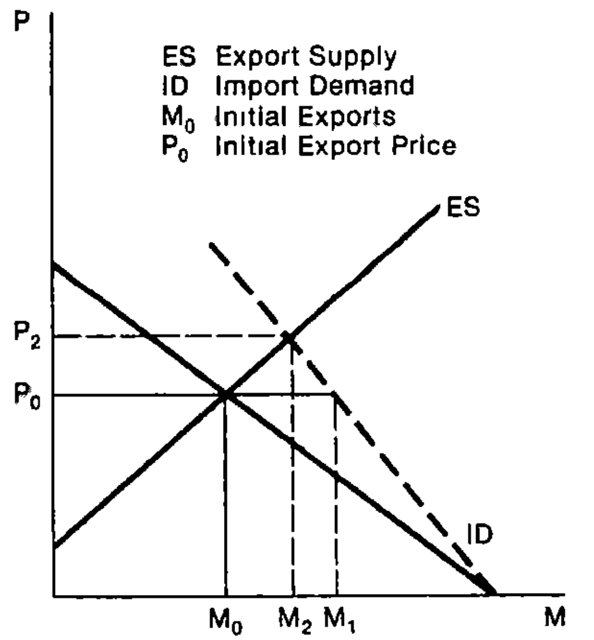
[1] Italicized numbers in parentheses refer to items in References at the end of this article.

[2] See (*3*), for a more detailed treatment.

[3] For the relative shift (such as dM/M), we use the notation $\hat{M}$.

Countries must be treated individually, because exchange rates behave differently in each country

Illustration of the Components of An Exchange Rate Impact



Shifts in exchange rates would not affect current supply in the short run, because of production lags. Thus, separation of the relative shift in import demand by country becomes

$$\hat{M} = \sum_i \hat{D}_i \frac{D_i}{M} \qquad (4)$$

where

$\hat{D}_i$ = the relative shift in the i^{th} country's demand resulting from an exchange rate change

A revaluation of an importer's currency relative to the dollar reduces the importer's cost of purchasing a given quantity of U.S commodities Whether such revaluation influences the level of imports depends on whether the resulting cost reduction is passed along as lower domestic commodity prices In some cases, internal prices are clearly insulated from world market influences, for example, feed grains and wheat in the EC, where variable levies protect internal prices The extent of price insulation is an empirical question needing research We specify price linkage relationships in this model to measure the amount of price transmission In situations where internal prices respond to world price fluctuations, the response in import levels to changes in exchange rates depends on the internal price elasticity of demand

As exchange rates are assumed to affect demand through the price mechanism, we abstract from other demand factors and specify demand as a function of own-price (P) and the price of other commodities (PO)

$$D_i = f_i(P_i, PO_i) \qquad (5)$$

We further specify relationships to link the domestic prices of the i^{th} country to U S prices (P and PO) and to incorporate explicity the exchange rate (r_i)

$$P_i = g_i(r_i P) \qquad (6)$$

$$PO_i = h_i(r_i PO) \qquad (7)$$

We derive the shift in demand due to an exchange rate adjustment by substituting equations (6) and (7) into (5) and taking the partial derivative of D_i with respect to r_i The result can be expressed more conveniently as the exchange rate elasticity of demand (E_{dri})[4]

$$E_{dri} = E_{d1i}E_{P1i} + E_{d2i}E_{P2i} \qquad (8)$$

[4] This result is easily extended to demand specifications with more than two prices by simply adding to the summations on the right-hand side of equation (8)

in situations where internal prices respond to world price fluctuations, the response in import levels to changes in exchange rates depends on the internal price elasticity of demand

where

E_{d1i} = Elasticity of demand with respect to P_i,
E_{d2i} = Elasticity of demand with respect to PO_i,
E_{P1i} = Price transmission elasticity of P_i,
E_{P2i} = Price transmission elasticity of PO_i

Noting that

$$\hat{D}_i = E_{dri}\hat{r}_i, \qquad (9)$$

we combine equations (2), (4), and (9) to obtain

$$\hat{X} = \frac{\eta_{es}}{\eta_{es} - \eta_{ed}} \sum_i \left(E_{dri}\hat{r}_i \frac{D_i}{M} \right) \qquad (10)$$

We determine the impact of changes in exchange rates on U S exports by the elasticities of export supply (η_{es}) and aggregate import demand[5] (η_{ed}) and the demand shift in each country ($E_{dri}\hat{r}_i$) weighted by the size of the country's domestic market relative to U S exports (D_i/M) [6]

The model represented by equations (8) and (10) has interesting features First, we would not expect exchange rates to have impact in countries which insulate all relevant internal prices from world market prices Regardless of what the demand elasticities (E_{d1i}, E_{d2i}) may be, the price transmission elasticities would all be zero and import demand would not change (E_{dri} = 0)

Second, if a derived demand curve is homogeneous of degree zero in prices, an exchange rate adjustment would have no impact if all the price transmission elasticities are equal in magnitude However, if the transmission elasticities differ due to price policies or nontraded goods, there could be an impact For example, if the own-price of the commodity is insulated but at least one other price is not, some exchange rate effect is expected Whether imports increase or decrease depends on the sign of the cross-price elasticity If the market determines a substitute price (E_{d2i} $E_{P2i} > 0$), a currency revaluation would decrease rather than increase imports of that commodity ($E_{dri} > 0$) This may well be true for EC imports of corn, as the import price is fixed for corn but not for soybeans or soymeal

Finally, a weighted exchange rate computed conventionally (without regard to price insulation policies) will be of little value in estimating exchange rate impacts For example, it is clear from equation (10) that countries with complete price insulation should not be included in such a computation

THE MODEL APPLIED

Country by-country analysis implied by equation (10) lies beyond the scope of this article The major unknown variables in equation (10) are the exchange rate elasticities (E_{dri}) We estimate these below for major grains and feeds imported by Japan, and use the results for a partial equilibrium analysis

We chose Japan because of the large appreciation of the yen against the dollar, and because Japan is an important customer for U S corn, sorghum, soybeans, and wheat The Japanese yen has appreciated nearly 40 percent relative to the U S dollar since 1970 Japan has strict price-insulating policies only for wheat

We analyze impacts on feed grains and soybeans by estimating demand functions for these commodities and price linkage equations for the appropriate prices Wheat is analyzed more simply, as fixed resale prices exist for wheat and rice (the major substitute for wheat) in Japan, set by the Government well above world market prices The price transmission elasticities therefore become zero for both commodities This means that exchange rate changes will not affect domestic prices in Japan for wheat or rice As a result, no matter what the internal demand elasticities for wheat in Japan might be, exchange rate fluctuations would not be expected to influence Japanese wheat demand and imports [7]

Demand for Feed Grains

Corn and sorghum are combined into a single feed grain demand with the following specification

[5] The import demand elasticity must also account for the price transmission elasticities of trading countries, as in (2) In terms of the shortrun model, equation (10), it can be shown that $\eta_{ed} = \sum_i (E_{dri}D_i/M)$

[6] Note that if exchange rate changes were equal across countries ($\hat{r}_i = \hat{r}$), equation (10) would simplify to $\hat{X} = \frac{\eta_{es}\eta_{ed}}{\eta_{es} - \eta_{ed}}\hat{r}$ which is equivalent to the formula derived in (3)

[7] The price transmission effect was apparently overlooked in a previous study (4) which imputed an exchange rate effect to Japanese wheat imports

Conventional weighted exchange rates and other analyses which ignore government price-insulating policies will not measure exchange rate effects reliably

$$QFG_t = a_0 + a_1 PC_t + a_2 PSM_t + a_3 LP_t + a_4 RF_t + u_t \quad (11)$$

where

QFG = Total demand for corn and sorghum (1,000 metric tons),
PC = Corn, wholesale price index, Japan (1970 = 100),
PSM = Soymeal, wholesale price index, Japan (1970 = 100),
LP = Pork and poultry, production index, Japan (1970 = 100),
RF = Rice fed to livestock in Japan (1,000 metric tons)

Ordinary least squares estimates of these demand coefficients are equations (1) and (2) in table 1 The coefficient on rice fed (RF) indicates that the program in Japan to divert surplus rice to feeding in the early seventies displaced corn and sorghum at a rate of about 0 8 to 1 0 Livestock production (LP), the major demand shift variable, has an elasticity of approximately 1 0 In equation (1) the soymeal price coefficient has a high standard error It was omitted in equation (2), and the corn direct price elasticity changed only slightly

Demand for Soybeans

Japan's demand for soybeans is also specified as a feed demand equation

$$QSB_t = b_0 + b_1 PS_t + b_2 PC_t + b_3 LP_t + u_t \quad (12)$$

where

QSB = Total soybean demand (1,000 metric tons),
PS = Soybeans, wholesale price index, Japan (1970 = 100),
PC = Corn, wholesale price index, Japan (1970 = 100),
LP = Pork and poultry, production index, Japan (1970 = 100)

The OLS estimates of these demand coefficients are equations (3) and (4) in table 1 A dummy variable for 1972/73 (DV72) accounts for effects of the U S soybean embargo in those years Its coefficient reflects the unusually high Japanese soybean imports in 1972/73 [8] Livestock production is again the major cause of growth in demand, its elasticity is 0 68 at the means In equation (3), elasticities at mean levels are -0 37 and 0 02 for soybean and corn prices, respectively The corn price, however, is not significant In equation (4) it is omitted, which reduces the direct price elasticity for soybeans to -0 35

Price Linkage Equations

The price linkages for each commodity are specified as follows

$$JP_t = c_0 + c_1 (USP_t \quad r_t) + u_t \quad (13)$$

where

JP = Japanese wholesale price index (1970 = 100) [9]
USP = U S price (dollars per bushel)
r = Japanese exchange rate (yen per U S dollar)

The estimated price transmission elasticities computed at means range from 0 99 for soybeans to 0 77 for soybean meal (equations (6) and (7) in table 1) The estimate for corn price (5) is 0 85

Exchange Rate Impact

We compute the price elasticities of demand and the price transmission elasticities from the estimated relations using the mean of the last 4 years in the estimation period (1973/74 to 1976/77) These are used in table 2 to compute exchange rate elasticities The computed elasticities of demand for the exchange rate are -0 21 and -0 42 for feed grains and soybeans, respectively Recall that these shifts in demand (with U S commodity prices constant) give the maximum exchange rate impact Thus, a 10-percent appreciation of the yen would at most increase Japanese feed grain demand 2 1 percent and soybean demand 4 2 percent At 1977 levels, Japanese demand and U S exports would increase 300,000 metric tons (12 million bushels) for corn and 155,000 metric tons (5 7 million bushels) for soybeans

IMPLICATIONS

Conventional weighted exchange rates and other analysts which ignore government price-insulating policies will not measure exchange

[8] Some analysts believe this resulted from Japanese overreaction to the embargo scare

[9] Although the Japanese price is in index form, the only effect is to change the coefficients on the right-hand side by a constant multiple

Table 1—Ordinary least squares estimates of demand coefficients and price linkages for feed grains and soybeans, Japan (1960-76)

Corn and sorghum	C	PC	PSM	LP	RF	$\bar{R}^2$	Standard error	Durbin Watson statistic
(1) Coefficient	1804	−19 41	5 893	2 334	−0 7934	0 97	663	1 27
(*t*)	(2 2)	(−1 9)	(0 62)	(9 7)	(−1 4)			
Elasticity		−0 26	0 08	0 96	−0 02			
(2) Coefficient	2082	−18 53		2 426	−0 8594	0 97	647	1 43
(*t*)	(3 1)	(−1 9)		(13 2)	(−1 6)			
Elasticity		−0 25		1 00	−0 02			

Soybeans	C	PC	PS	LP	DV72	$\bar{R}^2$	Standard error	Durbin Watson statistic
(3) Coefficient	1729	0 3745	−8 238	0 5671	569 9	0 97	131	3 26
(*t*)	(14 1)	(0 13)	(−3 3)	(15 8)	(3 9)			
Elasticity		0 01	−0 37	0 68				
(4) Coefficient	1737		−7 965	0 5666	564 5	0 97	126	3 26
(*t*)	(17 1)		(−5 7)	(16 5)	(4 2)			
Elasticity			−0 35	0 68				

Dependent variable	C	(USP)	$\bar{R}^2$	Standard error	Durbin Watson statistic
Corn price					
(5) Coefficient	15 59	0 1805	0 94	7 13	1 57
(*t*)	(2 8)	(16 3)			
Elasticity		0 85			
Soybean price					
(6) Coefficient	0 8150	0 0966	0 94	9 47	1 95
(*t*)	(0 11)	(16 6)			
Elasticity		0 99			
Soybean meal					
(7) Coefficient	25 00	0 0026	0 84	13 2	2 52
(*t*)	(2 6)	(9 4)			
Elasticity		0 77			

Note Elasticities are computed at means of variables

Table 2—Demand and price transmission elasticities and computation of Japanese exchange rate elasticity

Price	Commodity	
	Feed grains[1]	Soybeans[2]
Demand elasticity	-0 23	-0 44
Transmission elasticity	0 90	0 96
Exchange rate elasticity	-0 21	-0 42

Note All elasticities are the mean of 1973/74 to 1976/77 The computations are based on equation (8) in the text

[1] Equation 2, table 1
[2] Equation 4, table 1

rate effects reliably The measurement error will be greater for commodities whose prices are more highly protected by trading countries

The commodity equilibrium model we presented incorporates the effect of price insulating policies It requires the weighting and summing of exchange rate effects within individual countries to obtain the impact on equilibrium price and export levels The procedure, although not complex, requires large amounts of data The elasticities of demand and price transmission used in the model could be assumed or obtained from previous studies to reduce the computational requirements The model was discussed in the context of analyzing U S exports but can be applied to any exporting country The same procedure could be used to derive a model for import analysis

The model could be enhanced by adding a supply response component for each country The data requirements would increase but it would be possible to analyze longer run impacts of exchange rate changes The individual country components of the model can also be used for partial equilibrium analysis (with U S prices constant) This simple procedure, as applied to Japan above, provides useful estimates of the maximum exchange rate impacts

REFERENCES

(1) Bredahl, Maury E , and Abner Womack "Trade Restrictions and Currency Value Changes " *Agr Econ Res* , Vol 30, No 4, October 1978

(2) Bredahl, Maury E , William H Meyers, and Keith J Collins "The Elasticity of Foreign Demand for U S Agricultural Products The Importance of the Price Transmission Elasticities " *Amer J Agr Econ* 61(1979) 58-63

(3) Bredahl, Maury E , and Paul Gallagher "Comment on 'Effects of an Exchange Rate Change on Agricultural Trade ' " *Agr Econ Res* , Vol 29, No 2, April 1977

(4) Greenshields, Bruce L "Changes in Exchange Rates," USDA, ERS-Foreign 364 1-17

(5) Johnson, Paul R , Thomas Grennes, Marie Thursby "Devaluation, Foreign Trade Controls and Domestic Wheat Price " *Amer J Agr Econ* 59(1977) 619-627

(6) Kost, William E "Effects of an Exchange Rate Change on Agricultural Trade " *Agr Econ Res* , Vol 28, No 3, July 1976

(7) Schuh, G Edward "The Exchange Rate and U S Agriculture " *Amer J Agr Econ* 56(1974) 1 13

(8) Schuh, G Edward "The Exchange Rate and U S Agriculture Reply " *Amer J Agr Econ* 57(1975) 696-700

(9) Tweeten, Luther G "The Demand for United States Farm Output " Food Research Institute Studies 7(1967) 343 369

(10) Yandle, C A "Using the Commodity Method for Analyzing the Effects of Exchange Rate Changes—Some Considerations " *The Effects of Exchange Rate Adjust ments*, edited by Peter B Clark *et al* , pp 341-354 Proceedings of conference sponsored by Office of the Assistant Secretary for International Affairs, U S Department of the Treasury, Washington, D C , April 4-5, 1974