SENSITIVITY OF U.S. WHEAT AND CORN EXPORTS TO JAPANESE MONETARY POLICY: AN ARMINGTON ANALYSIS

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One of the major criticisms typically leveled at U.S. agricultural trade models is that they frequently focus on total U.S. exports of a particular commodity to an aggregate rest-of-the-world (ROW) entity (Thompson). Others have criticized these models because they inadequately endogenize U.S. and non-U.S. policy linkages. Among the linkages often overlooked are the effects of the macroeconomic and trade policies of the U.S. and our major trading partners.

The first objective of this paper is to modify an existing macroeconomic model of the U.S. economy which previously contained a "two region" orientation to U.S. crop exports. Export equations for selected crops will be disaggregated into selected trade flow groups. The import demand equations in the revised model will reflect Armington demand theory, which captures the often observed two-stage importer budget procedure without departing from Hicksian demand theory. The second objective is to endogenize U.S. and non-U.S. policy linkages and to simulate the effects that three alternative Japanese monetary policies would have upon the projected levels of U.S. exports of wheat and corn to Japan. Of interest here is the extent to which monetary disturbances influence real variables such as U.S. crop exports.

Armington Model of Import Demand

Armington (1969a,b) developed a theory of international demand for commodities differentiated by kind and by origin.

Evidence suggests that a commodity supplied by different exporting nations is seldom viewed by importing nations as perfect substitutes (Armington 1969b, p. 159; Johnson et al. 1979). Sources of differentiation can include political alliances, actual quality differences, and degreee of procurement risk (Grennes, et al.; Thompson).

The structure of the Armington demand model is summarized in equations (1) and (2). The first equation represents a Marshallian market demand for the ith product resulting from maximization of the importing nation's utility subject to a national income constraint. The second equation represents the importing nation's second stage demand for the ith good supplied by the jth exporting nation. As such, this equation reflects a Hicksian demand which captures the importing nation's ith market expenditure subject to the stage one market demand level.

(1) $x_i = h^i(RLY, p_1, \ldots, p_i, \ldots, p_n)$

(2) $x_{ij} = g^{ij}(x_i, \ldots, p_{ij}, \ldots, p_{im})$

which can be restated as follows:

(3) $x_{ij} = b_{ij}^{oi}\, x_i (p_{ij}/p_i)^{-oi}$

where n represents the number of goods, m represents the number of regions, x_i is the quantity index of the ith good demanded from all sources (i.e., the first stage demand), h^i is the first stage Marshallian demand for the ith good, RLY is the importing nation's real national income, x_{ij} is the second stage demand for

the ith good supplied by the jth exporting nation, g^{ij} is the second stage Hicksian demand for ijth product, p_i is the real index of m number of export prices for the ith good expressed in the importing nation's currency, p_{ij} is the real export price for the ith commodity supplied by the jth exporting nation, b_{ij} is a constant demand parameter associated with the demand for the ijth product, and oi represents the importing nation's constant elasticity of substitution associated with each product pair in the ith market.

Japanese Crop Import Demand and Linkage Equations

Japan is one of numerous U.S. client regions that have been endogenized in the macroeconomic model utilized in this study (Babula). The equations presented in Table 1 include those associated with Armington's two-stage import demand for corn and wheat. Also presented are those equations which endogenize the effects of U.S. and Japanese macroeconomic policies on U.S. crop exports. This requires capturing such policy transmission mechanisms as nominal and real yen/dollar exchange rates, the Japanese CPI, and real Japanese economic growth.

Equations (1.1) and (1.3) in Table 1 represent the first stage or market demands for wheat and corn by Japan. Cross price arguments are excluded from the Japanese market demand for wheat equation because pretesting proved them to be insignificant. The weak t-statistic associated with the coefficient for the real price index for crude petroleum in the Japanese wheat market demand equation may have arisen from the variable's collinearity

Table 1 -- Estimated demand and linkage equations for Japan.

Japanese Total Wheat Imports:

(1.1) $TLWTJP = 3890 + \underset{(5.12)}{.0345*RLYJP} - \underset{(2.20)}{.0474*WTWAPJP} - \underset{(1.07)}{63.0*RLPETP}$

$R^2 = .865 \quad d = 1.30$

Japanese Imports of U.S. Wheat:

(1.2) $\ln(USWTJP) = -5.51 + \underset{(20.1)}{1.57*\ln(TLWTJP)} - \underset{(0.83)}{1.13*\ln(PUSWT/WTWAP)_{t-1}}$

$R^2 = .941 \quad d = 2.14$

Japanese Total Corn Imports:

(1.3) $TLCOJP = 108500 + \underset{(2.66)}{.0447*RLYJP} - \underset{(2.82)}{.0324*COWAPJP}$

$\underset{(2.56)}{-.186*SOYPUSJP} + \underset{(3.51)}{2370*DUMMY73}$

$R^2 = .953 \quad d = 1.02$

Japanese Imports of U.S. Corn:

(1.4) $\ln(USCOJP) = -4.30 + \underset{(24.9)}{1.44*\ln(TLCOJP)} - \underset{(0.896)}{1.91*\ln(PUSCO/COWAP)}$

$R^2 = .967 \quad d = 1.97$

Japanese Real National Income:

(1.5) $RLYJP = 4280 + \underset{(30.8)}{2.94*RLM1JP}$

$R^2 = .973 \quad d = 0.64$

Japanese Consumer Price Index:

(1.6) $CPIJP = 0.544 + \underset{(32.9)}{.0000306*NOMM1JP}$

$R^2 = .976 \quad d = 1.46$

Real Exchange Rate:

$$(1.7)\quad RLXRTJP = -17.2 + \underset{(4.95)}{213.0}*RLCHGM1JP - \underset{(1.57)}{3.56}*RLCHGM1US - \underset{(2.19)}{4.34}*RLBCAJP + \underset{(2.08)}{.887}*RLUSDEF + \underset{(14.8)}{.959}*RLXRTJP_{t-1}$$

$R^2 = .953 \quad h = 1.86$

Real Yen Denominated World Average Price for Wheat:

$$(1.8)\quad WTWAPJP = RLXRTJP*WTWAP$$

Real Yen Denominated World Average Price for Corn:

$$(1.9)\quad COWAPJP = RLXRTJP*COWAP$$

where:

COWAPJP	Real world average price of corn during July/June marketing year; real yen per metric ton.
COWAP	Real world average price of corn; real dollars per metric ton; calander year.
CPIJP	Japanese consumer price index; 1967 base.
DUMMY73	Dummy variable for floating exchange rates and high OPEC crude oil prices; zero before 1973, one afterward.
NOMM1JP	Nominal Japanese M1 money supply; billions of yen.
PUSCO	Real U.S. export price of corn; real dollars per metric ton FOB U.S. gulfports; calander year.
PUSWT	Real U.S. export price of wheat, CIF Rotterdam, during July/June marketing year; real dollars per metric ton.
RLBCAJP	Real Japanese balance on current account; billions of real U.S. dollars.
RLCHGM1JP	Real change in the Japanese M1 money supply.
RLCHGM1US	Real change in the U.S. M1 money supply.
RLYJP	Real national income of Japan; Billions of 1967 yen.
RLM1JP	Real Japanese M1 money supply; billions of real yen.

RLPETP	Real crude petroleum price index.
RLUSDEF	Real U.S. federal budget deficit; billions of real U.S. dollars.
RLXRTJP	Real Japanese/U.S. exchange rate; real yen per real U.S. dollar.
SOYPUSJP	Real U.S. price of soybeans; deflated yen per metric ton; calander year.
TLWTGP	Total wheat imports by Japan from all sources during July/June marketing year; 1000 metric tons.
TLCOJP	Total corn imports by Japan from all sources during July/June marketing year; 1000 metric tons.
USCOJP	Japanese imports of U.S. corn during July/June marketing year; 1000 metric tons.
USWTJP	Japanese imports of U.S. wheat during the July/June marketing year; 1000 metric tons.
WTWAP	Real world average price of wheat, CIF Rotterdam, during July/June marketing year; real dollars per metric ton.
WTWAPJP	Real world average price of wheat during July/June marketing year; real yen per metric ton.

with the Japanese real national income. The coefficients for the Japanese first stage corn demand arguments were significant and had the expected signs.

Equations (1.2) and (1.4) in Table 1 represent the Japanese second stage demands for U.S. wheat and corn, respectively. The weak t-statistics for the second stage Armington price ratios may have arisen due to two reasons. First, these weak t-statistics may be due to the inadequate number of world export prices incorporated in the denominator of these ratios. Only one non-U.S. corn export price and two non-U.S. wheat export prices had adequate historical observations for use in this study. Babula and Duffy both reported significant Armington price ratios for cotton when more non-U.S. export prices were available for inclusion in the denominator of the Armington price ratio. Second, the weak t-statistics may also suggest weak sample evidence to support Armington's assumptions about the coefficient (i.e., the negative substitution elasticity).

Equations (1.5) through (1.7) in Table 1 capture the linkages between U.S. crop exports and the implementation of Japanese macroeconomic policy. For example, U.S. monetary policy influences total market demand, and ultimately the second stage demand for U.S. consignments, by having an impact on the real yen per dollar exchange rate and the real yen-denominated world average price. U.S. fiscal policy is also captured through the effects that the real U.S. federal budget deficit has upon the real yen/dollar exchange rate, which in turn, influences real

yen-denominated world average crop prices. Japanese monetary policy influences the real Japanese national income, and hence both the first and second stage Japanese demands for wheat and corn. Changes in the real yen supply also affect the real exchange rate.

Evidence is sufficient at the 95 percent confidence level to reject the null hypothesis of zero autocorrelation in the real Japanese national income equation. This reduced form equation represents a "first attempt" at capturing the linkage between Japanese economic growth and its monetary policy.

Analysis of Alternative Japanese Monetary Policies

This section examines the sensitivity of U.S. exports of wheat and corn to Japan under specific assumptions about Japanese monetary policy. Japan is an extremely important trading partner with the United States. Japan accounted for 8.7 percent of U.S. wheat exports and 27 percent of U.S. corn exports during the 1982-1984 period. In addition, Japan accounted for one-third of the unprecedented $100 to $125 billion nominal annual trade deficits occuring in the 1980s. Many have attributed this growing Japan/U.S. trade imbalance to "structural" factors such as a Japanese affinity for its own goods and their protectionist trade policies. Reinhart refutes this, contending that the growing imbalance has arisen due to macroeconomic disturbances. Specifically, Reinhart suggests that the increased U.S. trade deficit with Japan has been due to a strong value of the dollar relative to the yen and to the narrowing of the annual growth

rate differential between the real national incomes registered in the Japanese and U.S. economies.

Scenario Design

Three Japanese monetary policy scenarios are examined in this study, each cast within the context of a continuation of current U.S. and non-Japanese foreign macroeconomic policies. The baseline monetary policy scenario assumed a series of 3.27 percent annual shocks to the Japanese M1 money supply; the average annual growth rate in Japanese M1 observed during the 1983-1985 period. This baseline will serve as the basis for comparison with two alternative series of annual shocks to the Japanese money supply. A "moderate growth" monetary policy scenario assumes a series of 6.02 percent annual shocks to the Japanese M1 money supply; the average annual growth rate in Japanese M1 observed over the 1976-1982 period. Finally, a "high growth" monetary policy scenario assumes a series of 16.8 percent annual shocks to the Japanese money supply, the annual growth rate observed in 1972.

Real Exchange Rates Matter

Part of the debate as to whether or not nominal exchange rates explain real U.S. export fluctuations relates to the concept of purchasing power parity. If an increase in the nominal "rf" yen/dollar exchange rate is offset by a lower ratio of U.S. to Japanese general price levels, purchasing power parity holds and real exchange rates would remain unchanged. This, in turn, would mean that the real yen-denominated world average price for

wheat and corn in the first stage import demand equations would not significantly alter Japanese total imports of these commodities. While strict purchasing power parity is rarely observed in the real world, particularly in the short run, the forces underlying this concept should be captured when investigating trade flows and market shares.

The results presented in Table 2 show that the moderate and high growth Japanese monetary policy scenarios led to sharp increases in the nominal yen/dollar exchange rates over baseline levels during the 1986-1990 period. The nominal exchange rate under the moderate growth monetary scenario was 17.1 percent higher than the baseline value by 1990. The 1990 rate would be almost 103 percent higher than the baseline value under the high growth monetary policy scenario. This same table shows, however, that U.S. wheat and corn exports to Japan over this period did not change appreciably from the baseline values despite the substantial increase in nominal exchange rates. The studies by Schuh, by Johnson et al., and by Chambers and Just would suggest that a cheapening of the yen relative to the dollar as reported in Table 2 would raise the yen denominated prices of U.S. wheat and corn and hence discouraged their export to Japan. This study therefore refutes their thesis, suggesting that these studies neglected to account, among other things, for the offsetting effects of Japanese inflation associated with expansionary Japanese monetary policies. The results presented in this paper instead supports the conclusions by Batten and Belongia that real exchange rates influence real economic variables such as U.S.

Table 2 -- Percent change from baseline values for selected variables under alternative Japanese monetary growth rates, 1986-1990.

	1986	1987	1988	1989	1990
			- Percent -		
Moderate money growth:					
U.S. wheat exports to Japan	0.2	0.5	0.7	0.9	1.1
U.S. corn exports to Japan	0.0	0.1	0.1	0.2	0.2
Nominal exchange rate	3.1	6.9	11.3	14.9	17.1
Real exchange rate	0.8	2.2	4.1	5.0	4.6
Japanese consumer price index	2.2	4.6	6.9	9.5	12.0
Real Japanese national income	0.4	0.8	1.1	1.4	1.7
High money growth:					
U.S. wheat exports to Japan	1.1	2.0	2.9	3.7	4.4
U.S. corn exports to Japan	0.1	0.4	0.5	0.8	0.9
Nominal exchange rate	15.1	35.5	61.1	85.1	102.8
Real exchange rate	3.7	9.7	16.8	20.1	17.4
Japanese consumer price index	11.0	23.5	37.9	54.2	72.7
Real Japanese national income	1.8	3.4	4.7	5.9	6.8

exports of farm products.

Real Economic Growth Matters Too

The results presented in Table 2 indicate that the series of annual shocks to Japanese money supply assumed in the moderate and high growth monetary policy scenarios led to higher real Japanese national incomes. These higher levels of annual real Japanese national income, in turn, enhanced Japanese import demand for U.S. wheat and corn.

The slight increase rather than sharp decrease in Japanese imports of U.S. corn and wheat one might expect by looking only at the annual nominal exchange rates in Table 2 can therefore be explained by two additional transmission mechanisms: (1) higher Japanese inflation, which lowers the real yen/dollar exchange rate, and (2) higher real national income in the Japanese economy. The results presented in Table 2 suggest that these two factors swamped the negative impact of annual shocks to the Japanese money supply on the annual nominal "rf" yen/dollar exchange rates, actually leading to a modest expansion of exports of U.S. corn and wheat to Japan. This supports the conclusions drawn by Reinhart that an increase in the growth rate differentials between the Japanese and U.S. economies will have a positive influence on U.S. exports to Japan.

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