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

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The relatIonship between ex­

change rate nuctuatlOns and U S
agncultural exports has been a tOPIC
of considerable Interest to policy­
makers and economists since the
currency adjustments of the early
seventies The recent weakening of
the US dollar has mtenSlfied the
debate on the nature and magnItude
of exchange rate

Schuh postulated that the currency reahgn
ment of the early seventies had a
major effect on subsequent crop
price Increases (7) Kost proposed
some theoretical reasons
why
the
Impact should be small (6) Bredahl
and Gallagher extended Kost's
analysIs
by
developmg 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 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 insulatmg policies
in trading countries leads to serious
overstatements of U S export
demand elasticities (2) These in­
ternal 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 insulatmg policies
The model derives the commodity
equilibrium impacts on US price
and exports as a weighted summa

tion 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 US agricultural exports
can be divided into two components
(see figure) A devaluatIOn of US
currency rotates import demand
(1D) to the right 2 Exports Increase
from M₀ to M₁ at the initial export
price P₀ — this is the maximum im­
 pact on exports Equilibrium price
rises to P₂ if export supply is not
perfectly elastic, and the net in­
crease in exports is reduced to
M₂—M₀ Given the elasticities of
export supply (ηes) and import
demand (ηed) and the relative
shift in import demand at P₀(M),³
the relative changes in equilibrium
price (P) and exports (X) can be
determined by

\[ \hat{P} = \frac{1}{\eta_{es} - \eta_{ed}} (\hat{M}) \]  (1)

\[ \hat{X} = \frac{\eta_{es}}{\eta_{es} - \eta_{ed}} (\hat{M}) \]  (2)

Countries must be treated indi­
vidually, because exchange rates
behave differently in each country
The shift in the import demand at
P₀(dM) can be separated into shifts
in demand (dD) and supply (dS) by
country

\[ dM = \sum (dD_i - dS_i) \]  (3)

2See (3), for a more detailed
treatment

3For the relative shift (such as
dM/M), we use the notation M
Countries must be treated individually, because exchange rates behave differently in each country.

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

$$\Delta D_i = \frac{\Delta M_i}{M_i}$$

where

$$\Delta D_i$$ = 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 \((PO)\)

$$D_i = f_i(P_i, PO_i)$$

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

$$P_i = g_i(r_i P)$$
$$PO_i = h_i(r_i PO)$$

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 \((E_{dri})\):}

$$E_{dri} = E_{d1i}E_{p1i} + E_{d2i}E_{p2i}$$

\(^4\) 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).
where

\[ E'_{d1} = \text{Elasticity of demand with respect to } P \]
\[ E'_{d2} = \text{Elasticity of demand with respect to } PO \]
\[ E'_{r1} = \text{Price transmission elasticity of } P \]
\[ E'_{r2} = \text{Price transmission elasticity of } PO \]

Noting that

\[ \hat{D}_i = E'_{dri} \hat{r}_i \]  \hspace{1cm} (9)

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

\[ \dot{X} = \frac{\eta_{es}}{\eta_{es} - \eta_{ed}} \sum \left( E'_{dri} \hat{r}_i \right) \]  \hspace{1cm} (10)

We determine the impact of changes in exchange rates on US exports by the elasticities of export supply (\( \eta_{es} \)) and aggregate import demand (\( \eta_{ed} \)).

The model represented by equations (8) and (10) has interesting features. First, we would not expect exchange rate changes to have an impact 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 (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 US corn, sorghum, soybeans, and wheat. The Japanese yen has appreciated nearly 40 percent relative to the US 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.

**Demand for Feed Grains**

Corn and sorghum are combined into a single feed grain demand with the following specification.
Conventional weighted exchange rates and other analyses which ignore government price-insulating policies will not measure exchange rate effects reliably

\[ Q_{FG} = a_0 + a_1 PC + a_2 PSM + a_3 LP + a_4 RF + u_t \]  
\[ (11) \]

where

\[ Q_{FG} = \text{Total demand for corn and sorghum (1,000 metric tons)}, \]
\[ PC = \text{Corn, wholesale price index, Japan (1970 = 100)}, \]
\[ PSM = \text{Soymeal, wholesale price index, Japan (1970 = 100)}, \]
\[ LP = \text{Pork and poultry, production index, Japan (1970 = 100)}, \]
\[ RF = \text{Rice fed to livestock in Japan (1,000 metric tons)} \]

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

\[ Q_{SB} = b_0 + b_1 PS + b_2 PC + b_3 LP + u_t \]  
\[ (12) \]

where

\[ Q_{SB} = \text{Total soybean demand (1,000 metric tons)}, \]
\[ PS = \text{Soybeans, wholesale price index, Japan (1970 = 100)}, \]
\[ PC = \text{Corn, wholesale price index, Japan (1970 = 100)}, \]
\[ LP = \text{Pork and poultry, production index, Japan (1970 = 100)} \]

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 US soybean embargo in those years. Its coefficient reflects the unusually high Japanese soybean imports in 1972/73. Livestock production is again the major cause of growth in demand, so 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

\[ JP_t = c_0 + c_1 (USP_t \times r_t) + u_t \]  
\[ (13) \]

where

\[ JP = \text{Japanese wholesale price index (1970 = 100)} \]

\[ USP = \text{US price (dollars per bushel)} \]

\[ r = \text{Japanese exchange rate (yen per US dollar)} \]

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 US 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 US 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 analyses which ignore government price-insulating policies will not measure exchange rate effects reliably.
Table 1—Ordinary least squares estimates of demand coefficients and price linkages for feed grains and soybeans, Japan (1960-76)

<table>
<thead>
<tr>
<th>Corn and sorghum</th>
<th>C</th>
<th>PC</th>
<th>PSM</th>
<th>LP</th>
<th>RF</th>
<th>(\bar{R}^2)</th>
<th>Standard error</th>
<th>Durbin Watson statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Coefficient</td>
<td>1804</td>
<td>-19.41</td>
<td>5.893</td>
<td>2.334</td>
<td>-0.7934</td>
<td>0.97</td>
<td>663</td>
<td>1.27</td>
</tr>
<tr>
<td>Elasticity</td>
<td>(22)</td>
<td>(1.9)</td>
<td>(0.62)</td>
<td>(9.7)</td>
<td>(-1.4)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(2) Coefficient</td>
<td>2082</td>
<td>-18.53</td>
<td>2.426</td>
<td>-0.8594</td>
<td>0.97</td>
<td>647</td>
<td></td>
<td>1.43</td>
</tr>
<tr>
<td>Elasticity</td>
<td>(31)</td>
<td>(1.9)</td>
<td>(13.2)</td>
<td>(-1.6)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Soybeans</th>
<th>C</th>
<th>PC</th>
<th>PS</th>
<th>LP</th>
<th>DV72</th>
<th>(\bar{R}^2)</th>
<th>Standard error</th>
<th>Durbin Watson statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>(3) Coefficient</td>
<td>1729</td>
<td>0.3745</td>
<td>-8.238</td>
<td>0.5671</td>
<td>569.9</td>
<td>0.97</td>
<td>131</td>
<td>3.26</td>
</tr>
<tr>
<td>Elasticity</td>
<td>(141)</td>
<td>(0.13)</td>
<td>(-3.3)</td>
<td>(15.8)</td>
<td>(3.9)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(4) Coefficient</td>
<td>1737</td>
<td>-7.965</td>
<td>0.5666</td>
<td>564.5</td>
<td>0.97</td>
<td>126</td>
<td></td>
<td>3.26</td>
</tr>
<tr>
<td>Elasticity</td>
<td>(171)</td>
<td>(-5.7)</td>
<td>(16.5)</td>
<td>(4.2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Dependent variable</th>
<th>C</th>
<th>(USP)</th>
<th>(\bar{R}^2)</th>
<th>Standard error</th>
<th>Durbin Watson statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn price</td>
<td>15.59</td>
<td>0.1805</td>
<td>0.94</td>
<td>7.13</td>
<td>1.67</td>
</tr>
<tr>
<td>Elasticity</td>
<td>(28)</td>
<td>(16.3)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soybean meal</td>
<td>25.00</td>
<td>0.0026</td>
<td>0.84</td>
<td>13.2</td>
<td>2.52</td>
</tr>
<tr>
<td>Elasticity</td>
<td>(26)</td>
<td>(9.4)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Elasticities are computed at means of variables.
Table 2—Demand and price transmission elasticities and computation of Japanese exchange rate elasticity

<table>
<thead>
<tr>
<th>Commodity</th>
<th>Price</th>
<th>Demand elasticity</th>
<th>Transmission elasticity</th>
<th>Exchange rate elasticity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feed grains</td>
<td>-0.23</td>
<td>-0.44</td>
<td>0.90</td>
<td>-0.21</td>
</tr>
<tr>
<td>Soybeans</td>
<td>-0.44</td>
<td></td>
<td>0.96</td>
<td>-0.42</td>
</tr>
</tbody>
</table>

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

REFERENCES

4. Greenshields, Bruce L “Changes in Exchange Rates,” USDA, ERS-Foreign 364 1-17
9. Tweeten, Luther G “The Demand for United States Farm Output” *Food Research Institute Studies* 7(1967) 343 369