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AN INVESTIGATION OF THE ROLE OF EXCHANGE
RATES ON U.S. EXPORTS OF SELECTED
AGRICULTURAL PRODUCTS: 1968-1983

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Abstract

An econometric partial equilibrium trade model of the U.S. corn, wheat, soybean, cotton, and tobacco market is developed for the yearly periods 1968-1983. The effect of real exchange rates, real price, and demand factors on the exports of each commodity is examined to test the hypothesis that monetary factors can affect the agricultural sector. An examination of the elasticities of real price, real exchange rate, and real income indicate that an extremely inelastic response to both price movements and exchange rate adjustments. Foreign buying power is the strongest explanatory variable. An exchange rate linkage with the agricultural sector is not proven.

An Investigation of the Role of Exchange
Rates on U.S. Exports of Selected
Agricultural Products: 1968-2983

I. Introduction

Since the devaluation of the dollar in 1971 and 1973 and the move-
ment to floating exchange rates in 1973, there has been considerable
debate over the effect that exchange rate movements have had on the
agricultural sector of the economy. Schuh argued, in 1974, that the
overvaluation of the U.S. exchange rate, during the 1950's and 1960's,
resulted in reduced agricultural exports, lower domestic prices, and an
undervaluation of agricultural resources. He proposed the exchange rate
as the "omitted variable" in the explanation of the paradox that the
world's most technologically advanced agriculture simultaneously needed
price supports to retain resources in agriculture and export subsidies
to compete in international markets. After a decade of rising agricul-
tural output, prices, and exports during the 1970's, the exchange rate
is again being investigated as a primary cause of the falling agricul-
tural prices and exports since 1980. The exchange rate is the key link-
age between the monetary sector and agricultural sector. If the
exchange rate is the primary variable affecting farm exports, and hence
the health of the agricultural sector, then federal policy makers must
consider the consequences to agriculture of Federal Reserve policy aimed
at fighting inflation and tools such as open market operations.

This paper serves two purposes. First, research results and meth-
odology of past analyses of the linkages between the U.S. exchange rate
and agricultural commodity prices and trade are summarized. Second, the
relative importance of exchange rates, prices, and demand shifters as
explanatory variable affecting the level of farm exports is empirically

tested. The empirical test is accomplished through the use of a partial equilibrium trade model for five primary commodities (corn, wheat, soybeans, cotton, and tobacco) explaining simultaneously domestic production, domestic disappearance, carryover, and exports. The results of this study will be compared to the results of previous noted work.

Motivation for this work stems from the fact that U.S. agricultural exports have declined in quantity since 1980 and in value since 1981, while the exchange rate for agricultural products has steadily risen since 1980. The U.S. has incurred huge federal deficits since 1980 that it has refused to monotize. The Fed changed its target policy variable from interest rates to the money supply growth rate in 1979 to combat inflation allowing real interest rates to vary. These policies have put upward pressure on real interest rates and the value of the dollar. Declining real commodity prices since 1980 have been unable to expand U.S. farm exports while new competitors enter our markets. Total developing country debt has grown (in 1967 dollars) from $117 billion in 1973 to $242 billion in 1982, and most developing nations have experienced sharp recessions since the oil price rise of 1979 and contractionary monetary policy in the U.S. in the early 1980's. Rising real interest rates, caused by U.S. monetary and fiscal policy, contributed to these nations' debt repayment and cash flow problems. These nations had been buyers of 40 percent of U.S. agricultural products, but with slow growth and huge debt repayments, buying capacity has been sharply reduced. Of equal vitality to the agricultural export sector has been the extremely slow or even negative growth in real incomes of the the Western European trading nations since 1980.

The purpose of this project is to determine which of these factors

The second study used a time series analysis to see if exchange rate movements explain variations in imports and exports over time. The analysis measured the impact of exchange rate changes in other countries' agricultural imports from the U.S. and the rest of the world. The period 1960 to mid-1969 was chosen because exchange rates were generally stable. Twenty countries and five commodities (wheat, corn, cotton, tobacco, and oilseeds) were examined. Regressions were run on U.S. exports (value and quantity) to these 20 countries for the five commodities. Time served as a simple proxy for income, population, and other structural variables.

In 1977, Johnson, Grennes, and Thursby (JGT) developed a partial equilibrium trade model for wheat that distinguished wheat by country of origin for the years 1973-1974. With the supply side assumed exogenous, their formulation resulted in three sets of equations: (a) a set of demand equations, (b) a set of price relations, (c) a set of market clearing equations. The quantity imported by country i from country j was a function of the import price of wheat from the country of origin and demand shifters such as buying capacity and substitute grain prices. Import price was the exchange rate times the supplier's price plus the exogenous shifters (tariffs, freight cost, export subsidies) that affect the difference between origin price and consumer price. The relative importance of the variables affecting import price was examined.

Chambers, in his 1979 dissertation, criticized the assumption made by JGT that the percentage change in price must be less than or equal to the percentage change in the value of the dollar. He developed an econometric model of exchange rate determination in the monetary sector that was causally linked to the agricultural sector through similar market

models for wheat, corn, and soybeans. Exports for each commodity were a function of expected price, expected exports, lagged exchange rate, and variables reflecting international demand conditions. Chambers linked the two sectors by specifying the exchange rate as a function of the balance of payments and the balance of payments determined by aggregate exports.

Chambers and Just (1981) developed an econometric model of the wheat, corn, and soybean markets to examine the dynamic effects of exchange rate fluctuations on U.S. commodity markets. The econometric model consisted of fifteen equations, three of which were identities. These equations explained disappearance, inventories, exports, and production for the three commodities on a quarterly basis from 1969(I)-1977(II). Per capita exports were defined as a function of expected per capita exports, real price, current exchange rates, and other factors affecting world demand. As opposed to a trade weighted exchange rate, these authors used the Special Drawings Rights value as a proxy for foreign currency for each period.

In 1982, Chambers and Just expanded on Chamber's dissertation by using an econometric model to assess some of the effects of macroeconomic monetary factors on U.S. agriculture. Attention was focused on the impact on agricultural trade, prices, inventory accumulation, and domestic disappearance of varying the level of domestic credit. Chambers and Just incorporated the effect of monetary factors into empirical models of agricultural activity. The econometric model developed was a three-block recursive model. The agriculture block contained trade models for the wheat, corn, and soybeans markets. An aggregate export block contained a model of the balance of payments net the value of

wheat, corn, and soybean exports. The final block was a reduced-form model for exchange rate determination based on the hypothesis that the balance of payments is the key variable affecting the exchange rate.

The final previous model examined was an attempt, in 1984 by Batten and Belongia, to determine if the recent decline in U.S. agriculture exports was primarily caused by the rise in the value of the dollar. As an explanatory variable, the exchange rate was compared with a trade weighted index of foreign real GNP and the price index of U.S. agricultural exports divided by the U.S. consumer price index. The exchange rate variable was the real trade-weighted index of the foreign exchange value of the dollar. The real exchange value for the dollar between each country was determined by multiplying the nominal exchange rate by the inflation differential between the trading nations. Assuming the purchasing parity argument is valid, in the long-run the exchange rate movements caused solely by inflation differentials between nations should have no effect on the level of trade. This model merely looked at agricultural exports in the aggregate as opposed to specific commodities.

III. The Structural Model

A partial equilibrium agricultural trade model was developed for five commodities that simultaneously explains U.S. production, disappearance, inventory accumulation, and exports on a commodity basis for the yearly periods 1968-1983. Prices were derived from market equilibrating identities. The model is formulated in a seemingly recursive form with a separate block for each commodity. The estimating technique used is two-stage least squares with the endogenous variables price, production, ending inventory, domestic disappearance, and exports. Each

functional relationship is assumed to be linear in the parameters to simplify the estimation and subsequent analysis of the model.

The five commodities chosen were corn, wheat, soybeans, cotton, and tobacco. The model structure for each commodity is essentially the same. Together, these commodities accounted for over 60 percent of the value of U.S. agricultural exports in 1983. The years chosen for study allow us to examine the effect on agriculture exports of the devaluations in 1971 and 1973, the movement to floating exchange rates in 1973, the loose monetary policy from 1977-1979, and the tight monetary policy of the early 1980's. The oil shocks of 1973-74 and 1979-80 and the world recession of 1981-1983 are included in the period under study as well as the Third World debt crisis beginning in the early 1980's. For further analysis, only the export equation for each of the five commodities will be examined. The results of the structural estimation with the variable definitions and data sources are presented in Tables I and II.[1]

For each commodity, two export demand equations are developed. One treats the exchange rate as a separate regressor while the other uses the import price directly. According to Chambers and Just (1981) the first specification is correct because economic agents may react differently to exchange rate adjustments than to market price movements. In addition, deflating own-price by the exchange rate introduces a significant nonlinearity into the system, making multiplier analysis extremely difficult. The import price of a commodity is the supply price divided by the exchange rate where the exchange rate is defined in terms of dollars per foreign currency.

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[1]Results of the remaining structural relations may be obtained from the authors on request.

For each commodity the export demand equation will be represented as follows:

$$X_t = X(RP_t, RX_t, M_t^*) \qquad t=1,\ldots 16$$
and
$$X_t = X(\frac{RP_t}{RX_t}, M_t^*)$$

where

X_t = U.S. exports in metric tons

RP_t = real U.S. price

RX_t = real trade-weighted exchange rate in dollars per trade weighted foreign currency

M_t^* = a variable(s) reflecting international demand conditions

t = period, one year

The estimated model is substantially more aggregated than many models of agricultural markets although less aggregated than those presented by Clark (1976) or Egbert (1969). For example, many empirical works separate domestic disappearance of wheat and corn into food and feed disappearance. Also, several empirical studies on U.S. grain exports--for example, Fletcher, Just, and Schmitz; and Johnson, Grennes, and Thursby--differentiate U.S. exports by country of destination. The aggregate nature of the present study, however, is justified by the fact that interest is centered on the net effects of exchange rate fluctuation in each of the markets rather than on each particular component of the market.

With this in mind, the three grain exports (corn, wheat, soybeans) are each assumed to be a linear function of their own deflated price (denominated in domestic currency units), the real commodity specific trade-weighted exchange rate, the summation of the commodity specific importing countries' GDP's (in dollars) deflated by their GDP weighted CPI, and the total population of cattle and hogs in the appropriate

importing countries. Foreign income and foreign livestock population are both demand shifters while the real price and real exchange rate measure the relative price of the specific commodity exports. Cotton and tobacco exports are represented as a linear function of their own deflated price, the real commodity specific trade-weighted exchange rate, and a summation of the GDP's of the commodity importing countries deflated by their GDP weighted CPI.

The choice of countries used in the model was based on the quantity of exports to the country, the consistency of exports over time, and the reliability of the data.[2] Some nations included in the study imported only a subset of the five commodities chosen for study. When this occurred, a zero value was assigned for that nation's importation of the non-traded commodities for all periods and the nation's income was not considered as a demand factor for that particular commodity. For the calculation of the trade-weighted exchange rate for the commodity, the non-importing nations exchange rate was totally dropped. All commodities had at least 13 major importers. Centrally planned economies were not considered since restrictions on trade were made during the period under consideration for political reasons. The exchange rate figure used was the yearly average as reported in the IMF-IFS 4th Quarter Report for each year under consideration. The CPI for each trading country was chosen in an identical manner. Price of the commodities was a yearly average at the farm gate reported in the USDA Agricultural Sta-

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[2]Principal importers of U.S. agricultural products chosen in this study are: Austrailia, Belgium, Brazil, Canada, Chile, Denmark, Egypt, France, Germany, Greece, India, Indonesia, Italy, Japan, Korea, Luxembourg, Mexico, Netherlands, Norway, Pakistan, Philippines, Portugal, Spain, Switzerland, Sweden, Taiwan, Thailand, and United Kingdom.

tistics Yearbook.

IV. Empirical Results and Conclusions

The coefficients of the structural form equations conform to the
signs expected from a priori considerations with the exception of the
exchange rate variable in the soybean equation and the price variable in
the tobacco equation. However, American tobacco is sold primarily for
its superior quality and hence does not compete directly with foreign
producers and neither the soybean exchange rate nor the tobacco price
are significant explanatory variables. All the grains and cotton are
price inelastic and our estimates fit reasonably well with past studies
of price elasticities. Soybeans and cotton are the most price respon-
sive of the commodities considered with corn being the least elastic.
With all export price elasticities less than 1 in absolute value (tobac-
co's price elasticity is meaningless), the falling real price of U.S.
agricultural exports will not increase farm export revenue. This is in
sharp contrast to the theoretical work of Schuh who argues that export
price elasticity is greater than $|-1|$.

For all five commodities, except tobacco, the exchange rate vari-
ables as separate regressors were insignificant. The standard errors
were large relative to the estimated coefficients. Apparently little of
the variation in the movement of U.S. exports can be explained by
exchange rate fluctuations.

For all commodities the export price elasticity was found to be
larger than the exchange rate elasticity. This is in sharp contrast to
the work of Chambers and Just (1981) who found wheat, corn, and soybean
exchange rate elasticities to be all greater than their respective own-
price elasticities and to all be in the elastic range. This further

confirms the hypothesis that movements in the exchange rate will have
only minimal effect on U.S. agricultural exports. Monetarists such as
Laffer (1969, 1976) have argued that devaluations will have only mone-
tary effects like portfolio adjustments, as opposed to seriously affect-
ing trade balances. These low export exchange rate elasticities seem to
support the monetarist view on exchange rate movements. For a compari-
son of export exchange rate elasticities, see Table III. One of the
main differences between this study and that by Chambers and Just (1981)
is that they used quarterly data and this study used annual data. Cham-
bers and Just (1981) found the exchange rate effect to be most dramatic
in the first period and then taper away. By using a longer examination
period, this study found little exchange rate effect.

This study found the foreign buyer's income to be the most signifi-
cant variable affecting exports for all five commodities except soybeans
when the exchange rate was entered as a separate regressor. Wheat GDP
did have a large standard error and the equation had a rather low R^2.
This is probably because other factors such as European threshold price
of wheat and world wheat stocks are missing from the equations. Both
corn and cotton have an income elasticity greater than one and the soy-
bean income elasticity is almost equal to one. With the elastic income
response and high significance of real foreign buying power in the
export equations, our conclusion seems to be similar to that of Batten
and Belongia--that the sluggish growth in world incomes in the 1980's
has been the primary explanatory variable associated with the decline in
the U.S. farm exports. For a comparison of income elasticities, see
Table IV.

The results and conclusions of this study are similar to that of

Johnson, Grennes, and Thursby who found that other trade factors besides the exchange rate had a larger impact on wheat exports. Specifically, they found that export subsidies, tariffs, and shipping policies all had a greater impact on wheat exports than a 10 percent devaluation of the dollar. This study found foreign income and foreign livestock populations to have a greater impact on U.S. grain exports than movements in the exchange rate. In addition, Vallianitis-Fidas concluded in her 1976 study that changes in the exchange rate of the United States, a major supplier of agricultural commodities on the world market, did not significantly affect agricultural trade. Theoretically this argument is supported by the low supply and demand elasticities of price for agricultural products, particularly in the short run. As seen from the export equations where the real price is deflated by the exchange rate to give a trade-weighted import price, the export elasticity is still quite small, almost zero.

Policy conclusions of this study indicate that current tight monetary policy to prevent inflation has not seriously hurt U.S. agricultural exports due to the linkage with exchange rate determination. Of more importance to the farm sector is the Third World recession and cash flow problem. To the extent that budget deficits raise real interest rates and hinder the cash flow of indebted developing nations, current fiscal policy could be a major factor affecting the exportability of the farm sector. Neither lower prices for farm products at the farm gate nor a lower import price for foreign buyers will significantly help release the over capacity in farm production. Instead, sharper real growth in both the developing countries and developed countries is the key variable that will revive the agriculture export sector of the U.S.

economy.

Table I. Structural Equations.

$CXPT = -14528 - .4352\ RPC + 1.96\ CXR + 825\ CIN + 32.5\ FLV$
  (3450) (.130) (14.8) (130) (8.93)
   [-.035] [.02] [1.38] $R^2 = .95$
  d.w. = 2.8

$CXPT = -129 - 945\ \dfrac{RPC}{CXR} + 7.80\ CIN + .277\ FLV$
   (33.6) (326) (1.15) (.0857)
   [-.02] [1.3] $R^2 = .95$
  d.w. = 2.4

$WXPT = -5187 - .0881\ RPW + 2.02\ WXR + 194\ WIN + 15.9\ FLV$
  (8188) (.1152) (28.3) (189) (19.2)
   [-.18] [.02] [.63] $R^2 = .42$
  d.w. = .95

$WXPT = -6297 - 41959\ \dfrac{RPW}{WXR} + 155\ WIN + 19.7\ FLV$
   (4831) (32545) (151) (12.3)
   [-.02] [.5] $R^2 = .48$
  d.w. = 81

$SXPT = -177 - .0105\ RPS - .841\ SXR + 17.8\ SIN + .751\ FLV$
  (213) (.0029) (2.91) (10.9) (.535)
   [-.70] [-.15] [.97] $R^2 = .81$
  d.w. = 1.9

$SXPT = 120 - 387.3\ \dfrac{RPS}{SXR} + 5.98\ SIN + .240\ FLV$
  (269) (1110) (6.38) (.615)
   [-.06] [.37] $R^2 = .78$
  d.w. = 1.6

$CTXPT = -371516 - .112\ RPCT + 12874\ CTXR + 196379\ CTIN$
  (773019) (.0647) (61469) (31863)
   [-.61] [.13] [1.85] $R^2 = .58$
  d.w. = 2.6

$CTXPT = -355611 - 12194\ \dfrac{RPCT}{CTXR} + 194955\ CTIN$
  (459206) (6069) (50100)
   [-.49] [1.8] $R^2 = .60$
  d.w. = 2.8

(continued)

has the predominant effect on U.S. commodity exports: real prices, real exchange rates, or foreign buying capacity. Past studies used different time spans as well as different lengths of periods for modeling. Also, many of the previous studies of the role of exchange rates on agricultural exports used different levels of aggregation than that used here as well as examining a smaller set of commodities. Model specification used in this study differs from that used in certain previous works. Some studies did not use the exchange rate variable as a seperate regressor and instead merely deflated the export's price by the exchange rate to determine the price percieved by the importer. Finally, certain previous studies restricted the percentage change in price to be no greater than the percentage change in the value of that nations currency. No such restriction was applied in this model.

II. Previous Literature

Vallianitis-Fidas conducted two studies in 1976, in the wake of the enormous agricultural price increases of 1972 and 1973, to test the hypothesis that exchange rate changes have had a significant impact on the demand for U.S. agricultural exports. The first was a cross sectional study of the demand for U.S. agricultural exports by major trading partners in 1971-73. The method used was ordinary least squares regression with a stepwise procedure of eight variables for wheat and corn and seven variables for soybeans. The variables included exchange rate changes and normal demand variables. The importance of the exchange rate variable was investigated but the effect of price was not examined.

Table II. Variables Defined.

A. Jointly Dependent Variables:

CXPT = U.S. exports of corn in metric tons

WXPT = U.S. exports of wheat in metric tons

SXPT = U.S. exports of soybeans in metric tons

CTXPT = U.S. exports of cotton in metric tons

TXPT = U.S. exports of tobacco in metric tons

RPC = U.S. price of corn at farm level (dollars per metric ton) divided by U.S. consumer price index

RPW = U.S. price of wheat at the farm level (dollars per metric ton) divided by U.S. consumer price index

RPS = U.S. price of soybeans at the farm level (dollars per metric ton) divided by the U.S. consumer price index

RPCT = U.S. price of cotton at the farm level (dollars per metric ton) divided by the U.S. consumer index price

RPT = U.S. price of tobacco at the farm level (dollars per metric ton) divided by the U.S. consumer price index

B. Predetermined Variables:

CXR = real corn trade-weighted exchange rate

WXR = real wheat trade-weighted exchange rate

SXR = real soybean trade-weighted exchange rate

CTXR = real cotton trade-weighted exchange rate

TXR = real tobacco trade-weighted exchange rate

CIN = summation of the GDP's of importing countries of U.S. corn divided by the GDP weighted CPI of those countries

WIN = summation of the GDP's of importing countries of U.S. wheat divided by the GDP weighted CPI of those countries

SIN = summation of the GDP's of importing countries of U.S. soybeans divided by the GDP weighted CPI of those countries

Table I.   (continued) Structural Equations.

TXPT = 17.8 + .531 RPT + .0345 TXR + .936 TIN
     (3.80)   (6.00)   (.0196)   (.348)
              [.0025]   [.09]   [.31] R^2=.56
                                             d.w.=1.8

$$TXPT = 22 - .0947\ \frac{RPT}{TXR} + .928\ TIN$$

   (4.21)   (.0892) (.365)
              [.05]   [.31] R^2=.46
                                             d.w.=1.77

Note: Numbers in parentheses are standard errors; numbers in brackets
        are elasticities.

Table II.   (continued) Variables Defined.

CTIN = summation of the GDP's of importing countries of U.S. cotton
       divided by the GDP weighted CPI of those countries

 TIN = summation of the GDP's of importing countries of U.S. tobacco
       divided by the GDP weighted CPI of those countries

 FLV = summation of cattle and hog populations for countries that are
       principle importers of U.S. feed grains

Note: The real exchange rate for any trading partner is found by the
        following method:

A - nominal exchange rate = dollars/foreign currency

B - real exchange rate=

$$\frac{\text{dollars/U.S. CPI}}{\text{foreign currency/foreign CPI}} =$$

$$\frac{\text{dollars}}{\text{foreign currency}} \quad \frac{\text{foreign CPI}}{\text{U.S. CPI}} =$$

$$\text{nominal exchange rate X } \frac{\text{foreign CPI}}{\text{U.S. CPI}}$$

Source:

Food and Agriculture Organization of the United Nations, Production Yearbook (various issues), Rome, Italy.

International Monetary Fund, International Finance Statistics (various issues), Washington, D.C.

United States Department of Agriculture, Agricultural Statistics, Washington, D.C.   1968-1984 editions.

Table III. Comparison of Export Exchange Rate Elasticities and Export
           Price Elasticities

| | Chambers and Just | | Childs and Hammig | |
Commodity	Price	Exchange Rate	Price	Exchange Rate
Wheat	-.174	-2.045	-.184	.024
Corn	-.465	-5.227	-.035	.020
Soybeans	-.202	-1.311	-.70	-.15
Cotton	N/A	N/A	-.61	-.13
Tobacco	N/A	N/A	N/A	.093

Table IV. Comparison Income Elasticities

Commodity	Batten and Belongia	Childs and Hammig
Corn	N/A	1.38
Wheat	N/A	.636
Soybeans	N/A	.978
Cotton	N/A	1.85
Tobacco	N/A	.013
Aggregate	1.32	N/A

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