AN EMPIRICAL ANALYSIS OF MACROECONOMIC FACTORS INFLUENCING THE AGRICULTURAL EXCHANGE RATE OF THE DOLLAR

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ABSTRACT

This paper tests empirically a number of models, based on the "asset-market" view of exchange rates, which explain movements in the agricultural trade-weighted dollar exchange rate. Our results indicate that the portfolio balance approach more accurately accounts for the determinants of the effective agricultural exchange rate.

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The emergence of the system of floating exchange rates has been among the most significant international economic developments of the last decade. Under this system, exchange rates have been determined largely by private market forces rather than by government fiat. Despite occasional interventions by national monetary authorities, exchange rate behavior under the current floating rate system has been characterized by high volatility.

This increased exchange rate volatility is of particular importance to American agriculture. A number of authors (Schuh (1975, 1981), Chambers and Just, Pagoulatos and Canler) have pointed out that unstable fiscal and monetary policies affect the agricultural sector via their effect on exchange rates and agricultural trade. Current and expected developments in monetary and fiscal policy in the U.S. and in other countries are reflected, for example, in an appreciation of the dollar exchange rate. This rise in the foreign exchange value of the dollar in turn increases the prices paid by importing countries, thus reducing the demand for U.S. farm exports abroad and providing a stimulus for increased agricultural output in other countries. As a first step toward understanding the role of macroeconomic instability in influencing the prosperity of the U.S. agricultural sector, it is necessary to understand the factors that explain the behavior of the foreign exchange rate of the dollar.

This paper tests empirically a number of models, based on the "asset-market" view of exchange rates, which explain movements in the agricultural trade-weighted dollar exchange rate. Our results indicate that the portfolio balance approach more accurately accounts for the determinants of the effective agricultural exchange rate.

Exchange Rate Determination Models

One of the earliest models of exchange rate behavior is the "purchasing-power parity" doctrine (Officer) which argues that changes in domestic prices relative to foreign prices determine the exchange rate. While the "purchasing-power parity" theory (PPP for short) has a long history in economics, there is considerable controversy about the precise linkages between exchange rates and prices and about the ability of PPP to account for short-term variations in exchange rates. Over the last decade, for example, short-run movements in exchange rates have been far greater than the corresponding movements in domestic price levels. As a consequence, economists have turned to new models of exchange rate determinations that are more appropriate for a floating exchange rate environment.

The modern theories on the determination of the flexible exchange rate are generally limited to the short-run and view foreign exchange markets as asset markets characterized by conditions of perfect capital mobility. The implication of the "asset-market" view is that exchange rates adjust instantaneously to equilibrate the international demand for stocks of assets. Thus, changes in the way participants in asset markets allocate their foreign currency-denominated financial portfolios directly influence foreign exchange rates.

A large number of asset-market models have been developed during the last decade. Typically, they differ with respect to the assumptions made about asset substitutability and exchange rate expecttions. Excellent surveys of the range of asset-market models have been recently provided by Frankel (1983), Meese and Rogoff, and Gylfason and Helliwell. The general concensus in these surveys is that asset-market models can be classified into two broad groups. One group of models, representing the "portfolio-balance approach," assumes that foreign and domestic bonds are imperfect substitutes and stresses portfolio considerations in financial markets (Branson, Isard, Hooper and Morton). Specifically, portfolio holders seek the optimal balance of domestic and foreign assets in light of their returns and risk differentials. The other group of models, the "monetary approach," assumes foreign and domestic assets to be perfect substitutes, so that portfolio holders are indifferent between the two. Additionally, the monetary models assume wealth effects to have no role in determining the exchange rate, so it is possible to focus only on money market equilibrium for exchange rate determination. The "monetary approach" models can be further subdivided into the "Flexible-Price Monetary" models (Frenkel), which assume purchasing-power parity, and the "Sticky-Price Monetary" models (Dornbush), which allow for slow domestic price adjustment and deviations from PPP.

In order to specify and statistically estimate the various competing asset-market models, we follow Meese and Rogoff, and Gylfason and Helliwell in using the following general reduce-form equation of exchange rate determination, presented in double-logarithmic form:

$$(1) \quad \ln e_t = a_0 - a_1 \ln (p^{us}/p^o)_t + a_2 \ln (y^{us}/y^o)_t - a_3 \ln (m^{us}/m^o)_t + a_4 \ln (r^{us}/r^o)_t - a_5 \ln B_t^{us} - a_6 \ln CCA_{t-1}^{us} + a_7 \ln e_{t-1} + u$$

where e_t is the foreign currency price of the dollar, $(p^{us}/p^{o})_t$ is the ratio of U.S. to foreign inflation rate, $(y^{us}/y^{o})_t$ is the ratio of U.S. to foreign real income, $(m^{u}/m^{o})_t$ is the ratio of the U.S. and foreign money stocks, (r^{us}/r^{o}) is the nominal interest rate differential, B_t^{us} is the net U.S. capital outflow, CCA_{t-1}^{us} is the lagged exchange rate, and U is a stochastic term.

The implication of the PPP model is that $a_2 = a_3 = a_4 = a_5 = a_6 = 0$. The "Flexible-Price Monetary" model implies that $a_1 = a_5 = a_6 = 0$, while the "Sticky-Price Monetary" model constraints $a_5 = a_6 = 0$. Finally, the "Portfolio Balance" model imposes no restrictions on the coefficients of equation (1).

The motivations for the various competing specifications as well as the expected effects of the regressors can be explained with reference to the "asset-market" and PPP models. The PPP model implies that an increase in U.S. inflation relative to the rest of the world will result over time to an external depreciation of the dollar.

An increase in the U.S. real income relative to the rest of the world results in an excess money demand. This excess need for cash can be met by obtaining dollar cash balances through the sale of foreign currencies. The movement out of foreign currencies drives down their value relative to the dollar. The relative value of the dollar rises until people become unwilling to sell off more foreign currencies. Conversely, the relative supply of money is negatively related to the exchange rate. An increase in the U.S. money supply finds people holding more dollars than they desire. They attempt to sell dollars for other currencies, precipitating a fall in dollar prices. The fall will continue until people are satisfied with the value of the stocks of dollars and foreign currencies they hold. A long-run model would need to consider the feedback effects of changes in the money stock on prices and income, but are assumed unimportant within the one quarter-framework of the present model.

An increase in the domestic relative to the foreign interest rate should lower the exchange rate by affecting the willingness to hold the domestic currency. As the dollar interest rate rises, people in search of higher returns will try to buy dollars, driving up its price. At the same time, however, higher interest rates induce people to economize on cash balances. This reluctance to hold dollars adversely affects the exchange rate.

The cumulated current account balance is included in the portfolio balance model in order to account for expectations about current account developments and for the transfer of wealth from foreign residents to domestic residents implicit in a current account surplus. This variable is expected to positively affect the exchange rate. In addition, following the portfolio approach that assumes imperfect substitutability between domestic and foreign bonds, we include the net outflow of capital B as an explanatory variable. An increased net outflow can be expected to lower the dollar exchange rate.

The level of the exchange rate in the previous period is also included. It is assumed that the financial market conditions which make an exchange rate "high" or "low" are not quickly reversed. Therefore, a high exchange rate in the previous quarter is associated with a high rate in the current quarter and vice versa. The coefficient should have a positive sign.

Empirical Results

In this section we apply the alternative theories of exchange rate determination summarized above in equation (1) in order to explain movements in the effective agricultural exchange rate of the dollar over the floating rate period. The effective exchange rate is a multilateral rate that measures the overall value of the U.S. dollar in the foreign exchange market. This exchange rate (AGER) is a weighted average of the nine largest importers of U.S. agricultural products which have had floating currencies in relation to the U.S. dollar since the inception of the float. The countries included are Japan, Netherlands, United Kingdom, France, West Germany, Italy, Canada, Spain and Belgium. The weights are calculated by the value of exports to each country as a proportion to the total for the nine countries. These weights change yearly to reflect changes in the U.S. agricultural export pattern. The method used to compute the effective change for agricultural exports along with the other variable definitions and data sources are presented in Appendix A at the end of the paper.

Because it was desired to preserve comparability between the models of exchange rate determination, each model was specified as having an autocorrelated error structure in both its static and dynamic forms. This in turn provides a point estimate of ρ, the autoregressive parameter, and its associated (asymptotic) standard error. However when the lagged dependent variable is included in each of the four models, the traditional generalized least squares estimator should not be employed due to the fact that biased parameter estimates result (Johnston, p. 317). Instead, a non-linear least squares estimator is employed to determine both ρ and the coefficient on the lagged dependent variable simultaneously. This approach provides conditional maximum likelihood estimators of the parameters (Judge, et al.) and enables the discrimination between them whether the models are autocorrelated, dynamic or both. If the static models have autocorrelated errors because a variable such as the lagged dependent variable is omitted, then the inclusion of the lagged dependent variable should yield a model with an insignificant estimate of ρ (Gupta and Maasoumi). The empirical results using quarterly data from 1972II to 1981IV are shown in Table 1.

The results presented in Table 1 conform well with theoretical expectations. All of the coefficients have the expected sign and all except the coefficients on the relative price, the relative interest rate, and net capital outflow variables exhibit low standard errors. Over 80 percent of the quarterly variation in the dollar's average agricultural exchange value is explained by the portfolio balance formulation of equation (1). As expected, the PPP explanation of exchange rates failed to account for variations of the U.S. agricultural rate. Finally, the lagged value of AGER proved to be a significant explanatory variable in all estimated models, providing evidence of considerable friction in asset markets.

Table 2 shows estimates of the agricultural exchange rate impacts of unit changes in U.S. economic variables based on the equations in Table 1. The highest impact is registered by the changes in U.S. real income and the U.S. money supply.

The results presented in Tables 1 and 2 also indicate that, although important, the role of the money supply in the determination of the agricultural exchange rate can be exaggerated. Other variables -- the real GNP, the lagged exchange rate, and the cumulative current

Table 1. Estimation Results for the Agricultural Exchange Rate Equations (ln AGER).

Independent Variables: / Model:	Purchasing Power Parity		Flexible-Price Monetary		Sticky-Price Monetary		Portfolio-Balance	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Constant	4.74	2.71	2.06	.202	2.08	.312	2.18	1.32
	(.166)	(3.35)	(.525)	(.595)	(.507)	(.645)	(.562)	(.672)
$\ln(p^{us}/p^{o})$	-.257	-.132			-.349	-.112	-.062	-.029
	(.298)	(.293)			(.269)	(.231)	(.227)	(.209)
$\ln(y^{us}/y^{o})$			.541	.389	.577	.408	.475	.360
			(.112)	(.093)	(.107)	(.102)	(.081)	(.092)
$\ln(m^{us}/m^{o})$			-.158	-.082	-.183	-.093	-.283	-.180
			(.053)	(.038)	(.051)	(.045)	(.037)	(.056)
$\ln(r^{us}/r^{o})$			-.051	-.0005	-.052	-.0003	-.054	-.009
			(.034)	(.029)	(.033)	(.029)	(.025)	(.029)
$\ln B^{us}$							-.018	-.039
							(.032)	(.033)
$\ln CCA^{us}_{t-1}$							.044	.030
							(.009)	(.010)
$\ln AGER_{t-1}$		.426		.560		.530		.374
		(.728)		(.158)		(.170)		(.174)
ρ	.733	.628	.459	.093	.379	.102	.028	.093
	(.109)	(.657)	(.142)	(.228)	(.148)	(.230)	(.160)	(.217)
Standard error of equation	.040	.038	.037	.032	.037	.033	.031	.029
R^2	-	.674	-	.784	-	.786	-	.837

All equations estimated using quarterly data from 1972 II to 1981 IV. Standard errors in parentheses.

Table 2. Change in the Average Exchange Value of the Dollar Resulting from Unit Changes in U. S. Economic Variables

	Percent Change in the Dollar's Average Exchange Value		
	Model (3)[a]	Model (5)	Model (7)
1 percent increase in U. S. inflation rate	-	-.35	-.06
1 percent increase in U. S. real GNP	.54	.58	.48
1 percent increase in U. S. interest rate (12-mo T-bill)	-.05	-.05	-.05
1 percent increase in U. S. money supply (M1)	-.16	-.18	-.28
1 percent increase in U. S. cumulative current account balance	-	-	.04
1 percent increase in net outflow of U. S. capital assets	-	-	-.02

[a]Estimates based on equations (3), (5), and (7), respectively, in Table 1.

account balance -- also play an important role in the determination of the effective agricultural exchange rate. It is these monetary and real factors that ultimately affect the U.S. agricultural sector through their impact on AGER and agricultural exports.

Conclusions

In a world of flexible exchange rates monetary instability is transmitted through the exchange rate to agricultural trade and ultimately to the domestic agricultural sector. It is therefore important to understand the sources of exchange rate volatility.

In this paper an effective U.S. agricultural exchange rate was constructed and its determinants were investigated on the basis of the "asset-market" view of exchange rates. Our empirical results indicate that the portfolio balance approach more accurately accounts for the determinants of the effective agricultural exchange rate of the dollar.

APPENDIX A

VARIABLE DEFINITIONS AND DATA SOURCES

-All data are quarterly and cover 1972: II to 1981: IV. The superscript "us" refers to the U.S. variable, while the superscript "o" refers to the other countries' variable. The other countries' variables are a weighted average utilizing the same weights used to compute the effective exchange rate for agricultural exports.

-exchange rate: (AGER), the effective exchange rate for agricultural exports was computed by taking a weighted average of the U.S. dollar exchange rates of Canada, Japan, Italy, France, West Germany, Belgium, Netherlands, Spain and the United Kingdom. The yearly weights were calculated as the proportion of each country's imports of U.S. agricultural products with respect to total imports for the group. These countries were the largest importers with floating currencies. Sources: International Financial Statistics; U.S. Foreign Agricultural Trade.

-relative prices: (p^{us}), is the U.S. producer price index for all commodities (1967=100). Source: Survey of Current Business. (p^{o}), other countries' producer price index. Source: International Financial Statistics.

-real income: (y^{us}), the U.S. gross national product in constant 1972 dollars. Source: Survey of Current Business. (y^{o}), other countries' real GNP. Source: International Financial Statistics.

-nominal money stocks: (m^{us}), the U.S. M1 definition of money supply (billion dollars). Monthly figures were averaged for each quarter. Source: Federal Reserve Bulletin. (m^{o}), other countries' money supply (M1). Source: International Financial Statistics.

-nominal interest rates: (r^{us}), the interest paid on the 12-month U.S. T-Bill. The average of monthly rates was taken for each quarter. Source: Federal Reserve Bulletin. (r^{o}), other countries' comparable nominal interest rates. Source: International Financial Statistics.

-net U.S. capital outflow: (B), the net change in U.S. assets abroad minus the net change in foreign assets held in the United States. A constant of 30000 was added to all observations to allow estimation in log form. Source: Survey of Current Business.

-U.S. current account: (CCA), the cumulative balance on the current account since 1971 I (million dollars). A constant of 30000 was added to all observations to allow estimation in log form. Source: Survey of Current Business.

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