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# EXCHANGE RATES, MONEY AND RELATIVE PRICES: THE DOLLAR-POUND IN THE 1920's

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## ABSTRACT

This paper applies the analytical framework of the monetary approach to exchange rate determination to the analysis of the Dollar/Pound exchange rate during the first part of the 1920's. The analysis uses monthly data up to the return of Britain to gold in 1925. The equilibrium exchange rate is shown to be influenced by both real and monetary factors which operate through their influence on the relative demands and supplies of monies. Special attention is given to examination of the relationship between exchange rates and the relative price of traded to non-traded goods. In the empirical work the prices of traded goods are proxied by the wholesale price indices and the prices of non-traded are proxied by wages. One of the key findings of the paper is the estimate of the elasticity of the exchange rate with respect to the relative price of traded to non-traded goods. This elasticity is estimated with high precision and is shown to be .415 which provides an independent measure of the relative share of spending on non-traded goods. This estimate is consistent with other estimates obtained in studies of expenditure shares. The paper concluded with a dynamic simulation which indicates the satisfactory quality of the predective ability of the model.



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# Exchange Rates, Money and Relative Prices:

# The Dollar-Pound in the 1920's*

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This paper applies the monetary approach to exchange rate determination to the analysis of the monthly Dollar/Pound exchange rate during the period preceeding the return of Britain to Gold in 1925. The analytical framework emphasizes that the exchange rate is influenced by real and monetary factors. Special attention is given to the relationship between the exchange rate and the relative price of traded to non-traded goods. The estimated elasticity of the exchange rate with respect to this relative price is shown to be about 0.4 which provides an independent measure of the relative share of spending on non-traded goods.

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The monetary approach to the exchange rate emphasizes that, being a relative price of two monies, the equilibrium exchange rate is attained when the existing stocks of the two monies are willingly held and that a theory of exchange rate determination can be stated conveniently in terms of the supply of and the demand for these monies. The equilibrium exchange rate is influenced by both real and monetary factors which, according to the analytical framework that is provided by the monetary approach, operate through their influence on the relative demands and supplies of monies.[1] Previous work showed that one of the important channels through which real factors affect the exchange rate is the relative price of (internationally) traded to non-traded goods -- the "real exchange rate" [e.g. Dornbusch, 1976b and Calvo and Rodriguez (1977)]. In this paper we extend our earlier analysis [Frenkel and Clements (1978)] by applying the monetary approach to an examination of the Dollar/Pound exchange rate during the 1920's. We adopt the analytical framework developed by Dornbusch (1976b) with special emphasis on the role of relative prices. In Section I we outline the basic elements of the monetary model and in Section II we present the empirical results. Section III contains some concluding remarks.

## I. The Analytical Framework

The key features of the model relate to assumptions concerning (i) equilibrium in the money markets and (ii) interrelationships between domestic and foreign prices through the condition of purchasing power parity.

Let the demand for real balances be $L(\ )$ -- the determinants of which are specified below -- and let the supply of real balances be $M/P$ where $M$ and $P$ denote the nominal quantity of money and the price level, respectively. Equilibrium in the domestic and the foreign money markets can be written as

$$L(\quad) = M/P \tag{1}$$

$$L^*(\quad) = M^*/P^* \tag{2}$$

where variables which pertain to the foreign economy are denoted by an asterisk. When money markets clear the ratio of the two price levels can be expressed as:

$$\frac{P}{P^*} = \frac{M}{M^*}\,\frac{L^*(\quad)}{L(\quad)} \quad . \tag{3}$$

The price level is assumed to be a linear homogenous (Cobb-Douglas) function of the prices of non-traded goods $P_N$ and traded goods $P_T$:

$$P = P_N^{\beta}\, P_T^{1-\beta} \tag{4}$$

$$P^* = P_N^{*\,\beta^*} P_T^{*\,1-\beta^*} \tag{5}$$

where $\beta$ and $\beta^*$ denote domestic and foreign expenditure shares on non-traded goods. From (4) and (5) the ratio of traded goods prices $P_T/P_T^*$ can be written as:

$$\frac{P_T}{P_T^*} = \frac{(P_T/P_N)^{\beta}}{(P_T^*/P_N^*)^{\beta^*}}\,\frac{P}{P^*} \quad . \tag{6}$$

Equation (6) links the relative price of traded goods to the ratio of the price levels through terms which summarize the price structures in the two economies.

The second link between domestic and foreign prices is provided by the condition of purchasing power parity. Assuming that purchasing power parity applies to traded goods, we may express the parity as

$$\frac{P_T}{P_T^*} = S \tag{7}$$

where S denotes the exchange rate -- the price of foreign currency in terms of domestic currency.[2]

Substituting equations (3) and (7) into (6) yields the exchange rate equation that is familiar from Dornbusch (1976b):

$$S = \frac{(P_T/P_N)^{\beta}}{(P_T^*/P_N^*)^{\beta^*}} \frac{M}{M^*} \frac{L^*(\quad)}{L(\quad)} \quad . \tag{8}$$

Equation (8) expresses the exchange rate in terms of three basic determinants: the relative price structure, the relative (nominal) money supplies and the relative (real) money demands. Embodied in this relationship are the two basic assumptions of money markets equilibrium and (traded goods) purchasing power parity. As is evident the determinants of the exchange rate in (8) include both real and monetary factors.

The discussion hitherto has not specified the determinants of the various demands for real balances. In order to set the stage for the empirical analysis it is assumed that the demand for money depends on real income (y) and the rate of interest (i) according to:

$$L = ay^{\eta}e^{-\alpha i} \tag{9}$$

$$L^* = a^*y^{*\eta^*}e^{-\alpha^* i^*} \tag{10}$$

Substituting (9) - (10) in (8) and assuming, for expository purposes, that domestic and foreign parameters are the same, i.e., that $\eta = \eta^*$, $\alpha = \alpha^*$, $\beta = \beta^*$ (these assumptions are tested in Section II) the exchange rate equation becomes[3]

$$\ell nS = c + \beta\, \ell n \frac{P_T/P_N}{P_T^*/P_N^*} + \ell n \frac{M}{M^*} + \eta\, \ell n \frac{y^*}{y} + \alpha(i-i^*) \quad . \tag{11}$$

The implications of equation (11) are straightforward. For example, a rise in the domestic relative price of traded goods results in a depreciation of the currency, i.e., a rise in S. The elasticity of the exchange rate with respect to the relative price should approximate $\beta$ -- the relative share of spending on non-traded goods. Likewise, a rise in the supply of domestic money should depreciate the currency (raise S) with an elasticity of unity;

a rise in domestic income should appreciate the currency (lower S) since, ceteris paribus, the rise in income creates a relative excess demand for domestic money.[4] Finally, a rise in the rate of interest should raise S since it reduces the quantity demanded of the domestic currency[5]. Analogous inferences hold with respect to the effects of changes in the foreign variables.

## II. Empirical Results

In this section we apply the monetary model to an analysis of the Dollar/Pound monthly exchange rate over the period February 1921 - May 1925 during which exchange rates were flexible. The period is the same as in Frenkel (1978) and in Frenkel and Clements (1978) and it terminates with the return of Britain to gold. Details on the data and on data sources are reported in the Appendix. Since there are no available data for the prices of traded and non-traded goods[6] we proxied the prices of traded goods by the wholesale price indices and the prices of non-traded goods by wages. For $P_N$ (U.S. price) we used actual average hourly earnings of all wage earners[7] and for $P_N^*$ (U.K. price) we used an index of average weekly earnings.

The use of these proxies for the relative prices permits an interpretation of the estimate of the coefficient $\beta$ in equation (11) in terms of the elasticity of the exchange rate with respect to the relative real wage rates. Substituting the nominal wage rates w and w* for $P_N$ and $P_N^*$, and the wholesale price indices $P_w$ and $P_w^*$ for $P_T$ and $P_T^*$ yields in equation (11) $\ln[(w^*/P_w^*)/(w/P_w)]$ instead of $\ln[(P_T/P_N)/(P_T^*/P_N^*)]$. By this interpretation the coefficient $\beta$ measures the elasticity of the exchange rate with respect to the ratio of the real wage rates, and the analytical framework implies that a rise in the domestic real wage relative to the foreign real wage results in an appreciation of the

currency, i.e., a decline in S. This positive association between the real wage and the international value of the currency is explained by the fact that a higher real wage reflects a higher productivity of domestic labor relative to foreign labor.

In estimating the exchange rate equation our methodology was to estimate an equation like (11) without imposing any of the restrictions of equality between domestic and foreign parameters. We then proceeded to impose those restrictions that, according to the F test, were compatible with the data. The result of these tests suggest that the data are consistent with the joint hypotheses that (i) the domestic and foreign shares of spending on non-traded goods are the same, i.e., $\beta = \beta^*$, (ii) the elasticity of the exchange rate with respect to domestic income equals minus the elasticity with respect to foreign income, i.e. $\eta = \eta^*$ and, (iii) the interest (semi) elasticities are the same, i.e. $\alpha = \alpha^*$. The hypothesis of equality of the absolute values of the elasticities with respect to domestic and foreign monies is rejected.[8]

The resulting OLS estimate of the exchange rate equation are reported in equation (12) with standard errors below the coefficients. An iterative Cochran-Orcutt transformation was employed to account for first order serial correlation of the residuals with $\rho$ being the final value of the auto-correlation coefficient.

$$\ell nS = \underset{(1.396)}{-4.297} + \underset{(.099)}{.415}\ \ell n \frac{P_T/P_N}{P^*/P^*} + \underset{(.182)}{1.050}\ \ell nM - \underset{(.143)}{.044}\ \ell nM^* + \underset{(.066)}{.188}\ \ell n \frac{Y}{y^*} \qquad (12)$$

$$+ \underset{(.350)}{.363}\ (i-i^*)$$

$$R^2 = .96,\ \text{s.e.} = .015,\ \text{D.W.} = 1.55,\ \rho = .88.$$

Broadly, the results in equation (12) are reasonably satisfactory. The coefficient of relative prices is estimated with high precision and it

implies that the relative share of expenditures on non-traded goods is about .42. It is interesting to note that Bilson (1978) estimated this share for the U.K. and Germany during the 1970's to be .425; this estimate is also similar to the one in Clements (1979) who, using a very different methodology, estimated the marginal share of spending on non-traded goods in the U.S. (using recent data) to be .37.[9]

The elasticity of the exchange rate with respect to the domestic money supply is 1.05 and is consistent with the homogeneity postulate that, ceteris paribus, a given change in the supply of money results in an equiproportionate change in the exchange rate. The elasticity with respect to the foreign money supply does not differ significantly from zero and, as indicated above, the data reject the restriction of equality between domestic and foreign elasticities. There are three possible reasons for this rejection. First, it might be due to the fact that the definitions of the U.S. and the U.K. money supplies used in our monthly series are not strictly the same.[10] Second, it might be due to the fact that the U.K. monetary series have varied much less than that of the U.S.; the coefficient of variation of the U.K. monetary series is about one-half that of the U.S. series. As a third reason one should note the unique reserve currency role which was played by the U.K. pound; as a result variations in the supply of the U.K. money might have reflected variations in a third country's demand.

The elasticity of the exchange rate with respect to the income ratio is positive and significant indicating that, ceteris paribus, a ten percent rise in the ratio of domestic to foreign income results in about a 1.9 percent depreciation of the home currency. This result is in contrast with the prediction of the simple monetary model. A possible explanation is the implicit assumption that the terms of trade between imports and exports

were given. As a matter of fact, during the period of analysis the U.S. terms of trade (measured by the ratio of U.K. to U.S. wholesale price indices) have improved from 2.14 in February 1921 to 1.57 in May 1925. The correlation between changes in the ratio of incomes and changes in the terms of trade and their effects on the exchange rate (along the lines suggested in footnote 2 on page 4 above) might be responsible for the positive dependence of the exchange rate on income. Another explanation stems from the distinction between current and permanent income along the lines developed by Rodriguez (1976) in his analysis of the short-run interpretation of the monetary approach to the balance of payments.[11]

Finally, the coefficient on the interest rate differential has the expected (positive) sign but the parameter estimate is imprecise and does not differ significantly from zero at the 95 percent confidence level. To allow for a substitution between domestic and foreign currency we have also included in the estimated equation the forward premium on foreign exchange (in addition to the interest rate differential) and have experimented with various restrictions. In all cases (probably due to the collinearity implied by the interest parity theory) the coefficient on the forward premium did not differ significantly from zero.

To examine how well the estimated model tracks the (logarithm of) the exchange rate we have simulated the model dynamically using the parameter estimates of equation (12) and taking only the initial value of the exchange rate as given. This dynamic simulation is a relatively severe test of the predictive ability of the model since, in principle, the errors are cumulative. The results of the simulation are satisfactory. The squared correlation coefficient between actual and simulated exchange rates is .879, the mean error is .007, the root mean square error is .027, and the mean absolute

error is .022. Theil's inequality coefficient[12] (which ranges between zero and one and which assumes the value zero in the case of perfect forecast) is also extremely low -- .009, indicating the satisfactory quality of the predictive ability of the model.

## III. Concluding Remarks

In this paper we applied the monetary approach to the exchange rate to an analysis of the monthly Dollar/Pound exchange rate for the period preceding the return of Britain to gold in 1925. The analytical framework emphasized the relationship between relative prices and the exchange rate and we view the precise estimate of this relationship as one of the key results of the analysis. The estimated elasticity of the exchange rate with respect to the relative price of traded goods was shown to be .415 which provides an independent measure of the relative share of spending on non-traded goods. This estimate is consistent with other estimates obtained in studies of expenditure shares.

The basic assumptions which underlie the analysis were the assumption of money market equilibrium and the assumption of purchasing power parity. In principle these two assumptions could be tested directly. A regression of the logarithm of the exchange rate on the logarithm of the terms of trade (proxied by the ratio of wholesale price indices) yields an elasticity of .897 with a standard error of .267. Thus the monthly data seems to be consistent with the assumption that, on average, purchasing power parity held. The estimated standard error of the regression -- 1.9 percent per month -- indicates, however, that (as expected in an application of purchasing power parities to monthly data) this relationship was not precise.[13] The main source for some of the mixed results in the exchange rate equation, however, seems to lie with the assumption that both money markets have been

in continuous equilibria during each month of the sample period. A useful extension would allow for a distinction between short-run and long-run equilibria and would examine the dynamics of adjustment. It is noteworthy, however, that adding a lagged dependent variable to the estimated equation did not improve the estimates and yielded an insignificant coefficient on the lagged dependent variable; thus, the process of adjustment seems to be much more complex.

# Appendix

## THE DATA BASE

The data base is made up of 52 monthly observations on each variable for the period February, 1921 to May, 1925. Data on the Dollar/Pound spot exchange rate, and the United States and United Kingdom money supplies and real incomes are taken directly from Frenkel and Clements (1978, Appendix B, pp. 35-42).

### Traded and Nontraded Prices

Wage data were used as a proxy for nontraded goods prices in both countries. For U.S. wages, actual average hourly earnings of all wage earners were used. This series is from National Industrial Conference Board (1928, pp. 161-162).

Data for this series were not available from January 1922-June 1922. We use the available data to interpolate the missing observations as follows. First we regress the change in wages on a quadratic time trend. This yields (standard errors are given in parentheses below each estimated parameter):

$$\Delta w_t = \underset{(.002)}{-.016} + \underset{(.0002)}{.0013t} - \underset{(.000003)}{.00002t^2}$$

$$R^2 = .55$$

in which

$\Delta w = w_t - w_{t-1}$, the monthly change in the wage rate

$t = 2, 3, 4, \ldots 12, 20, 21, 22, \ldots, 53$ a monthly time trend.

This equation was estimated with data from January 1921 through May 1925 with a gap of six months representing the missing data.

Using the estimated coefficients we then interpolated values by setting $t = 13, 14, \ldots, 19$. Finally, we calculated the predicted wage levels for the period as

$$\hat{w}_{t+1} = \hat{w}_t + \hat{\Delta w}_{t+1}$$

in which $t$ runs from December 1921 through May 1922

$\hat{\Delta w}$ is the estimated monthly change in the wage rate

$\hat{w}$ is the estimated wage level.

To initialize this recursive relationship, we use the actual wage in December 1921.

For nontraded goods prices in the United Kingdom an index of average weekly earnings from Tinbergen (1934, pp. 105-6, column 29) was used. An explanation of the data is available in Bowley (1929).

The wage series for the U.S. and the U.K. are listed in Table A-1.

Wholesale price indices were used as proxies for traded goods prices in both countries. The data on wholesale prices are from Tinbergen (1934). For the U.K. the wholesale price index is from pp. 105-6, column 21. The primary source is the Board of Trade General Index. For the U.S. the wholesale price index is from pp. 210-11, column 28. The primary source is the Bureau of Labor Statistics.

The wholesale price indices for the U.S., denoted by $p_w$, and the U.K., denoted by $p_w^*$, are listed in Table A-2.

Rates of Interest

The rates of interest are short term rates from Tinbergen (1934). For the U.K. the rates are the day to day rate from pp. 105-6 column 17. These rates are averages for the week ending by the 15th day of the month. For the U.S. the rates are the call loan renewal from pp. 210-11 column 25. These rates are averages of daily rates obtained from the New York Sun.

The rates of interest series for the U.S. (denoted by i) and the U.K. (denoted by $i^*$) are listed in Table A-3.

TABLE A-1

WAGES IN THE U.S. AND U.K.: MONTHLY DATA

| Year and Month | | Hourly wages U.S. | Wage Index U.K. 1913 = 100 |
|---|---|---|---|
| 1921 | 2 | .564 | 276.0 |
| | 3 | .549 | 275.0 |
| | 4 | .541 | 271.0 |
| | 5 | .530 | 269.0 |
| | 6 | .521 | 264.0 |
| | 7 | .507 | 253.0 |
| | 8 | .503 | 243.0 |
| | 9 | .494 | 237.0 |
| | 10 | .487 | 233.0 |
| | 11 | .485 | 227.0 |
| | 12 | .480 | 223.0 |
| 1922 | 1 | .477 | 217.0 |
| | 2 | .475 | 214.0 |
| | 3 | .474 | 214.0 |
| | 4 | .474 | 206.0 |
| | 5 | .474 | 202.0 |
| | 6 | .474 | 197.0 |
| | 7 | .475 | 194.0 |
| | 8 | .480 | 191.0 |
| | 9 | .493 | 181.0 |
| | 10 | .498 | 180.0 |
| | 11 | .500 | 179.0 |
| | 12 | .503 | 178.0 |
| 1923 | 1 | .501 | 177.0 |
| | 2 | .505 | 177.0 |
| | 3 | .512 | 177.0 |
| | 4 | .529 | 177.0 |
| | 5 | .547 | 177.0 |
| | 6 | .548 | 176.0 |
| | 7 | .546 | 174.0 |
| | 8 | .550 | 174.0 |
| | 9 | .559 | 174.0 |
| | 10 | .561 | 174.0 |
| | 11 | .559 | 173.0 |
| | 12 | .559 | 173.0 |
| 1924 | 1 | .560 | 173.0 |
| | 2 | .561 | 174.0 |
| | 3 | .561 | 176.0 |
| | 4 | .560 | 176.0 |
| | 5 | .559 | 177.0 |
| | 6 | .559 | 178.0 |
| | 7 | .560 | 179.0 |
| | 8 | .556 | 179.0 |
| | 9 | .561 | 179.0 |
| | 10 | .562 | 178.0 |
| | 11 | .558 | 179.0 |
| | 12 | .561 | 179.0 |
| 1925 | 1 | .559 | 180.0 |
| | 2 | .558 | 180.0 |
| | 3 | .560 | 180.0 |
| | 4 | .561 | 181.0 |
| | 5 | .561 | 181.0 |
| Sample Mean | | .528 | 197.2 |
| Standard Deviation | | .034 | 31.7 |

TABLE A-2

WHOLESALE PRICE INDICES IN THE U.S. AND U.K.: MONTHLY DATA[a]

| Year and Month | $p_w$ 1926 = 100 | $p_w^*$ 1913 = 100 |
|---|---|---|
| 1921 2 | 104.9 | 225.0 |
| 3 | 102.4 | 211.0 |
| 4 | 98.9 | 205.0 |
| 5 | 96.2 | 202.0 |
| 6 | 93.4 | 198.0 |
| 7 | 93.4 | 194.0 |
| 8 | 93.5 | 190.0 |
| 9 | 93.4 | 187.0 |
| 10 | 94.1 | 181.0 |
| 11 | 94.2 | 173.0 |
| 12 | 92.9 | 168.0 |
| 1922 1 | 91.4 | 164.0 |
| 2 | 92.9 | 162.0 |
| 3 | 92.8 | 160.0 |
| 4 | 93.2 | 160.0 |
| 5 | 96.1 | 160.0 |
| 6 | 96.3 | 160.0 |
| 7 | 99.4 | 160.0 |
| 8 | 98.6 | 156.0 |
| 9 | 99.3 | 154.0 |
| 10 | 99.6 | 155.0 |
| 11 | 100.5 | 157.0 |
| 12 | 100.7 | 156.0 |
| 1923 1 | 102.0 | 157.0 |
| 2 | 103.3 | 158.0 |
| 3 | 104.5 | 160.0 |
| 4 | 103.9 | 162.0 |
| 5 | 101.9 | 160.0 |
| 6 | 100.3 | 159.0 |
| 7 | 98.4 | 157.0 |
| 8 | 97.8 | 155.0 |
| 9 | 99.7 | 158.0 |
| 10 | 99.4 | 158.0 |
| 11 | 98.4 | 161.0 |
| 12 | 98.1 | 163.0 |
| 1924 1 | 99.6 | 165.0 |
| 2 | 99.7 | 167.0 |
| 3 | 98.5 | 165.0 |
| 4 | 97.3 | 165.0 |
| 5 | 95.9 | 164.0 |
| 6 | 94.9 | 163.0 |
| 7 | 95.6 | 163.0 |
| 8 | 97.0 | 165.0 |
| 9 | 97.1 | 167.0 |
| 10 | 98.2 | 170.0 |
| 11 | 99.1 | 170.0 |
| 12 | 101.5 | 170.0 |
| 1925 1 | 102.9 | 171.0 |
| 2 | 104.0 | 169.0 |
| 3 | 104.2 | 166.0 |
| 4 | 101.9 | 162.0 |
| 5 | 101.6 | 159.0 |
| Sample Mean | 98.4 | 168.6 |
| Standard Deviation | 3.6 | 15.7 |

[a] $p_w$ and $p_w^*$ denote the wholesale price indices in the U.S. and the U.K., respectively.

Table A-3

RATES OF INTEREST IN THE U.S. AND U.K.

| Year and Month | Call loan renewal U.S. (100 × i) | Day to day rate U.K. (100 × i*) |
|---|---|---|
| 1921 2 | 7.25 | 6.50 |
| 3 | 6.80 | 5.75 |
| 4 | 6.44 | 5.50 |
| 5 | 6.85 | 4.38 |
| 6 | 5.81 | 4.19 |
| 7 | 5.62 | 4.12 |
| 8 | 5.60 | 4.19 |
| 9 | 5.12 | 2.75 |
| 10 | 5.25 | 3.50 |
| 11 | 5.05 | 3.63 |
| 12 | 5.12 | 2.44 |
| 1922 1 | 4.70 | 2.63 |
| 2 | 4.81 | 2.00 |
| 3 | 4.25 | 3.12 |
| 4 | 3.94 | 2.13 |
| 5 | 4.00 | 1.75 |
| 6 | 3.62 | 2.10 |
| 7 | 3.93 | 1.58 |
| 8 | 3.74 | 1.88 |
| 9 | 4.31 | 1.79 |
| 10 | 4.78 | 1.58 |
| 11 | 4.94 | 1.91 |
| 12 | 4.56 | 1.29 |
| 1923 1 | 4.30 | 1.21 |
| 2 | 4.81 | 1.79 |
| 3 | 5.19 | 1.92 |
| 4 | 4.94 | 1.98 |
| 5 | 4.75 | 1.63 |
| 6 | 5.00 | 1.40 |
| 7 | 4.75 | 2.42 |
| 8 | 5.00 | 2.10 |
| 9 | 4.94 | 2.40 |
| 10 | 4.80 | 2.48 |
| 11 | 4.81 | 2.54 |
| 12 | 4.81 | 1.67 |
| 1924 1 | 4.55 | 2.04 |
| 2 | 4.31 | 2.65 |
| 3 | 4.00 | 2.10 |
| 4 | 4.25 | 2.23 |
| 5 | 3.25 | 2.17 |
| 6 | 2.25 | 1.80 |
| 7 | 2.05 | 2.40 |
| 8 | 2.00 | 2.92 |
| 9 | 2.06 | 2.71 |
| 10 | 2.40 | 2.79 |
| 11 | 2.38 | 2.90 |
| 12 | 3.70 | 2.46 |
| 1925 1 | 3.12 | 2.85 |
| 2 | 3.56 | 2.94 |
| 3 | 3.81 | 3.50 |
| 4 | 4.00 | 3.92 |
| 5 | 3.81 | 4.27 |
| Sample Mean | 4.42 | 2.71 |
| Standard Deviation | 1.18 | 1.15 |

FOOTNOTES

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1. See, for example, Dornbusch (1976a, 1976b), Frenkel (1976), Frenkel and Clements (1978), Kouri (1976), Mussa (1976), Bilson (1978) and the various studies in Frenkel and Johnson (1978).

2. For a discussion of the choice of the proper price index relevant for the parity condition see Frenkel (1978). In the presence of tariffs the formulation in (7) should be modified in an obvious manner. If domestic and foreign traded goods are not the same, equation (7) would be modified to become $P_T/P_T^* = \lambda S$ where $\lambda$ denotes the terms of trade -- the relative price of imported goods in terms of exported goods; in (7) the implicit value of $\lambda$ is unity. In a manner that is familiar from the pure theory of international trade the value of $\lambda$ depends on domestic and foreign incomes as well as on the various measures of commercial policies.

3. The formulation of the demands for money in (9)-(10) assumes that domestic bonds are the only relevant alternative to domestic money while foreign bonds are the only relevant substitute for foreign money and thus that the appropriate measures of the alternative cost of holding domestic and foreign monies are respectively, domestic and foreign rates of interest. In principle the spectrum of the margins of substitution could be broader

including the substitution of foreign bonds and foreign exchange for domestic money. In that case the demand for domestic money would also include the foreigh rate of interest and the forward premium on foreign exchange. For an elaboration see Frenkel and Clements (1978), Frenkel (1979) and Abel, et. al. (1979).

4. The inference concerning the effect of a rise in income on the exchange rate does not allow for the possibility that the rise in income may affect the terms of trade $\lambda$ and thereby affect the exchange rate. The net effect would depend on whether growth is neutral or biased towards one of the commodities, as well as on the relationship between the magnitudes of the various price elasticities (which determine the change in the terms of trade) and the income elasticity of the demand for money. Another factor that is ignored in the present formulation is the phenomenon of currency substitution according to which a rise in income affects the demand for both monies with the net result depending on the relative intensities of the two monies in the portfolios of domestic and foreign asset-holders; see Frenkel and Clements (1978).

5. This description of the dependence of the exchange rate on the various right hand side variables should be interpreted with some care since in a fundamental sense these variables are determined jointly with the exchange rate. As a practical matter, however, outputs and the relative prices are determined to a large extent by real factors that are exogenous with respect to the exchange rate. The issue of simultaneity is potentially more serious with respect to the relationship between the rates of interest and the exchange rate. Likewise, the discussion did not distinguish whether the rise in the rate of interest is due to a rise in the real rate or due to a rise in

inflationary expectations. It seems that the predicted positive association between i and S is more likely to occur in cases where changes in the rate of interest are dominated by changes in inflationary expectations, the extreme case of which is of course the case of a hyperinflation; see Frenkel (1976). In the empirical section we deal with the simultaneity issue by employing in a two-stage least squares estimation procedure. The exchange rate determinants in equation (11) were derived explicitly from the previous equations characterizing the monetary model. It should be noted, however, that the resulting determinants of exchange rate (money supplies, incomes, relative prices and rates of interest) would also be included in the typical "final" equation of alternative models of exchange rate determination.

6. For a recent computation of the relative price of traded to non-traded goods see Goldstein and Officer (1977).

7. We also tried proxying $P_N$ by the average hourly earnings of skilled males and none of the results reported below were materially affected.

8. The values of the various F statistics relevant for testing the restrictions were all below the critical value at a conventional confidence level. Testing the restriction that $\alpha = \alpha^*$ yields F = .097. Given that $\alpha = \alpha^*$ we tested whether $\beta = \beta^*$ with the resulting F = 2.785. The joint restriction that $\beta = \beta^*$ and that $\eta = \eta^*$ yields F = 1.564. For test procedures see Theil (1971, Sec. 3.7).

9. To allow for endogeneity of relative prices and interest rate differential we have also estimated equation (11) using two-stage least squares estimation procedure and employing Fair's method; the instruments were lagged values

of the dependent and independent variables and a constant. There was no significant change in the estimates.

10. For the U.S. we used $M_2$ while for the U.K. the available monthly series do not include total deposits and thus we used deposits of the London Clearing Banks. These banks accounted for, on average, 78% of total deposits in the U.K. during the interwar years; see Howson (1975, p. 146).

11. In addition the results might be due to the poor quality of the income series which is proxied for the U.S. by an index of volume of manufactured output and for the U.K. is proxied by an interpolated index of industrial production.

12. Theil's inequality coefficient U measures the quality of forecasts. Denoting the series of predictions and outcomes by $P_i$ and $A_i$, respectively, U is

$$U = \sqrt{\frac{1}{n}\Sigma(P_i - A_i)^2} \Big/ \left( \sqrt{\frac{1}{n}\Sigma P_i^2} + \sqrt{\frac{1}{n}\Sigma A_i^2} \right)$$

and as can be seen the coefficient is bounded between zero and one and when $A_i = P_i$, $U = 0$; see Theil (1961).

13. The estimate of the purchasing power parity used two-stage-least-squares estimation following Fair's method. The instruments were lagged values of the dependent variables, a constant, time and time squared. For similar inferences concerning purchasing power parity see Krugman (1978).

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