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von

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José L. Gutierrez-Camara and Roland Vaubel

I. The State of Empirical Research

At the latest since 1978, international shifts in the demand for money have widely been recognized as a major problem for monetary-policy making under flexible exchange rates. To the extent that such shifts are unpredictable, the case for monetary preannouncement is weakened (Giersch, 1977; Girton, Roper, 1978; Sachverständigenrat, 1978/9; Vaubel, 1980). To the extent that they are unidentifiable once they occur, the case for flexible exchange rates is weakened (Giersch, 1977; King et al., 1977; Sachverständigenrat, 1978/9; Vaubel, 1980).

Empirical identification of international shifts in the demand for money (or, what is the same, of "currency substitution in demand") has been attempted though estimation of money-demand functions and exchange-rate functions. Concentrating on international stock shifts in the demand for money rather than on portfolio-growth effects (which are likely to be far less volatile), most researchers used the forward premium/discount or, what is approximately the same, the international interest-rate differential as the most promising determinant of currency substitution; for these variables reflect the expected difference in the opportunity cost of holding the monies concerned if interest is not paid on money balances or on required reserves. However, since the foreign interest rate

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figures in the monetarist exchange-rate equation not only in virtue of its effect on international shifts in money demand between the two currencies concerned but also as a determinant of foreigners' demand for their own money (as an alternative to foreign financial or real assets), it was soon agreed that international shifts in the demand for money could not be identified in the exchange-rate equation but only in the money-demand equation. Such money-demand equations allowing for currency substitution were estimated, in one form or other, by Frenkel(1977,1979,1980), Brillembourg, Schadler (1979), Vaubel (1980).[1] Another interesting but less direct approach was chosen by Brittain (1980) who tried to identify currency substitution by looking for negative cross-correlation between the residuals from the conventional money demand functions of various pairs of countries.

For which monetary aggregate should demand be estimated?. Some studies concentrated on bank deposits denominated in a currency foreign to the holder (Chrystal, 1977; Miles, 1978; Vaubel, 1978; Ortiz, Solis, 1981). Frenkel (1977) and Brillembourg, Schadler (1979) used domestic money supply, Vaubel (1980) took what he called "total money supply" in each currency (M2 plus domestic deposits held by foreign non-banks plus eurocurrency deposits of non-banks). While from an analytical point of view, the demand for total money supply is most relevant because it comprises currency substitution by both residents and foreigners, the monetary-policy problem relates only to the monetary aggregate for which money-supply targets are preannounced, i.e., usually domestic money supply.[2] Since, moreover, the quality of the available data is far superior for the domestic money-supply aggregates, both in terms of accuracy and seasonal adjustment, and since the inflation tax is heaviest on currency

1 See also Hamburger (1977), although he did not realize that he was testing for currency substitution.

2 Among the major industrial countries, France is now the only exception. The US changed over to domestic money-supply targets at the beginning of 1980.

in circulation and on demand deposits (highest reserve requirements), we shall here confine ourselves to M1.

With the exception of Brillembourg, Schadler (1979), who estimated money-demand equations for eight currencies simultaneously within an international currency portfolio model, all previous estimates of domestic or total money demand functions allowing for currency substitution have been single-equation regressions. Vaubel (1980) also estimated exchange-rate functions separately and tried to infer the exchange-rate effects of currency substitution from the parameter estimates of the money-demand functions, but he found that the results were not always consistent between the money-demand and exchange-rate functions. Moreover, both money-demand and exchange-rate equations showed signs of simultaneity bias due to the fact that neither monetary policy nor income growth nor interest rates had been endogenized.

In terms of domestic money demand, Vaubel's (1980) equations reduce to the following:

$$\hat{P}_{i,t} = p(\overset{+}{\hat{M}}_{i,t-x}, \overset{-}{\hat{y}}_{i,t-x}, \overset{+}{\Delta i}_{i,t-x}, \overset{-}{\Delta i^{*}_{t-x}}) \qquad (1)$$

$$\hat{S}_{i,j-t} = s(\overset{+}{\hat{M}_{i,t}-\hat{M}_{j,t}}, \overset{-}{\hat{y}_{i,t}-\hat{y}_{j,t}}, \overset{+}{\Delta(i_{i,t}-i_{j,t})}, K) \qquad (2)$$

where P is the price level (CPI),
M is the money supply,
y is real income (GDP or GNP),
i is the (short term) interest rate,
s is the spot exchange rate (per unit of foreign currency),
K is a constant allowing for real exchange rate trend, and
$\hat{}$ denotes rates of change.

While equation (1) is derived from conventional money demand equations with lagged price-level adjustment, Vaubel's equation (2) is not based on the assumption of relative purchasing-power parity but on the hypothesis that the exchange-rate change is determined by the difference between the long-run equilibrium inflation rates expected on the basis of current money-market conditions. The most serious problem about such single-equation estimation seems to be that the probable effects of $\hat{M}$ on Δi in (1) and (2) and of $\hat{s}$ on $\hat{M}_i - \hat{M}_j$ in (2) are not allowed for. In the present framework, the interest-rate variables cannot be endogenized on traditional lines (i.e., by breaking them up into their real interest component and expected inflation and by substituting expected values of (1) as the determinants of expected inflation) because the world interest rate as a whole is the determinant of currency substitution in demand. Thus, simultaneous estimation of a structural model is called for.

II. A Small Monetarist Model

To endogenize also $\hat{M}$, $\hat{y}$, and Δi, we add three stochastic equations. Assuming constant elasticities (or, in the case of interest rates, constant semi-elasticities), the five-equation model takes the following structure:

$$\text{I.} \quad \hat{P}_t = a_o + a_1 \hat{M}_{t-z} - a_2 \hat{y}_{t-z} + a_3 \, \Delta i^s_{t-z} - a_4 \, \Delta i^{s*}_{t-z} + a_5 \, \Delta(i^s_{t-z} - i^l_{t-z}) + a_6 \Delta(i^{s*}_{t-z} - i^{l*}_{t-z}) + U_1$$

$$\text{II.} \quad \hat{M}_t = b_o - b_1 \, \hat{s}^{eff}_t - b_2 \hat{P}_t + b_3 UR_t + b_4 i_t + U_2$$

$$\text{III.} \quad \hat{y}_t = c_o + c_1 \hat{M}_{t-m} - c_2 (\hat{W} - \hat{P})_{t-w} + c_3 \hat{y}^*_{t-x} + c_4 \hat{s}^{real}_{t-s} + U_3$$

$$\text{IV.} \quad \Delta i^s_t = d_o - d_1 \hat{M}_t + d_2 \hat{y}_t + d_3 \Delta i^{s*}_t + d_4 \hat{P}_t - d_5 \Delta(i^s_t - i^l_t) - d_6 \Delta(i^{s*}_t - i^{l*}_t) + U_4$$

$$\text{V.} \quad \hat{s}^{eff.}_t = e_o + e_1 (\hat{M}_t - \hat{M}^*_t) - e_2 (\hat{y}_t - \hat{y}^*_t) + e_3 (\Delta i^s_t - \Delta i^*_t) + e_4 \Delta(i^s_t - i^l_t) - e_5 \Delta(i^{s*}_t - i^{l*}_t) + U_5$$

Equation (I) corresponds to (1) except that it has been augmented by a domestic and a foreign proxy for the term structure of interest rates. The coefficient of the change in the domestic short-long interest differential ($\Delta i^s - i^l$) should take a positive sign because a large differential implies expectations of a fall in short-term interest rates (i.e., of capital gains) and thus reduced willingness to substitute money for short-term financial assets (see Heller, Khan, 1979). Analogously, changes in the world-short-long interest differential affect the demand for the domestic money as an alternative to foreign financial assets with a positive sign.

Equation (II) is a monetary-policy reaction function. Monetary expansion is hypothesized to increase

- if the domestic currency effectively appreciates at an accelerating pace or depreciates at a decelerating pace,
- if the inflation rate falls,
- if the unemployment rate (UR) rises, and
- if the interest rate rises.

Since equation (II) is not a market equilibrium condition but a behavioural relationship, none of the explanatory variables is necessarily indispensable.

Equation (III) combines domestic and foreign demand proxies and a domestic supply variable. The two foreign demand variables, i.e., foreign real income growth ($\hat{y}^*$) and effective real exchange-rate changes ($\hat{s}^{real}$), are straightforward proxies of foreign quantity changes and international relative price changes. The rate of domestic monetary expansion has been selected as the most important money market variable affecting the demand for goods (with a lag); if the number of degrees of freedom did permit, $\hat{P}$ and the four interest rate variables of equation (I) could also be included here. Real wage increases ($\hat{W}-\hat{P}$) reduce the amount of labour demanded, the level of employment, the supply of output and real income, if they exceed productivity growth; the omission of productivity growth in equation (III) is justified if productivity growth is either constant or proxied by real income growth.[1)]

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1 Note that there may be collinearity problems in equation (III): an increase in $\hat{M}$ may temporarily reduce ($\hat{W}-\hat{P}$) and raise $\hat{s}^{real}$ (which may also be affected by $\hat{y}^*$). However, as will be seen shortly, some of these potential collinearities are avoided by imposing plausibility constraints on the lengh of lags for the various variables.

Equation (IV) contains the same variables as equation (I) but represents an instantaneous relationship. The model thus depicts the traditional monetarist hypothesis that an (unexpected[1]) increase in monetary expansion at first and immediately (but temporarily) reduces interest rates (equation (IV)), than (temporarily) raises real income (equation (III)) and finally (permanently) raises the price level (equation (I)).

Equation (V) is the standard monetary approach to exchange rates augmented for term structure effects. We are assuming that financial assets are closer substitutes for domestic money than for foreign money. As in the case of equation (2), the constant term measures the real exchange-rate trend. Moreover, since the equation is not derived from PPP but from the hypothesis that $\hat{s}^{eff}_{i/j,t} = E(\hat{P}_{i,t+z}) - E(\hat{P}_{j,t+z})$, it allows for temporary real exchange-rate changes due to differential adjustment speeds in the goods and exchange market (for the theoretical underpinnings see Vaubel, 1980).

The system then has five endogenous variables:

$$\hat{P}_t,\ \hat{M}_t,\ \hat{Y}_t,\ \ i^s_t\ \text{ and }\ \hat{s}^{eff}_t,$$

together with 16 predetermined variables: $\hat{M}_{t-z}$, $\hat{Y}_{t-z}$, Δi^s_{t-z}, Δi^{s*}_{t-z}, $\Delta(i^s_{t-z} - i^l_{t-z})$, $\Delta(i^{s*}_{t-z} - i^{l*}_{t-z})$, UR_t, M_{t-m}, $(\hat{W}-\hat{P})_{t-w}$, $\hat{y}^*_{t-x}$, $\hat{s}^{real}_{t-s}$, Δi^{s*}_t, $\Delta(i^{s*}_t - i^{l*}_t)$, $\hat{M}^*_t$, y^*_t and Δi^l_t.

It can be easily seen that there are enough exclusion restricting within the equations to render each of them overidentified.

III. Empirical Estimation

As compared with separate OLS estimation, the gain in consistency from using methods of estimation such as 2SLS, 3SLS or FIML would only apply to the policy reaction function

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1 It would be preferable to distinguish between expected and unexpected changes throughout this study, but in view of the formidable difficulties of doing so in a structural model, we have confined ourselves to the traditional monetarist approach.

equation (II), to the interest rate equation (IV) and, of course, to the exchange-rate equation (V) since they are the only ones which are genuinely simultaneous. The inflation and output equations are entirely determined by exogenous or lagged endogenous variables and therefore amenable to estimation by O.L.S.

The main advantage of using a truly simultaneous method like 3SLS or FIML which take into account the restrictions on the parameters of all equations as well as the variances and co-variances of the residuals, would be that they yield lower variance estimates than do single-equation methods like 2SLS in which restrictions on the coefficients of other equations are only used for identification of the particular equation being considered. On the other hand it is well known that full-information methods are particularly sensible to specification errors anywhere in the system. This trade-off between increased efficiency and the potential damage of specification error, together with the asymptotic equivalence of both methods, was the criterion for choosing 2SLS as the method of estimation.

The estimation of the model was carried out using quarterly data from the sample period 1973-II to 1979-IV for nine major industrial countries: U.S.A., U.K., France, Germany, Italy, Netherlands, Switzerland, Canada and Japan. The sample period has been restricted to the era of largely flexible exchange rates because currency substitution in demand is most likely to pose a problem for monetary preannouncement under exchange rate flexibility.

The world nominal interest rate i^* is formed for each country as a weighted average of nominal interest rates in the other countries under study, the weights being the relative shares of each country's money supply M1 in the world aggregate M^*, all converted into dollars. These same weights have been used to compute the effective spot exchange rates s^{eff}, defined as domestic currency units per one unit of foreign currencies and constructed by weighting the relevant bilateral rates for each country.

The model has been estimated with several general plausibility constraints on lags, namely,

equation I : uniform lag between 4 and 10 quarters
equation II : lags may differ but do not exceed 1 quarter
equation III: $\hat{M}_{t-m}$, 2 to 5 quarters
$(\hat{w}-\hat{P})_{t-w}$, 1 to 6 quarters
$\hat{y}^*_{t-x}$, 0 to 1 quarter
$\hat{s}^{real}_{t-s}$, 2 to 5 quarters

equation IV and V: preferably no lag or at most one quarter. Of course, there is no reason to assume that the lags are the same for all countries.

The theoretical plausibility of some long lag structures together with the large number of predetermined variables needed for the first stage of 2SLS and the necessarily small sample used are all factors making for an uncomfortably small number of degrees of freedom. Bearing this inevitable shortcoming in mind, a selective set of estimates is shown in Table 1.

A substantial number of parameter estimates of the original model, corresponding to those cases in which they did not come out with the expected sign, are not reported in the Table, since the corresponding variables were dropped altogether to reestimate the equations. The selection criterion was to stop the estimation for that particular structure which gave the maximum number of coefficients with the predicted sign which were not totally insignificant ($t > 1.o$).

The policy reaction function, endogenizing changes in money supply, had to be dropped in those cases (Japan, Netherlands, Canada) in which all coefficients either came out with wrong signs or were totally insignificant. The poor overall performance of this equation is not an entirely new phenomenon in econometric estimation. Even over a rather short period of estimation as the one considered here, there is not likely to be a 'fixed' structure of behavioural response of monetary policy to changes in certain sensitive economic variables such as inflation, unemployment or the level of interest rates.

Not in a single country, any of the regressors was able to explain a significant variation of changes in the money supply about its mean with a D.W. statistic pointing unsurprisingly to a badly specified equation. The impossibility of endogenizing the money supply is certainly one of the major disappointments of the model.

With respect to international shifts in the demand for money the relevant equations are (I), (IV) and (V) because they contain "world" nominal interest rates (in particular, Δi^{*s}). As for equation (I), as can be seen from Table 1, the range of lags which gave most explanatory power in the inflation equation varies across countries from 4 (Japan, U.S.A.) to 10 quarters (Italy). Out of all the cases here considered, the coefficients related to 'world' nominal interest rates, a_4 and a_6, came out both significant at the same time only in the U.S.A. and Canada. a_4 had also a relatively high t-value in Japan. While direct evidence of important international shifts in the demand for money had already been presented by Vaubel (1980) for the DMark and the Swiss France, this is the first time that such results are obtained for the US and the Canadian dollar and the Japanese Yen.[1)]

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[1] Brittain's indirect evidence indicated currency substitution between the DMark and the dollar, the Swiss Franc and the dollar, the Swiss Franc and the Italian Lira and the Swiss Franc and the Pound Sterling (1980, Table 2). Miles' (1978) results had also indicated currency substitution between Canadian and US dollars held by Canadian residents but they were simply obtained by regressing a money stock relative on the interest rate differential.

However, it is disturbing that this time a_4 is not significant in the German and Swiss equations and that the world interest variable does not figure in equation (IV) for the U.S., Canada and Japan, whereas it does so for the French Franc and the Pound Sterling. In the case of France and the Netherlands, $\hat{M}$ and $\hat{P}$ had to be pooled into a single variable $(\hat{M}-\hat{P})$ to obtain the hypothesized signs, and for Italy, Canada and Japan, the interest-rate equation even had to be dropped altogether.

The results for the output equation (III) are not very impressive either, except perhaps for Germany and the Netherlands where both monetary expansion and real-wage increases take significant coefficients. Otherwise, the real wage variable plays a significant role in the Swiss output equation. World output growth comes out with significant coefficients for Germany and Japan. The real exchange-rate variable does not enter with a significant coefficient at all, probably because its effect is already captured by $\hat{M}$ and $\hat{y}^*$.

The most pleasant surprise is the performance of the exchange-rate equation (V), the more so as previous studies on the lines of the monetary approach, found it difficult to arrive at significant estimates, except perhaps by introducing prior information.

The most interesting result is the surprisingly satisfactory performance of the term $e_1(\hat{M}_t-\hat{M}_t^*)$. The coefficient e_1 is clearly significant for France, Japan, Netherlands, U.K., Italy, Switzerland and Germany. Only for the U.S. and Canada does it perform poorly. Relatively satisfactory is the performance of $\Delta(i_t^s-i_t^{s*})$ which takes a significantly positive coefficient in France, U.K., Italy and Germany. Thus our results strongly support the monetarist asset market approach to exchange rates with its emphasis on money stocks and exchange-rate (or inflation) expectations. While it is somewhat disturbing that the same variables did not perform as well in the inflation-rate equation (I), the explanation may be the long and diffused lag structure and the reduced sample size typical of equation (I).

Notwithstanding the apparently not so great gains derived from endogenizing money supply, real output and nominal interest rates as judged by performance of the equations attempting to explain them, the extent of possible simultaneity bias due to estimating independently an equation explaining exchange-rate changes is shown in Table 2 where the same equations of Table 1 have been reestimated by O.L.S. The results show a substantial downward bias in the estimates of the exchange-rate equation occurs when it is estimated on its own.

IV. Summary

The purpose of this paper has been to identify the determinants of international shifts in the demand for money in the money-demand function of a small monetarist structural model which endogenizes monetary policy, real growth and short term interest rates. While the attempt to endogenize monetary policy and interest rates was hardly successful, the empirical results are noteworthy for indicating important currency substitution in demand for the US dollar, the Canadian dollar and, somewhat less so, for the Yen and for yielding satisfactory exchange rate equations with significant coefficients for contemporaneous international interest rate relatives and money supply relatives, thus supporting the monetary asset market approach to exchange rates.

TABLE 1

(2SLS)

FRANCE	$\hat{P} = 2.31^{*} + 0.02\hat{M}_{-7} - 0.09\hat{y}_{-7} + 0.10\Delta i^{s}_{-7} - 0.03\Delta i^{s*}_{-7}$	DW 2.37
	(14.6) (0.57) (-1.17) (0.88) (-0.19)	
	$\hat{M} = 6.80^{*} - 1.76\hat{P}$	DW 1.26
	(2.72) (-1.65)	
	$\hat{y} = 0.20 \quad 0.14\hat{M}_{-4} - 0.02(\hat{W}-\hat{P})_{-5} + 0.44\hat{y}^{*}_{t-1} + 0.03\hat{s}^{real}_{-2}$	DW 2.22
	(0.27) (1.30) (-0.09) (1.52) (0.44)	
	$\Delta i^{s} = -0.26 - 0.09(\hat{M}-\hat{P}) + 0.15\hat{y} + 0.89^{+}\Delta i^{s*}$	DW 1.55
	(-0.72) (-0.43) (0.55) (2.08)	
	$\hat{s}^{eff} = -0.68 \quad 0.97^{*}(\hat{M}-\hat{M}^{*}) - 1.38^{+}(\hat{y}-\hat{y}^{*}) + 1.38^{*}\Delta(i^{s}-i^{s*})$	DW 2.11
	(-1.31) (5.00) (-2.01) (2.46)	
JAPAN	$\hat{P} = 1.03 + 0.53^{*}\hat{M}_{-4} - 0.38\hat{y}_{-4} - 0.58\Delta i^{s*}_{-4}$	DW 1.85
	(1.45) (2.35) (-1.48) (-1.43)	
	$\hat{y} = 1.05^{*} - 0.04(\hat{w}-\hat{P})_{-1} + 0.30y^{*}_{-1}$	DW 2.54
	(5.74) (-0.89) (2.12)	
	$\hat{s}^{eff} = -1.56 \quad 1.03^{*}(\hat{M}-\hat{M}^{*}) + 0.81\Delta(i^{s}-i^{s*})$	DW 1.39
	(-1.56) (2.26) (0.77)	
NETHERLANDS	$\hat{P} = 1.35^{*} + 0.07\hat{M}_{-8} - 0.04\hat{y}_{-8} + 0.10\Delta i^{s}_{-8}$	DW 1.53
	(4.01) (0.76) (-0.31) (1.12)	
	$\hat{y} = 0.44 + 0.16^{+}\hat{M}_{-5} - 0.28^{*}(\hat{w}-\hat{P})_{-4}$	DW 2.32
	(1.32) (2.03) (-2.62)	
	$\Delta i^{s} = 0.30 - 0.89^{*}(\hat{M}-\hat{P}) + 0.76\hat{y}$	DW 2.58
	(0.39) (-4.33) (1.29)	
	$\hat{s}^{eff} = -1.59 + 0.76^{*}(\hat{M}-\hat{M}^{*}) - 0.34(\hat{y}-\hat{y}^{*}) + 0.56\Delta(i^{s}-i^{s*})$	DW 2.00
	(-1.92) (3.00) (-0.30) (1.32)	
U.S.A.	$\hat{P} = 1.45^{*} + 0.46^{*}\hat{M}_{-4} - 0.20^{+}\hat{y}_{-4} + 0.20\Delta i^{s}_{-4} - 0.72^{+}\Delta i^{s*}_{-4} + 1.39^{*}\Delta(i^{s*}-i^{l*})_{-4}$	DW 1.35
	(7.16) (3.29) (-1.81) (1.22) (-1.78) (2.56)	
	$\hat{M} = 1.39^{*} - 0.07\hat{s}^{eff}$	DW 1.85
	(7.03) (-0.94)	
	$\hat{y} = 0.20 + 0.09\hat{M}_{-3} + 0.44\hat{y}^{*}_{-1}$	DW 1.24
	(0.37) (0.28) (1.46)	
	$\Delta i^{s} = -1.32 - 0.23\hat{M} + 0.66^{+}\hat{y} + 0.65\hat{P}$	DW 1.97
	(-1.17) (-0.59) (2.04) (1.20)	
	$\hat{s}^{eff} = 0.001 + 0.04(\hat{M}-\hat{M}^{*})_{-1} - 0.90(\hat{y}-\hat{y}^{*})_{-1} + 0.12\Delta(i^{s}-i^{s*})_{-1} + 2.54^{+}\Delta(i^{s}-i^{l})_{-1}$	DW 1.73
	(0.002) (0.21) (-1.16) (0.12) (2.01)	

TABLE 1 continued

(2SLS)

U.K.

$$\hat{P} = 3.15^{*} + 0.08\hat{M}_{-7} - 0.04\hat{y}_{-7} + 0.42\Delta i^{s}_{-7} \qquad \text{DW } 0.88$$
(3.81) (0.38) (-0.49) (1.39)

$$\hat{M} = 3.36^{*} + 0.13\ \text{UR} \qquad \text{DW } 1.20$$
(4.15) (0.74)

$$\hat{y} = 0.45 + 0.11\hat{M}_{-3} - 0.64(\hat{w}-\hat{P})_{-6} + 0.35\hat{s}^{real}_{-4} \qquad \text{DW } 2.65$$
(0.16) (0.16) (-1.61) (1.66)

$$\Delta i^{s} = -1.60 - 0.01\hat{M} + 0.22^{+}\hat{y} + 2.75^{+}\Delta i^{s*} + 0.52\hat{P} \qquad \text{DW } 1.46$$
(-0.82) (-0.03) (1.98) (2.08) (1.34)

$$\hat{s}^{eff} = -1.48 + 1.13^{*}(\hat{M}-\hat{M}^{*}) - 0.15(\hat{y}-\hat{y}^{*}) + 1.67^{+}\Delta(i^{s}-i^{s*}) \qquad \text{DW } 1.17$$
(-1.19) (2.52) (-0.57) (1.83)

ITALY

$$\hat{P} = 3.57^{*} + 0.07\hat{M}_{-10} - 0.19\hat{y}_{-10} + 0.32\Delta(i^{s}-i^{l})_{-10} \qquad \text{DW } 2.68$$
(4.82) (0.04) (-1.04) (0.51)

$$\hat{M} = 4.29 + 0.10\ \text{UR} \qquad \text{DW } 1.93$$
(0.68) (0.11)

$$\hat{y} = -1.10 + 0.18\hat{M}_{-3} - 0.05(\hat{w}-\hat{P})_{-5} + 1.12^{+}\hat{y}^{*}_{-1} \qquad \text{DW } 1.82$$
(-0.98) (1.19) (-0.45) (1.79)

$$\hat{s}^{eff} = -0.63 + 0.72^{*}(\hat{M}-\hat{M}^{*}) + 1.04^{*}\Delta(i^{s}-i^{s*}) \qquad \text{DW } 1.48$$
(-1.04) (3.63) (5.13)

CANADA

$$\hat{P} = 2.10^{*} + 0.09^{+}\hat{M}_{-8} + 0.11\Delta i^{s}_{-8} - 1.73^{*}\Delta i^{s*}_{-8} + 2.33^{*}\Delta(i^{s}-i^{l*})_{-8} \qquad \text{DW } 2.42$$
(16.01) (2.01) (0.78) (-3.23) (3.61)

$$\hat{y} = 0.77^{*} - 0.19(\hat{w}-\hat{P})_{-2} + 0.14\hat{y}^{*}_{-1} + 0.09\hat{s}^{real}_{-4} \qquad \text{DW } 2.16$$
(2.79) (-1.23) (0.73) (1.10)

$$\hat{s}^{eff} = 0.12 - 0.07(\hat{y}-\hat{y}^{*})_{-1} \qquad \text{DW } 1.00$$
(0.20) (-0.11)

SWITZER-LAND

$$\hat{P} = 0.35 + 0.18\hat{M}_{-9} - 0.0008\hat{y}_{-9} + 0.03\Delta i^{s}_{-9} - 0.13\Delta i^{s*}_{-9} + 0.24\Delta(i^{s}-i^{l*})_{-9} \qquad \text{DW } 1.00$$
(1.39) (1.19) (-0.02) (0.38) (-0.15) (0.22)

$$\hat{M} = 2.12^{*} - 0.37\hat{P} \qquad \text{DW } 2.03$$
(2.30) (-0.26)

$$\hat{y} = -0.86 + 0.37\hat{M}_{-4} - 2.43^{*}(\hat{w}-\hat{P})_{-4} + 0.88\hat{y}^{*}_{-1} \qquad \text{DW } 2.74$$
(-0.33) (0.76) (-3.77) (0.48)

$$\Delta i^{s} = -0.02 - 0.06\hat{M}_{-1} + 0.43\hat{P}_{-1} - 0.23\Delta(i^{s}-i^{l})_{-1} \qquad \text{DW } 1.77$$
(-0.07) (-0.58) (0.76) (0.88)

$$\hat{s}^{eff} = -2.20 + 1.14^{*}(\hat{M}-\hat{M}^{*}) + 1.96\Delta(i^{s}-i^{s*}) - 1.86\Delta(i^{s*}-i^{l*}) \qquad \text{DW } 1.45$$
(-1.75) (2.52) (1.39) (-0.48)

TABLE 1 continued

(2SLS)

GERMANY

$$\hat{P} = \underset{(2.76)}{0.81^*} + \underset{(1.27)}{0.16\hat{M}_{-6}} - \underset{(-0.76)}{0.11\hat{y}_{-6}} + \underset{(1.06)}{0.16\Delta i^{s}_{-6}} - \underset{(-0.45)}{0.31\Delta i^{s*}_{-6}} + \underset{(1.16)}{1.06\Delta(i^{s*}-i^{l*})_{-6}} \qquad \text{DW } 1.59$$

$$\hat{M} = \underset{(-0.67)}{-2.66} - \underset{(-0.24)}{0.10\hat{P}} + \underset{(1.38)}{1.38\ UR} \qquad \text{DW } 1.08$$

$$\hat{y} = \underset{(-0.61)}{-0.34} + \underset{(1.63)}{0.35\hat{M}_{-5}} - \underset{(-1.84)}{0.30^+(\hat{w}-\hat{P})_{-2}} + \underset{(2.00)}{0.49^+\hat{y}^*_{-1}} \qquad \text{DW } 1.98$$

$$\Delta i^{s} = \underset{(1.08)}{0.42} - \underset{(-2.59)}{0.34^*\hat{M}} + \underset{(3.01)}{0.41^*\hat{y}} + \underset{(1.24)}{0.95\Delta i^{s}} - \underset{(-0.95)}{0.84\Delta(i^{s*}-i^{l*})} \qquad \text{DW } 2.44$$

$$\hat{s}^{eff} = \underset{(-2.99)}{-2.20^*} + \underset{(3.50)}{1.30^*(\hat{M}-\hat{M}^*)} + \underset{(1.91)}{1.84^+\Delta(i^{s}-i^{s*})} \qquad \text{DW } 2.40$$

TABLE 2

(OLS)

			R^2	D.W.
FRANCE	$\hat{P}$ =	Same estimates as in Table 1	0.13	2.37
	$\hat{M}$ =	$5.16^{*} - 1.05\hat{P}$ (2.83) (-1.36)	0.10	1.10
	$\hat{y}$ =	Table 1	0.25	2.22
	Δi^{s} =	$-0.30 \quad 0.08(\hat{M}-\hat{P}) + 0.10\hat{y} + 0.77^{+}\Delta i^{s*}$ (-0.90) (0.44) (0.40) (1.89)	0.28	1.35
	$\hat{s}^{eff}$ =	$-0.72 + 0.95^{*}(\hat{M}-\hat{M}^{*}) - 1.23^{*}(\hat{y}-\hat{y}^{*}) + 1.59^{*}\Delta(i^{s}-i^{s*})$ (-1.43) (5.01) (-2.17) (2.91)	0.75	1.88
JAPAN	$\hat{P}$ =	Table 1	0.30	1.85
	$\hat{y}$ =	Table 1	0.20	2.54
	$\hat{s}^{eff}$ =	Table 1	0.23	1.39
NETHER-LANDS	$\hat{P}$ =	Table 1	0.09	1.63
	$\hat{y}$ =	Table 1	0.40	2.32
	Δi^{s} =	$0.32 - 0.89^{*}(\hat{M}-\hat{P}) + 0.73\hat{y}$ (0.48) (-4.57) (1.59)	0.72	2.59
	$\hat{s}^{eff}$ =	$-1.61^{+} + 0.73^{*}(\hat{M}-\hat{M}^{*}) - 0.39(\hat{y}-\hat{y}^{*}) + 0.51\Delta(i^{s}-i^{s*})$ (-2.04) (3.30) (-0.48) (1.61)	0.46	1.97
U.S.A.	$\hat{P}$ =	Table 1	0.66	1.35
	$\hat{M}$ =	$1.39^{*} - 0.11^{+}\hat{s}^{eff}$ (7.16) (-2.09)	0.18	1.59
	$\hat{y}$ =	Table 1	0.14	1.24
	Δi^{s} =	$-0.51 - 0.23\hat{M} + 0.33\hat{P}$ (-0.65) (-0.87) (0.88)	0.18	1.87
	$\hat{s}^{eff}$ =	Table 1	0.31	1.73
U.K.	$\hat{P}$ =	Table 1	0.13	0.88
	$\hat{M}$ =	$3.36 + 0.13\ UR$ (4.15) (0.79)	0.03	1.20
	$\hat{y}$ =	Table 1	0.37	2.65
	Δi^{s} =	$-0.02 - 0.13\hat{M} + 0.19^{+}\hat{y} + 1.92\Delta i^{s*} + 0.19\hat{P}$ (-0.01) (-0.50) (2.03) (1.70) (0.61)	0.32	1.43
	$\hat{s}^{eff}$ =	$-1.43 \quad 1.15^{*}(\hat{M}-\hat{M}^{*}) - 0.04(\hat{y}-\hat{y}^{*}) + 1.53^{+}\Delta(i^{s}-i^{s*})$ (-1.17) (2.66) (-0.19) (2.00)	0.44	1.15

TABLE 2

(OLS) continued

			R^2	D.W.
ITALY	$\hat{P}$ =	Table 1	0.12	2.68
	$\hat{M}$ =	Table 1	0.001	1.93
	$\hat{y}$ =	Table 1	0.25	1.82
	$\hat{s}^{eff}$ =	$-0.57\ \ 0.70^{*}(\hat{M}-\hat{M}^{*}) + 1.05^{*}\Delta(i^{s}-i^{s*})$ (-0.96) (3.60) (5.21)	0.83	1.45
CANADA	$\hat{P}$ =	Table 1	0.60	2.41
	$\hat{y}$ =	Table 1	0.38	2.16
	$\hat{s}^{eff}$ =	Table 1	0.0009	1.00
SWITZER-LAND	$\hat{P}$ =	Table 1	0.20	1.00
	$\hat{M}$ =	$2.43^{*} - 1.04\hat{P}$ (2.76) (-0.78)	0.04	2.04
	$\hat{y}$ =	Table 1	0.56	2.74
	Δi^{s} =	Table 1	0.14	1.77
	$\hat{s}^{eff}$ =	$-2.45^{+} + 0.86^{+}(\hat{M}-\hat{M}^{*}) + 1.82\Delta(i^{s}-i^{s*}) - 1.97\Delta(i^{s*}-i^{l*})$ (-2.01) (2.16) (1.37) (-0.53)	0.46	1.21
GERMANY	$\hat{P}$ =	Table 1	0.35	1.59
	$\hat{M}$ =	$-2.47 - 0.22\hat{P} + 1.36\ UR$	0.13	1.07
	$\hat{y}$ =	Table 1	0.47	1.98
	Δi^{s} =	$0.27 - 0.29^{*}\hat{M} + 0.42^{*}\hat{y}^{*} + 0.99\Delta i^{s*} - 0.87\Delta(i^{s*}-i^{l*})$ (0.74) (-2.34) (3.48) (1.33) (-1.01)	0.71	2.27
	$\hat{s}^{eff}$ =	$-2.22^{*} + 1.22^{*}(\hat{M}-\hat{M}^{*}) + 1.54\Delta(i^{s}-i^{s*})$ (-3.03) (3.36) (1.75)	0.47	2.28

Statistic Appendix

Definition and Sources of Variables:

P : CPI (IMF,IFS)

M : M1 seasonally adjusted (IMF, IFS), quarterly average of end-of-month data

y : real income, seasonally adjusted (GDP of where this was not available GNP from either IMF-IFS or OECD-MEI)

i^s : 90-day interest rate (IMF-IFS). Period average

i^l : Government Bond Yield (IMF-IFS)

UR : Unemployment Rate seasonally adjusted. (OECD-Labour Force Statistics & B.L.S. 1978)

w : Average earnings (IMF-IFS or OECD-MEI)

s^{eff}: spot exchange rate, effective, domestic currency units per one unit of foreign currencies; Bilateral rates obtained from IMF-IFS. The bilateral rates have been weighted by the relative share of each country's money supply (M_1) in the world aggregate M^* (both converted into dollars)

i^{s*} and i^{l*} : "world" nominal short and long interest rates are constructed using the same weights as for s^{eff}.

$\hat{s}^{real} = \hat{s}^{eff} - (\hat{P} - \hat{P}^*)$ where "world" $\hat{P}^*$ uses the same weights as $\hat{s}^{eff}$.

$\hat{y}^*$: "world" real income growth, has been constructed using 1972 base weights for nominal income converted into dollars.

$$w_{1972,i} = y_i \cdot s_{i/\$} \Big/ \Sigma y_i \cdot s_{i/\$}$$

$$w_{i,t} = w_{1972,i}(1+\hat{y}_i) \Big/ \Sigma w_{1972,i}(1+\hat{y}_i)$$

$$\hat{y}^*_t = \Sigma w_{i,t} \cdot \hat{y}_i$$

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