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7 Tests of Monetary and Portfolio Balance Models of Exchange Rate Determination

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Such titles of recent papers as "Exchange Rate Economics: Where Do We Stand?" and "Exchange Rate Models of the 1970's: Are Any Fit to Survive?" indicate that the field has entered an introspective and skeptical phase, after the initial enthusiastic burst of model building and estimation that followed the beginning of floating exchange rates. In the same spirit of "taking stock," I was asked in the present paper to present some econometric tests of competing monetary and portfolio balance models of exchange rate determination.[1]

7.1 The Monetary Model

The first part of the paper deals with the monetary approach to the exchange rate, as it was developed in the first five years after 1973. Because the theory is by now well known, we go through it as quickly as possible—the version that assumes perfectly flexible goods prices as well as the version that assumes sticky goods prices—and pass on to the econometric estimation. The estimation, for five currencies from 1974 up to mid-1981, turns out to favor the sticky price monetary equation over the flexible price equation, if one must choose between them. However, the results must be pronounced poor for both versions. Thus we are led to consider possible ways of "patching up" the monetary model.

7.1.1 The Flexible Price Monetary Equation

We begin with the version of the monetary approach attributed to Frenkel (1976), Mussa (1976), and Bilson (1978). This version assumes that goods

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1. The two classes of models are surveyed by Dornbusch (1980) and Frankel (1980).

prices are perfectly flexible and thus that purchasing power parity holds instantaneously:

$$(1) \qquad s = p - p^*,$$

where s is the log of the spot exchange rate, defined as the price of foreign currency in terms of domestic and p and p^* are the logs of the domestic and foreign price levels, respectively. We assume conventional money demand functions at home and abroad,

$$(2) \qquad \begin{aligned} m &= p + \phi y - \lambda i \\ m^* &= p^* + \phi y^* - \lambda i^*, \end{aligned}$$

where m and m^* are the logs of the domestic and foreign money supplies, respectively; y and y^* are the logs of domestic and foreign real income; and i and i^* the domestic and foreign interest rate. For simplicity, we assume that the elasticity with respect to income, ϕ, and the semielasticity with respect to the interest rate, λ, are equal across countries. Combining equations (1) and (2) we have one representation of the flexible price monetary equation:

$$(3) \qquad s = (m - m^*) - \phi(y - y^*) + \lambda(i - i^*).$$

The monetary approach, if it is to maintain that bond supplies do not affect interest or exchange rates as money supplies do, must assume that domestic and foreign bonds are perfect substitutes and thus that uncovered interest parity holds,

$$(4) \qquad i - i^* = \Delta s^e,$$

where Δs^e is the expected depreciation of domestic currency. The market will be aware of the purchasing power parity condition (1), and so we will have

$$(1') \qquad \Delta s^e = \pi - \pi^*,$$

where π and π^* are the expected inflation rates, at home and abroad, respectively. Substituting (4) and (1′) into (3), we get an alternative representation of the flexible price monetary equation:

$$(3') \qquad s = (m - m^*) - \phi(y - y^*) + \lambda(\pi - \pi^*).$$

Equation (3′) says that the exchange rate, as the relative price of moneys, is determined by the supply and demand for money. An increase in the supply of domestic money causes a proportionate depreciation. An increase in the demand for domestic money, such as results from an increase in domestic income or a decrease in expected inflation, causes an appreciation. The equation has been widely estimated econometrically.

7.1.2 The Sticky Price Monetary Equation

Dornbusch (1976) took exception with the assumption that prices are perfectly flexible even in the short run, as unrealistic. Instead, purchasing power parity is assumed to hold only in the long run:

$$\bar{s} = \bar{p} - \bar{p}^*, \tag{5}$$

where a "bar" over a variable denotes long-run equilibrium.[2] Thus the Frenkel-Mussa-Bilson equation (3′) holds only in long-run equilibrium:

$$\bar{s} = (\bar{m} - \bar{m}^*) - \phi(\bar{y} - \bar{y}^*) + \lambda(\bar{\pi} - \bar{\pi}^*). \tag{6}$$

In the short run, the spot rate can deviate from its equilibrium value, but the market expects the spot rate to regress toward equilibrium at a rate proportional to the gap:

$$\Delta s^e = -\theta(s - \bar{s}) + \bar{\pi} - \bar{\pi}^*. \tag{7}$$

This form of expectations turns out to be rational in a model in which prices adjust gradually over time in response to excess goods demand but also move in line with the underlying inflation rate $\bar{\pi}$.[3] Combining (7) with the monetary approach's assumption of uncovered interest parity (4), which is retained in the Dornbusch model, we have an expression for the gap between the current spot rate and its equilibrium level:

$$s - \bar{s} = -\frac{1}{\theta}[(i - \bar{\pi}) - (i^* - \bar{\pi}^*)]. \tag{8}$$

A tight monetary policy raises the real interest differential, attracts a capital inflow, and appreciates the currency above its equilibrium value.

We combine equations (6) and (8) to obtain the sticky price monetary equation of exchange rate determination:

$$s = (\bar{m} - \bar{m}^*) - \phi(\bar{y} - \bar{y}^*) + \left(\lambda + \frac{1}{\theta}\right)(\bar{\pi} - \bar{\pi}^*) - \frac{1}{\theta}(i - i^*). \tag{9}$$

2. Evidence that purchasing power parity holds in the long-run despite large short-run deviations is offered by Genberg (1978) and Krugman (1978). One survey of the PPP literature is Katseli-Papaefstratiou (1979).

3. This is the Dornbusch model as extended to the case of secular inflation in Frankel (1979). The inflation rate $\bar{\pi}$ and $\bar{\pi}^*$ can be thought of as the countries' expected money growth rates. An implication of this formulation is that a sudden decline $\Delta\bar{\pi}$ in the expected money growth rate, in addition to its appreciation of the currency in equilibrium by $\lambda\Delta\bar{\pi}$, will cause the currency to overshoot its equilibrium by $\frac{1}{\theta}\Delta\bar{\pi}$. Buiter and Miller (1981) offer an alternative way of extending the Dornbusch model to the case of secular inflation; the money growth rate is assumed to have less than the full impact on $\bar{\pi}$ and therefore on s in the short run. Both formulations are very suggestive of the recent experience of the United Kingdom and United States vis-à-vis other countries.

The flexible price version can be viewed as the special case in which adjustment to long-run equilibrium is instantaneous, so $\theta = \infty$ and the coefficient on the interest differential is not less than zero. In the following section we estimate this equation econometrically.

7.1.3 Estimation for Five Currencies

Prior empirical studies of the monetary model have produced different results depending on the currency used. For example, Bilson (1978) claimed support for the flexible price version from the pound/dollar data, while I found evidence for the sticky price version in the mark/dollar data in Frankel (1979). In this section we test equation (9) for five exchange rates at the same time: the mark, pound, franc, yen, and Canadian dollar, each against the United States dollar.

The sample begins in January 1974 and ends in mid-1981, with the exact limits for each currency depending on data availability. The "equilibrium" money supplies are represented by their current values, though we must recognize that much of the monthly fluctuation in the monetary aggregates is in fact transitory. The equilibrium income levels are represented by industrial production. The equilibrium expected inflation rates are measured by actual CPI inflation over the preceding 12 months. Finally, the nominal interest rates are represented by annualized short-term money market rates.

Table 7.1 presents estimates for the five exchange rates using the iterative Cochrane-Orcutt technique to correct for high serial correlation. Only in the case of France are all four coefficients of the hypothesized sign. The coefficient on the interest differential is always of the negative sign hypothesized by the sticky price model. In the case of England, this represents a reversal in sign over earlier studies. The reversal is attributable to the unprecedented variation in interest rates of 1980–81, and confirms a finding of Hacche and Townend (1981). But overall, the presence of wrong signs on the other coefficients and the predominance of low significance levels render the results discouraging for the monetary equation.

There are several ways that one can bring more information to bear in order to get more efficient estimates. First, one can impose the constraint of a unit coefficient on the relative money supply.[4] The results in table 7.1 indicate no improvement, except for the case of Japan. Second, we can impose the constraint that the coefficients are the same across all five equations. This technique is achieved by "stacking" the regressions. The results, reported in table 7.2, show some improvement. The negative coefficient on the interest differential is now highly significant. But the other three coefficients, though of the correct sign, are still not significantly different from

4. Imposition of this constraint has the added benefit that if the money stocks are endogenous, as they surely are, then it allows consistent estimation of the other coefficients.

Table 7.1 **Monetary Equation (Dependent Variable: Log of Exchange Rate per United States Dollar)**

Country	Constant	$m1 - m1b_{US}$	$y - y_{US}$	$INFL - INFL_{US}$	$i - i_{US}$	Sample	ρ	s.e.r.
Germany:	.80	−.05	.07	1.34	−.61[a]	90	.95	.033
	(.21)	(.33)	(.22)	(.82)	(.27)			
	1.37	1.00	.12	1.59	−.62[a]		.96	.034
	(.12)	(Constrained)	(.23)	(.86)	(.28)			
France:	1.34	.17	−.23	2.41[a]	−.24	87	.81	.029
	(.07)	(.17)	(.13)	(.69)	(.24)			
	1.07	1.00	−.16	1.53	−.28		.90	.032
	(.06)	(Constrained)	(.14)	(.83)	(.27)			
United	−.20	.12	−.13	−.06	−.28	89	.97	.029
Kingdom:	(.61)	(.22)	(.17)	(.05)	(.21)			
	2.10	1.00	−.09	−.07	−.24		.98	.032
	(.23)	(Constrained)	(.18)	(.05)	(.22)			
Japan:	4.39	.21	.27	.53	−.40	89	.98	.031
	(1.00)	(.20)	(.23)	(.33)	(.27)			
	.44	1.00	.60[b]	.73[a]	−.61[a]		.98	.034
	(.17)	(Constrained)	(.23)	(.36)	(.29)			
Canada:	.44	.08	.18	−.48	−.27	89	.98	.014
	(.32)	(.12)	(.12)	(.32)	(.17)			
	2.85	1.00	.18	−.31	−.29		.99	.018
	(.15)	(Constrained)	(.15)	(.41)	(.22)			

[a]Significant at the 95% level and of the correct sign.

[b]Significant at the 95% level and of the incorrect sign. (Standard errors in parentheses.)

Technique: Cochrane-Orcutt.

Samples: 90 = 2/74–7/81, 87 = 2/74–4/81, 89 = 2/74–6/81.

Table 7.2 Five Monetary Equations "Stacked" (Dependent Variable: Log of Exchange Rate per United States Dollar)

Constant Terms					Coefficients					
Germany	France	U.K.	Japan	Canada	$m1 - m1b_{US}$	$y - y_{US}$	$INFL - INFL_{US}$	$i - i_{US}$	ρ	s.e.r.
.77	1.46	−1.08	4.98	.35	.09	−.05	.24	−.36[a]	.97	.028
(.10)	(.09)	(.40)	(.49)	(.25)	(.09)	(.08)	(.19)	(.11)		
1.28	1.10	−4.93	.31	2.66	1.00	−.03	.31	−.39[a]	.96	.031
(.09)	(.09)	(.09)	(.09)	(.09)	(Constrained)	(.08)	(.21)	(.12)		

[a]Significant at the 95% level. (Standard errors in parentheses.)

Technique: Cochrane-Orcutt.

Sample: same as table 7.1; 444 observations.

zero. It appears that we must consider theoretical modifications of the monetary model.[5]

7.1.4 Drift in Velocity and the Real Exchange Rate

Some recent literature on exchange rate determination has proposed modifications in the monetary models, partly in response to poor results like those reported in section 7.1.3. As a matter of logic, one or more of the assumptions, or building blocks, in sections 7.1.1 and 7.1.2 would have to be modified.

First, one could question assumption (5), that purchasing power parity holds, even in the long run.[6] The most commonly cited sources of recent shifts in the long-run terms of trade are the oil price rises of the 1970s,[7] though these shifts do not automatically imply changes in the long-run real exchange rate between pairs of industrialized countries, as pointed out by Krugman (1980). Other possible sources include nontraded goods prices that rise more rapidly in countries with more rapid income growth, as argued years ago by Balassa (1964). Whatever the source of shifts in the long-run real exchange rate, they are easily integrated into the monetary equation of exchange rate determination, as in Hooper and Morton (1982). If (5) is replaced by

$$r \equiv \bar{s} - \bar{p} + \bar{p}^*, \tag{5'}$$

then the long-run real exchange rate r simply appears as an additional term in (9).

A second building block that has been called into question is the money demand equation (2). A downward shift in United States money demand in the 1970s has been widely noted. In Frankel (1982) I argue that there has also been an upward shift in German money demand, and that the two shifts

5. A third way to obtain still more efficient estimates is to take advantage of the joint distribution that the error terms must have in a world of multilateral floating, through Zellner's technique of seemingly unrelated regressions. The membership of Germany and France in the European Monetary System, for example, provides particularly strong grounds for expecting their exchange rates against the dollar to be highly correlated. However, the results obtained from using Zellner's technique suggest that the cost exceeds the benefit of the slight gain in efficiency. Of course, the theory may be correct and yet the economic estimation plagued by more serious problems than high standard errors, that is, by inconsistency resulting from misspecification or simultaneity. Haynes and Stone (1981) argue against imposing the constraint that the money demand parameters in eq. (2) are equal across countries. But the results in table 7.1 are little affected by relaxing the constraints. Driskill and Sheffrin (1981) and others argue that the interest differential is endogenous, requiring simultaneous-equation estimation. In Frankel (1981) I use the ratio of the monetary base to government debt as an instrumental variable to estimate the coefficient of the interest differential.

6. The turnabout on purchasing power parity is strikingly symbolized by the title of Frenkel (1981), in contrast to the title of Katseli-Papaefstratiou (1979).

7. The role of an oil shock in determining the real exchange rate is examined by Obstfeld (1980) and Giavazzi and Wyplosz (in this volume).

explain the fall in the mark/dollar rate of the late 1970s. If we add a shift term to each money demand function,

$$(2') \qquad \begin{aligned} \bar{m} &= \bar{p} + \phi\bar{y} + \lambda\bar{i} + v \\ \bar{m}^* &= \bar{p}^* + \phi\bar{y}^* + \lambda\bar{i}^* + v^*, \end{aligned}$$

they show up as two more terms in the exchange rate equation:

$$(9') \qquad \begin{aligned} s = (\bar{m} - \bar{m}^*) - \phi(\bar{y} - \bar{y}^*) + \left(\lambda + \frac{1}{\theta}\right)(\bar{\pi} - \bar{\pi}^*) \\ - \frac{1}{\theta}(i - i^*) + r - (v - v^*). \end{aligned}$$

The third building block that has been called into question is the uncovered interest parity condition (4). If domestic and foreign bonds are imperfect substitutes, then the interest differential will differ from the expected rate of depreciation by a term that is most naturally thought of as a risk premium. The risk premium can be integrated into the monetary equation as yet another additional term in (9).

The question remains how to represent for empirical work our additional terms arising from shifts in purchasing power parity, money demand, and the risk premium. In each case, authors who have proposed the additional terms have constructed fairly ad hoc measures based largely on the current account. The current account is argued, alternatively, to give signals regarding long-run competitiveness, to constitute an important component of wealth which in turn belongs in the money demand function, and to be a determinant of the risk premium. Indeed, a major motivation for these modifications has been to "get the current account back into the monetary model." One obvious disadvantage with using these ad hoc measures is that it would be difficult to discriminate among the three alternative rationales.

The aim of this section is the very limited one of identifying which of the possible shifts is responsible for the apparent breakdown in the monetary model, without attempting to model the particular shift in question. This is possible by making use of the one structural variable in the monetary model that does not appear in the "reduced form" (9): the price level. In equation (9′) we represent r by a 1-year polynomial distributed lag of the real exchange rate $(e - p + p^*)$, and we represent $v - v^*$ by a 1-year polynomial distributed lag of relative velocity, $(p + y - m) - (p^* + y^* - m^*)$, both in log form. If one variable or the other gets the equation running smoothly again, then at least the source of the malfunction will have been localized.

In table 7.3 the lags on velocity and the real exchange rate are in every case but one highly significant and of the correct sign. Far more interestingly, the coefficients on each of the original four variables are now usually significant and of the correct sign. These results suggest that shifts in the money demand function and the long-run real exchange rate may equally be responsible for the problems of the monetary equation. The results tell us

Table 7.3 **Monetary Equation with Drift in Velocity and the Real Exchange Rate (Dependent Variable: Log of Exchange Rate per United States Dollar)**

						Sum of Lag Coefficients				
Country	Constant	$m1 - m1b_{US}$	$y - y_{US}$	$INFL - INFL_{US}$	$i - i_{US}$	Velocity	Real Exchange Rate	Sample	ρ	s.e.r.
Germany	−.19	.46[a]	−.26	.81[b]	−.59[a]	.65[a]	1.00[a]	78	.24	.018
	(.15)	(.17)	(.18)	(.45)	(.17)	(.09)	(.11)		(.11)	
France	−.49	.64[a]	−.50[a]	.54	−.54[a]	38[a]	1.05[a]	86	.51	.019
	(.20)	(.18)	(.12)	(.51)	(.17)	(.17)	(.12)		(.09)	
United Kingdom	.75	.88[a]	−.54[a]	.04[b]	−.14	.52[a]	1.06[a]	88	.49	.021
	(.27)	(.09)	(.13)	(.02)	(.15)	(.12)	(.07)		(.09)	
Japan	1.84	.61[a]	−.81[a]	.51[a]	.06	.77[a]	81[a]	89	.46	.020
	(.50)	(.13)	(.10)	(.24)	(.14)	(.09)	(.07)		(.09)	
Canada	.27	−.02	.30[c]	.40[b]	−.43[a]	−.38[c]	.98[a]	89	.85	.010
	(.24)	(.10)	(.10)	(.22)	(.13)	(.08)	(.11)		(.06)	

[a]Significant at the 95% level and of the correct sign.
[b]Significant at the 90% level and of the correct sign.
[c]Significant at the 95% level and of the incorrect sign. (Standard errors reported in parentheses.)
Technique: Cochrane-Orcutt.
Samples: 78 = 2/75–7/81, 86 = 3/74–4/81, 88 = 3/74–6/81, 89 = 2/74–6/81.

nothing about what is causing these shifts, but they do indicate that these are two promising areas for future research.

It is clearer how to go about modeling the third factor, shifts in the risk premium, than the first two. This leads us to the portfolio-balance approach, the subject of the remainder of the paper.

7.2 The Portfolio Balance Model and Synthesis

7.2.1 The Portfolio Balance Equation

The portfolio balance approach to flexible exchange rates was pioneered in a small country framework by Black (1973), Kouri (1976*a*), Branson (1977), and Girton and Henderson (1977). In this paper we will consider a simple model in which only two assets are held in the portfolio: those denominated in domestic currency, and those denominated in foreign currency (dollars). We assume that domestic investors allocate a proportion β_d of their total financial wealth W_d to domestic assets B_d and the remainder to dollars F_d:

(10) $$B_d = \beta_d W_d,$$

where $W_d \equiv B_d + SF_d$. If we could assume that domestic assets were not held by foreign residents, so that all current account imbalances were necessarily financed in dollars, then we could compute F_d as the accumulation of past current account surpluses. With B_d computed as the accumulation of past government budget deficits, and both variables corrected for any foreign exchange intervention, it would be a simple matter to solve (10) for the exchange rate S and estimate the parameter β_d. This is how Porter (1979), for example, proceeds.

However, the "small country" assumption that foreigners hold no domestic bonds is unrealistic for most countries, at least most with floating exchange rates. We must, at a minimum, specify another portfolio balance equation for United States investors:

(11) $$B_{us} = \beta_{us} W_{us},$$

where $W_{us} \equiv B_{us} + SF_{us}$, and a third equation for residents of the rest of the world:

(12) $$B_r = \beta_r W_r,$$

where $W_r \equiv B_r + SF_r$. Data on B_d, B_{us}, and B_r, or on F_d, F_{us}, and F_r, are not normally available. We can compute only the totals $B \equiv B_d + B_{us} + B_r$ and $F \equiv F_d + F_{us} + F_r$, as the cumulation in each country of the government deficit plus foreign exchange intervention. It is not clear how to express S as a function of B, F, W_d, and W_{us}. But it is clear that the signs in such a relationship would be, respectively, positive, negative, negative, and positive. An increase in the supply of dollar assets F lowers their price S; an increase in B has the opposite effect. An increase in United States wealth W_{us} through a current account surplus, raises the net demand for dollar assets, assuming United States residents choose to allocate a greater share of their portfolio to dollar assets than do residents in the rest of the world, and thus raises their price S; an increase in W_d has the opposite effect. Branson, Haltunnen and Masson (1977, 1979) and Frankel (1980) regress the exchange rate against four variables similar to these, for the mark/dollar rate.

Table 7.4 presents estimates of the portfolio balance model.[8] Though the own asset and wealth variables are significant for some of the countries, the results in general are as poor as those for the monetary equation in table 7.1. Particularly dismal is the equation for Germany: the coefficients on mark and dollar assets have the wrong signs. The supply of mark bonds, like the German money supply, has increased during precisely those periods in which the mark has *appreciated* rather than depreciated, due largely to the Bundesbank's habit of resisting such appreciation through foreign exchange intervention.

7.2.2 The Risk Premium and Synthesis with the Monetary Equation

The portfolio balance model has always specified that the shares β_d and β_f depend on rates of return: the domestic and foreign interest rates i and i^*, and the expected rate of depreciation Δs^e. But recent applications of finance theory by Kouri (1976*b*), Kouri and de Macedo (1978), Macedo (1980), Krugman (1981) and Dornbusch (1983), have shown the precise nature of this dependence, on the assumption that investors determine the parameters in their asset demand functions by mean-variance optimization rather than arbitrarily. The asset demand functions are

$$B_d = [a_d + b(i - i^* - \Delta s^e)]W_d, \tag{10'}$$

$$B_{us} = [a_{us} + b(i - i^* - \Delta s^e)]W_{us}, \tag{11'}$$

$$B_r = [a_r + b(i - i^* - \Delta s^e)]W_r. \tag{12'}$$

The coefficient b is related inversely to the coefficient of relative risk aversion, assumed to be the same in both countries, and to the variance of the exchange rate; it multiplies the risk premium to give the "speculative portfolio." The constant terms a_d, a_{us}, and a_r are related positively to the shares of consumption that residents of the three countries allocate to domestic goods; they constitute the "minimum variance" portfolio.

To use aggregate world data, we must add the three equations,

$$B = a_dW_d + a_{us}W_{us} + a_rW_r + b(i - i^* - \Delta s^e)W,$$

8. The data are described in an Appendix.

Table 7.4 Portfolio Balance Equation (Dependent Variable: Exchange Rate per United States Dollar)

Country	Constant	Asset	$Asset_{\$}$	W_d	W_{US}	Sample	ρ	s.e.r.
Germany	3.36	−.009[b]	.006[b]	.002	−.004[c]	83	.77	.056
	(.16)	(.002)	(.002)	(.002)	(.002)			
France	10.66	.002[a]	.005	−.019[a]	−.009[b]	83	.90	.100
	(1.40)	(.004)	(.005)	(.004)	(.003)			
United	1.07	−.014[b]	.000	.010[b]	−.000	83	.97	.013
Kingdom	(.27)	(.005)	(.001)	(.004)	(.001)			
Japan	782.16	.015[a]	−.069	−.014[a]	−.099	79	.90	6.067
	(71.67)	(.002)	(.307)	(.002)	(.275)			
Canada	.94	.007[a]	−.000	−.005	.000	86	.86	.016
	(.08)	(.002)	(.000)	(.004)	(.000)			

[a]Significant at the 95% level and of the correct sign.
[b]Significant at the 95% level and of the incorrect sign.
[c]Significant at the 90% level and of the incorrect sign.
(Standard errors reported in parentheses.)
Technique: Cochrane-Orcutt.

where we have defined world wealth $W \equiv W_d + W_{us} + W_r$. We solve for the risk premium:

$$(13) \qquad i - i^* - \Delta s^e = \frac{1}{b}\left(\frac{B}{W}\right) - \frac{a_d - a_r}{b}\frac{W_d}{W} + \frac{a_r - a_{us}}{b}\frac{W_{us}}{W} - \frac{a_r}{b}.$$

Notice first that an increase in the relative supply of domestic assets that must be held in investor portfolios requires a higher relative return on domestic assets. Now assume that domestic residents have the greatest preference for domestic asset and United States residents for dollar assets. (Krugman [1981] has shown that this requires not only that residents of each country consume relatively more of their own goods but also that the constant of relative risk aversion be greater than one.) Then equation (13) implies also that a redistribution of wealth from the rest of the world toward domestic residents will raise the net world demand for domestic assets, and thus lower the relative returns that must be paid on them. A redistribution of wealth toward United States residents will have the opposite effect.

One might wish to make the risk premium equation (13) into a complete model of exchange rate determination like that estimated in the last section. It would be necessary to specify the determination of the interest rates (e.g., by the proportions of money and bonds within the asset variables) and of expected depreciation (e.g., by a rationally expected future path of the asset supplies and a saddle-point stability assumption).

Here, instead, we integrate the portfolio balance model with the monetary model of the first part of the paper. We simply allow for deviations from the uncovered interest parity condition (4), substituting instead our new risk premium equation (13), much as we earlier allowed for deviations from the long-run purchasing power parity condition and the money demand equations. The risk premium is added to the monetary equation of exchange rate determination (9), in the form of the relative asset supply and the distribution of wealth variables:

$$(14) \qquad s = (\overline{m} - \overline{m}_{us}) - \phi(\overline{y} - \overline{y}_{us}) + \left((\lambda + \frac{1}{\theta}\right)(\overline{\pi} - \overline{\pi}_{us}) - \frac{1}{\theta}(i - i_{us}) + \frac{1}{\theta b}\left(\frac{B}{W}\right) - \frac{a_d - a_r}{\theta b}\left(\frac{W_d}{W}\right) + \frac{a_r - a_{us}}{\theta b}\left(\frac{W_{us}}{W}\right) - \frac{a_r}{\theta b}.$$

We have special cases *(a)* uniform asset demand preferences ($a_d - a_r = a_r - a_{us} = 0$) and *(b)* perfect substitutability ($b = \infty$) in addition to the

Table 7.5 **Monetary and Risk-Premium Synthesis Equation (Dependent Variable: Log of Exchange Rate per United States Dollar)**

		Monetary Model				Risk Premium					
Country	Constant	$m1 - m1b_{US}$	$y - y_{US}$	$INFL - INFL_{US}$	$i - i_{US}$	$\frac{B}{W}$	$\frac{W_D}{W}$	$\frac{W_{US}}{W}$	Sample	ρ	s.e.r.
Germany	−.05	.15	.06	−.24	.05	−.06	−2.21[a]	1.13[a]	83	.98	.008
	(.22)	(.10)	(.05)	(.24)	(.08)	(.44)	(.32)	(.16)			
France	.16	.01	−.00	.02	−.06	7.40[a]	−6.92[a]	1.16[a]	83	.98	.001
	(.29)	(.08)	(.05)	(.32)	(.10)	(.73)	(.39)	(.19)			
United Kingdom	−2.07	−.03	.03	.00	.03	−3.44[c]	2.26[c]	1.67[a]	83	1.00	.007
	(.24)	(.05)	(.04)	(.01)	(.05)	(.32)	(.44)	(.14)			
Japan	4.57	−.03[c]	−.05	−.10	−.10	3.64[a]	−2.99[a]	1.47[a]	79	.96	.009
	(.39)	(.06)	(.07)	(.10)	(.10)	(.30)	(.12)	(.15)			
Canada	.37	.07	.16	−.55	−.38[a]	3.25[a]	−4.08[a]	.003[b]	86	.91	.014
	(.33)	(.13)	(.12)	(.34)	(.19)	(.88)	(1.12)	(.002)			

[a]Significant at the 95% level and of the correct sign.
[b]Significant at the 90% level and of the correct sign.
[c]Significant at the 95% level and of the incorrect sign.
(Standard errors in parentheses.)

usual special case within the monetary model of *(c)* perfect price flexibility ($\theta = \infty$).

The synthesis equation is estimated in table 7.5. The results are surprising. Contrary to what one might expect from the earlier poor portfolio balance results, each of the three risk premium variables has a coefficient that appears significant and of the correct sign for most of the countries. But one cannot claim that the synthesis works better than the sum of the parts, because the coefficients on the variables from the monetary model are almost invariably insignificant.

To sum up the empirical findings of this paper, only those in table 7.3 could be described as favorable.[9] The implication is that further research into shifts in money demand and in the long-run real exchange rate, within the framework of the monetary model, appears justified.

Appendix
Data

Monetary Models

For each of the countries, the exchange rate against the United States dollar was obtained from the IMF's *International Financial Statistics,* and the money market interest rates from Morgan Guaranty Trust's *World Financial Markets*. The source for M1, industrial production, and the Consumer Price Index for the United States was the *Federal Reserve Bulletin* (tables 1.21, 2.10, and 2.10, respectively). The source for Germany was the *Statistical Supplement to the Monthly Report* of the Deutsche Bundesbank, series IV (tables 33, 7, and 11, respectively). The source for France, the United Kingdom, Japan, and Canada was *International Financial Statistics* (lines 34b, 66c, and 64, respectively).

Portfolio Balance Models

The supply of each country's asset is calculated as the cumulation of its government debt corrected for (1) issuance of debt denominated in foreign currency, if any; (2) foreign exchange market intervention by the country's central bank; and (3) foreign exchange market intervention by *other* countries' central banks in the domestic currency. The corrections are necessary

9. Adding the three risk premium variables to the regressions in table 7.3—the monetary model with drift in velocity and the real exchange rate—turns out only to vitiate the relatively positive results. And attempts to relate the risk premium variables directly to the excess return on countries' assets as in equation (13) have not been successful (Dooley and Isard 1983).

under the assumption that what matters for asset demand functions is currency of denomination and exchange risk, rather than location of issuance and political risk. These calculations give the net supply of assets denominated in a country's currency, including both money and bonds. It is easy enough to use the monetary base in regressions like those in table 7.4, if one believes that only the net supply of money should matter (as in "currency substitution" models), or to subtract off the monetary base from total assets if one believes that only the net supply of bonds should matter (as in Dooley and Isard 1979). However, such regressions yield results similar to those in table 7.4. (See Frankel 1980.)

United States Dollar Assets

DOASST = world supply of dollar assets. Calculated as DODEBT + FEDINT − NDOLCB.

DODEBT = gross public debt of the United States Treasury and other United States government agencies, excluding that held by United States government agencies and trust funds—i.e., debt held by the Federal Reserve, private domestic investors, and foreigners, at end of month (source: *Treasury Bulletin,* table FD-1, as reported by DRI); minus two issues of "Carter notes," which are denominated in foreign currency: $1,595.2 million dating from December 1978 and another $1,351.5 million from March 1979 (source: Federal Reserve press release, June 1979).

FEDINT = dollars supplied by the Fed in cumulative foreign exchange intervention. Computed by $\text{FEDINT}_t = \text{FEDINT}_{t-1} + \Delta\text{FEDINT}_t$, on a benchmark of the dollar value of all United States international reserve assets (gold, foreign exchange, SDRs, and IMF position) in January 1974 (source: Federal Reserve *Annual Statistical Digest 1973–1977,* table 51, or *F. R. Bulletin,* table 3, p. A59, e.g., June 1975).

ΔFEDINT = intervention, equal to increases in reserves, corrected for valuation changes. Computed as change in gold holdings (there have been no valuation changes since 1973), plus change in foreign exchange holdings in dollars minus valuation change (last period's foreign exchange holdings times the change in the dollar/mark rate; most of the holdings have been in marks during the only period in which they have been significant, i.e., since November 1978), plus change in SDRs and IMF position in dollars minus valuation change (last period's SDRs and IMF position times the change in the dollar/SDR rate; relevant since July 1974), minus new SDR allocations (nonzero only for January 1979, 1980, and 1981). Source for reserve holdings through 1977: F. R. *Annual Statistical Digest 1973–1977,* table 51; source for reserve holdings 1978–81: *F. R. Bulletin,* table 3.12. Source for dollar/SDR rate: IMF *International Financial Statistics,* line 78bd.

NDOLCB = holdings of dollar assets (regardless whether government securities) by foreign central banks as foreign exchange reserves. Source for 1973II–1979: IMF; 1979IV: IMF *Annual Report,* 1980, tables 15 and 16. Monthly numbers obtained by interpolation.

Deutsche Mark Assets

DMASST = world supply of mark assets. Calculated as DMDEBT + BBINT − NDMCB.

DMDEBT = debt of the German federal government, end of month. Source: Deutsche Bundesbank, *Monthly Report,* table VIII-10.

BBINT = cumulative Bundesbank sales of mark assets for international reserves in exchange market intervention, calculated as GRES − GADJ.

GRES = net external position of the Bundesbank, valued in marks, at end of month. Source: Bundesbank, *Statistical Supplements to the Monthly Report,* Series 3, table 9a.

GADJ = "balancing item to the Bundesbank's external position," an adjustment by the Bundesbank every December to reflect capital gains on foreign exchange and other reserves (these numbers are also available from table IX-6 [1], col. 12) and every January (except when zero: 1975–78) to reflect new SDR allocations. These items must be taken back out of GRES so that only changes in reserves due to purchases or sales of mark assets are counted. Cumulated with a benchmark of zero in 70:1. Source: Bundesbank, *Monthly Report,* table IX-1, col. 7.

NDMCB = holdings of mark assets (regardless whether government securities) by foreign central banks as foreign exchange reserves. Source for 1973II–1979I: IMF; for 1979IV: IMF *Annual Report* 1980, tables 15 and 16. Monthly numbers obtained by interpolation.

Pound Sterling Assets

PSASST = world supply of pound assets. Calculated as PSDEBT + BEINT − NPSCB.

$PSDEBT_t$ = pound sterling debt of the British government. Computed by $PSDEBT_t = PSDEBT_{t-1} - UKDFCT$ (source: IMF *IFS,* line 80) on a March 1973 benchmark of £37,156 million (source: *UN Statistical Yearbook 1977,* Public Finance table #201). The government deficit was used for UKDFCT rather than the better-known Public Sector Borrowing Requirement because the deficit "corresponds to a negative figure of net acquisition of financial assets" while the PSBR (according to *Central Statistical Office Financial Statistics,* 2.3, col. 1) exceeds the deficit by "net government lending to private sector and overseas" and "other financial transactions."

BEINT = cumulative Bank of England sales of pound assets for international reserves in exchange market intervention. Computed by $BEINT_t = BEINT_{t-1} + \Delta BEINT_t$ (U.K. Balance for Official Financing; source: *CSO Financial Statistics,* HI), on a 1973:1 benchmark of total international reserves in dollars (source: IMF *IFS,* line 1 d..d) times the pound/dollar exchange rate.

NPSCB = holdings of pound assets (regardless whether government securities) by foreign central banks as foreign exchange reserves. Source for 1973 II–1979I: IMF; for 1979IV: IMF *Annual Report* 1980, tables 15 and 16. Monthly numbers obtained by interpolation.

Japanese Yen Assets

JYASST = world supply of yen assets. Calculated as JYDEBT + BJINT − NJYCB.

JYDEBT = yen-denominated debt of Japanese government. Computed as JADEBT − JYCURD.

JADEBT = total Japanese debt, computed by $JADEBT_t = JADEBT_{t-1}$ + JSURP (government surplus; source: *IFS*, line 80), on a benchmark of yen debt in January 1970 (source: *IFS*, line 88b).

JYCURD = Japanese debt denominated in foreign currency. Source: *IFS*, line 89b.

BJINT = cumulative Bank of Japan sales of yen assets for international reserves in exchange market intervention. Computed as yen/dollar exchange rate × BJINTD, which is cumulative intervention expressed in dollars and is in turn computed by $BJINTD_t = BJINTD_{t-1} + \Delta BJINTD_t$, on a benchmark of the dollar value of all Japanese international reserve assets in November 1973 (source: *IFS*, line 1).

ΔBJINTD = intervention in dollars. Computed as increases in reserves (source: *IFS*, minus of line 79 k.d) minus new SDR allocations (source: *IFS*, line 78 bd; nonzero only for January 1978, 1980, 1981), minus capital gains (source: *IFS*, line 78 dd).

NJYCB = holdings of yen assets (regardless whether government securities) by foreign central banks as foreign exchange reserves. Source: IMF *Annual Report* 1980, tables 15 and 16. Monthly numbers obtained by interpolation.

French Franc Assets

FFASST = world supply of franc assets, calculated as FFDEBT + BFINT − NFFCB.

FFDEBT = franc-denominated debt of French government. Computed as FRDEBT − FYCURD.

FRDEBT = total French debt, computed by $FRDEBT_t = FRDEBT_{t-1}$ + FSURP (government surplus; source: *IFS*, line 80), on a June 1974 benchmark of F137.345 billion of franc debt (source: *IFS*, line 88b).

FYCURD = French debt denominated in foreign currency. Source: *IFS*, line 89b.

BFINT = cumulative Banque de France sales of franc assets for international reserves in exchange market intervention. Computed as franc/dollar exchange rate times BFINTD, which is cumulative intervention expressed in dollars and is in turn computed by $BFINTD_t = BFINTD_{t-1} + \Delta BFINTD_t$, on a benchmark of the dollar value of all French international reserve assets in January 1973 (source: *IFS*, line 1).

ΔBFINTD = intervention expressed in dollars. Computed as increases in reserves (source: *IFS*, minus line 79 k.d), minus new SDR allocations (source: *IFS,* line 79 bd; nonzero only for January 1979, 1980, 1981), minus capital gains (source: *IFS,* line 78 dd).

NFFCB = holdings of franc assets (regardless whether government securities) by foreign central banks as foreign exchange reserves. Source: IMF *Annual Report,* 1980, tables 15 and 16. Monthly numbers obtained by interpolation.

Canadian Dollar Assets

CDASST = world supply of Canadian dollar assets. Calculated as CDDEBT + BCINT. (Canadian dollars are not held as reserves by other central banks.)

CDDEBT = net debt of the Canadian federal government. Computed by CADEBT − CINTRA (intragovernmental debt; source: *IFS,* line 88s).

CADEBT = gross debt of the Canadian federal government. Source for 1970:1 to 1976:4: *IFS,* line 80. For 1976:5 to 1981:4, *CADEBT* computed by $CADEBT_t = CADEBT_{t-1}$ + CSURP (government surplus; source: *IFS,* line 80).

BCINT = cumulative Bank of Canada sales of Canadian dollar assets for international reserves in exchange market intervention. Computed as Canadian dollar/United States dollar exchange rate times BCINTD, which is cumulative intervention expressed in United States dollars and is in turn computed as $BCINTD_t = BCINTD_{t-1} + \Delta BCINTD_t$, on a benchmark of the dollar value of all Canadian international reserve assets in January 1972 (source: *IFS,* line 1).

ΔBCINTD = intervention expressed in dollars. Computed as increases in reserves (source: *IFS,* minus line 79 k.d), minus new SDR allocations (source: *IFS,* line 78 bd; nonzero only for January 1979, 1980, 1981), minus capital gains (source: *IFS,* line 78 dd).

Wealth Variables

Wealth in each country is computed as the cumulation of the current account surplus and government debt. Sources for the current account were as follows. Germany: *Monthly Report* of the Deutsche Bundesbank, table IX, 1. United States: *Survey of Current Business,* using the monthly balance of trade to interpolate between the quarterly current account figures. France, United Kingdom, Japan, and Canada: *IFS* lines 77 aad, abd, acd, add, aed, and agd summed and divided by 3 to get monthly figures.

The benchmarks for wealth were computed in a very ad hoc manner, since accurate data on the *level* of wealth are difficult to get, and since they are only constant terms in the regressions anyway. For the United States and Germany the benchmarks were taken from Dooley and Isard's (1983) figures for wealth "estimated from end-of-1972 stocks in Federal debt, monetary bases, and net claims on foreigners" (p. 699). For the other four countries end-of-1973 benchmarks were constructed by assuming that their wealths (expressed in own currency) at that time were proportional to United States wealth, with the proportionality constants taken to be GNP (nominal, 1977, as reported in *IFS*). The wealth series, observed at the end of 1973, translate into billions of dollars as follows: United States 415.041, Germany 80.779, France 86.95, United Kingdom 58.452, Japan 169.427, and Canada 42.136.

References

Balassa, Bela. 1964. The purchasing-power parity doctrine: A reappraisal. *Journal of Political Economy* 72:584–96.

Bilson, John. 1978. The monetary approach to the exchange rate—some empirical evidence. *IMF Staff Papers* 25 (March): 48–75.

Black, Stanley, 1973. International money markets and flexible exchange rates. *Studies in International Finance,* no. 25. Princeton University.

Branson, William. 1977 Asset markets and relative prices in exchange rate determination. *Sozialwissenschaftliche Annalen* 1:69–89.

Branson, William; Halttunen, Hannu; and Masson, Paul. 1977. Exchange rates in the short run: The dollar-deutschemark rate. *European Economic Review* 10:303–24.

Branson William; Halttunen, Hannu; and Masson, Paul. 1979. Exchange rates in the short run: Some further results. *European Economic Review* 12 (October): 395–402.

Buiter, Willem, and Miller, Marcus. 1981. Monetary policy and international competitiveness: The problems of adjustment. *Oxford Economic Papers* 33 (July): 143–75.

Dooley, Michael, and Isard, Peter. 1983. The portfolio-balance model of exchange rates and some structural estimates of the risk premium. *IMF Staff Papers* 30 (December): 683–702.

Dornbusch, Rudiger. 1976. Expectations and exchange rate dynamics. *Journal of Political Economy* 84:1161–76.

———. 1980. Exchange rate economics: Where do we stand? *Brookings Papers on Economic Activity,* 1:143–94

———. 1983. Exchange risk and the macroeconomics of exchange rate determination. In *The Internationalization of Financial Markers and National Economic Policy,* ed. R. Hawkins, R. Levich, and C. Wihlborg. Greenwich, Conn.: JAI Press.

Driskill, Robert, and Sheffrin, Steven. 1981. On the mark: Comment. *American Economic Revew* 71 (December): 1068–74.

Frankel, Jeffrey. 1979. On the mark: A theory of floating exchange rates based on real interest differentials. *American Economic Review* 69 (September): 610–22.

———. 1980. Monetary and portfolio-balance models of exchange rate determination. NBER Summer Institute Paper 80–7. In *Economic Interde-*

pendence and Flexible Exchange Rates, ed. J. Bhandari. Cambridge, Mass.: MIT Press, 1983.

———. 1981. On the mark: Reply. *American Economic Review AER* 71 (December): 1075–82.

———. 1982. The mystery of the multiplying marks: A modification of the monetary model. *Review of Economics and Statistics* 64 (August): 515–19.

Frenkel, Jacob. 1976. A monetary approach to the exchange rate: Doctrinal aspects and empirical evidence. *Scandinavian Journal of Economics* 76 (May): 200–224.

———. 1981. The collapse of purchasing power parities during the 1970s. *European Economic Review,* 16:145–65.

Genberg, Hans. 1978. Purchasing power parity under fixed and flexible exchange rates. *Journal of International Economics* 8 (May): 247–76.

Girton, Lance, and Henderson, Dale. 1977. Central bank operations in foreign and domestic assets under fixed and flexible exchange rates. In *The effects of exchange rate adjustment,* ed. P. Clark, D. Logue, and R. Sweeney. Washington: United States Treasury.

Hacche, Graham, and Townend, John. 1981. Exchange rates and monetary policy: Modelling Sterling's effective exchange rate, 1972–1980. In *The Money Supply and the Exchange Rate,* ed. W. A. Eltis and P. J. N. Sinclair. Oxford: Clarendon Press.

Haynes, Steven, and Stone, Joe. 1981. On the mark: Comment. *American Economic Review* 71 (December): 1060–67.

Hooper, Peter and Morton, John. 1982. Fluctuations in the dollar: A model of nominal and real exchange rate determination. Journal of International Money and Finance 1, no. 1:39–56.

Katseli-Papaefstratiou, Louka. 1979. The reemergence of the purchasing power parity doctrine in the 1970s. Special Papers in International Economics no. 13. Princeton: Princeton University, December.

Kouri, Pentti. 1976*a*. The exchange rate and the balance of payments in the short run and in the long run: A monetary approach. *Scandinavian Journal of Economics* 78 (May): 280–308.

———. 1976*b*. The determinants of the forward premium. Institute for International Economic Studies Seminar Paper 62. Stockholm: University of Stockholm, August.

Kouri, Pentti, and Macedo, Jorge de. 1978. Exchange rates and the international adjustment process. *Brookings Papers on Economic Activity* 1:111–57.

Krugman, Paul. 1978. Purchasing power parity and exchange rates: Another look at the evidence. *Journal of International Economics* 8 (August): 397–407.

———. 1980. Oil and the dollar. NBER Working Paper no. 554. In *Economic Interdependence and Flexible Exchange Rates,* ed. J. Bhandari. Cambridge, Mass.: Press, 1983.

———. 1981. Consumption preferences, asset demands, and distribution effects in international financial markets. NBER Working Paper no. 651 (March).

Macedo, Jorge de. 1980. Portfolio diversification across countries. Princeton International Finance Section. Working Paper (November).

Meese, Richard, and Rogoff, Kenneth. 1981. Empirical exchange rate models of the seventies: Are any fit to survive? International Finance Discussion Paper no. 184. Washington, D.C.: Federal Reserve Board, June. *Journal of International Economics*, March 1983.

Mussa, Michael. 1976. The exchange rate, the balance of payments, and monetary and fiscal policy under a regime of controlled floating. *Scandinavian Journal of Economics* 78 (May): 229–48.

Obstfeld, Maurice. 1980. Intermediate imports, the terms of trade, and the dynamics of the exchange rate and current account. *Journal of International Economics* (November). 10:461–80.

Porter, Michael. 1979. Exchange rates, current accounts, and economic activity. Federal Reserve Board, June.