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A Test of the Existence of the Risk Premium in the Foreign Exchange Market vs. the Hypothesis of Perfect Substitutability

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Summary

The paper tests for the existence of a risk premium in the foreign exchange market. The alternative is that exchange risk is completely diversifiable, and thus warrants no premium. A discussion of exchange rate models subdivides the asset-market approach into those that assume imperfect substitutability between domestic and foreign assets, classified under the portfolio-balance approach, and those that assume perfect substitutability, classified under the monetary approach. Since the existence of nondiversifiable exchange risk is the leading reason cited in support of imperfect substitutability, the test of the existence of a risk premium is to some extent a test of the portfolio-balance approach.

The test begins by specifying asset demands: the portfolio share allocated to domestic assets is a function of the exchange risk premium, that is of expected appreciation in excess of the forward premium. The function is then inverted and expectations are assumed to be rational. It follows that the ex post risk premium, that is actual appreciation in excess of the forward premium, is a function of the portfolio share allocated to domestic assets, plus a

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random error term. In regressions of this equation, the risk-premium hypothesis implies a positive coefficient on the portfolio share. The null hypothesis of a zero risk premium implies a zero coefficient.

The paper discusses and tests various issues within the portfolio balance approach: which assets belong in the demand function? Does the transactions motive play a role? Is the foreign propensity to hold domestic assets less than the domestic propensity (or is it even zero), giving the current account a role in exchange rate determination?

However, all tests indicate a striking inability to reject the null hypothesis. The other tests become irrelevant. The evidence points toward the hypothesis that the risk premium is a mythical construct, and that exchange risk cannot be used as a justification for imperfect substitutability. The failure to reject the null hypothesis is also a failure to reject rational expectations.

In recent theoretical modeling of international capital and exchange markets, the assumption of efficiency has become quite standard. One attraction is the property, in the resulting models, that small changes in exogenous variables can cause large changes in exchange rates, a realistic characterization of the floating-rate experience since 1973. The other attraction of the market efficiency assumption is the realism of its two components. The first component is perfect capital mobility, that is, the absence of transactions costs, capital controls, or other impediments to the flow of capital. Empirical tests have shown it to hold to a high degree of approximation, at least among some countries, such as Germany and the United States.[1] The second component is rational expectations. Empirical tests of rational expectations in the forward exchange market have produced conflicting results, but the positions of their authors are less conflicting: most are trying to test a hypothesis that on theoretical grounds they believe anyway.[2]

One possible reason for the failure of some of the tests is that the forward rate may not be equal to the market's true expected future spot rate. The two may differ by a nonzero risk premium. Richard Levich (1979) has emphasized this point and argued that modelling the risk premium is a prerequisite for testing efficiency.

It is useful to distinguish the assumption of perfect capital mobility from the assumption of perfect substitutability between domestic and foreign bonds.[3] The latter assumption, that is, the proposition that in equilibrium market participants are at the margin indifferent as to the currency composition of their portfolio, is far from standard. In fact, exchange rate models that assume perfect capital mobility ("the asset market approach") can be subclassified into those that assume imperfect substitutability ("the portfolio-balance approach") and those that assume perfect substitutability ("the monetary approach").[4]

There are a number of reasons why two financial securities may be imperfect substitutes: liquidity, tax treatment, default risk, political risk and exchange risk. Of these, the last seems the most relevant for describing the securities of the major industrialized countries that are traded in world capital markets. If the creation of additional units of a country's securities would expose their holders to increased risk because of a variable exchange rate, then the market will require a risk premium to induce it to hold that country's securities.[5]

Though the portfolio-balance models lean heavily on exchange risk as a justification for imperfect substitutability, the existence of the risk premium is far more often assumed than it is demonstrated theoretically or observed empirically. On a theoretical level, Frankel (1979b) shows that risk-aversion is not in itself sufficient to guarantee the existence of the risk premium . If every asset held is viewed as someone else's liability, then all exchange risk might be diversifiable. Market participants who expose themselves to exchange risk by failing to use the forward market would not be compensated by a greater expected rate of return any more than (according to the capital asset pricing model) would holders of an equity the return of which is variable but uncorrelated with the market basket. In terms of the traditional theory of the forward exchange rate (e.g. Tsiang 1959), the supply of speculative funds would be infinitely elastic at the level of the expected future spot rate.

On an empirical level, one could interpret tests of whether the forward rate systematically overpredicts or underpredicts the spot rate as tests of the existence of a risk premium, under the assumptions of rational expectations and a stable risk premium . But the forward rate very rarely fails this weak test; if the risk premium exists, it would have to fluctuate between positive and negative frequently to account for this finding.[6]

2. A Test for the Existence of the Risk Premium

This paper suggests a way of testing the existence of a non-zero risk premium. The method is as follows. First, we specify an asset-demand function of the portfolio-balance type; that is the demand for a country's assets is a definite proportion of wealth, where the proportion depends inversely on the expected rate of depreciation of the currency. Then the demand function is inverted, giving the expected rate of depreciation as a function of asset stocks. Under rational expectations,[7] the actual ex post rate of depreciation is equal to the expected rate of depreciation plus an error term that is uncorrelated with all past variables, including the stocks of assets. In regressions with the ex post rate of depreciation on the left-hand side and the relative asset stocks on the righthand side, the coefficients should be zero under the null hypothesis of a zero risk premium and perfect substitutability, and should be non-zero under the alternative hypothesis of a non-zero risk premium and imperfect substitutability.[8]

On the side of the null hypothesis, the technique is very general, in that any model that assumes rational expectations and perfect substitutability implies a zero coefficient. But on the side of the alternative hypothesis, different portfolio-balance models entail different asset-demand specifications. Thus we subdivide portfolio-balance models initially into four categories, represented by four equations.

According to Equation (1), the market allocates its portfolio between domestic bonds and foreign bonds as a function of the ex ante risk premium, that is of the expected rate of appreciation of the domestic currency in excess of the forward premium.

(1) $B = \beta(\hat{\phi})\ (B + SF)$,

where $\hat{\phi} = -[(\hat{S}_{+1} - S)/S - D]$, is the ex ante risk premium

B is the net supply of domestic bonds in the private market, which are willingly held

S is the exchange rate, defined as units of domestic currency per unit of foreign currency

F is the net supply of foreign bonds

D is the forward discount rate, equal to the interest differential by covered interest parity.

$\hat{S}_{+1}$ is the spot rate expected to prevail next period, when the bonds mature, and

β the share of the portfolio allocated to domestic assets, is an increasing function of $\hat{\phi}$.

Inverting (1), we find

$$\hat{\phi} = \beta^{-1}\ (B/(B + SF)).$$

We invoke the assumption of rational expectations.

$$\phi_{+1} = \hat{\phi} + \varepsilon_{+1} = \beta^{-1}(B/(B + SF)) + \varepsilon_{+1},$$

where $\phi_{+1} = -[(S_{+1} - S)/S - D]$, which might be called the ex post risk premium, and ε_{+1} is white noise.

The null hypothesis is that $\hat{\phi} = 0$; ϕ_{+1} is itself white noise and should be unaffected by $B/(B + SF)$. The risk-premium hypothesis is that, if Equation 1 is correctly specified, ϕ_{+1} should be significantly affected by $B/(B + SF)$.

In Equation 2, the market allocates its portfolio between total domestic assets and total foreign assets, where assets are defined to include both money and bonds, as a function of the ex ante risk premium. The argument for Equation 2 as opposed to Equation 1 is that market participants must count equally all assets whose return is fixed in nominal terms in calculating their exchange risk. Presumably the allocation of assets between money and bonds is specified separately, as a function of the interest rate and income.

(2) $$M + B = \beta(\hat{\phi})W$$

where $W = M + B + S\ (M^* + F)$,

M is the domestic high-powered money supply,

and M^* is the foreign high-powered money supply.

Inverting (2) and invoking rational expectations, we find

$$\phi_{+1} = \beta^{-1}((M + B)/W) + \varepsilon_{+1}.$$

In Equation 3, the market portfolio is allocated between total domestic assets and total foreign assets as in Equation 2, but as a function simply of the expected depreciation of the currency. The argument for Equation 3 is that if non-interest-bearing money is being included in the assets, then interest rates should not be included in the rate of return.

(3) $$M + B = \beta(-(\hat{S}_{+1} - S)/S)W$$

$$-(S_{+1} - S)/S = \beta^{-1}((M + B)/W) + \varepsilon_{+1}$$

In the last equation, the market portfolio is allocated only between domestic and foreign money, as a function of expected depreciation; Equation 4 represents "currency-substitution" models.[9]

(4) $$M = \beta(-(\hat{S}_{+1} - S)/S)\ (M + M^*)$$

$$-(S_{+1} - S)/S = \beta^{-1}(M/(M + M^*)) + \varepsilon_{+1}$$

The question of the functional form of β is to a large extent arbitrary.[10] The specification adopted here is a simple linear one. Equation (1) becomes

$$B = (a + b\,\hat{\phi})\,(B + SF),$$

where $b > 0$. Then:

$$(1') \qquad \phi_{+1} = \frac{-a}{b} + \frac{1}{b}\, B/(B + SF) + \varepsilon_{+1}.$$

The analogous version of Equation (2) is

$$(2') \qquad \phi_{+1} = \frac{-a}{b} + \frac{1}{b}\, \frac{M+B}{W} + \varepsilon_{+1}.$$

To distinguish Equation (3) from Equation (2), we add the interest differential as an additional term.

$$(3') \qquad \phi_{+1} = \frac{-a}{b} + \frac{1}{b}\, \frac{M+B}{W} + cD + \varepsilon_{+1}.$$

In light of the definition $\phi_{+1} = -[(S_{+1} - S)/S - D]$, c should appear as unity if Equation (3) is correct, and as zero if Equation (2) is correct. Finally, Equation (4) is specified analogously.[11]

$$(4') \qquad \phi_{+1} = \frac{-a}{b} + \frac{1}{b}\, \frac{M}{M+SM^*} + cD + \varepsilon_{+1}.$$

Although the transactions motive for asset demand is not as crucial to the portfolio-balance approach as it is to the monetary approach, it may still play a role. This possibility can be tested by including domestic and foreign income as variables in the regressions. For example, if (4), the currency-substitution equation, is respecified as

$$M = (a + b(\hat{S}_{+1}-S)/S + dY - d^*Y^*)(M + SM^*),$$

where Y is the log of domestic income and Y* is the log of foreign income, then (4') becomes

$$(S_{+1}-S)/S = -\frac{a}{b} + \frac{1}{b}\frac{M}{M+SM^*} + \frac{d}{b}Y - \frac{d^*}{b}Y^* + \varepsilon_{+1} .$$

The hypothesis that the transactions motive plays a role in portfolio balance implies that the regression should yield a positive coefficient on Y and a negative one on Y*.[12] Equations (1), (2) and (3) can be respecified analogously, although the argument for a transactions demand for bonds is of course weaker than the argument for a transactions demand for money.

It is worth emphasizing again that under the null hypothesis of a zero ex ante risk premium, all coefficients are zero.

3. Different Foreign and Domestic Asset Preferences

There is another important issue upon which the econometric procedure outlined above might throw some light. Equations (1) - (4) indicate that the entire world portfolio (abstracting from the existence of third countries) is allocated between domestic and foreign assets. Yet many portfolio-balance models assume that only the domestic portfolio is allocated between domestic and foreign assets, the rationalization being that the country is too small for foreigners to be interested in holding its assets.[13] One motivation for this assumption has been to simplify the accounting; it allows the identification of a capital inflow or outflow with an increase or decrease in the supply of foreign assets in the home market, thus assuming away the problem of the currency of denomination. A second motivation for the assumption is that, under floating exchange rates, it leads to the result that a current account deficit causes a depreciation of the home currency, since the counterpart to the current account deficit is a capital outflow: the reduction in the supply of foreign-denominated assets in the market leads to a rise in their price in terms of domestic currency.

This second motivation has become especially important since 1977 because most of the asset-market models (of every variety) have ceased to work well empirically in explaining actual exchange rate movements. Instead, the overwhelming empirical regularity has been a correlation between current account deficits and depreciation (suffered most notably by the United States) or surpluses and appreciation (for example, Germany and Switzerland). One possible conclusion to be drawn from this development is that the asset-market approach should be abandoned in favor of the traditional flow approach, which never has lost popularity in the textbooks and media. But in light of the strong case for perfect capital mobility mentioned in the opening paragraph of this paper, many authors have taken the tack of trying to "put the current account back" into the asset-market models.[14]

A realistic portfolio-balance model for large countries must recognize that residents of both countries hold assets issued by both countries. But the (cumulated) current account will still have the expected effect on the exchange rate, provided domestic residents wish to hold a greater proportion of their wealth as domestic assets and foreign residents wish to hold a greater proportion as foreign assets.[15,16]

It is a simple matter to specify separate asset demand functions for domestic and foreign residents. For example, (1) becomes

$$B_H = \beta_H(\hat{\phi})(B_H + SF_H), \quad \text{and} \tag{5}$$

$$B_F = \beta_F(\hat{\phi})(B_F + SF_F), \tag{6}$$

where the subscripts H and F denote holdings by home and foreign residents. If data on B_H, B_F, F_F and F_F were available, each of these two equations could be inverted separately and estimated separately. Unfortunately, data on who holds how much of what asset is virtually impossible to obtain.

A solution is to sum the two equations:

$$B = \beta_H(\hat{\phi})(B_H + SF_H) + \beta_F(\hat{\phi})(B_F + SF_F).$$

Data on privately-held assets can be obtained broken down by country of issuance (B vs. F) and by residence of holder ($B_H + SF_H$ vs. $B_F + SF_F$); it is merely the four-way breakdown which is unavailable.

The only problem that remains is solving for $\hat{\phi}$. Dooley and Isard (1979, p.14) specify B_H and B_F linearly and invert to get essentially

$$\hat{\phi} = a + \frac{B}{b_H(B_H + SF_H) + b_F(B_F + SF_F)} \, . \tag{7}$$

But this nonlinear equation cannot be estimated by OLS; they perform a grid-search over values of b_H and b_F. An alternative strategy is to specify a reciprocal functional form for β:

$$\beta_H(\hat{\phi}) = b_H \, 1/(-\hat{\phi} + a)$$

$$\beta_F(\hat{\phi}) = b_F \, 1/(\hat{\phi} + a) \, .$$

In the two-country specification of, for example, equation (1), we invert each function, getting

$$\hat{\phi} = a - b_H \frac{B_H + SF_H}{B_H} = a - b_F \frac{B_F + SF_F}{B_F} ,$$

Note that in the reciprocal form the portfolio-balance hypothesis is that the coefficients will be significantly less than zero, rather than greater than zero. We take a weighted average of the two expressions, with weights B_H/B and B_F/B respectively, to arrive at an estimable equation:

$$\phi_{+1} = a - b_H \frac{B_H + SF_H}{B} - b_F \frac{B_F + SF_F}{B} + \varepsilon_{+1} . \tag{8}$$

Equations (2) - (4) are handled analogously. The hypothesis that domestic and foreign residents have the same asset demands is represented as $b_H = b_F$, in which case equation (8) becomes identical with the aggregate form, equation (1). The alternate hypothesis that domestic residents have a greater propensity to hold domestic assets than do foreign residents, is represented as $b_H > b_F$. The extreme small-country assumption is that foreigners hold no domestic assets: $b_F = 0$.

4. Empirical Results

The following equation summarizes the tests run:

$$\phi_{+1} = \alpha + \beta\frac{V}{W} + \gamma D + \delta Y + \delta^{*}Y^{*} + \varepsilon \tag{9}$$

where ϕ_{+1} is the ex post risk premium, i.e. the rate of appreciation in excess of D,

D is the forward premium,

V is the stock of domestically-issued assets,

W is the total stock of assets, expressed in domestic currency

Y is the log of domestic output, and

Y* is the log of foreign output.

The assets were variously taken to be bonds, money, and bonds and money combined. The null hypothesis of a zero ex ante risk premium implies $\alpha = \beta = \gamma = \delta = \delta^{*} = 0$.

The rejection of the null hypothesis, in particular a finding of $\beta > 0$, would support the portfolio-balance approach and allow testing of further questions. The hypothesis that the ex ante risk premium is the proper rate of return variable in the asset demand functions implies $\gamma = 0$; the hypothesis that the expected rate of appreciation is the proper variable implies $\gamma = 1$. The hypothesis that the transactions motive plays a role in the portfolio-balance model implies $\delta > 0$ and $\delta^{*} < 0$. The alternate reciprocal specification allows the possibility of distinguishing asset demand preferences by country of residence:

$$\hat{\phi}_{+1} = \alpha + \beta_H\frac{W_H}{V} + \beta_F\frac{W_F}{V} + \gamma D + \delta Y + \delta^{*}Y^{*} + \varepsilon . \tag{10}$$

Now the risk-premium hypothesis is that $\beta_H < 0$, $\beta_F \leq 0$. The hypothesis that domestic residents have a greater tendency to hold domestic assets implies $-\beta_H > -B_F$; the alternative is $\beta_H = \beta_F$.

Before we turn to the empirical results, some qualifications are in order regarding the possible endogeneity of the right-hand side variables. If the asset demand functions specified in Equations (1) through (4) hold exactly,[17] then there is no simultaneity problem with the regression; the error term consists purely of expectational errors, with which all right-hand side variables are uncorrelated. However it is difficult to deny the existence of error terms in the asset demand functions. Even so, it is possible that such errors occur when the expected rate of return is expressed as a function of asset stocks, rather than when asset demands are expressed as a function of the expected rate of return, i.e. that the right-hand side variables are uncorrelated with these errors as well. Government policy variables, such as stocks of money and national debt, are conventionally the best candidates for exogeneity (especially on a quarterly basis, which allows enough time for the authorities to hit targets for the stock variables that they might miss on a shorter-term basis). But the exchange rate, which also appears on the right-hand side as the price at which foreign assets are valued, is a poor candidate for exogeneity. And if governments' monetary and fiscal policies are considered endogenous, then ignoring the reaction function would produce simultaneity bias.

It is not clear which way the bias would go. If an exogenous increase in expected future appreciation (holding interest rates constant) causes a shift into domestic assets and an instantaneous appreciation in the present, i.e. if S is a decreasing function of $\hat{\phi}$, then ignoring the exchange rate equation biases the coefficient upward; a coefficient that appeared insignificantly greater than zero would support the null hypothesis, but the opposite outcome would be inconclusive. Again, if an exogenous fall in domestic demand, reflected in an expected future appreciation, causes the government to expand by increasing the supply of domestic assets, then ignoring the reaction function biases the coefficient upward. But other kinds of exchange rate equations and reaction functions might have different implications. And if there are errors in the measurement of the asset stock variables, as there well might be, then the coefficient will be biased toward zero; a coefficient that appeared insignificantly greater than zero would be inconclusive, but the opposite outcome would support the existence of the risk premium.

A possible solution would be to use instrumental variables or simultaneous equation estimation techniques, for example using the unemployment and inflation rates as exogenous instruments for the government reaction function.[18] The econometrics for the present paper did not go beyond single-equation techniques. Until further analysis of the possible endogeneity problem, it remains a limitation of the study.

The countries used in the tests were the United States and Germany.[19] The United States was arbitrarily chosen as the domestic country. The sample consisted of quarterly observations from 1973I to 1978 IV. All variables (except the output variables Y and Y*) were measured at the end of the quarter. D was represented by the 3-month interest differential. The only variables to present important data problems were the asset stocks. The total net supply of domestically-denominated assets to the private market, M + B, was calculated as the stock of federal securities outstanding (whether monetized by the Central Bank or not) plus the Central Bank's accumulation of international reserves (representing cumulative sales of domestic assets in foreign exchange intervention) minus a measure of the holdings by foreign central banks of the country's assets in the form of foreign exchange reserves.

Table 1

Independent Varible: ex post risk premium ϕ_{+1} (=appreciation of dollar relative to mark in excess of forward premium $-[(S_{+1} - S)/S - D]$)
Sample: 1973I - 1978IV Technique: OLS

LINEAR SPECIFICATION (9)

Equation (1'): Bonds

Constant	Coefficient of $B/(B + SF)$	R^2	D.W.
.617 (.469)	-.761 (.567)	.08	1.79

Equation (2'): Bonds plus high-powered money

Constant	Coefficient of $(M+B)/(M+B+S(M^*+F))$	R^2	D.W.
.318 (.445)	.361 (.487)	.02	1.89

RECIPROCAL SPECIFICATION (10)

Equation (1'): Bonds

Constant	Coefficient of W/B	R^2	D.W.
-.333 (.189)	.168 (.098)	.12	1.94

Equation (8): Bonds, by country of holder

Constant	Coefficient of W_{US}/B	Coefficient of W_G/B	R^2	D.W.
-.269 (.193)	-.065 (.128)	.333 (.165)	.18	1.82

(Estimated standard errors are reported in parentheses.)

The net supply of domestically-denominated bonds to the private market, B, was calculated as the total net supply of assets M + B, minus the high-powered money supply M.

For purposes of distinguishing between domestically-held wealth and foreign-held wealth, in each country the current account surplus and increases in M + B were accumulated to arrive at the private sector's total net claims on its own government and on foreigners. The initial values for U.S. wealth and German wealth were taken from estimates by Dooley and Isard (1979b), but in some regressions a $\frac{1}{V}$ term was added to equation (10); its coefficient is an estimate of β_H (error in estimate of initial U.S. wealth) + β_F (error in estimate of initial German wealth). The tests were not extended beyond the two-country model, although it would be straightforward to include the portfolios of third-country residents.

Sources and definitions for the data are explained at some length in the appendix.

Of the hundreds of regressions run (representing different combinations of specifications and constraints), not a single one contained a single variable that was significant and of the sign hypothesized by the portfolio balance model. Table 1 reports four of these regressions with most of the constraints imposed (for example, D, Y and Y* are excluded) to maximize the power of the test. The linear specification shows no significant positive relationship between appreciation of the dollar and the share of the world portfolio allocated to dollar assets. The reciprocal specification shows no significant negative relationship; when U.S. wealth and German wealth are distinguished, the latter appears significant but the sign is incorrect.

The finding that emerges from these four regressions, and from the many others which there seemed no point in reporting, is a striking failure to reject the null hypothesis that there is no risk premium. The evidence points in the direction of perfect substitutability between domestic and foreign assets. In one sense this finding is reassuring. In the first place it is also a failure to reject rational expectations. In the second place, the conclusion that domestic and foreign bonds are perfect substitutes can be a very convenient one in model-building. In the third place, it must be remembered that the a priori case in favor of the existence of the risk premium is not an unassailable one; as discussed in Section 1 it is possible that exchange risk is diversifiable if all assets are viewed as "inside" assets.

On the other hand, the finding is in another sense somewhat disappointing. A failure to reject a null hypothesis is always a bit anti-climactic. Furthermore, in this case the null hypothesis rules out a whole interesting variety of models - the portfolio-balance approach. It would have been particularly interesting to explore the role of the current account in the portfolio-balance models, to test whether the foreign propensity to hold domestic assets is less than the domestic propensity, or whether it might even be close to zero. It would also have been interesting, if a genuine risk premium had been found, to perform on the residuals the standard rational expectations tests, such as testing for serial correlation in expectational errors.

Of course several qualifications lie between the test results and a writing-off of the portfolio-balance approach. First, the portfolio-balance authors may have in mind other justifications than exchange risk for their assumption of imperfect substitutability. Second, and more importantly, failure to reject the null hypothesis is not the same as acceptance. The very high variability of the dependent variable and the fairly small number of quarterly observations (24) limits the power of the test. Third, simultaneity bias and errors-in-variables might render the estimates inconsistent. The existence of simultaneous equations for the exchange rate and government policy variables might bias the estimates either toward or away from the null hypothesis; further research could extend the tests to simultaneous equation techniques. On the other hand, errors in the measurement of the stock variables would certainly bias the finding toward the null hypothesis; this problem has no cure other than further refinement of the data calculations described in the appendix.

DATA APPENDIX

X = exchange rate in dollars/mark, on the last Friday of the quarter. Source: Federal Reserve Data files.

D = 90-day Eurrocurrency interest rate differential on or near the last day of the quarter, the dollar (Source: Morgan Guaranty's World Financial Markets) minus the mark (Source: Bank of America's data file).

M + B = total net supply of dollar-denominated assets to the private market, in billions of dollars, calculated as DOLDEBT + CUMINTFR - DOLFORCB.

DOLDEBT = gross public debt of the U.S. Treasury, excluding that held by U.S. Government agencies and trust funds, end of quarter (held by the Federal Reserve, private domestic investors, and foreigners). Source: Federal Reserve Board's Annual Statistical Digest 1973-1977 (1978), Table 31, and Federal Reserve Bulletin (1978 and 1979 issues) Table 1.42.

CUMINTFR = cumulative Federal Reserve sales of dollar assets for international reserves in exchange market intervention, calculated as RESFR + VALADJUS. (also reported in FRB Stat Dig. p. 356 for 1973-1977).

RESFR = U.S. reserve assets, valued in dollars, end of quarter (consisting of Gold, SDRs, IMF reserve position, and foreign currencies). Source: Federal Reserve Bulletin (Dec. and June issues, 1973-1979), Table 3.12.

VALADJUS = valuation adjustment, necessary to remove capital gains on U.S. reserve assets, specifically those resulting from changes in the dollar/SDR rate since it ceased to be pegged at 1.20635 in July 1974, computed as {SDR's + IMF reserve position (Source: ibid.)} x {[1.20635/end-of-quarter dollar/SDR rate (Source: IMF International Finance Statistics (1974-1979))] - 1}. No adjustment was made for gold, which is still valued at the official price. (Capital gains generated by the discrepancy between the official price and the market price in gold sales are realized by the Treasury as profits.) Nor was any adjustment made for foreign currency holdings which were not valued at current market exchange rates until Nov. 1978, and which in any case were negligibly small before then. New SDR allocations (and IMF restitution of gold to central banks) would also have to be subtracted off, but none were made during the sample period.

DOLFORCB = holdings of dollar assets (regardless whether government securities), by foreign central banks as foreign exchange reserves, calculated as DOLSHARE x FOREXRES.

DOLSHARE = share of foreign exchange reserves held as dollar assets, 1973-1977; 1977IV was extrapolated to 1978I-1978IV. Source: I.M.F. Survey (May 22, 1978), p. 154-155.

FOREXRES = total holdings of foreign exchange reserves (expressed in dollars) by monetary authorities of all countries. Source: IMF International Financial Statistics (June 1974, June 1976, Oct. 1977, May 1979), Table 1ds. Figures for 1976-1978 had to be converted from SDRs to dollars by the end-of-period rate (ibid).

M = U.S. monetary base, seasonally adjusted, and adjusted for breaks due to changes in Regulation D, last month in quarter. Source: Federal Reserve Data.

B = net supply of dollar-denominated bonds to the private market, calculated as (M+B)-M.

WUS = Net financial wealth of U.S. residents, expressed in dollars, equal to DOLDEBT plus accumulated net private capital inflows, computed as WUS_0 + (M+B)$-DOLDEBT_0$ + CUMCASUS.

WUS_0 = Initial (1972IV) value of WUS, taken from Dooley and Isard (1979c), "estimated from end-of-1972 stocks of Federal debt, monetary bases, and net claims on foreigners," (p.24) at $400 billion.

(M+B)$-DOLDEBT_0$ + CUMCASUS = Additions to U.S. net financial wealth through purchases of government securities and private capital outflows, computed as (M+B), minus the initial (1972IV) value of DOLDEBT, plus the accumulated U.S. current account surplus (seasonally adjusted). Source for the latter: Federal Reserve Board data bank.

Y = Log of U.S. GNP in constant 1970 prices. Source: IMF International Financial Statistics

M* + F = total net supply of mark-denominated assets to the private market, in billions of marks, calculated as DMDEBT - CUMINTBB - DMFORCB.

DMDEBT = debt of the German Federal government, end-of-quarter. Source: Bundesbank Monthly Report (June issues, 1974-1979), Table VIII 10.

CUMINTBB = cumulative BundesBank sales of mark assets for international reserves in exchange market intervention, calculated as RESBB - VALADJG.

RESBB = net external position of the Bundesbank, valued in marks, end of quarter. Source: Bundesbank's Statistical Supplements to the Monthly Report, Series 3 (Dec. 1974, July 1977, June 1979), Table 9a.

VALADJG = "balancing item in respect of valuation adjustment of monetary reserves," adjusted by Bundesbank every December to reflect capital gains on foreign exchange and other reserves since the date of acquisition. The item must be taken back out of RESBB so that only changes in reserves equal to purchases or sales of mark assets are reflected.

DMFORCB = holdings of mark assets (regardless whether government securities) by foreign central banks as foreign exchange reserves, calculated as DMSHARE x FOREXRES.

DMSHARE = share of foreign exchange reserves held as mark assets, 1973-1977; 1977 IV was extrapolated to 1978I-1978IV. Source: IMF Survey (May 22, 1978), p. 154-155.

M* = German monetary base, seasonally adjusted, last month in quarter. Source: Bundesbank's Stat. Sup. to the Mo. Report Series 4.

F = Net supply of mark-denominated bonds to the private market, calculated as (M* + F) - M*.

XWG = Net financial wealth of German residents, expressed in dollars, computed analogously to WUS as $X \times [WG_o + (M^* + F) - DMDEBT_o + CUMCASG]$.

WG_o = Initial (1972 IV) value of WG, taken from Dooley and Isard (1979c), estimated at DM 200 billion.

$(M^* + F) - DMDEBT_o + CUMCASG$ = Additions to German net financial wealth through purchases of government securities and private capital outflows, computed as (M* + F), minus the initial (1972 IV) value of DMDEBT, plus the accumulated German current account surplus (seasonally adjusted). Source for the latter: Bundesbank's Stat. Sup to the Mo. Report, Series 4.

Y* = Log of German GNP, in constant 1970 prices. Source: IMF International Financial Statistics.

Footnotes

[1]See, for example, Branson (1977), Frenkel and Levich (1975, 1977) and McCormick (1979). Aliber (1973), Dooley (1976), Dooley and Isard (1978, 1979b) and Deardorff (1979) discuss reasons for the deviations that do occur.

[2]See Dooley and Shafer (1976), Frenkel (1976, 1977), Bilson and Levich (1977), Kohlgagen (1977), Krugman (1977), Cornell (1977), Cornell and Dietrich (1979), Levich (1979), Frankel (1979a), Tryon (1979), and Krasker (1979), among others. The claim is that most, though not all, of these authors believe that the market's forecasts of the future spot exchange rate are unbiased when the information set is defined to include such obvious and publicly-available data as the past time series of the spot and forward rates themselves.

[3]The models of Mundell (1968) and Fleming (1962) can be interpreted as assuming perfect substitutability: a discrepancy between domestic and foreign rates of return gives rise to a capital flow which is finite in the short run if capital is imperfectly mobile, but which arbitrages the discrepancy to zero in the long run or if capital is perfectly mobile. (There is an analogy with a common characterization of goods markets: a discrepancy between domestic and foreign prices gives rise to a trade flow which is finite in the short run, because of contracts, information lags and transportation costs, but which enforces purchasing power parity in the long run.)

The point that the stock of capital, rather than the flow, is the relevant variable was made early by McKinnon and Oates (1966), p.30, and Branson (1969), p.2 (though Kouri (1976) and Porter (1979a, 1979b) claim that it is all in Robinson (1947) and even Keynes (1923)). The point is now commonplace. However the distinction between imperfect mobility, describing the "traditional" Mundell-Fleming model, and imperfect substitutability, describing the portfolio-balance models, is by no means universally observed. It may have originated with Girton and Henderson (1976), p.35; it is mentioned by Girton and Roper (1976), p.3, and Dornbusch (1977), p. 106 and is explained clearly by Dornbusch and Krugman (1976), p.554.

[4]Some examples of the first class of exchange models are Dornbusch (1975), Kouri (1976, 1976b), Flood (1976), Girton and Henderson (1976, 1977), Henderson (1977, 1979), Porter (1977, 1979a, 1979b) and Dooley and Isard (1979a, 1979c). In the tradition of the seminal Tobin (1969) paper, the natural name for the models that rely on imperfect substitutability between domestic and foreign assets is the portfolio-balance approach. However, there are cases of such models going by other names (for example, the "currency substitution" models referred to in footnote 9), and cases of other models going under the portfolio-balance name. (Sometimes the portfolio-balance name is used when wealth enters the expenditure function, even if wealth consists of only one asset, which is essentially the case, for example, in McKinnon and Oates (1966).)

The assumption that domestic and foreign bonds are perfect substitutes shifts responsibility for determining the exchange rate onto the money markets, suggesting that the second class of models be referred to as the monetary approach. But there are also some problems with this terminology. The word "monetary" is occasionally used more broadly, to describe any model in which the money supply plays an important role, though this criterion would include virtually all modern models. On the other hand, it is sometimes used more narrowly, to describe only models in which government policy can have no real effects on income or the balance of trade. As suggested by Whitman (1975), the term "monetarist" could be reserved for this latter class. Frankel (1979c) subdivides the monetary models of exchange rates into the monetarist or "Chicago" models, such as Frenkel (1976, 1977), Mussa (1976), Bilson (1978a, 1978b), and Hodrick (1978), which make the assumption that goods prices are perfectly flexible, and the "Keynesian" models, such as Dornbusch (1976), which assume that goods prices are sticky.

[5]Most portfolio-balance models, especially those dealing with fixed exchange rates, or at least with static exchange rate expectations, do not explain why domestic and foreign assets should be imperfect substitutes. One exception is Girton and Henderson (1977), who mention exchange risk explicitly (p.153). The term portfolio-balance will henceforth be used narrowly to refer to models in which exchange risk is at least one reason why domestic and foreign bonds are not perfect substitutes.

[6]Stockman (1978) claims some evidence for non-zero risk premia on the basis of such a test, but only after dividing the four-year sample into subsamples, and only for two countries out of six. As Cornell (1977) says, "it is hard to believe that the premium could change sign over a period as short as four years," (p. 59), implying that the risk premium does not exist.

If one ignores significance levels and interprets mean overpredictions as risk premia, one would have to conclude from the results in either Stockman, Cornell, or Frankel (1979a) that the dollar has been viewed as safer than all other major currencies, except for the pound, which became viewed as safer than the dollar in the period after 1974. The former conclusion might agree with one's prior expectations; the latter does not.

[7]The term "rational expectations" is used in place of the term "market efficiency," even though the latter would be technically more correct in this case, since what is being assumed in not just that agents form expectations rationally but also that these expectations are not prevented from being fully reflected in market prices by transactions costs or other barriers.

[8]The test was largely inspired by Dooley and Isard (1978, 1979b). Their approach is similar, but they never explicitly test the existence of the risk premium. Rather they take its existence for granted, and use regressions like equations (1') and (7) below to estimate the parameters of the portfolio-balance model. They use fitted values of the regressions to get estimates of expected depreciation, which they then compare to actual depreciation. Judged by goodness-of-fit statistics, the fitted values do a slightly better job of predicting actual exchange rate changes than does the forward rate (though the forward rate does a better job of predicting exchange rate levels.) Dooley and Isard only mention in passing this evidence that the risk premium exists (1978, p.25 - 27). Their interest focusses primarily on the fact, which they find surprising, that

the fitted values do not predict all or most of the actual variation in the exchange rate. The premise of the present paper is that this fact is less interesting than the claim that the fitted values predict more of the actual variation than does the forward rate.

[9] The term currency substitution was originated by Girton and Roper (1976) to describe the allocation of market portfolios between domestic and foreign money. Other examples are Barro (1977) and Calvo and Rodriguez (1977). In many of the theoretical models, only the use of the words "money" or "currency" distinguishes them from the other portfolio-balance models, which use the words "bonds" or "assets." But one could argue that, to the extent that government debt implies future tax liabilities to pay it off, high-powered money is the only true outside asset, and thus the only asset able to create non-diversifiable exchange risk for the private market.

Other models, such as Miles (1978), Bilson (1978), and Brillembourg and Schadler (1979) go by the currency-substitution name, but specify the relative demands for two moneys as a function of the interest differential rather than the expected depreciation rate, usually because domestic and foreign bonds (as opposed to moneys) are assumed perfect substitutes, so that the interest differential is a measure of the expected depreciation rate. These models are not portfolio-balance models in the exchange-risk sense. (See footnote 5.) Furthermore it is difficult to distinguish their final equations from those of models - classified in footnote 4 under the names "monetarist" or "Chicago" - which assume that national moneys are held only in their own countries but that bonds and goods are perfect substitutes across countries. Bilson (1978c) argues that the currency substitution model is distinguished from the monetarist model by a dropping out of the country price levels and income levels. Brillembourg and Schadler argue that the distinguishing characteristic is non-zero cross-elasticities in an n-country study.

[10] The derivation of a market-clearing equilibrium condition from first principles of expected utility maximization does not lead to an expression for asset demands as functions of expected depreciation, much less as functions homogenous in wealth, despite the overwhelming popularity of such a formulation. See Frankel (1979b).

[11] One might argue that c should be constrained to unity in (4'), so that money demand is a function only of expected depreciation. But Brillembourg and Schadler (1979), for example, emphasize the possibility that money could earn a non-zero nominal return, "which may take an explicit form such as interest paid on savings deposits or an implicit form such as services rendered for checking accounts" (p.7), and add a proportion of the return on bonds as a measure of the nominal return on money, which would imply a value for c between zero and unity. Note that the hypothesis that the interest differential has a positive effect on the relative demand for domestic money is the reverse of the hypothesis that it has a negative effect either because it proxies for expected depreciation, as is argued in Calvo and Rodriguez (1977), Bilson (1978b) and Brillembourg and Schadler (1979), or else because it represents the opportunity cost of holding bonds, as is argued in Frenkel (1976, 1977), Dornbusch (1976), Bilson (1978a, 1978b), Hodrick (1978), Miles (1978) and Frankel (1979c). See footnotes 4 and 9 for a classification of these models as "currency substitution" on the one hand, or "monetary " on the other.

[12] As is discussed in Section 3 below, in many of the portfolio-balance models foreign residents have a tendency to hold their wealth in the form of the domestic country's assets that is less than their tendency to hold their own assets, or that is even zero. In such models, domestic and foreign income might proxy for domestic and foreign wealth. However it is possible to measure wealth explicitly, so income will here be identified exclusively with the transactions motive.

[13] Dornbusch (1975), Branson (1975), Kouri (1976), Flood (1976), Branson, Halttunen and Masson (1977), and Porter (1977, 1979a, 1979b) all assume that domestic assets are not held by foreigners. This small-country assumption is hard to justify in empirical work that includes the U.S., as do many of these papers.

[14] This tack is made explicit, on a purely theoretical level by Dornbusch and Fischer (1978), on a purely empirical level by Hooper and Morton (1978), and on both levels by Porter (1977, 1979a, 1979b), Kouri and de Macedo (1978) and Dooley and Isard (1979b). Of course the (cumulated) current account was there all along in those portfolio-balance models mentioned in the last footnote.

In fact, in any of the monetary models (i.e. those referred to as such in footnote 4) that care to allow income to be endogenous, an exogenous improvement in the flow current account will also lead to an appreciation because it will lead to an increase in income and thus in demand for domestic money; and an improvement in the cumulated current account will have a further effect, if wealth enters the consumption function and domestic residents have a higher propensity to consume domestic goods than do foreign residents.

[15] And provided that there is no foreign exchange intervention. As Hooper and Morton (1979) point out, one cannot use the portfolio-balance approach and the 1977-78 U.S. current account deficit to explain the large depreciation of the dollar, because the deficit was more than offset by exchange intervention on the part of foreign central banks. Even under the extreme ("small-country") assumption that dollar assets are held only by U.S. residents, the fall in demand for dollar assets caused by the transfer of wealth from domestic residents to foreign residents has to have been less than the fall in the supply of dollar assets caused by exchange intervention, leading to a prediction of an appreciation of the dollar under the portfolio-balance approach.

A more general point regarding the wealth-transfer argument is that capital flows, even when they are of the correct sign, may be too small in magnitude relative to existing stocks of assets to be significant on a monthly or quarterly basis.

[16]There is an analogy with the transfer problem: a transfer of income from domestic residents to foreign residents causes an adverse shift in the terms of trade provided domestic residents have a greater propensity to consume domestic goods and foreign residents have a greater propensity to consume foreign goods.

Kouri (1976) derives theoretically the asset demands that would minimize portfolio-holders' purchasing-power risk, based on their propensities to consume domestic and foreign goods. Kouri and de Macedo (1978) derive these hypothetical asset demands statistically, from observed purchasing-power variability.

[17]Obviously if any one of (1'), (3') and (4') is correct, then the others will in general be misspecified (though theoretically there is nothing to stop them from holding simultaneously). (2') is nested within (3').

[18]Branson, Halttunen and Masson (1977) estimate simultaneously an exchange rate equation, with asset stocks on the right-hand side, and a foreign exchange intervention equation, with exchange rate changes on the right hand side. (The rate-of-return variables, which appear in the portfolio-balance theory, are dropped in their econometrics.)

[19]A study across a cross-section of countries, besides bringing additional data to bear on the question, would allow the inclusion of a variable to measure the variability of the exchange rate, to test the hypothesis that the (absolute) magnitude of the risk premium is an increasing function of variability.

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