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by

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1. Introduction

Since the collapse of the Bretton Woods regime, models of asset-stock equilibrium have dominated professional thinking about exchange-rate determination. A number of empirical investigations have established that changes in relative stocks of moneys explain a considerable portion of the behavior of exchange rates (see Frenkel, 1976, 1977, 1978; Bilson, 1978a, 1978b; Girton and Roper, 1977; Hodrick, 1978). It has also been established, however, that persistant deviations from purchasing-power parity weaken the links between exchange rates and relative stocks of money in the short run (see Kravis and Lipsey, 1978), and that relative rates of money growth by themselves do a poor job of explaining the behavior of exchange rates since late 1975, when real economic growth in the United States recovered to a rate that exceeded and continued to outpace growth rates in other industrialized countries (see Dornbusch, 1978)

As a consequence, attention has focussed increasingly on the role of the current account. According to the portfolio-balance model of asset equilbrium, current-account imbalances can affect exchange rates by shifting the residence of wealth between regions with different portfolio preferences. Branson, Halttunen and Masson (1977) and Porter (1977, 1979) have set out to estimate this "wealth" effect empirically and have indeed verified that exchange rates do respond to current-account imbalances. Their empirical tests, however, do not establish whether

*/ The analysis and conclusions of this paper are those of the authors and do not necessarily represent the views of the Federal Reserve System or anyone else on its staff.

a significant rebalancing of portfolios occurs following wealth transfers, or whether current-account imbalances predominantly affect exchange rates through other channels. One purpose of this paper is to argue that under reasonable restrictions on behavioral relationships, wealth effects can explain only a small part of the apparent response of exchange rates to current-account imbalances.

In section 2 we spell out the portfolio-balance framework and stress that it can not determine both the level and the expected rate of appreciation of the exchange rate. The portfolio-balance framework is a model that relates excess demands for stocks of outside assets to the expected yields on these assets. The relative levels of current and expected future exchange rates are determined as elements of expected yields, but by itself the portfolio-balance model does not determine the nominal values of either.

In section 3 the expected rate of appreciation of the exchange rate is viewed as the sum of an observable forward premium plus an unobservable exchange-risk premium. The risk premium is related to asset stocks and wealth variables, and it is shown that changes in the risk premium depend on budget deficits, current-account imbalances and official foreign-exchange interventions. Section 4 documents that observed forward premiums have been small relative to the changes in exchange rates that have occurred since March 1973. In addition, empirical evidence is presented which suggests that the risk premium derived from the portfolio-balance model can only explain a small portion of the discrepancies between forward premiums and observed changes in exchange rates. This suggests that observed exchange-rate changes have been predominantly unexpected and cannot be explained by the portfolio-balance framework in isolation.

Section 5 discusses alternative assumptions that can be appended to the portfolio-balance framework to explain unexpected jumps in observed exchange rates in terms of revisions in expectations about future exchange rates. If future exchange rates are expected to be consistent with any of a broad set of assumptions about future current-account positions, unexpected imbalances in observed current accounts will generate unexpected jumps in observed exchange rates. More generally, observed nominal exchange rates will jump on the one hand in response to unexpected information about current-account positions, potential-income levels, or whatever leads to revisions in expectations about future real terms of trade, and on the other hand in response to unexpected information about monetary-growth rates or whatever leads to revisions in expectations about future ratios of national price levels. This general point has been noted by Dornbusch (1978) and is developed further by Isard (1979).

Section 6 presents several conclusions for empirical research. To the extent that exchange-rate changes in the past six years have been predominantly unexpected, we should search for empirical explanations that distinguish between expected and unexpected changes in explanatory variables. Moreover, we should recognize that the integration of the unexpected monetary and balance-of-payments factors that underlie exchange-rate movements involves the integration of a model of asset-stock equilibrium with a model of (expected future) balance-of-payments flows. Such a model can help us understand history, but insofar as exchange rates are driven predominantly by unexpected real and monetary shocks, accurate forecasting of exchange-rate changes requires relatively advanced foresight of real and monetary events.

2. The Portfolio-Balance Framework

In the spirit of the original portfolio-balance models of McKinnon and Oates (1966) and McKinnon (1969), and the two-country formulation by Girton and Henderson (1973), we consider a two-country, two-currency world in which private sectors hold interest-bearing and non-interest-bearing claims on governments.

Let MB and MB* denote the monetary bases of the home country and the foreign country -- i.e., the stocks of non-interest-bearing outside assets -- respectively denominated in home and foreign currencies. Let B and F respectively denote the stocks of interest-bearing outside assets denominated in home and foreign currencies. These stocks are measured net of the claims of official agencies on each other. The net holdings of private residents of the home country (H) and the foreign country (F) are respectively denoted by MB_H, B_H, F_H and MB^*_F, B_F, F_F, such that

(1) $MB_H = MB$

(2) $B_H + B_F = B$

(3) $F_H + F_F = F$

(4) $MB^*_F = MB^*$

W_H and W_F denote the "wealths" of private home residents and private foreign residents, respectively valued in home and foreign currency units.

(5) $W_H = MB_H + B_H + sF_H$

(6) $W_F = MB_F^* + B_F/s + F_F$

where the exchange rate s is measured as domestic currency per unit foreign currency.

The stocks of base moneys and bonds are determined by the interactions of monetary policies, government budget deficits, and official exchange-market interventions. B is equal to the cumulative budget deficit of the home government ($\int DEF$) minus cumulative open market purchases of bonds in exchange for base money issued by the home monetary authority (MB) minus cumulative purchases of home-currency bonds by official foreign-exchange intervention authorities in the home and foreign countries combined ($\int INT$)

(7) $B = \int DEF - MB - \int INT$

Similarly

(8) $F = \int DEF^* - MB^* + \int INT^*$

where DEF* is the foreign budget deficit and INT* is the quantity of foreign bonds that are sold to purchase INT units of home bonds

(9) $INT^* = INT/s$

We limit capital gains and losses to those associated with exchange-rate movements by assuming that B and F are one-period bonds; stocks of government debt are viewed to be refinanced at the beginning of each period.

We make the following behavioral assumptions about the stocks of assets that are held in private portfolios. No distinctions are drawn between actual and desired portfolio holdings. The division of home-country private wealth between home money, home bonds and foreign bonds is assumed to depend on the own rate of interest on home bonds, r; the expected home-currency yield on foreign bonds, $r^* - \pi$, where r^* is the own rate of interest on foreign bonds and π is the expected rate of appreciation of home currency; and a vector of other variables, Q, which conventially includes an index of transactions demand.

$$(10)\quad MB_H = m_H\,(r,\ r^* - \pi, Q)W_H$$

$$(11)\quad B_H = b_H\,(r,\ r^* - \pi, Q)W_H$$

$$(12)\quad sF_H = sf_H\,(r,\ r^* - \pi, Q)W_H$$

Similarly, the division of W_F between foreign money, home bonds and foreign bonds depends on the own rate of interest on foreign bonds, the expected foreign-currency yield on home bonds, and a vector of other variables, Q^*.

$$(13)\quad MB_F^* = m_F(r^*,\ r+\pi,\ Q^*)W_F$$

$$(14)\quad B_F/s = (1/s)b_F(r^*,\ r+\pi,\ Q^*)W_F$$

$$(15)\quad F_F = f_F\,(r^*,\ r+\pi.\ Q^*)W_F$$

By definitions (5) and (6), the portfolio shares must add to unity:

$$(5a)\quad m_H + b_H + sf_H = 1$$

$$(6a)\quad m_F + b_F/s + f_F = 1$$

The residents of each country are assumed to be risk averse and accordingly to view home and foreign bonds as imperfect substitutes.1/

1/ Conditions (10)-(15) do not treat the degree of substitution as a variable. In particular, we are implicitly assuming that subjective perceptions of the variance of π either are constant or do not affect desired portfolio shares.

We can substitute behavioral assumptions (10)-(15) into the market clearing conditions (1)-(4) to solve for the variables that clear asset markets. We consider the case in which asset stocks are predetermined and interest rates and exchange rates are variable. By constraints (5a) and (6a), only three of the four market-clearing conditions are independent. Thus, we can solve the system for only three of the four variables s, π, r and r^*. If we view the portfolio-balance framework to determine both home and foreign interest rates -- for example, if we view interest rates to be determined in money markets, independently of exchange rates -- it cannot also determine both the current level of the exchange rate and its expected rate of appreciation. The portfolio-balance framework can be solved for the relative levels of current and expected future exchange rates, but it cannot determine the nominal values of either.

3. The Exchange-Risk Premium

We are interested in solving the portfolio-balance model for π, the rate of appreciation of home currency that must be expected for asset markets to clear. It is convenient to write the solution in the form

$$(16)\quad \pi = r^* - r + \varphi$$

where φ is in general a function of all of the variables (other than π) on which portfolio behavior depends. The interest differential r^*-r can be viewed as the forward premium in favor of home currency [2/]

2/ This equivalence is well established for Eurocurrency differentials; see Aliber, 1973; Dooley, 1974; or Herring and Marston, 1976.

φ is the exchange-risk premium that must be expected, over and above the interest differential or forward premium, for asset holders to be indifferent at the margin between uncovered holdings of home bonds and foreign bonds.[3/] In a risk-neutral world, φ would be identically zero.

To gain insights about φ in a risk averse world we consider the following simplified version of the portfolio balance model.

$$(10a)\quad MB_H = m_H(r,Q)W_H \qquad \text{with } 0 \le m_H \le 1$$

$$(11a)\quad B_H = b_H(\varphi)[W_H - MB_H] \qquad \text{with } b_H' = \partial b_H/\partial\varphi > 0$$

$$(12a)\quad sF_H = (1 - b_H)[W_H - MB_H]$$

$$(13a)\quad MB_F^* = m_F(r^*, Q^*)W_F^* \qquad \text{with } 0 \le m_F \le 1$$

$$(14a)\quad B_F/s = b_F(\varphi)[W_F - MB_F^*] \text{ with } b_F' = \partial b_F/\partial\varphi > 0$$

$$(15a)\quad F_F = (1-b_F)[W_F - MB_F^*]$$

Money holdings depend on domestic interest rates, transactions demand variables and wealths, while the shares of wealth that are not held as money are divided between home and foreign bonds as functions of the differential expected yield, $\varphi = r - r^* + \pi$.

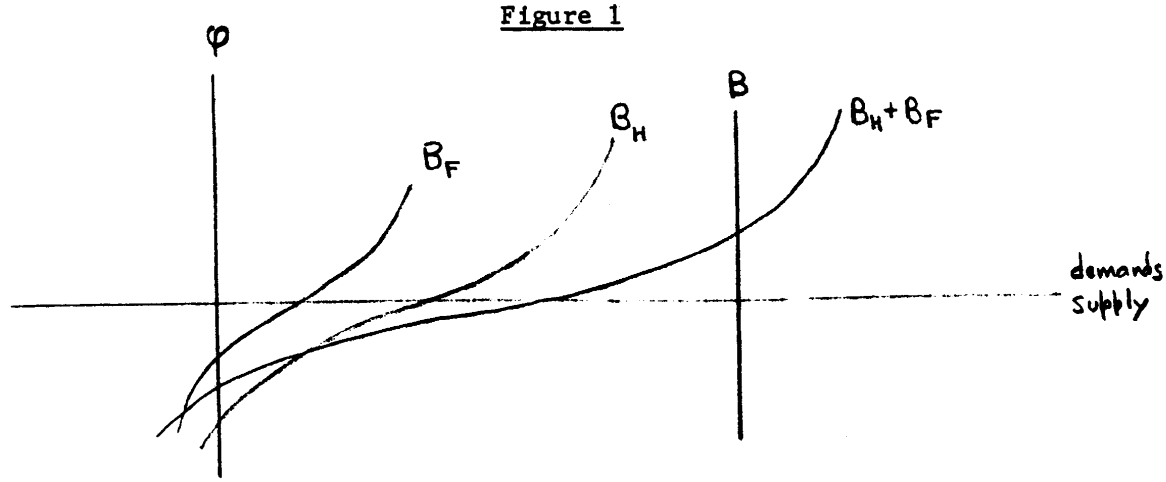
In solving for π we can choose conditions (1), (2) and (4) as our three independent market-clearing conditions. Conditions (1), (4), (10a) and (13a) determine interest rates. Conditions (11a), (14a), (1) and (4) can be substituted into condition (2) to yield.

$$(17)\quad B = b_H(\varphi)[W_H - MB] + b_F(\varphi)[sW_F - sMB^*]$$

3/ See Dooley and Isard (1979) for a distinction between the exchange-risk premium and the political-risk premium. The latter is ignored in this paper.

Condition (17) can then be inverted to solve for φ, the amount by which the rate of appreciation of home currency must be expected to exceed the interest differential if existing stocks of outside assets are to be willingly held uncovered. This condition is pictured in Figure 1: the supply of home bonds B is fixed, independently of the risk premium; and the home and foreign demands for home bonds are positively sloped, since b_H' and b_F' are positive.

Figure 1



An increase in the stock of home bonds shifts the vertical supply curve to the right and raises the risk premium that is necessary to induce home and foreign portfolio managers to increase their combined demand (i.e., to slide along the B_H+B_F curve) by the increment in supply. An increase in either home wealth or foreign wealth shifts either the B_H or the B_F curve to the right, and the associated rightward shift in the B_H+B_F curve leads to a fall in the risk premium. These effects can be expressed formally by taking the total differential of condition (17) and rearranging terms to arrive at

$$(18)\quad d\varphi = \frac{dB - b_H d(W_H - MB) - b_F d(sW_F - sMB^*)}{(W_H - MB)b_H' + s(W_F - MB^*)b_F'}$$

where b_H', b_F' and hence the denominator are positive.

If we look behind the determinants of wealths we can derive an equivalent expression for $d\varphi$ in terms of budget deficits, current account imbalances and intervention flows. Conditions (1), (2), (5) and (7) imply

$$(19)\quad W_H = \int DEF - \int INT + sF_H - B_F$$

while conditions (3), (4), (6) and (8) similarly imply

$$(20)\quad sW_F = s\int DEF^* + s\int INT^* - sF_H + B_F$$

Conditions (7), (19) and (20) can be differentiated and substituted into the numerator of (18). In addition, if we let CAS denote the home country's current-account surplus, which must satisfy the balance-of-payments identity

$$(21)\quad CAS = sdF_H - dB_F - INT$$

condition (18) can be shown to be equivalent to

$$(22)\quad d\varphi = \frac{(1-b_H)\ (DEF-dMB) - b_F s(DEF^*-dMB^*) - (b_H-b_F)CAS - INT - (b_H F_H + b_F F_F)ds}{(W_H-MB)b_H' + s(W_F-MB^*)b_F'}$$

Ceteris paribus, the expected rate of appreciation of home currency must increase (relative to the interest differential) to induce private portfolio managers to increase their holdings of home bonds by DEF-dMB, and must decrease to induce private portfolio managers to increase their holdings of foreign bonds by DEF*-dMB*. A home-country current-account surplus that shifts the residence of private wealth toward the home country will reduce the risk premium on home currency, _ceteris paribus_, if and only if private residents of the home country have a relatively stronger preference for home bonds than private residents of the foreign country -- i.e., if and only if $b_H - b_F > 0$. An intervention purchase of one unit of home bonds has the same effect on the risk premium as simultaneously reducing DEF-dMB and increasing both s(DEF*-dMB*) and CAS by one unit each; this is because an intervention purchase of home bonds changes the currency denomination of INT units of the bonds that are held in private portfolios and is also counterpart -- given the current account flow -- to a capital flow of INT units of wealth from foreign private residents to home private residents. Finally, an appreciation of foreign currency (ds>o) reduces the risk premium on home bonds because it raises the home-currency valuations of both home and foreign wealths relative to the stock of home bonds (recall condition 18).

4. To What Extent Have Observed Exchange-Rate Changes Been Expected?

Having characterized the risk premium by condition (22), we now focus on the extent to which portfolio managers could plausibly have expected the changes in exchange rates that have been observed since March 1973. Condition (16) divides the expected rate of exchange-rate change into two components: an observed interest differential or forward premium and an unobserved risk premium. Using end-of-quarter data for the dollar-Deutschemark exchange rate, Table 1 shows that end-of-quarter forward premiums (measured as Eurocurrency interest differentials) explained only a minor portion of exchange-rate changes during the 1973-78 period. The coefficient of correlation between

Table 1*/

Time Period	next quarter's actual rate of appreciation of the dollar (%/quarter)	forward premium in favor of the dollar (%/quarter)
731	-16.9	-1.8
732	-.6	-.8
733	10.6	-.9
734	-6.6	.2
741	.5	-.0
742	4.1	-.7
743	-9.9	-.6
744	-3.1	-.5
751	.3	-.4
752	11.7	-.4
753	-2.0	-.9
754	-2.2	-.4
761	.9	-.5
762	-4.1	-.4
763	-4.8	-.3
764	1.2	-.0
771	-1.5	-.1
772	-2.0	-.4
773	-10.0	-.7
774	-4.9	-1.1
781	3.5	-1.0
782	-6.8	-1.2
783	-6.5	-1.4
784	2.5	-2.0

*/ See appendix for data sources.

the percentage forward premium and the subsequently observed percentage change in the exchange rate was .19; the root-mean-squared error of predictions based on the forward premium exceeded the mean absolute value of the observed changes; and in 10 of the 24 quarters the forward premium mispredicted the direction of exchange-rate change. Moreover, the average absolute value of the change in the exchange rate was 4.9 per cent per quarter during this period, seven times the average absolute value of the forward premium.

It can also be argued that the expectations embodied in risk premiums have explained only a small portion of the exchange-rate changes that have occurred since 1973. This argument can be tested by regressing changes in the dollar-Deutschemark exchange rate (net of the forward premium) on a general expression for the risk premium that is derived after extending the market-clearing condition (17) to recognize wealth holders in third countries

$$\text{(17a)} \quad B = b_H(\varphi)[W_H - MB] + b_F(\varphi)[sW_F - sMB^*] + b_R(\varphi)W_{ROW}$$

The three terms on the right-hand side of (17a) respectively represent the net dollar bond holdings of private U.S. residents, private German residents and private and official residents of the rest of the world. W_{ROW} is the dollar valuation of the net money and bond holdings of the rest of the world and b_R (φ) is the share of this wealth that is held in the form of dollar-denominated interest-bearing assets.

In order to solve the market-clearing condition approximately for φ we replace each of the portfolio-share functions by a first-order Taylor approximation around some point φ_o

$$\begin{aligned} b_H(\varphi) &= \bar{b}_H + b_H'[\varphi-\varphi_o] \\ (23)\quad b_F(\varphi) &= \bar{b}_F + b_F'[\varphi-\varphi_o] \\ b_R(\varphi) &= \bar{b}_R + b_R'[\varphi-\varphi_o] \end{aligned}$$

Under this substitution the solution to (17a) is

$$(24)\qquad \varphi = \varphi_o + \frac{B - \bar{b}_H[W_H-MB] - \bar{b}_F[sW_F-sMB^*] - \bar{b}_R W_{ROW}}{b_H'[W_H-MB] + b_F'[sW_F-sMB^*] + b_R' W_{ROW}}$$

If all three portfolio-share functions are assumed to exhibit the same elasticity ε with respect to the risk premium at φ_o

$$(25)\qquad \varphi_o b_H'/\bar{b}_H = \varphi_o b_F'/\bar{b}_F = \varphi_o b_R'/\bar{b}_R = \varepsilon$$

and condition (24) can then be expressed as

$$(26)\qquad \varphi = \varphi_o + (\varphi_o/\varepsilon)(B-\bar{B})/\bar{B}$$

where

$$(27)\qquad \bar{B} = \bar{b}_H[W_H-MB] + \bar{b}_F[sW_F-sMB^*] + \bar{b}_R W_{ROW}$$

denotes the aggregate world demand for dollar bonds when the risk premium equals φ_o.

We now turn to regression analysis to determine how accurately the right-hand-side of condition (26) explains observed changes in the dollar-Deutschmark exchange rate (net of the changes predicted by forward premiums) under ordinary least-squares estimates of the parameters φ_o and

φ_0/ε. Because data on the currency compositions of our wealth variables are not available, we focus on a range of constructions of $\bar{B}$ that correspond to a broad range of plausible assumptions about $\bar{b}_H$, $\bar{b}_F$ and $\bar{b}_R$. The observations of exchange rates, forward premiums, asset stocks and wealth variables represent 24 end-of-quarter data points during the 1973-78 period. The value of the dependent variable at the end of quarter t is the observed percentage change in the exchange rate between the end of quarter t and the end of quarter t + 1 minus the 3-month percentage forward premium at the end of quarter t. Data sources are described in the appendix.

Our regression estimates scan the plausibility set of the triplet ($\bar{b}_H$, $\bar{b}_F$, $\bar{b}_R$) using a grid of the 200 combinations of $\bar{b}_H$ = .95, .90, .85, .80, .75; $\bar{b}_F$ = .05, .10, .15, .20, .25; and $\bar{b}_R$ = .1, .2, .3, .4, .5, .6, .7, .8. The Cochrane-Orcutt procedure is used in all cases to correct for first-order serial correlation. Table 2 shows how the goodness-of-fit statistics and coefficient estimates vary as the prespecified portfolio-share parameters are varied one at a time from the point ($\bar{b}_H$, $\bar{b}_F$, $\bar{b}_R$) = (.85, .15, .4). Also tabulated are two cases which generated maximum or minimum values of each of the goodness-of-fit statistics over the entire set of grid points. Each of the goodness-of-fit statistics and the estimates of φ_0 and φ_0/ε change very gradually and smoothly as the three portfolio-share parameters are varied in any direction (either one at a time or in combination), leaving us confident that scanning a finer grid would not have generated cases with substantially better fits.

Table 2: Goodness-of-Fit Statistics and Parameter Estimates[a/]

Prespecified parameters			goodness-of-fit statistics				regression estimates						
$\bar{b}_H$	$\bar{b}_F$	$\bar{b}_R$	RMSE	RHO_1	SIGNS	SCALE	MEAN φ	ϵ	φ_o	φ_o/ϵ	$t\varphi_o$	$t\varphi_o/\epsilon$	RHO_2
.85	.15	.1	1.10	.289	14	.320	-.62	.025	-2.04	-81.5	-1.33	-1.22	-.077
.85	.15	.2	1.09	.308	15	.330	-.62	.029	-2.39	-80.9	-1.44	-1.33	-.075
.85	.15	.3	1.09	.315	16	.324	-.62	.034	-2.56	-73.8	-1.48	-1.37	-.077
.85	.15	.4	1.09	.316	16	.317	-.62	.040	-2.62	-64.9	-1.49	-1.37	-.082
.85	.15	.5	1.09	.313	15	.308	-.62	.046	-2.62	-56.6	-1.48	-1.35	-.087
.85	.15	.6	1.09	.310	14	.299	-.62	.052	-2.59	-49.6	-1.46	-1.32	-.092
.85	.15	.7	1.09	.306	14	.294	-.62	.058	-2.55	-43.8	-1.44	-1.30	-.096
.85	.15	.8	1.09	.313	16	.305	-.62	.064	-2.54	-34.3	-1.48	-1.33	-.109
.85	.05	.4	1.09	.326	16	.310	-.62	.043	-2.71	-62.2	-1.54	-1.42	-.091
.85	.10	.4	1.09	.323	15	.315	-.62	.041	-2.69	-64.5	-1.53	-1.41	-.086
.85	.15	.4	1.09	.316	16	.317	-.62	.040	-2.62	-64.9	-1.49	-1.37	-.082
.85	.20	.4	1.09	.304	16	.317	-.62	.039	-2.48	-63.1	-1.43	-1.31	-.080
.85	.25	.4	1.10	.289	15	.311	-.62	.039	-2.28	-59.0	-1.35	-1.22	-.080
.95	.15	.4	1.13	.163	14	.192	-.62	.067	-0.90	-134.6	-.741	-.308	-.119
.90	.15	.4	1.12	.241	15	.277	-.62	.037	-1.72	-91.8	-1.11	-.918	-.091
.85	.15	.4	1.09	.316	16	.317	-.62	.040	-2.62	-64.9	-1.49	-1.37	-.082
.80	.15	.4	1.08	.341	16	.323	-.62	.049	-2.84	-57.5	-1.62	-1.51	-.095
.75	.15	.4	1.08	.341	17	.332	-.62	.060	-2.72	-45.2	-1.62	-1.50	-.110
.8	.25	.1	1.08	.353	15	.357	-.62	.029	-2.85	-99.6	-1.66	-1.61	-.066
.75	.25	.1	1.06	.393	18	.354	-.62	.037	-3.34	-90.0	-1.89	-1.83	--.080

a/ RMSE is the ratio of the root-mean squared prediction error to mean absolute value of the dependent variable.

RHO_1 is the coefficient of correlation between the estimated risk premium and the dependent variable.

SIGNS is the number of observed changes in the dependent variable (out of 24 total observations) that are correctly predicted in sign.

SCALE is the average absolute value of the estimated risk premium divided by the average absolute value of the dependent variable.

MEANφ is the mean of the estimated risk premium.

$t\varphi_o$ and $t\varphi_o/\epsilon$ are t-statistics associated with the regression estimates φ_o and φ_o/ϵ

RHO_2 is the coefficient of first-order autocorrelation in the residuals from the regressions after the Cochrane-Orcutt correction.

The basic conclusion that we draw from the regression analysis is that the risk premiums associated with our particular representation of the portfolio-balance model explain only a small part of the discrepancies between observed percentage changes in exchange rates and forward premiums. For all of the grid points we examined, the root-mean-squared prediction error exceeds the mean absolute value of the dependent variable; and the highest coefficient of correlation between the estimated risk premiums and subsequent percentage changes in the exchange rate (over and above forward premiums) is .393. The estimated risk premiums correctly predict the direction at most 18 of the 24 observed changes in exchange rates (relative to forward premiums), and their average absolute value is less than two-fifths of the average absolute magnitude of observed percentage changes in exchange rates. In all cases the mean estimated risk premium over the sample period is -.62 per cent per quarter,[4/] an average (over time) expectation that the dollar would depreciate against the mark at a rate roughly 2.5 per cent per year in excess of the forward premium on the mark. The estimated elasticity of portfolio shares with respect to the risk premium is remarkably low in all cases; to the extent that this elasticity may be underestimated, however, the magnitudes of the estimated market-clearing risk premiums may correspondingly be overestimated and thus explain an even smaller portion of observed changes in exchange rates.[5/]

4/ The fact that the mean estimated risk premium is constant (up to two significant digits) in all cases merely reflects the fact that the mean of the fitted values from any regression is generally a close approximation to the mean of the dependent variable, which is identical in all of our cases.

5/ None of these conclusions is very sensitive to the initial value of the rest-of-the-world's wealth, which we are forced to estimate arbitrarily. See the data appendix.

Our failure to explain more than a small part of observed changes in exchange rates can be attributed in part to the limitations of our particular representation of the portfolio-balance model and in part to the fact that observed changes in exchange rates can differ from the changes expected by portfolio managers. In Dooley and Isard (1978) we have relaxed several of the limiting assumptions of the model estimated above,[6/] but the resulting estimates of the risk premium are again capable of explaining only a small part of observed changes in exchange rates. Thus, we have failed to find empirical evidence that portfolio managers have expected the major portion of observed changes in exchange rates. Accordingly, we now consider a framework for providing an ex post explanation of the unexpected component of exchange-rate changes.

5. Appendages to the Portfolio-Balance Framework

The previous sections have focussed on two limitations of the portfolio-balance model of exchange rates. Section 2 has emphasized that

6/ In particular (i) we disaggregated the rest of the world into OPEC and non-OPEC wealth holders in order to pay particular attention to the dramatic growth of OPEC wealth since 1973, and (ii) we assumed that desired portfolio shares reflected the type of risk-averse behavior pictured by the shapes of the B_H and B_F curves in Figure 1, in contrast to the linear curves that are implied by assumptions (23) above. That is, we assumed that successive unit increases in the risk premium lead to positive but successively-smaller increments in the shares of financial portfolios that are allocated to dollar-denominated bonds.

the portfolio-balance framework determines the relative levels of current and expected future exchange rates, but cannot in isolation explain the nominal values of either. Section 4 has illustrated further that empirical estimates of the expected exchange-rate changes that are derived from portfolio-balance models seem capable of explaining only a small part of observed exchange-rate changes, suggesting that the major part of observed exchange-rate changes may have been unexpected.

A natural resolution of these limitations is to append a model of expected future exchange rates to the portfolio-balance framework. Unexpected changes in observed exchange rates can then be viewed to result from whatever unexpected new information leads to revisions in expectations of future exchange rates. To the extent that we believe that observed changes in exchange rates are predominantly unexpected, we should not be impressed by models of expectations that accurately predict exchange rates in sample based on *ex ante* information, but should instead look for the model that can best explain why expectations have proved to be wrong *ex post*.

One method of tying down expected future exchange rates is the rational expectations approach that we have employed in Dooley and Isard (1978). Under this approach the expected level of some particular future exchange rate must be tied down arbitrarily, and other points on the time path of expected future exchange rates can then be related to expected future values of asset stocks, wealths and the other variables that enter the portfolio-balance framework. Unexpected changes in exchange rates are then explained *ex post* in terms of revisions in expectations about asset stocks, wealths and other explanatory variables.

A second method of tying down exchange-rate expectations is to follow the recent literature on exchange-rate dynamics and appeal to the notion of a long-run equilibrium exchange rate. Most of this literature defines the long-run equilibrium rate to be the exchange rate consistent with current-account balance in a stationary state (see Kouri, 1976; Dornbusch, 1976 and 1978; and Dornbusch and Fischer, 1978). More precisely, the long-run equilibrium nominal exchange rate is viewed as the product of an equilibrium real terms of trade and a ratio of long-run price levels in the home and foreign countries.

It is equally true, however, that the nominal value of the exchange rate that is expected to prevail at the end of a short horizon is the expected product of what the real terms of trade and the ratio of home and foreign price levels will be at the end of the horizon. Thus, we can model the nominal value of the expected future exchange rate by modelling the expected product of the real terms of trade and price ratio at any horizon.

It is worth noting that under this view of the world the expected future exchange rate is linked to the future by flow concepts and to the present by notions of stock equilibrium. Looking forward, the expected future exchange rate is explained as the terms of trade that is required to generate expected balance-of-payments flows. But we must also somehow quantify or substitute for the expected future exchange rate in our empirical tests, and the evidence of section 4 warns us to stay away from the perfect foresight assumption. Instead we should measure current expectations of the future spot rate by adjusting the current spot rate for the change predicted by either the forward premium as a first approximation, or preferably the sum of the forward premium plus an estimate of the exchange-risk premium. This recognizes that the expected future spot rate differs from the current spot rate by the expected rate of return that is required for asset-stock equilibrium, either in a risk-neutral world as a first approximation, or preferably with an allowance for risk aversion.

Although empirical work has not yet been formulated correctly for testing how well we can explain the expected future exchange rate in terms of expectations of future balance-of-payments flows, the empirical work of Branson, Halttunen and Masson (1977), Porter (1977, 1979), and Hooper and Morton (1978) suggests that current account imbalances have played an important role in driving exchange rates in recent years. Insofar as exchange-rate changes have been predominantly unexpected, these empirical findings are consistent with the hypothesis that exchange rates have jumped unexpectedly in response to unexpected information about current accounts that in turn has led portfolio managers to revise their expectations about future balance-of-payments flows and future real terms of trade.

This, in our view, is the important link between current accounts and exchange rates. Our empirical investigations suggest that current-account imbalances have small wealth effects on risk premiums or expected future changes in exchange rates, but the revisions in expected future exchange rates that are generated by unexpected current-account imbalances can potentially explain large unexpected changes in observed exchange rates.

Needless to say, unexpected news about current-account imbalances is not the only type of unexpected news that can lead portfolio holders to revise their expectations about future exchange rates. In general, observed exchange rates will shift unexpectedly on the one hand in response to unexpected information about current-account positions, potential-income levels, or whatever leads to revisions in expectations about future real terms of trade, and on the other hand in response to unexpected information about monetary-growth rates or whatever leads to revisions in expectations about future ratios of national price levels. This general point has been noted by Dornbusch (1978) and is developed further by Isard (1979).[7/]

Conclusions for Empirical Research

The above arguments suggest several general conclusions for empirical research. To the extent that exchange-rate movements since 1973 have been predominantly unexpected, we should search for empirical explanations that distinguish between expected and unexpected changes in explanatory variables. In addition, we should combine the unexpected monetary and balance-of-payments factors that underlie exchange-rate movements into a framework that properly integrates a model of asset-

7/ Although it is a tautology that the expected nominal value of the future exchange rate is the expected product of the future real terms of trade and the future price ratio, the usefulness of this identity for explaining the expected future exchange rate depends on how accurately we can model expectations of future real terms of trade and price ratios. To the extent that exchange-rate expectations are affected by "psychological factors" that are not based on an economist's view of fundamentals, expectations about future real terms of trade may not be a stable function of fundamental economic variables.

stock equilibrium with a model of (expected future) balance-of-payments flows. Finally, we should avoid being impressed by models that accurately predict exchange rates in sample based on ex ante information, and instead look for models that can best explain unexpected exchange-rate movements ex post in terms of unexpected real and monetary shocks. We can hope to understand history ex post, but insofar as exchange rates are driven predominantly by unexpected real and monetary shocks, we should recognize that accurate forecasting of future exchange-rate movements requires relatively advanced foresight of real and monetary events.

Data Appendix

Exchange rates are measured on the last Friday of the quarter, taken from Federal Reserve data files. Interest rates are 90-day Eurocurrency rates measured on or near the last day of the quarter, taken from Morgan Guaranty's *World Financial Markets* and the Bank of America's data file. DEF represents the change in the stock of U.S. Federal securities held by the public, as published in the Federal Reserve Board's *Annual Statistical Digest* and monthly *Bulletin*. Forward premiums are constructed to equal Eurocurrency interest differentials. CAS is the U.S. current account surplus published in the *Survey of Current Business*. MB, represented by Federal Reserve data, is adjusted for breaks due to changes in reserve requirements. DEF* represents the German Federal budget deficit, taken from the *Monthly Report* of the Bundesbank, Reihe 4. MB* and the German current account surplus, CAS*, are from the same source.

Private U.S. wealth W_H is constructed as \$400 billion + $\int$(DEF + CAS). Private German wealth W_F is constructed as DM 200 billion + $\int$(DEF* + CAS*). The initial values of W_H and W_F are estimated from end-of-1972 stocks of Federal debt, monetary bases, and net claims on foreigners, as published in the Federal Reserve Board's Annual Statistical Digest and monthly Bulletin and the Monthly Report of the Bundesbank. The dollar value of the wealth of the rest of the world, W_{ROW}, is constructed by subtracting the combined U.S. and German cumulative current-account surpluses from an estimated initial value W^o_{ROW}.

$$W_{ROW} = W^o_{ROW} - \int (CAS + sCAS*)$$

We rely on the market-clearing conditions of the model to provide estimates of W^o_{ROW} under the alternative assumptions (i) that the risk premium was zero at the end of 1976, which was the middle of a long interval of relatively small fluctuations in the dollar-mark rate, or (ii) that on average during the entire sample period the dollar-bond market cleared at a zero risk premium. In case (i) we solve for W_{ROW} (1976Q4) and then W^o_{ROW} by setting $\bar{B}$(1976Q4) = B(1976Q4) in equation (27); in the second case we solve for the W^o_{ROW} that is consistent with the assumption that $\bar{B}$-B has a zero mean over the entire 24-quarter sample. In each case W^o_{ROW} is estimated as a function of the prespecified values of the triplet $(\bar{b}_H, \bar{b}_F, \bar{b}_R)$. Table 2 is based on the former choice of W^o_{ROW}. However the goodness-of-fit statistics and mean (ϕ) estimates are quite insensitive to this choice of W^o_{ROW}, and the estimates of ϵ are lower in case (ii) than in case (i).

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