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MONETARY AND PORTFOLIO-BALANCE MODELS OF EXCHANGE RATE DETERMINATION

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Abstract

"Monetary and Portfolio-Balance Models of Exchange Rate Determination" was a survey of empirical models of the 1970s, published in *Economic Interdependence and Flexible Exchange Rates*, edited by J. Bhandari (M.I.T. Press: Cambridge), in 1983. It is here supplemented with a brief epilogue to update the literature to 1987, including some skeptical observations on recent claims that "random walk" results constitute evidence in favor of an "equilibrium" model of the exchange rate. The paper is to be reprinted, with epilogue, in *International Economic Policies and Their Theoretical Foundations*, edited by Jack Letiche (Academic Press: London), second edition, forthcoming.

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3

Monetary and Portfolio-Balance Models of Exchange Rate Determination

Jeffrey A. Frankel

3.1 The Asset-Market View of Exchange Rates

The theoretical literature on the "asset-market" view of exchange rates has been expanding voluminously in recent years. The popularity of this view may be attributed to the compelling realism in today's world of both its distinguishing theoretical assumption and its distinguishing empirical implication. The theoretical assumption that all asset-market models share is the absence of substantial transactions costs, capital controls, or other impediments to the flow of capital between countries, an assumption which will here be referred to as perfect capital mobility. Thus the exchange rate must adjust instantly to equilibrate the international demand for stocks of national assets—as opposed to adjusting to equilibrate the international demand for flows of national goods as in the more traditional view. The empirical implication is that floating exchange rates will exhibit high variability, variability that exceeds what one might regard as that of their underlying determinants.

But beyond this common point, the asset-market models diverge down a bewildering complexity of routes. Synthesis models and comprehensive surveys are notably lacking. Furthermore, the specific empirical implications of the various theories conflict with observed events, as well as with each other. Econometric attempts to relate the theory to recent data have

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foundered on the dollar depreciation, which, in 1977 and 1978, was too highly correlated with the US current account deficit to be explained readily by the asset-market approach, and which rather seemed to fit the more traditional approach.

This chapter proposes a taxonomy of asset-market models of floating exchange rates, as illustrated in figure 3.1. The most important dichotomy is according to whether or not domestic and foreign bonds are assumed to be perfect substitutes in asset-holders' portfolios. It is important to note the distinction between capital mobility, as the term is used here, and substitutability.[1] Perfect capital mobility between countries means that actual portfolio composition adjusts instantaneously to desired portfolio composition. Assuming no risk of default or future capital controls, perfect capital mobility implies, for example, covered interest parity: The interest rate on a domestic bond is equal to the interest rate on a similar foreign bond plus the forward premium on foreign exchange.[2] Perfect substitutability between domestic and foreign bonds is the much stronger assumption that asset holders are indifferent as to the composition of their bond portfolios as long as the expected rate of return on the two countries' bonds is the same when expressed in any common numeraire. It would imply, for example, uncovered interest parity: The interest rate on a domestic bond is equal to the interest rate on a foreign bond plus the *expected* rate of appreciation of foreign currency.[3]

In one class of asset-market models, domestic and foreign bonds are imperfect substitutes. This is the "portfolio-balance approach" to exchange rates, in which asset holders wish to allocate their portfolios in shares that are well-defined functions of expected rates of return.[4]

In the other class of asset-market models, domestic and foreign bonds are perfect substitutes: Portfolio shares are infinitely sensitive to expected rates of return. Thus uncovered interest parity must hold. But given that it does hold, bond supplies then become irrelevant. The responsibility for determining the exchange rate is shifted onto the money markets. Such models belong to the "monetary approach" to exchange rates,[5] which focuses on the demand for and supply of money.

3.2 The Monetary Approach

3.2.1 The Flexible-Price ("Monetarist") Monetary Model

We have defined the monetary approach by the assumption that not only are there no barriers (such as transaction costs or capital controls) segmenting international capital markets, but domestic and foreign bonds

The one-bond assumption gives us uncovered interest parity:

$$i - i^* = \mathscr{E}(\Delta e) \tag{3}$$

where $\mathscr{E}(\Delta e) \equiv$ the expected depreciation of domestic currency. We combine (2) and (3) and solve for the relative price level:

$$(p - p^*) = (m - m^*) - \phi(y - y^*) + \lambda\mathscr{E}(\Delta e). \tag{4}$$

The one-good assumption gives us purchasing power parity:

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

where $e \equiv$ log of the spot exchange rate, defined as the price of foreign currency in terms of domestic. A consequence is that expected depreciation is equal to the expected inflation differential:

$$\mathscr{E}(\Delta e) = \mathscr{E}(\Delta p) - \mathscr{E}(\Delta p^*). \tag{6}$$

We combine (5), (4), and (6) to obtain the monetarist equation of exchange rate determination:

$$e = (m - m^*) - \phi(y - y^*) + \lambda(\mathscr{E}\,\Delta p - \mathscr{E}\,\Delta p^*). \tag{7}$$

Equation (7) says that the exchange rate, as the relative price of currency, is determined by the supply and demand for money. An increase in the supply of domestic money causes a proportionate depreciation. An increase in domestic income, or a decrease in the expected inflation rate, raises the demand for domestic money and thus causes an appreciation. The equation has been widely estimated econometrically.

Assume that expectations are rational and the system is stable. Assume further that income growth is exogenous (for simplicity equal to zero, so $y - y^* = \bar{y} - \bar{y}^*$), as it usually is in monetarist models. Then the expected inflation rate is equal to the rationally expected monetary growth rate. A benchmark specification of the money supply process is that monetary growth follows a random walk. Then the rationally expected future relative monetary growth rate, and thus the last term in equation (7), is simply the current relative monetary growth rate, which we will represent by $\Pi - \Pi^*$:

$$e = (m - m^*) - \phi(\bar{y} - \bar{y}^*) + \lambda(\Pi - \Pi^*). \tag{8}$$

As an alternative to the benchmark specification, a very restrictive special case occurs when we specify the *level* of the money supply, rather than the change in the money supply, to be a random walk. Then the expected relative rate of monetary growth, $\Pi - \Pi^*$, is zero. The level of expectations adaptively. But then Dornbusch [1976b] offered a model in which expectations are specified rationally. In this model purchasing power parity does hold in the long run, so that a given increase in the money supply raises the exchange rate proportionately as in the monetarist model, but *only* in the long run. In the short run, because prices are sticky, a monetary expansion has the liquidity effects of the Mundell model. The interest rate falls, generating an incipient capital outflow, which causes the currency to depreciate instantaneously *more* than it will in the long run; it depreciates just enough so that the rationally expected rate of future *appreciation* precisely cancels out the interest differential. The phenomenon just described is known as "overshooting" of the spot rate. In its honor, this paper will use the name "overshooting model" for the sticky-price monetary approach to distinguish it from the monetarist (flexible-price monetary approach) model.[10]

The overshooting model retains the money demand function (1) and uncovered interest parity condition (3) essential to the monetary approach. It replaces the instantaneous purchasing power parity condition (5) with a long-run version:

$$\bar{e} = \bar{p} - \bar{p}^*, \tag{9}$$

where bars over variables signify a relation that holds in the long run. Thus the monetarist exchange rate equation (7) is replaced by a long-run version:

$$\bar{e} = (\bar{m} - \bar{m}^*) - \phi(\bar{y} - \bar{y}^*) + \lambda(\overline{\mathscr{E}(\Delta p)} - \overline{\mathscr{E}(\Delta p^*)}). \tag{10}$$

Precisely as we did in the monetarist model, we assume that expectations are rational and the system is stable; for simplicity, income growth is exogenous (or random with mean zero); and as a benchmark specification, monetary growth follows a random walk. It then follows that the relative money supply, and in the long run the relative price level and exchange rate, are all rationally expected to follow paths along which they increase at the current rate of relative monetary growth $\Pi - \Pi^*$. Equation (10) becomes

$$\bar{e} = (m - m^*) - \phi(y - y^*) + \lambda(\Pi - \Pi^*). \tag{11}$$

It remains only to specify expectations. In the short run, when the exchange rate deviates from its equilibrium path, it is expected to close that gap with a speed of adjustment θ. In the long run, when the exchange rate lies on its equilibrium path, it is expected to increase at $\Pi - \Pi^*$:[11]

$$\mathscr{E}(\Delta e) = -\theta(e - \bar{e}) + \Pi - \Pi^*. \tag{12}$$

and Gray and Turnovsky [1979], who distinguish between anticipated and unanticipated monetary disturances.

3.2.3 Empirical Application of the Monetary Approach

Five years or so after exchange rates began to float in 1973, a number of empirical studies of the period appeared.[12] These studies tended generally to support the implications of the monetary approach against those of the traditional flow approach: a coefficient on the relative money supply which is positive or—more precisely—unity, and a coefficient on relative income which is negative and interpretable as the income elasticity of money demand. However, the empirical basis for a choice between the flexible-price and sticky-price variants of the monetary approach was less clear-cut. When the United Kingdom was one of the two countries whose exchange rate was studied, Bilson [1978a] and Hodrick [1978] found the interest differential to show the significant positive coefficient that is implied by the flexible-price model represented by equation (8). But Hodrick [1978] found the German interest rate to show the significant negative effect on the mark/dollar rate that is implied by the sticky-price model represented by equation (15). Estimation of equation (14)—Frankel [1979b]—supported the general monetary model for the mark/dollar rate from July 1974 to February 1978. The coefficient on the short-term interest differential was significantly less than zero, as in the sticky-price model, while the coefficient on the expected long-run inflation differential was significantly greater than zero, as in the flexible-price model.

In 1978 the dollar depreciated sharply. The depreciation prompted increasing political criticism of the noninterventionist policies of the US government and did not come to an end until the November package of increased monetary restraint and direct intervention to support the dollar. Much of the criticism, such as that appearing in repeated *Wall Street Journal* editorials, subscribed to the monetary model. In this view the declining price of dollars was simply due to the rapid increase in the supply of dollars "spewing forth from Federal Reserve printing presses." The behavior of the Bundesbank and the performance of the mark were pointed to as paragons of monetary restraint and its rewards. Unfortunately for this theory, German monetary growth in 1978 was, and has been for some years, actually *higher* than US monetary growth. The reason for the surprisingly high rate of monetary growth in Germany, ironically, was the strength in the value of the mark against the dollar. The Bundesbank resisted this appreciation by buying dollars, without

Table 3.1
Estimation of monetary exchange rate equation (14): dependent variable—log of mark/dollar rate[a]

Sample	Technique	c	gml − usmlb	gy	usy	gi − usi	gΠ	usΠ	R^2	D.W.	$\hat{\rho}$
7401–8012	OLSQ	3.229	−0.835[b]	−0.885[c]	0.289	−0.190	4.717[c]	−3.932[c]	0.93	0.92	
		(0.570)	(0.158)	(0.255)	(0.195)	(0.300)	(0.813)	(0.301)			
	CORC	3.283	−0.770[b]	−0.382	−0.199	−0.698[c]	3.485[c]	−3.444[c]	0.95		0.67
		(1.018)	(0.268)	(0.271)	(0.240)	(0.328)	(1.187)	(0.539)			
7402–8011	FAIR	2.453	−0.503	−0.167	−0.222	−1.465[c]	7.244[c]	−4.877[c]	0.94		0.66
		(1.217)	(0.335)	(0.319)	(0.294)	(0.516)	(2.081)	(0.755)			

a. Definitions: gml − usmlb ≡ log of relative money supply, Germany/U.S. (M1B); gy, usy ≡ log of real income levels (proxied by industrial production), Germany and United States, respectively; gi − usi ≡ nominal interest differential (short-term money market rates, per annum basis): gΠ, usΠ ≡ expected inflation rates (proxied by average CPI inflation over preceding twelve months): OLSQ, ordinary least squares; CORC, iterated Cochrane-Orcutt: FAIR, Fair's method of correcting for possible endogeneity of gi − usi, gΠ, and usΠ (instrumental variables are the German and US ratios of outstanding government bonds to monetary base, and the German and US long-term government bond interest rates) in the presence of serial correlation (current and lagged values of all endogenous and included exogenous variables are added to the list of instruments). (Standard errors are in parentheses.)

b. Significant at the 95% level and of the incorrect sign.

c. Significant at the 95% level and of the correct sign.

3.3.2 The Portfolio-Balance Equation

We retain our assumption that there are no barriers segmenting international capital markets, but we relax the assumption that domestic and foreign bonds are perfect substitutes. Thus investors allocate their bond portfolios between the two countries in proportions that are functions of the expected rates of return.

There are many reasons why two assets can be imperfect substitutes: liquidity, tax treatment, default risk, political risk, and exchange risk. However, at the level of aggregation relevant for most macroeconomic models (see note 2), and under our assumption of perfect international bond markets, the last of these is the most important. We assume that there is only one respect in which domestic and foreign bonds differ: their currency of denomination. Investors, in order to diversify the risk that comes from exchange rate variability, balance their bond portfolios between domestic and foreign bonds in proportions that depend on the expected relative rate of return (or risk premium):

$$B_j/EF_j = \boldsymbol{\beta}_j(i - i^* - \mathscr{E}\,\Delta e). \tag{16}$$

Here B_j is the stock of domestic-denominated bonds held by investor j; F_j, the stock of foreign-denominated bonds held; and E, the exchange rate. $\boldsymbol{\beta}_j$ is a positive-valued function; for concreteness let it be $\exp[\alpha_j + \beta_j (i - i^* - \mathscr{E}\,\Delta e)]$.[18] An increase in the interest differential or a fall in the expected rate of depreciation induces investors to shift their portfolios out of foreign bonds and into domestic bonds. (Note that B_j and F_j can be negative, which will be the case if agent j is a debtor.)

We assume at first that all active participants in the market have the same portfolio preferences, as represented by the function $\boldsymbol{\beta}$. This assumption allows us to add up individual asset demand functions into the aggregate asset demand equation (17):

$$\frac{B}{EF} = \boldsymbol{\beta}(i - i^* - \mathscr{E}\,\Delta e), \tag{17}$$

where

$$B \equiv \sum_{j=1} B_j \qquad \text{and} \qquad F \equiv \sum_{j=1} F_j.$$

B and F are the *net* supplies of bonds (domestically denominated and foreign denominated, respectively) in the market. If one market participant is in debt to another, the asset and liability will cancel out. All that matters are the supplies of *outside* assets in the market.

ones who *wish* to hold domestically denominated assets.[24] The domestic country is assumed to be too small for its assets to be of interest to foreign residents.

One motivation for this assumption is 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 by assuming away the problem of currency of denomination of the capital flow. The 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 inflow: The reduction in the supply of foreign-denominated assets in the market leads to a rise in their price in terms of domestic currency.

Thus as an alternative to (17), we aggregate (16) over all domestic residents only:

$$\frac{B_H}{EF_H} = \beta_H(i - i^* - \mathscr{E}\,\Delta e), \tag{19}$$

where B_H is defined as the sum of all domestic bonds held by home residents (identical to B, under the small-country assumption), F_H is defined as the sum of all foreign bonds held by home residents (equal to the accumulation of past current account surpluses under the small-country assumption), and β_H is the asset-demand function shared by all home residents. Assuming static expectations, the exchange rate equation is

$$e = -\alpha_H - \beta_H(i - i^*) + b - f_H, \tag{20}$$

where $b \equiv \log B$ and $F_H \equiv \log F_H$.

The small-country assumption—the assumption that foreign residents do not hold domestic bonds—is particularly unrealistic if the domestic country is the United States. One alternative is to assume that the *foreign* country is the small country—that domestic residents do not hold foreign bonds. Then (20) is replaced by

$$e = -\alpha_F - \beta_F(i - i^*) + b_F - f, \tag{21}$$

where b_F is defined as the log of domestic bonds held by foreign residents (equal to the accumulation of past foreign current account surpluses under the small-country assumption).[25] Equations (20) and (21) are estimated below.

A realistic portfolio-balance model for large countries must recognize

Table 3.2
Estimation of portfolio-balance equations—log of dollar/mark rate, January 1974–October 1978[a]

Asset preferences	Technique	c	usi − gi	usb	gb	usf	gf	R^2	D.W.	$\hat{\rho}$
1. Uniform worldwide	OLS	−0.485	−0.472	−0.798[b]	+0.916[b]			0.78	0.46	
		(0.215)	(0.579)	(0.122)	(0.116)					
	CORC	+0.733	−0.387	−0.343[b]	+0.431[b]			0.94		0.97
		(0.971)	(0.461)	(0.173)	(0.089)					
2. US bonds held only by US residents	OLS	−6.391	0.240	−0.393[b]		+1.255[b]		0.71	0.29	
		(0.831)	(0.643)	(0.098)		(0.217)				
	CORC	−10.312	−0.248	−0.117		+1.639[b]		0.92		0.95
		(3.202)	(0.525)	(0.171)		(0.524)				
3. German bonds held only by German residents	OLS	−1.530	1.920[b]		+0.224[b]		−0.096	0.61	0.23	
		(0.223)	(0.598)		(0.062)		(0.105)			
	CORC	+0.632	−0.311		+0.154		−0.521[b]	0.94		0.96
		(1.041)	(0.426)		(0.106)		(0.162)			
4. General case	OLS	−5.648	−1.595[c]	−0.607[b]	+0.893[b]	+1.330[b]	−0.295[b]	0.87	0.61	
		(0.881)	(0.491)	(0.105)	(0.102)	(0.226)	(0.096)			
	CORC	−5.620	−0.699	−0.188	+0.271	+1.174[b]	−0.463[b]	0.95		0.94
		(2.497)	(0.431)	(0.106)	(0.147)	(0.423)	(0.149)			

a. Definitions: usi − gi ≡ interest differential (short-term money market rates, per annum basis); usb ≡ log of net supply of dollar bonds to the private sector, calculated as US Treasury debt + cumulative Federal Reserve sales of dollar assets in foreign exchange intervention (inferred from Fed international reserves without valuation changes) − dollar assets held by other central banks − US monetary base; gb ≡ log of net supply of mark bonds to the private sector, calculated as German Treasury debt + cumulative Bundesbank sales of mark assets in foreign exchange intervention (inferred from Bundesbank international reserves without valuation changes) − mark assets held by other central banks − German monetary base; usf ≡ log of net supply of foreign bonds to the US private sector, under the (unrealistic) assumption that dollar assets are held only by US residents and that all capital flows are denominated in marks, calculated as the cumulation of (expressed in marks) the US current account − Federal Reserve purchases of foreign assets in foreign exchange intervention + sales by other central banks of foreign assets for dollars; gf ≡ log of net supply of foreign bonds to the German private sector, under the (unrealistic) assumption that mark assets are held only by German residents and that all capital flows are denominated in dollars, calculated as the cumulation of (expressed in dollars) the German current account − Bundesbank purchases of foreign assets in foreign exchange intervention + sales by other central banks of foreign assets for marks. (Standard errors in parentheses.)

b. Significant at the 95 percent level and of the incorrect sign.

c. Significant at the 95 percent level and of the correct sign.

represented by equation (14), with the portfolio-balance models, as represented by equation (17):

$$B/EF = \beta(i - i^* - \mathscr{E}\,\Delta e). \tag{17}$$

In logarithmic form (17) becomes

$$b - e - f = \alpha + \beta(i - i^* - \mathscr{E}\,\Delta e). \tag{23}$$

We repeat the expectation equation (12):

$$\mathscr{E}(\Delta e) = -\theta(e - \bar{e}) + \Pi - \Pi^*. \tag{12}$$

By adding and subtracting the nomial interest differential, we see that (12) implies that the exchange rate deviates from its long-run value by an amount proportional to the real interest differential and the risk premium:

$$e - \bar{e} = -(1/\theta)[(i - \Pi) - (i^* - \Pi^*)] + (1/\theta)[i - i^* - \mathscr{E}\,\Delta e]. \tag{24}$$

We substitute in equation (11) for the equilibrium exchange rate:

$$e = (m - m^*) - \phi(y - y^*) + \lambda(\Pi - \Pi^*)$$
$$-(1/\theta)[(i - \Pi) - (i^* - \Pi^*)] + (1/\theta)[i - i^* - \mathscr{E}\,\Delta e]. \tag{25}$$

In the monetarist model, purchasing power parity (6) ensured that the real interest differential was zero and uncovered interest parity (3) ensured that the risk premium was zero, so that equation (25) reduced to (8). The sticky-price monetary model relaxed the first condition but maintained the second, so that (25) reduced only to (14).

The synthesis of the monetary and portfolio-balance equations is accomplished simply by relaxing the second condition. We replace uncovered interest parity (3) with the imperfect substitutability condition (23). Now the exchange rate deviates from its equilibrium value not only because sticky goods prices create a real interest differential, but also because imperfect bond substitutability creates a risk premium. We substitute (23) into (25), getting bond supplies into the exchange rate equation in place of the unobservable risk premium:

$$e = (m - m^*) - \phi(y - y^*) + \lambda(\Pi - \Pi^*)$$
$$-(1/\theta)[(i - \Pi) - (i^* - \Pi^*)] + [1/(\theta\beta)][b - e - f - \alpha]. \tag{26}$$

Finally, we solve for e:

Table 3.4
Estimation of synthesis exchange rate Equation (27)—log of dollar/mark rate, January 1974–October 1978[a]

Technique	c	usmlb − gml	usy − gy	usi − gi	usΠ − gΠ	usb − gb	usb − usf	gb − gf	R^2	D.W.	$\hat{\rho}$
1. OLS	0.086	−0.751[b]	0.357	−1.588[c]	2.657[c]	−0.578[b]			0.86	0.56	
	(0.131)	(0.136)	(0.190)	(0.550)	(0.530)	(0.121)					
CORC	−0.260	−0.011	−0.133	−0.396	0.852	−0.398[b]			0.94		0.97
	(0.230)	(0.358)	(0.224)	(0.502)	(0.766)	(0.091)					
2. OLS	−0.520	−0.388	−0.281	0.706	5.559[c]		0.419[c]		0.83	0.84	
	(0.090)	(0.226)	(0.229)	(0.595)	(0.597)		(0.115)				
CORC	−0.674	0.190	−0.355	0.156	0.773		−0.184		0.92		0.98
	(0.256)	(0.416)	(0.255)	(0.570)	(0.928)		(0.194)				
3. OLS	−0.772	−0.687	−0.220	−0.491	4.480[c]			0.284[b]	0.89	0.76	
	(0.086)	(0.116)	(0.167)	(0.420)	(0.371)			(0.041)			
CORC	−1.103	0.050	−0.056	−0.358	1.851[c]			0.313[b]	0.95		0.92
	(0.186)	(0.314)	(0.208)	(0.465)	(0.691)			(0.052)			

a. Definitions: see tables 3.1 and 3.2. (Standard errors are in parentheses.)
b. Significant at the 95 percent level and of the incorrect sign.
c. Significant at the 95 percent level and of the correct sign.

Most such tests take the perfect substitutability component of the joint hypothesis as given and interpret the results as evidence on efficiency. See for example Cornell [1977], Cornell and Dietrich [1979], Frankel [1980], and Frenkel [1977]; the literature is surveyed by Levich [1979] and Kohlhagen [1978]. But a few such tests take the market efficiency component of the joint hypothesis as given and interpret the results as evidence on substitutability. See Stockman [1978], Cumby and Obstfeld [1979], and Frankel [1982b].

4. Some of the many examples are Allen and Kenen [1980]; Black [1973]; Branson [1976]; Branson, Halttunen, and Masson [1977]; Calvo and Rodriguez [1977]; Dooley and Isard [1979]; Dornbusch [1980a]; Flood [1979]; Girton and Henderson [1977]; Girton and Roper [1976]; Kouri [1976a, 1978]; Kouri and deMacedo [1978]; McKinnon [1976]; Porter [1979]; Tobin and deMacedo [1980]; and Rodriguez [1980]. The antecedents are the portfolio-balance approach under fixed exchange rates, as represented by Branson [1968], and the portfolio-balance model in a closed economy, as represented by Tobin [1969].

5. Examples are Frenkel [1976, 1977, 1980], Mussa [1976], Dornbusch [1976a,b], Girton and Roper [1977], Bilson [1978a,b], Hodrick [1978], and Frankel [1979b].

6. Officer [1976] surveys the literature on purchasing power parity. Some recent empirical studies are Isard [1977], Genberg [1978], and Krugman [1978].

7. This distinction between the monetary approach to exchange rates and the more restrictive monetarist model follows the distinction made by Whitman [1975] in the theory of fixed exchange rates between the monetary approach to the balance of payments and the more restrictive "global monetarist" model. (In the past—Frankel [1979b]—I have used the term "Chicago model" for what I am here calling the monetarist model.)

8. Little, if any, published monetarist work asserts this restrictive special case, the monetarists having long ago relaxed the quantity theory of money to study the effect of expected inflation on money demand.

A recent paper by Caves and Feige [1980] that purports to test "the monetary approach to exchange-rate determination" uses as its criterion the unusual proposition that the exchange rate is entirely explainable by the past history of the money supplies. Even the most extreme monetarist proponent of the monetary approach recognizes the importance of fluctuations in real income.

In a further confusion, Caves and Feige claim that proponents of the monetary approach "have failed to recognize that one of the consequences of an efficient foreign exchange market is to eliminate the possibility of directly observing a systematic relationship [between] exchange rates and past supplies of national monies. If the foreign exchange market is efficient, all monetary effects on exchange rates will be contemporaneous" [1980, p. 121]. But as is well known, market efficiency requires not that changes in the spot rate be independent of past variables such as money supplies, but that changes in the spot rate *in excess of the interest differential* (or forward discount) be independent of past variables. In any monetary model except the restrictive special case described above, the past history of the money supply may contain information on changes in the spot rate without violating efficiency. In the benchmark monetarist model, for example, the interest differential

19. If the expected future exchange rate is $\overline{\mathscr{E}e_{+1}}$, then the solution for the current exchange rate, in log form, is

$$e = -\frac{\alpha}{1+\beta} + \frac{1}{1+\beta}(b-f) + \frac{\beta}{1+\beta}(\overline{\mathscr{E}e_{+1}} - (i - i^*)).$$

20. Kouri [1976a] considers the alternatives of static and rational (or perfect foresight) expectations.

21. If government-issued assets are not considered net wealth by the private sector because they imply off-setting liabilities in the form of future taxation, the Ricardian principle, then the possibility arises that the net supply of outside assets to the world market is zero. If there are no outside assets (including real assets) then exchange risk is completely diversifiable. Under these very special circumstances, investors will consider domestic and foreign bonds perfect substitutes in market equilibrium because they can always cover any exchange risk on the forward market *without* paying any risk premium; the perfect substitutability assumption holds despite risk aversion. (The argument is made in Frankel [1979a]. For an empirical test of perfect substitutability based on equation (17) see Frankel [1982b].)

22. Of course many small countries do sometimes issue debt denomination in foreign currencies, and even the United States began to do so with its Carter notes. (The Roosa bonds of the 1960s do not count because they were held by foreign governments rather than citizens.) In empirical work, any such debt must be counted according to its currency of denomination. A bigger problem is central bank behavior. Purchases of domestically denominated assets in foreign exchange intervention (by foreign as well as domestic central banks) must be subtracted from treasury debt to arrive at the proper measure of the net supply of domestically denominated assets to the private market.

23. At the opposite extreme, Solnik [1974] derives asset-demand functions as the outcome of maximization by agents who consume only goods produced in their own countries.

24. Branson [1976], Kouri [1976a], Flood [1979], Branson, Halttunen, and Masson [1977], Porter [1979], Dornbusch and Fischer [1980], and Rodriguez [1980], among others, assume that domestic assets are not held by foreigners.

25. Shafer [1979] assumes that the foreign country is the small country, that is, the foreign accumulated current account surplus is the supply of domestically denominated bonds.

26. A small but growing number of models allow the foreign preference for holding domestic assets to be less than the domestic preference and yet greater than zero. In the category of finance models that derive asset-demand functions from expected-utility maximization are Kouri [1976b] and Kouri and deMacedo [1978] and the appendix to Dornbusch [1980a]. The necessary assumption at first appears to be only that the foreign preference for consuming domestic goods is less than the domestic preference and yet greater than zero. However, Krugman [1981] shows in a continuous-time stochastic model that it is also necessary that the coefficient of relative risk-aversion be greater than one.

In the category of macroeconomic models of portfolio balance which take asset-

SDR. This method of calculation produces results no better than those in table 3.2.
One possible rationale for such an equation is that it is a log-linear approximation to the two-country relation described after equation (22).

31. Hooper and Morton [1982] and Isard [1980] integrate the risk premium into the monetary equation in a very similar fashion. For a more theoretical synthesis of the portfolio-balance model and the sticky-price monetary model, see Henderson [1980].

32. In the monetary approach, foreign exchange intervention affects the exchange rate *only* to the extent that it is nonsterilized, that is, allowed by the central banks to affect the money supplies. Girton and Henderson [1977], p. 169, and Obstfeld [1980a, pp. 142–43], illustrate this point in portfolio-balance models as the special case in which domestic and foreign bonds are perfect substitutes.

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September 2, 1987

MONETARY AND PORTFOLIO-BALANCE MODELS OF EXCHANGE RATE DETERMINATION: EPILOGUE

Much has happened in the few years since the exchange rate models of the 1970s were developed and tested.

The early 1980s saw a wave of pessimism among international economists as to the empirical performance of the existing models, or indeed as to the possibility of ever constructing a model that would perform well. Haache and Townend (1981), Dornbusch (1983), Frankel (1984), and Backus (1984) were typical of the mounting pile of studies showing poor results by standard statistical criteria (incorrectly signed coefficients, insignificant magnitudes, low R^2, etc.). Recent surveys of the empirical models include Levich (1985) and Isard (1986).

Rendering the devastation seemingly complete was a series of papers by Meese and Rogoff (1983a,b; 1986). Meese and Rogoff (1983a) showed that the popular models of Frenkel (1976), Bilson (1978), Dornbusch (1976), Frankel (1979), and Hooper and Morton (1982), were of no use whatsoever in predicting exchange rates outside the sample in which the models had been estimated, that in every case a simple random walk predicted better than the structural models. In one sense, this finding should not have been at all surprising. A typical in-sample regression shows unsensible coefficient estimates (for example, near-zero or negative coefficients on the money supply variables, as in Table 3.1 above, attributable to simultaneity bias). Thus it should not have been surprising that the estimated equations made bad predictions out-of-sample.

But Meese and Rogoff (1983b) then tried an alternative to estimating the equations in-sample. They tried out an entire grid of possible combinations of parameter values, for example, a range of possible values of the semi-elasticity of money demand from -3 to -10. This way, any failure to predict could not be blamed on bad estimates arising from small samples or from simultaneity bias. The results were again discouraging. While many plausible combinations of parameter estimates did give predictions that beat a random walk, many other combinations did not, and the predictive performance was in no case very impressive compared to the total variation in exchange rates. What made these findings particularly humiliating is that the authors had from the beginning given the structural models the benefit of the doubt by using <u>ex post</u> realized values of the explanatory variables (money supply, income, interest rates, etc.), rather than making the models forecast them <u>ex ante</u> before forecasting the exchange rate.

Some economists tried to convert the inability of the structural models to predict from a liability into an asset. Their argument, in its least sophisticated form, was essentially a misunderstanding of the point by Dornbusch (1980) and Frenkel (1981) regarding the importance of "news" in determining exchange rates. The argument was that under the assumptions of high capital mobility and rational expectations, which almost all of the standard theoretical models share, new information regarding the money supply or other macroeconomic variables should have a big effect on the contemporaneous exchange rate, and this effect should not have

The response of international finance economists to their inability to predict or explain exchange rate movements has been to redefine the problem. Many were pre-disposed in any case to move away from the money-demand or portfolio-balance functions that were assumed in the models above, considering them too ad hoc, and instead to derive investor behavior more rigorously from principles of optimization. This is the way the theory has proceeded in the 1980s. A demand for money is created, within the optimization framework, either by assuming that money enters the utility function directly, or by assuming a "cash-in-advance" constraint for transactions. (Examples include Stockman (1980), Lucas (1982) and Svensson (1985). For a survey, see the last section of Obstfeld and Stockman (1985).)

Whatever their motivation, these models have the distinct advantage, from the viewpoint of their evolutionary survival, that they are generally too abstract to be subjected to genuine empirical testing at all. In fact, proponents of these models, in the economists' public relations coup of the decade, have managed to claim as econometric verification their inability to explain changes in the exchange rate. Examples typical of modern macroeconometric logic are Roll (1979) and Stockman (1987), who argue that the very slow tendency of the exchange rate to return to purchasing power parity supports the optimizing ("equilibrium") models against the overshooting ("disequilibrium") models. It is ironic that the earlier incarnation of equilibrium models, those called "flexible-price monetary" above, claimed support from the alleged empirical observation that the speed of adjustment to purchasing power parity was near-infinite, while the current generation of equilibrium models claims support from the alleged empirical observation that the speed of adjustment to purchasing power parity is near-zero. (Meanwhile, proponents of overshooting have consistently claimed a slow, but positive, rate of adjustment.)

The argument goes essentially as follows. According to the optimization models, exchange rate changes are due to shifts in technology and tastes that, though known to all agents in the economy, are not known to the economist. In fact, the economist doesn't even care to commit himself on questions such as whether the trend in domestic productivity is greater or less than in foreign productivity. Thus, as far as he or she is concerned, the exchange rate could as easily move up as down: the theory--which is admitted to be in its infancy--as yet contains no information that could be used to explain specific changes in the real exchange rate. He then goes to "test" his theory "empirically" by seeing whether he can statistically reject the hypothesis that the real exchange rate follows a random walk. Rather than being humbled or embarrassed about his statistical failure to explain any movement in the macroeconomic variable that he is investigating, he proudly proclaims it as confirming his theory, on the grounds that the theory too did not explain any movement in the variable![2]

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[2] This disturbing trend in modern macroeconometrics is an extreme case of the old problem that a statistical failure to reject a null hypothesis does not entitle one to claim an interesting finding. The failure to reject may simply be due to low power in the test, especially if the null hypothesis is a weak one. Traditionally in econometrics, the goal is supposed to be to succeed in statistically rejecting one economically interesting hypothesis in favor of another, i.e., to get results that are "statistically significant at the 95 per cent level," rather than the reverse. What makes the trend away from this principle so remarkable is that the popular null

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