2 An Accounting Framework and Some Issues for Modeling How Exchange Rates Respond to the News

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2.1 Introduction

This paper develops a framework of approximate accounting identities that is used to discuss the limitations of existing empirical models of exchange rate determination. The poor explanatory power of the empirical models of the seventies has now been well documented by Meese and Rogoff (1983 and in this volume) and Backus (1981). In this paper the limitations are first addressed by using the accounting framework to demonstrate that some commonly adopted behavioral assumptions cannot jointly explain a major portion of exchange rate movements. The middle sections of the paper address some issues in modeling how news leads to revisions in the expectational terms that enter the exchange rate accounting framework. The final sections illustrate the issues by drawing inferences and conjectures about the types of news that contributed to the major swings in mark/dollar exchange rates (spot and forward) during 1980–81. The paper stops short of using the accounting framework as a building block for conducting regression tests of specific behavioral assumptions about the expectational terms.

Most empirical models of exchange rate determination seem deficient in "anchoring" the level of the expected path of the (real) exchange rate.

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The observed level of an exchange rate can be explained in terms of expectations about the level of the exchange rate that will prevail at any future date, but the exchange rate level expected at *some* future date must be anchored independently to explain the general level of the expected exchange rate path. This point is clear from interest rate parity conditions under the assumption of risk neutrality, and the argument extends to finite-horizon portfolio balance analysis under the assumption of risk aversion, as emphasized by Dooley and Isard (1981).[1] One feature of the accounting framework is to provide a building block for using the notion of long-run goods market or balance of payments equilibrium to construct a behavioral model that anchors expectations about the long-run real exchange rate.

The accounting framework also describes the general (nonbehavioral) form of the "rope" that links the observed spot and forward exchange rates to the anchored but unobservable level of the expected long-run real exchange rate. Under risk neutrality, the long-term real interest differential is the link between the observed level of the (price-adjusted) spot rate and the expected long-run real spot rate. Equivalently, the expected long-term inflation differential is the link between the observed level of the (price-adjusted) long-term forward rate and the expected long-run real spot rate. For the risk averse case, a long-term exchange risk premium is added to the rope. The general form of the accounting framework can accommodate survey data, macromodel forecasts, autoregressive forecasts, or analytic structural models of inflation expectations. Similarly, it can accommodate either structural models or alternative representations of the risk premium. By characterizing the rope, moreover, the accounting framework suggests that quantitative discussions of exchange rate volatility can benefit from focusing on the length of the rope. In particular, if it is expected to take T years for the real exchange rate to converge to its long-run level, then the percentage change in the spot exchange rate that should be associated with a ceteris paribus shift in the term structure of nominal interest differentials (and hence real interest differentials) is the percentage point change in the compound T-year interest differential, or roughly T times the change in the T-year interest differential as commonly measured in percentage points per annum.

1. By contrast, Rodriguez (1980) develops a reduced-form exchange rate equation for a rational expectations portfolio balance framework in which the coefficient on the exchange rate currently expected to prevail at horizon T converges to zero as T approaches infinity. The speed of convergence can be interpreted to depend inversely on the degree of substitutability between assets denominated in domestic and foreign currencies, and the assumption of imperfect substitutability or risk aversion is a necessary condition for the rational expectations assumption to "eliminate" the expected future exchange rate from the model by pushing the future to infinity (see Dooley and Isard 1982*a*).

The accounting framework is developed in section 2.2 by manipulating the covered interest rate parity condition and some definitional identities. Attention is focused on one resulting form of the exchange rate equation in which the observable long-term forward rate, deflated (or price-adjusted) by the observable ratio of current domestic and foreign price levels, is approximately identical (in logarithmic form) to the sum of three unobservable terms: the expected long-run real exchange rate, the expected long-term inflation differential, and the expected long-term premium for bearing exchange risk. The framework emphasizes the different channels through which news can lead to changes in observed exchange rates (and/or interest rates and/or price levels) by generating revisions in the unobservable expectations terms.

Section 2.3 applies the accounting framework, using a time series of OECD (Organization for Economic Cooperation and Development) inflation expectations (forecasts) for seven industrial countries, to construct measures of the extent that observed changes in exchange rates (between six foreign currencies and the U.S. dollar) can be "explained" under the commonly adopted assumptions of time invariant expectations about the long-term real exchange rate (or purchasing power parity level, PPP) and the risk premium. Under these assumptions the substantial observed variability of spot exchange rates can only be explained by substantial variability in long-term real interest differentials. To the extent that real interest differentials are expected to vanish beyond the long-run horizon, this in turn suggests that exchange rate variability has been associated with variability in the shape of the term structure of nominal interest differentials (relative to the shape of the term structure of expected inflation differentials), and that the traditional use of short-term interest differentials in exchange rate equations may be a poor substitute for a focus on long-term interest differentials.

Section 2.4 provides some empirical evidence on the length of the horizon over which real interest differentials are expected to persist, which is assumed to be roughly the same as the length of time that is expected to elapse before the real exchange rate converges to its long-run value. The evidence compares survey data on long-term inflation expectations, collected several times between early October 1980 and early September 1981, with data on the two- to five-year and five- to ten-year forward nominal interest rates that are implicit in the term structures of yields on dollar- and mark-denominated Eurodeposits and Treasury issues. The evidence supports the assumption that it is expected to take longer than two years, but perhaps less than five years, for the real exchange rate to converge to its long-run value.

Empirical work on exchange rate determination has made only limited progress in modeling the news (see Dornbusch 1980; Frenkel 1981; Isard 1980; Longworth 1980), despite the strong presumption that changes in exchange rates predominantly reflect revisions in expectations in response to the news (see Mussa 1979). Sections 2.5–2.7 focus on some issues in modeling expectations of the long-run real exchange rate, the long-term inflation differential, and the premium for bearing exchange risk. Sections 2.8 and 2.9 illustrate the issues by focusing on the major swings in mark/dollar exchange rates (spot and five-year forward) during 1980–81 and by drawing inferences or conjectures about the extent to which the swings were "explained" by revisions in each of the three expectational terms. Section 2.10 summarizes the main points that emerge from sections 2.5–2.9.

An appendix discusses how the accounting framework can be used as a basis for forecasting.

2.2 An Accounting Framework

The framework developed in this section can be divided into two parts: an anchor and a rope. The anchor is a theory about the expected long-run real exchange rate based on notions of balance of payments equilibrium and consistent with the conditional expectation of long-run purchasing power parity (PPP). The rope that links observed exchange rates to the expected long-run real exchange rate is provided by the interest rate parity framework, as modified to allow for risk premiums.

The rope can be characterized by combining the covered interest rate parity condition,

$$s = f + R_B - R_A, \tag{1}$$

with definitions of the risk premium,

$$\text{risk}^e = s^e - f, \tag{2}$$

and the real exchange rate,

$$s\text{real} = s + p_B - p_A, \tag{3}$$

where s, f, and s^e denote the logarithms of the nominal values of the spot, forward, and expected long-run spot rates, in units of currency A per unit currency B; R_A and R_B denote nominal own rates of interest on assets denominated in currencies A and B, as compounded over horizons that extend until the long run is reached; p_A and p_B denote the logarithms of the price levels in countries A and B; and a superscript e labels the variable as an expectation. Together conditions (1)–(3) imply

$$s = s\text{real}^e + p_A^e - p_B^e - \text{risk}^e + R_B - R_A. \tag{4}$$

It is convenient to express the expected future logarithmic price levels in terms of expected rates of inflation ($\hat{P}_A^e$, $\hat{P}_B^e$) using the approximations

$$p_A^e = p_A + \hat{P}_A^e, \tag{5}$$

$$p_B^e = p_B + \hat{P}_B^e. \tag{6}$$

It is also convenient to introduce traditional definitions for real interest rates:

$$r_A^e = R_A - \hat{P}_A^e, \tag{7}$$

$$r_B^e = R_B - \hat{P}_B^e. \tag{8}$$

Substitution then converts (4) into

$$s = (p_A - p_B) + (r_B^e - r_A^e) + s\text{real}^e - \text{risk}^e. \tag{9}$$

Equivalently, when all observable variables are transposed to the left side,

$$f\text{adj} = \hat{P}_A^e - \hat{P}_B^e + s\text{real}^e - \text{risk}^e, \tag{10}$$

where the manipulation uses condition (1) and defines a price-adjusted forward rate,

$$f\text{adj} = f + p_B - p_A. \tag{11}$$

Condition (11) is analogous to condition (3). It is important to emphasize that the nominal forward rate is adjusted by current price levels rather than forward price levels; in a risk neutral world it would not be an unbiased estimator of the expected future real exchange rate unless the future relative price level was expected to equal the current relative price level.

Much of the discussion below will focus on equation (9), but (10) is more attractive for applying the model empirically since it imposes prior coefficient values on observable price and nominal interest rate levels. Models in which interest rates or money supplies are treated as "causing" the exchange rate, rather than as jointly endogenous variables, have been shown to involve specification bias by Glaessner (1979), Caves and Feige (1980), and Meese and Rogoff (1983), among others.

Equations (9) and (10) apply to any horizon for expectations. In this paper they are discussed in terms of a long-term horizon, based on the view that the most plausible behavioral hypotheses for anchoring an expected future exchange rate are hypotheses about the real exchange rate that is consistent with long-run goods market or balance of payments equilibrium. In empirical analysis based on condition (10), $f$adj is represented by a price-adjusted five-year forward rate after section 2.4 presents evidence suggesting that investors expect it to take longer than two years for the real exchange rate to converge to its long-run equilibrium value.

The right-side terms in condition (10) represent unobservable expectations. The spirit of condition (10) is that news about the factors on which expectations are based leads to unobservable revisions in expectations and observable changes in exchange rates (and/or interest rates and/or price levels). The usefulness of condition (10) is for testing behavior hypotheses about the expectational variables. Insofar as the expectational variables are unobservable, the behavioral tests must be implicit or indirect, and, given that three expectational variables enter the exchange rate equations, the tests are joint or simultaneous tests of three behavioral hypotheses. This paper is oriented toward addressing the inadequacies of commonly adopted behavioral hypotheses and stops short of subjecting alternative hypotheses to regression tests.

2.3 The Inadequacy of Some Common Behavioral Assumptions

In principle, all of the expectational terms on the right side of condition (10) should be treated as variables. Sections 2.5–2.7 will address the issues of modeling the expectational terms. This section uses the accounting framework in conjunction with OECD inflation expectations (forecasts) to argue that under the common assumptions of time invariant expectations about the long-run real exchange rate (PPP level) and the risk premium, only a minor portion of observed changes in exchange rates can be explained by focusing on the relationship between exchange rates and short-term interest differentials—as is commonly done—without explicitly taking account of changes in nominal interest differentials that can be earned on investments beyond a twelve-month horizon.[2]

The empirical exercise is to construct a time series of "residual" changes in the spot exchange rate that cannot be "explained" by observed changes in price levels or twelve-month nominal interest differentials, or by revisions in the twelve-month OECD inflation forecasts. The construction is based on a formula derived by first differencing condition (9), assuming time invariant values of $s\text{real}^e$ and risk^e. Reflecting the limited horizon of the OECD inflation forecasts, the real interest differential is truncated beyond the twelve-month horizon. This leads to

$$(12) \qquad \begin{aligned} \text{resid}_t = {} & s_t - s_{t-1} + (p_A - p_B)_t - (p_A - p_B)_{t-1} \\ & + (R_A - R_B)_{t,t+2} - (R_A - R_B)_{t-1,t+1} \\ & - (\hat{P}_A - \hat{P}_B)^e_{t,t+2} + (\hat{P}_A - \hat{P}_B)^e_{t-1,t+1}, \end{aligned}$$

2. The tradition of focusing on the relationship between exchange rates and short-term interest differentials partly reflects (and has contributed to) the fact that data on short-term interest rates that are comparable across currencies are more readily available than data on comparable long-term interest rates. The tradition also reflects an infatuation, prior to the development of Eurocurrency markets, with examining the relative behavior of spot and short-term forward exchange rates without providing a theory of the absolute level of either.

where t runs through semiannual observations, corresponding to the semiannual dates of the OECD forecasts. Given the assumptions underlying the derivation of condition (12), the proper interpretation is that "resid" measures the sum of the changes in the expected long-run real exchange rate, the expected return for bearing exchange risk, and the real interest differential beyond a twelve-month (i.e., two-period) horizon. The OECD forecasts are published for seven countries (Canada, France, Germany, Italy, Japan, the United Kingdom, and the United States) and thus provide time series of "residual" changes in the exchange rates between the U.S. dollar and six other currencies.

Table 2.1 shows the observed, explained, and residual changes in the logrithms of exchange rates, which correspond to percentage changes in the levels of exchange rates. (The explained changes are computed last as the differences between the observed and residual changes.) For thirty-nine of the forty-eight entries the residual changes are larger than the explained changes. As noted above, the residual changes can be viewed as the error terms that arise from the joint assumptions that the expected long-run real exchange rate and exchange risk premium are time invariant, and that real interest differentials are not expected to persist for longer than twelve months. The residuals are generally too large to attribute to differences between OECD inflation forecasts and "true" measures of inflation expectations. Accordingly, the evidence suggests that at least one of the following propositions must be true. Either (1) expectations about the long-run real exchange rate (or PPP level) vary widely over time, or (2) the exchange risk premium is large and variable, or (3) substantial real interest differentials are frequently expected to persist for longer than twelve months. Thus, to the extent that there is some long-run horizon beyond which real interest differentials are expected to vanish, the assumptions of time invariant expectations of the long-run real exchange rate and the risk premium would suggest that exchange rate variability has been associated with variability in the shape of the term structure of nominal interest differentials (relative to the term structure of expected inflation differentials), which in turn suggests that the traditional use of short-term interest differentials in exchange rate analysis may be a poor substitute for a focus on long-term interest differentials.

2.4 The Persistence of Real Interest Differentials: How Distant Is the Long Run?

Condition (10) provides a useful analytic framework only to the extent that the right-side expectational terms can be modeled, and among these terms, the expected future real exchange rate cannot be easily modeled (or convincingly assumed to be constant) without appealing to the notion

Table 2.1 Explained and Residual Percentage Changes in U.S. Dollar Price of Foreign Currencies[a]

	1977H1	1977H2	1978H1	1978H2	1979H1	1979H2	1980H1	1980H2
Japanese yen								
observed	10.85	11.36	9.58	12.73	−10.95	−12.38	12.60	3.96
explained	−0.55	−2.05	1.58	−0.45	9.26	2.14	9.31	−0.57
residual	11.40	13.41	8.00	13.18	−20.21	−14.52	3.29	4.53
German mark								
observed	3.19	5.39	6.34	8.51	0.68	7.90	−0.89	−8.63
explained	0.69	−0.52	2.24	−0.11	8.46	−0.15	6.07	−0.44
residual	2.50	5.91	4.10	8.62	−9.14	8.05	−6.96	−8.19
French franc								
observed	1.55	1.41	5.54	4.07	−.13	6.52	0.07	−8.02
explained	−1.21	−0.44	−3.34	−3.99	3.12	−3.67	1.84	−4.68
residual	2.76	1.85	8.88	8.06	−3.25	10.19	−1.77	−3.34

Italian lira								
observed	−2.19	0.88	1.97	1.03	−0.28	3.75	−1.45	−8.73
explained	−10.61	−5.50	−2.43	−2.83	−6.41	−2.57	−0.01	9.59
residual	8.42	6.38	4.40	3.86	6.13	6.32	−1.44	−0.86
Canadian dollar								
observed	−2.47	−4.24	−1.03	−4.58	−0.07	−0.15	1.71	−2.75
explained	−0.98	−0.40	0.89	−1.23	1.06	−1.68	0.39	−1.40
residual	−1.49	−3.84	−1.92	−3.35	−1.13	1.53	1.32	−1.35
British pound								
observed	3.36	5.60	0.99	6.06	6.14	4.63	7.19	3.11
explained	−7.85	−7.22	5.52	−1.99	−3.68	−7.06	−3.14	−6.16
residual	11.21	12.82	−4.53	8.05	9.82	11.69	10.33	9.27

[a]The half-year periods correspond to intervals between the published cutoff dates for material included in the semiannual issues of the OECD *Economic Outlook*. These cutoff dates are 1 December 1976, 29 June 1977, 28 November 1977, 12 June 1978, 23 November 1978, 11 June 1979, 23 November 1979, 4 June 1980, and 17 November 1980. Exchange rates and interest differentials (measured as forward premiums) are represented by Federal Reserve data for the cutoff dates. Observed and forecast inflation rates are taken from the OECD *Economic Outlook* and represent percentage changes in GNP or GDP deflators over corresponding half-year periods.

of a long-run steady state. For purposes of empirical analysis it is important to focus on forward exchange rate observations for a maturity that exceeds the expected length of the convergence interval over which the real exchange rate moves to its long-run steady-state value (following an isolated, ceteris paribus shock that disrupts an initial steady-state equilibrium).

For many currencies, adequate historical data on forward exchange rates against the U.S. dollar are not available for maturities longer than one year. For a few currencies, including the mark, two-year and five-year forward rates against the dollar are available (or can be constructed from Eurocurrency deposit rates) on a daily basis. This section argues for using the five-year forward rate in condition (10), based on evidence suggesting that it is expected to take longer than two years, but perhaps less than five years, for the real exchange rate to converge to its long-run level.

The evidence is presented in table 2.2 The first two rows of table 2.2 present time series of survey data on the average annual rates of U.S. inflation expected over the first and second halves of a ten-year horizon. The two series are assumed to provide upper and lower bounds on the U.S. inflation rates that were expected from the end of the second year through the end of the fifth year. The expected two- to five-year U.S. inflation rate declined from early October 1980 through early September 1981, and there is a strong presumption that any revisions in expected long-term German inflation rates were upward,[3] thus implying an even greater decline in the expected inflation differential. By contrast, there were increases over the same period in the differentials between the implicit two- to five-year nominal yields on dollar- and mark-denominated assets, as shown for both Eurocurrency deposits and Treasury issues.[4]

Such evidence indicates that real interest differentials beyond a two-year horizon were not time invariant, which rejects the assumption that real interest differentials were expected to vanish within a two-year horizon. Unless the substantial changes in two- to five-year real interest differentials were offset by equal and opposite changes in the implicit two- to five-year risk premium, the evidence also rejects the assumption that the real exchange rate was expected to converge to its long-run level within a two-year horizon.

3. Forecasts of German inflation. typically extending out over one-to-two-year horizons, were generally revised upward as the mark depreciated against the dollar from October 1980 through mid-August 1981.

4. The trends in the two- to five-year nominal interest differentials, computed for the samples of daily Eurocurrency observations and the twelve observations of Treasury differentials, pass the test of being significantly greater than zero with a high degree of confidence.

Table 2.2 Long-Term Inflation Expectations and Nominal Interest Rates[a]

	Early October 1980	Early January 1981	Early May 1981	Early September 1981	Early November 1981
Expected U.S. inflation[b]					
0–5 years	9.4	8.9	8.4	7.8	7.9
5–10 years	8.3	7.8	7.3	7.4	7.5
2–5 years	8.3–9.4	7.8–8.9	7.3–8.4	7.4–7.8	7.5–7.9
Eurodollar rates[c]					
2 years	12.5–13.1	14–14.5	16.4–16.8	17.5	14.6–14.8
5 years	12.5–13.0	13.9–14	15.9–16.5	16.8–17.0	14.9–15.3
2–5 years	12.5–13.0	13.5–13.9	15.5–16.3	16.3–16.7	15.0–15.6
Euromark rates[c]					
2 years	8.3–8.6	9–9.3	11.1–12	12.5	11
5 years	8.3–8.5	9–9.3	10.4–11	11.9	10.6
2–5 years	8.3–8.5	9–9.3	9.9–10.3	11.5	10.4
Eurodifferential					
2–5 years	4.2–4.6	4.5–5.8	5.7–6.1	4.9–5.1	4.7–5.2
Treasury differential[d]	*Sept./Oct.*	*Jan.*	*Apr./May*	*Aug./Sept.*	*Nov.*
2–5 years	3.7/3.7	3.6	4.2/3.7	4.9/5.6	4.6
5–10 years	3.3/3.1	3.3	3.2/3.0	3.1/3.4	3.4

[a]In percent per annum.

[b]Based on survey data on five- and ten-year U.S. inflation expectations collected about once each quarter since mid-1980 by Richard B. Hoey, vice-president and chief economist at Warburg Paribas/A. G. Becker, 55 Water Street, New York, N.Y. 10041. Data represent simple averages of the expectations of several hundred institutional investment decision makers.

[c]The two- and five-year interest rates represent yields (paid once a year) on fixed-term deposits, as collected daily by the Bank of America and made available through Data Resources, Inc. The two-to-five-year rates represent implicit fixed-term yields computed in the traditional manner.

[d]Based on averages within each month of market yields on U.S. and German Treasury debts, by horizon to maturity, as published in the *Federal Reserve Bulletin* and the *Monthly Report of the Bundesbank* (series 2, table 8c).

The bottom row of table 2.2 presents data on the differentials between the implicit five- to ten-year nominal yields on U.S. and German Treasury issues; data are not available on Eurocurrency yields for maturities longer than five years. The data on Treasury differentials are constructed from term structures of the average yields within each month. Together, the data in the bottom row and the second row from the top might be judged as a weak rejection of the hypothesis that real interest differentials beyond a five-year horizon are time invariant, but the evidence does not suggest substantial variation in the five- to ten-year real interest differential.

To summarize, the evidence in table 2.2 argues against the assumption that real interest differentials are expected to vanish within two years, and thus argues against using a two-year (or shorter maturity) forward rate in applying the accounting framework. Furthermore, the evidence is not strongly critical of using a five-year forward rate, which is the only alternative for which adequate data are available.

2.5 Some Difficulties in Modeling Inflation Expectations

With respect to modeling the expected inflation terms on the right side of condition (10), the traditional use of long-term nominal interest rates as proxy variables for long-term inflation expectations is inadequate, since it implicitly denies any difference between the paths of nominal interest rates and expected inflation rates over the horizon that is required to reach the long run. This point is underscored in section 2.9 below, where it is argued that the sharp appreciation of the dollar in the first half of 1981 was associated with a downward revision in U.S. long-term inflation expectations in response to fiscal policy news; yet long-term dollar interest rates rose in the periods following the arrival of the fiscal policy news.

The apparent responsiveness of inflation expectations to fiscal policy news during 1981 also poses the challenge of modeling inflation expectations in a rational, forward-looking context that spells out the channels through which budget deficits are assumed to influence inflation, whether through the money-supply mechanism or the Phillips curve. As section 2.9 will emphasize, the data on prices, monetary aggregates, activity indicators, and current budget deficits did not jump contemporaneously with the fiscal policy news of 1981. Thus, to capture the revisions in inflation expectations (without relying on survey data) requires not only a forward-looking rational expectations model but also measures of expected future values of "explanatory" variables (in the inflation equation) that are not merely generated from autoregressions.

2.6 The Expected Long-Run Purchasing Power Parity Level

It seems unacceptable to model real exchange rates without relying on some notion of goods market or balance of payments equilibrium. In a world of two countries, each producing a different good, the domestic price levels can be related to nominal money supplies, but an additional balance of payments condition is required to explain the relative price level or real exchange rate. In a Hechsher-Ohlin-Samuelson world in which the two countries each produce the same two goods, the production possibility frontiers and consumer indifference maps, which together determine the domestic relative price levels for each country under autarky, must be supplemented with a balance of trade condition (or perhaps a more broadly defined balance of payments condition) to determine the common relative price level that emerges under international trade.

Many analytic models of exchange rate dynamics assume that the world economy is expected to converge to a steady state in which the real exchange rate is consistent with long-run balance of payments equilibrium; examples include Kouri (1976), Dornbusch (1976), and Calvo and Rodriguez (1977). In principle, the existence of a long-run balance of payments constraint, regardless of its particular form, implies that the expected long-run value of the real exchange rate (if expectations are formed rationally) will vary over time in response to any shocks that generate revisions in expectations about the long-run values of other variables that influence the balance of payments. Thus the expected long-run PPP level should, in principle, be viewed as an endogenous variable.[5]

The empirical literature on exchange rate determination has taken only limited steps to endogenize the expected long-run real exchange rate, most notably those by Hooper and Morton (1982). The argument that the long-run PPP level is in principle a variable, of course, leaves open the question of whether it varies sufficiently to have a major influence on observed exchange rates.

The major shifts in the relative price of oil during the 1970s provides the strongest case for arguing that revisions in expectations about the long-run PPP level may have been empirically important over the past decade. The evidence seems clear (though not scientifically extracted with formal techniques) that news which leads to small changes in the outlook for the relative price of oil has a significant and predictable (ex post) impact—in the hours or days during which the news is digested—on the exchange values of the currencies of countries that are relatively well endowed or relatively poorly endowed with energy resources. A major difficulty that arises, however, in trying to identify such changes in exchange rates with revisions in expectations about the long-run PPP level is that the economic stabilization policies pursued by different countries have responded differently to oil price shocks. In terms of the accounting framework developed in section 2.2, empirical evidence that month-to-month movements in exchange rates reflect significant responses to changes in the expected long-run PPP level must be extracted from a joint test of behavioral specifications for the expected long-run PPP level, the expected long-term inflation differential, and the expected long-term return for bearing exchange risk. Identification is thus compli-

5. It is important to distinguish between conditional and time invariant expectations of PPP, that is, between the relatively weak assumption that the expected PPP level can be shocked by new information and the stronger assumption that the expected level of the long-run real exchange rate is exogenously given.

cated by the fact that behavioral specifications for the latter two expectational factors cannot realistically be abstracted from the perceived or expected responses of stabilization policies to the oil price shocks. In particular, inflation expectations are sensitive to revisions in expectations about monetary growth paths, and the risk premium may be sensitive to revisions in expectations about fiscal budget deficits.

The difficulties of modeling expectations and quantifying the news can hardly be avoided, however, in any serious attempt to resurrect faith in structural exchange rate models. The starting point for modeling the expected long-run real exchange rate is to specify the long-run balance of payments constraint as a relationship between a constant steady-state level of the real exchange rate and a list of other variables. In general, the long-run values of these other variables are not known with certainty but, presumably, can be described in terms of subjective probability distributions. Consistently, the balance of payments constraint can be viewed as anchoring the long-run real exchange rate in terms of a probability distribution that depends, under rationality assumptions, on the joint probability distribution of the other variables. For purposes of estimating an exchange rate model based on condition (10), the expected value of the long-run real exchange rate must be characterized to replace $sreal^e$ with a testable behavioral hypothesis, and the variance of the long-run real exchange rate is an important component of the risk premium, as will be discussed in section 2.7.

Several contributions to the literature have addressed the notion that unexpected shifts in (variables that influence) the current account lead to revisions in expectations about the long-run real exchange rate (see Dooley and Isard 1981; Hooper and Morton 1982; and Mussa 1980). None of these contributions, however, has provided a satisfactory description of the balance of payments constraint. Dooley (1980) has emphasized that the balance of payments is a concept of net debt flows between geographical regions and no longer a good measure of net debt flows denominated in any particular currency unit.[6] This implies that any long-run constraint on the balance of payments owes its existence to the political risk of default rather than to exchange rate risk. In a more recent

6. Many models of exchange rate dynamics assume that current account imbalances are "financed" entirely by assets denominated in one particular currency, which essentially amounts to assuming that residents of one of the two countries only hold assets denominated in their home currency unit; an exception is Henderson and Rogoff (1982). The unrealistic nature of the assumption is not problematic for models such as Mussa (1980) or Dornbusch and Fischer (1980), in which risk neutrality is assumed and the role of wealth is directed through its influence on the excess demand for goods. The assumption does raise problems, however, for interpreting the class of empirical portfolio balance models represented by Branson, Halttunen, and Masson (1977, 1979), Porter (1979), and Martin and Masson (1979), in which measures of portfolio stock variables have been constructed by equating net holdings of foreign currency denominated assets to cumulative current account imbalances (in some cases adjusted for direct investment flows).

paper, Dooley (1982) suggests that market mechanisms impose the long-run balance of payments constraint via increases in political risk premiums, and consequent exchange rate adjustments, which serve to prevent cumulative current account deficits from ever reaching a level at which debt service costs make default optimal for the debtor country.

The general nature of such a bound on cumulative balance of payments flows does not impose a rigid constraint on the balance of payments during any particular year in the long run, unless an assumption is made that constrains all years to be similar once the long run is reached. The latter assumption can be justified, however, not only on grounds of analytic convenience but also by the argument that long-run foresight is too imperfect to place any faith in predictions of how economic variables will fluctuate around their long-run trends. In sum, the assumption of a finite bound on cumulative balance of payments flows together with the steady-state assumption of smooth growth of economic activity after the long run is reached imply an expected balance of payments of zero over any finite interval of the infinite long-run horizon.[7]

With this justification, it is instructive to provide a simple characterization of the steady state. In the two-country context, real output can be imagined to grow at the same constant real rate of interest in each country, with balance of trade. If one of the two countries holds net claims on the other, the stock of these net claims also grows at the real interest rate and thereby amounts to a reinvestment of net interest income from abroad. Thus, net interest payments remain a constant proportion of the output of the debtor country, so the incentive to default never increases. Similarly, the wealth of the creditor country, as measured by portfolio size, increases over time in absolute size but remains stationary relative to income, and real transfers never occur.

Such a framework can be described formally in terms of a balance of payments condition:

$$\Delta \mathrm{NCF}_t = X_t - S\mathrm{REAL}_t M_t + r_t \mathrm{NCF}_t; \tag{13}$$

an import demand function:

$$\log(M_t/Y_t) = a_0 - a_1 r_t - \sum_{k=0}^{K} a_{2.k}\, s\mathrm{real}_{t-k}; \tag{14}$$

and an export function (or foreign import demand function):

$$\log(X_t/Y_t^*) = b_0 - b_1 r_t + \sum_{k=0}^{K} b_{2.k}\, s\,\mathrm{real}_{t-k}, \tag{15}$$

7. It is not being assumed that balance of payments fluctuations are expected to never occur, but rather that the ex ante subjective probability distribution of the balance of payments (over any interval after the long run is reached) has a zero mean.

where M and X denote import and export volumes; Y and Y^* denote domestic and foreign incomes in real terms; NCF denotes net domestic claims on foreigners in real terms; r denotes the domestic and foreign real interest rates (which need not be distinguished for purposes of describing the steady state); and $SREAL$ denotes the level (as distinct from the logarithm) of the real exchange rate. The steady state is characterized by trade balance, by equal domestic and foreign real interest rates $\bar{r}$, and by constant growth at rate $\bar{r}$ of domestic and foreign output, of net claims on foreigners, and hence of domestic and foreign incomes. Thus, conditions (13)–(15) can be solved for the steady-state logarithmic level of the real exchange rate.

$$(16) \qquad \overline{sreal} = \frac{(a_o - b_o) + (b_1 - a_1)\bar{r} + \log(\overline{Y/Y^*})}{a_2 + b_2 - 1},$$

where $a_2 = \Sigma a_{2,k}$, $b_2 = \Sigma b_{2,k}$, and $\overline{Y/Y^*}$ is the constant steady-state ratio of domestic and foreign incomes.

Condition (16) translates directly into a rational model of the expected long-run real exchange rate that appears in the spot and forward rate equations (9) and (10). The expected long-run real exchange rate depends, loosely speaking, on expectations of the long-run ratio of domestic-to-foreign activity levels, on perceived values of the exchange rate elasticities of import and export volumes, and on expectations or perceptions about $\bar{r}$, a_0, b_0, a_1, and b_1. Revisions in $sreal^e$, accordingly, can arise from revisions in expectations about the long-run values of Y/Y^* or r, or from revisions in perceptions about the values of the exchange rate elasticities or the other parameters. It is worth repeating that while $sreal^e$ is the mean of a subjective probability distribution, the range of the distribution may be wide and the variance high. The notion of long-run balance of payments equilibrium need not anchor the long-run real exchange rate at a point.

Condition (16) stops short of modeling how expectations about $\overline{Y/Y^*}$ and $\bar{r}$ and perceptions about the parameter values are formed and/or revised. But together with the Marshall-Lerner condition (i.e., the assumption that its denominator is positive) it provides a place for a number of phenomena that are viewed as influencing exchange rates: (1) An oil discovery in country A can be viewed—within the simple structure of trade equations (14) and (15)—as raising the perceived long-run value of b_0 or lowering the perceived value of a_0, thereby appreciating currency A. (2) A rise in the relative price of oil can be viewed as raising b_0 for oil exporting countries and as raising a_0 for oil importing countries, with well-recognized effects on exchange rates. (3) Larger-than-expected trade deficits (surpluses) in the short run that persist and do not merely reflect unexpected changes in the explanatory variables that enter trade equations can lead to revised perceptions of parameter values, to associated revisions in expectations about the long-run real exchange rate, and thereby to observed currency depreciation (appreciation). (4) Surprises about the extent to which a country's trade balance is improving (deteriorating) following currency depreciation (appreciation) may lead to upward revisions in perceptions of the elasticity parameters a_2 and b_2, to an associated revision in expectations about the long-run real value of the currency, and thereby to a change in observed exchange rates. (5) To the extent that a surprisingly sharp domestic recession (boom) is viewed as permanently lowering (raising) the level of domestic output relative to foreign output, the domestic currency should appreciate (depreciate); accordingly, activity shocks that are not expected to be completely offset can generate a positive correlation between shifts in the trade balance toward surplus (deficit) and currency appreciation (depreciation). (6) To the extent that policy actions (e.g., tax measures or other "supply-side" shocks) raise the domestic share of world markets at any given real exchange rate, the a_0 and b_0 parameters will shift, with $a_0 - b_0$ declining and thereby generating an appreciation of the expected long-run real value of domestic currency (i.e., a decline in $\overline{sreal}^e$).

2.7 The Expected Premium for Bearing Exchange Risk

By its definition in condition (2), the expected long-term premium for bearing exchange risk is the difference between the expected long-run nominal spot rate and the observed long-term nominal forward rate. A nonzero risk premium owes its existence to three factors: (i) a nonzero probability, and hence some risk, that the future spot exchange rate may differ from its expected level, (ii) private investors' aversion to that risk, and (iii) a difference between the currency composition of public debts that are forced (at market-clearing prices) into the portfolios of private investors (as an aggregate) and the currency composition of the aggregate portfolio that would minimize the risk assumed by private investors (see Dornbusch 1982). Without any one of these factors the risk premium would vanish.

Attempts to assess the empirical importance of the risk premium can be classified into three approaches. Dooley and Shafer (1976), Hansen and Hodrick (1980 and in this volume), Cumby and Obstfeld (1981), and Meese and Singleton (1982), among others, have employed a variety of methods to examine the time series properties of spot exchange rates and forward exchange rates (or interest differentials); such studies have generally concluded that the assumption of market efficiency implies that the risk premium is significantly greater than zero, although not necessarily very large. As a second approach, Dooley and Isard (1981) and Frankel (1981, 1982) have tested the significance of simple structural models of the ex ante risk premium in explaining the ex post change in the exchange rate (over and above the forward premium); these studies have found weak evidence of a small risk premium. As a third approach, Krugman (1981) has derived a structural form for the risk premium and inserted "reasonable" values of the structural parameters to calculate the extent to which the risk premium might be judged to change in association with given changes in asset stocks and wealth variables. Krugman also finds no reason to believe that the risk premium is large.

The Krugman-type exercise is repeated here with "more reasonable" parameter values. The purpose is to challenge Krugman's impression of the order of magnitude of the risk premium and to suggest, in particular, that changes in the risk premium may have accounted for a substantial portion of the swings in the mark/dollar rate during 1981, which strongly coincided (as documented in section 2.9 below) with shifts in the outlook for U.S. budget deficits. Given the limited objective of being suggestive, the formulation of the risk premium has been simplified in two important ways: by ignoring differences in the portfolio preferences of U.S. and foreign residents (i.e., wealth effects), and by assuming that both U.S. and foreign residents optimize with respect to the dollar value of their terminal wealths. Under these simplifications, the five-year risk premium can be derived from a utility-maximizing framework as the product of the coefficient of risk aversion (u), the perceived variance (v) of the ratio of the five-year future spot rate to the current five-year forward rate, and the share (Q) of dollar-denominated public debt in global private holdings of dollar- and mark-denominated public debts (see Dornbusch 1982; Isard 1980; or Krugman 1981):

$$\text{risk}^e = u \cdot v \cdot Q \,. \tag{17}$$

As the optimization problem is generally formulated, the asset-share variable is a current, beginning-of-period concept. A more realistic formulation for a rational expectations environment would provide an explicit role for expectations or subjective probability distributions about the future paths of asset stocks and wealth variables. In the absence of such a formulation, a third major simplification in what follows is to interpret Q, heroically, as an end-of-period concept.

With this basis and interpretation of condition (17), a Krugman-type calculation can be generated under the suggestions that $u = 4$, that $v = 1/4$, and that Q changed by at least 2 percent during the early months of the Reagan Administration. These numbers suggest that changes in the risk premium "explained" at least a 2 percent appreciation of the dollar against the mark during the first half of 1981. The value $u = 4$ is taken from Grossman and Shiller (1981), who place it within the range of estimates that have been published in the literature, and who argue as well that a value of at least 4 is suggested by an empirical application of their model of stock price variability. The value $v = 1/4$ reflects the assumption that the subjective probability distribution of the five-year future spot rate is normal, with a mean value of two marks per dollar (roughly equal to the five-year forward rate), and with 67 percent of the probability attached to the range between one and three marks per dollar; hence the variance of the five-year future spot rate is 1, and the variance of the ratio of the future spot rate to the forward rate is $1/4$. Finally, the alleged change of at least 2 percent in Q is based on the perception that the fiscal policy proposals in the early months of the Reagan Administration, and their acceptance by a surprising margin of victory in a House of Representatives vote on May 7, reduced the cumulative outlook for U.S. budget deficits over a five-year horizon by at least \$100 billion. Given an initial value of $Q = .8$, based on the initial trillion dollar stock of U.S. public debt and the one-quarter trillion dollar-equivalent stock of German public debt, a change of at least \$100 billion, or 10 percent, in the expected stock of U.S. public debt suggests a change of at least 2 percent in the expected ratio of U.S. to U.S. plus German public debts.

To lend further support to the suggestion of substantial changes in the risk premium, section 2.9 will present graphical evidence that movements in mark/dollar exchange rates during 1981 coincided strongly with fiscal policy news. As will also be detailed, survey data on long-term U.S. inflation expectations suggest that revisions in inflation expectations can only explain about half of the apparent responsiveness of the exchange rate to fiscal policy news. Such arithmetic raises the possibility that the five-year risk premium changed by as much as 5–10 percentage points during the early part of 1981—even more than suggested by the calculations based on the oversimplified condition (17)—or by as much as 1–2 percentage points when measured in per annum units. On a priori grounds, it does not seem implausible that rational investors may have been so uncertain and risk averse to have required an additional expected long-term yield of 1–2 percent per annum on their mark-denominated portfolio holdings, given the rosy expectations created early in the Reagan Administration.[8] Unfortunately, there seems to be no basis for a refined judgment of whether the risk premium could have changed so much without the analytical equipment of a forward-looking formulation of the risk premium in terms of expected future asset stocks and wealth variables, along with a better empirical assessment of parameter values

8. Dooley and Shafer (1976) have computed average profit rates, over and above opportunity cost and transactions charges, that investors could have earned during recent years by using filter rules to operate speculative positions in the foreign exchange markets. These ex post measures lend support to the notion of risk premiums on the order of several percentage points per annum.

and the extent to which expectations of future asset stocks and wealth variables have shifted.[9]

2.8 Explaining the Volatility of the Dollar during Spring 1980

This section and the next focus on the behavior of spot and forward mark/dollar exchange rates during 1980–81, using the accounting framework as a basis for drawing inferences and conjectures about the response of these exchange rates to major elements of the news. In this section the focus is on the extent to which the rise and fall of the dollar during January–May 1980 can be "explained" by changes in the compounded long-term real interest differential. The assessment involves a straightforward analysis of how much of the swing can be "explained" by changes in the compounded long-term nominal interest differential and an informal analysis of whether the magnitude and timing of changes in the residual can be plausibly attributed to revisions in expectations about the long-term inflation differential. The obverse of this question is whether it is plausible that the risk premium and the expected long-run value of the real exchange rate remained constant throughout the period.

Figure 2.1 shows the behavior of the mark value of the dollar from October 1979 through early December 1981, both on a spot basis and for three-month and five-year forward maturities. It is interesting to note that the correlation between the spot and five-year forward rate is high, though not as near perfect as the correlation between the spot and three-month forward rates.

Given the empirical evidence presented in section 2.4 and the fact that five years is the longest maturity for which adequate data are available on forward rates (or on differentials between interest rates on Eurodollar and Euromark deposits), the analysis for the most part adopts the assumption that the long run is expected to be reached within five years. This essentially amounts to assuming that real interest differentials are expected to vanish in less than five years—the equivalent (under risk neutrality) of the assumption that the real exchange rate is expected to converge to its long-run level in less than five years. Some consideration is also given to the assumptions that the long run is expected to be reached within one year or within two years (i.e., that real interest differentials are not expected to persist beyond one or two years). The data represent time series of Wednesday observations. An alternative focus on weekly average observations conveys virtually the same impressions.

Figure 2.2 shows cumulative percentage changes since the beginning of

9. Dooley and Isard (1982*b*) have estimated a rational expectations portfolio balance model of the exchange rate which explicitly incorporates the influence of the expected future paths of asset stocks and wealth variables on the risk premium, but which uses autoregressive representations of the expected future stocks of assets and wealth.

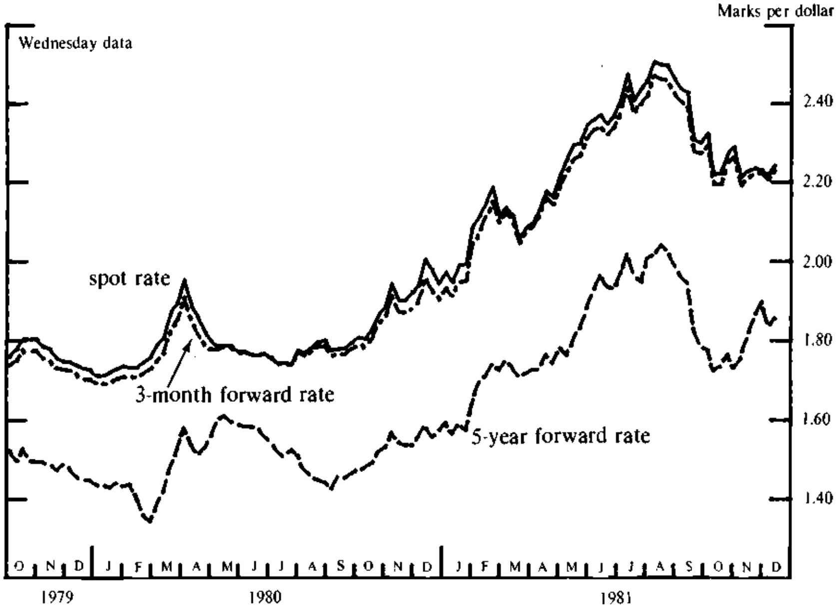
Marks per dollar
Wednesday data
2.40
2.20
2.00
1.80
1.60
1.40
spot rate
3-month forward rate
5-year forward rate
O N D J F M A M J J A S O N D J F M A M J J A S O N D
1979
1980
1981

Fig. 2.1

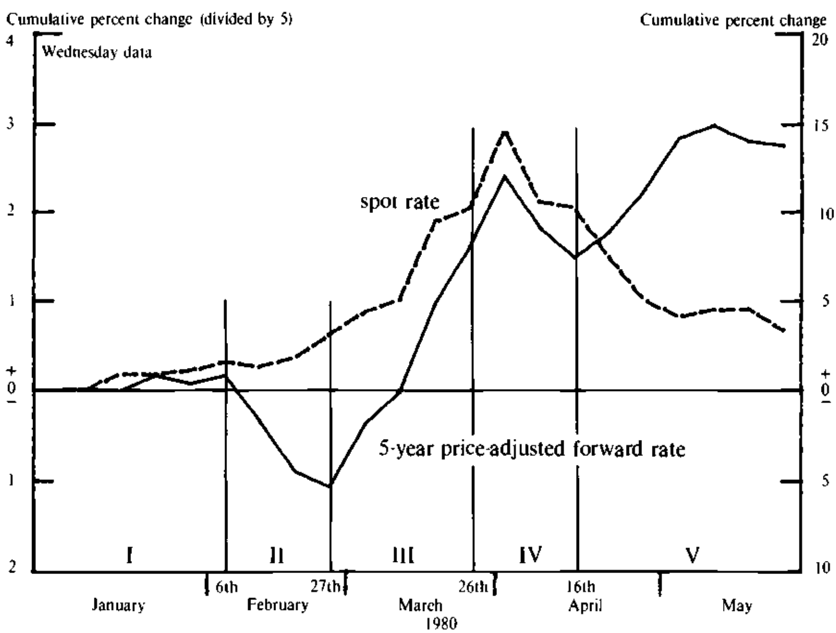
Cumulative percent change (divided by 5)
Cumulative percent change
Wednesday data
4
3
2
1
+
0
−
1
2
20
15
10
5
+
0
−
5
10
spot rate
5-year price-adjusted forward rate
I
II
III
IV
V
6th
27th
26th
16th
January
February
March
April
May
1980

Fig. 2.2

1980 in the spot rate and the five-year price-adjusted forward rate.[10] Based on condition (10), in the absence of revisions in expectations about the long-run real exchange rate or changes in the risk premium, movements in the five-year price-adjusted forward rate could be interpreted entirely as revisions in expectations about the differential between German and U.S. inflation rates over a five-year horizon.

To judge the maintained hypothesis that movements in the price-adjusted forward rate can be interpreted as revisions in the expected five-year inflation differential (measured per annum on the left scale in figure 2.2 and per five years on the right scale), the data period is divided into five subperiods. During January there was little movement in the two exchange rates. Subperiod II in figure 2.2 began right after the U.S. budget proposals and the Economic Report of the President were released on January 28 and 30, respectively. The subsequent three weeks brought an upward revision in the expected pace of U.S. inflation: by February 6 it had been discovered that the U.S. budget had substantially underestimated the costs of military outlays for fuel; by February 13 new data showed a strong acceleration in U.S. retail sales during January; by February 20 it had been revealed that U.S. wholesale prices had jumped 1.6 percent during January, a sharp acceleration from December; and on February 22 it was reported that U.S. consumer prices had also accelerated sharply in January. Consistently, the dollar depreciated forward over this subperiod, while downward pressures on the spot value of the dollar were offset by a 1½ percentage point increase in the Eurodollar rate relative to the Euromark rate (per annum).

The news of the January rise in U.S. consumer prices ushered in subperiod III in figure 2.2, as financial markets, according to Reuters, reacted "perversely." The consumer price data strengthened expectations of further anti-inflationary policy measures by the U.S. authorities—expectations that were confirmed by the new budget proposals and monetary and credit actions of March 14. Under the maintained hypothesis, the path of the forward rate would imply that the expected U.S. inflation rate, looking out over a five-year horizon, was revised downward over the course of a month by roughly 2½ percentage points per

10. The five-year forward rate is constructed from interest rates on fixed-term, five-year Eurodollar and Euromark deposits, as collected by the Bank of America and made available through Data Resources Inc. Similar interest rate data are available for five-year Eurodeposits in Dutch guilders, Swiss francs, and French francs. The data have two notable limitations. Markets are thin and on some days deposits are not transacted in each currency. In addition, to the extent that the term structures of dollar and mark interest rates are not flat, the data allow only an approximate construction of five-year forward rates, since interest on the five-year deposits is paid at the end of each year. The price adjustment is achieved by assuming that the change in relative price levels over the five-month period occurred at a constant rate (i.e., the price-adjusted forward rate is the forward rate adjusted for the trend in relative price levels, which was taken to be 7½ percent at an annual rate during the first half of 1980).

annum relative to the expected German inflation rate. The revision in inflation expectations was associated with an increase in real long-term dollar interest rates relative to real long-term mark interest rates and led to a strong appreciation of the spot dollar, even though nominal Euromark rates moved up somewhat faster than Eurodollar rates.

Subperiod IV in figure 2.2 began on March 27 with the decision, announced following the fortnightly meeting of the Bundesbank Central Council, that German credit policies would be left unchanged. The apparent upward revision in expectations about the pace of German inflation, relative to U.S. inflation, was supported on April 2 by the report of a full half-percentage point drop in the German unemployment rate during March. Additional support may have been provided by major new banking legislation, passed by the U.S. Congress on March 28, which strengthened the Federal Reserve's control over money and credit growth. During the first four trading days of April, spanning the long Easter weekend, the spot and forward values of the dollar wavered around levels 4 percent higher than where they had closed on March 26. Then they dropped the full 4 percent on April 9. Included in the news that may have led to the dollar's drop was the announcement late on April 8 that the German government had arranged to borrow one billion marks from the U.S. government, the release of data on April 9 indicating no change in German industrial production during February, and the prediction by a respected U.S. banker that dollar interest rates would soon begin to tumble. The first and second items suggested less pressure on the German money supply, given the authorities' reluctance to push interest rates higher, while the third item may have provided a revised impression of how contractionary a stance the Federal Reserve had taken.

Subperiod V started on April 16, the day that U.S. prime rates began the rapid descent from their peak. By the end of May, the five-year Eurodollar rate had fallen by more than 4 percentage points per annum, and by roughly 2½ percentage points relative to the five-year Euromark rate. Meanwhile the expected pace of U.S. inflation was revised downward, particularly in response to the May 2 announcement that U.S. unemployment had skyrocketed from 6.2 percent in March to 7.0 percent in April. Consistently, the five-year forward dollar appreciated sharply in response to the May 2 announcement.

The story provides reasonable explanations for the direction of swings in spot and forward rates under the maintained hypothesis. Are the magnitudes of the swings in the five-year forward rate also plausible estimates of revisions in inflation expectations? It is plausible that the inflation differential expected over a five-year horizon could have first increased (during subperiod II) by about 1 percentage point per annum and then declined (through the end of May) to roughly 3 percentage points per annum less than what had been expected during January?

Changes of such magnitude in the relative U.S. and German inflation outlooks were discussed by the financial press, although without explicitly looking much further into the future than the end of 1981. A convincing answer seems precluded by the absence of published inflation forecasts that extend as far as five years into the future and are revised frequently enough to provide an interesting time series.[11]

A major empirical point about the spring 1980 example is that changes in real interest differentials, when compounded or integrated over a long-term horizon, can potentially explain a substantial degree of exchange rate volatility.[12] The above analysis has focused on the revisions in expected inflation differentials that are implied by the joint hypothesis that spring 1980 was explained entirely by changes in real interest differentials and that real interest differentials were not expected to persist beyond a five-year horizon. For comparison, and despite the evidence to the contrary presented in section 2.4, it is interesting to consider what the joint hypothesis would imply if real interest differentials were only expected to persist for a year or two. Accordingly, in table 2.3 the third and second columns from the right have been constructed to represent the revisions in expected inflation differentials that are implied when the joint hypothesis is modified by assuming that real interest differentials were not expected to persist beyond horizons, alternatively, of one year and two years. The joint hypothesis seems implausible under either of these cases.

The issue of the horizon length over which real interest differentials are expected to persist is an important question for assessing the extent to which exchange rate volatility can be associated with changes in real interest differentials. Section 2.4 has begun to address the question empirically, but more extensive evidence and better tests are desirable, in particular to explore the question of whether real interest differentials beyond a five-year horizon are substantial. Economists who have been inclined to think that real interest differentials are generally expected to vanish within a year or two must confront the reality of five- to 10-year real dollar interest rates, as traditionally defined, rising well above 7 percent per annum in the first eight months of 1981 when measured with survey data on long-term inflation expectations. In the absence of a satisfactory explanation of the high level of long-term real interest rates,

11. Two sets of survey data are available on long-term U.S. inflation expectations. During each February, beginning in 1975, the Michigan Survey of Consumer Attitudes has sampled answers to the question: "About what percent per year do you think prices will be (up/down) on the average during the next five to ten years?" Beginning in 1980 the question has also been asked during August. A second set of data has been collected quarterly by Richard Hoey beginning in mid-1980; see table 2.2. note b.

12. With the exception of Fellner (1979). few models of exchange rate determination have focused explicitly on the arithmetic of compounding interest rates and expected inflation rates over a long-term horizon.

it is difficult to conceive of the mechanism that might have been expected to eliminate real interest differentials within a one- or two-year horizon.

2.9 The Mark/Dollar Rate from June 1980 through December 1981

This section uses the accounting framework to discuss plausible explanations for the major swings in the mark/dollar rate between June 1980 and early December 1981. Figure 2.3 illustrates that the swings in the five-year forward rate were concentrated during six intervals: (i) mid-June to early September 1980; (ii) early September to early November 1980; (iii) late January to mid-February 1981; (iv) late April to early June 1981; (v) mid-August through Setember 1981; and (vi) the first half of November 1981. Percentage changes in the five-year forward rate during those intervals—roughly corresponding by construction to percentage changes in the spot rate after adjustment for associated changes in the five-year nominal interest differential—can be associated either with revisions in expectations about the ratio of German and U.S. five-year inflation factors, or with revisions in expectations (explicit or implicit) about the long-run real exchange rate, or with changes in the risk premium.[13]

With respect to the 10 percent depreciation of the forward dollar from mid-June through early September 1980, it seems clear in retrospect that the major economic surprises during that period led to upward revisions in expectations about U.S. inflation. Economists may never agree on how to specify a structural model of inflation, but few structural models would fail to find a role for either the unexpectedly sudden bottoming out of the recession, the rapid rate of monetary growth, or the dismantling of credit controls. Whether U.S. five-year inflation expectations increased by 2 percentage points per annum, thereby "explaining" the entire depreciation, is subject to dispute. It does seem clear, however, that expectations about the duration of the recession began to be revised no sooner than early June but certainly by early July, consistent with the timing of the downturn in the forward rate. More specifically, the announcements on May 30 of a 4.8 percent April decline in the leading indicators, and on June 6 of a jump in May unemployment from 7.0 to 7.8 percent, suggested a continuing sharp downtrend in activity; while the announcements on July 3 of a 7.7 percent June unemployment rate and on July 10 of a 1.4 percent rise in June retail sales were reported (e.g., by *Business Week*) to have taken almost all economic forecasters by surprise. A final point that seems clear about this period is that news about

13. This statement ignores covariance in implicitly viewing the nominal forward rate as the product of the expected ratio of price levels (or inflation factors), the expected real value of the future spot rate, and a risk factor. The five-year forward rate is not adjusted for relative price trend, which was quantitatively minor during the period.

Table 2.3 **Changes in Spot, Forward, and Price-Adjusted Forward Rates: January–May 1980**

Date	Percent Change since 2 Jan. 1980				Adjustment for Relative Price Trend[b]	Percent Change since 2 Jan. 1980 per Year to Maturity		
		Forward Rates[a]				Price-Adjusted Forward Rates[c]		
	Spot Rate	1 Year	2 Year	5 Year		1 Year	2 Year	5 Year
January 9	0	−0.05	0.36	−0.05	0.14	0.09	0.25	0.02
16	0.94	0.98	1.28	−0.36	0.29	1.27	0.79	−0.01
23	0.92	0.68	1.12	0.43	0.43	1.11	0.78	0.17
30	1.14	0.72	0.64	−0.23	0.58	1.30	0.61	0.07
February 6	1.57	1.07	0.68	0.12	0.72	1.79	0.70	0.17
13	1.34	0.42	−0.58	−2.53	0.86	1.28	0.14	−0.33
20	1.84	0.55	−1.22	−5.48	1.01	1.56	−0.11	−0.89
27	3.11	1.71	0.46	−6.49	1.15	2.86	0.80	−1.07

March 5	4.39	2.39	1.20	−3.13	1.30	3.69	1.25	−0.37
12	5.09	3.04	2.16	−1.56	1.44	4.48	1.80	−0.02
19	9.42	7.22	7.14	3.20	1.56	8.80	4.36	0.96
26	10.25	8.07	7.60	6.33	1.73	9.80	4.67	1.61
April 2	14.69	13.21	12.62	10.20	1.87	15.08	7.25	2.41
9	10.59	8.86	8.20	7.15	2.02	10.88	5.11	1.83
16	10.28	8.65	8.02	5.32	2.16	10.81	5.09	1.49
23	7.44	6.73	6.26	6.56	2.31	9.04	4.29	1.77
30	5.07	5.71	5.02	8.79	2.45	8.16	3.74	2.25
May 7	4.11	6.84	6.64	11.62	2.59	9.43	4.62	2.84
14	4.49	7.04	7.54	12.15	2.74	9,78	5.14	2.98
21	4.56	7.26	7.80	11.13	2.88	10.14	5.34	2.80
28	3.34	6.38	6.50	10.73	3.02	9.40	4.76	2.75

[a]Data on one- and two-year forward rates are from the Federal Reserve Bank of New York, in marks per dollar. Data on the five-year forward rate are from the Bank of America (see note 10).

[b]Reflects trend inflation differential of 7½ percent at an annual rate.

[c]Percent changes in forward rates plus adjustment for relative price trend divided by years to maturity of forward contract.

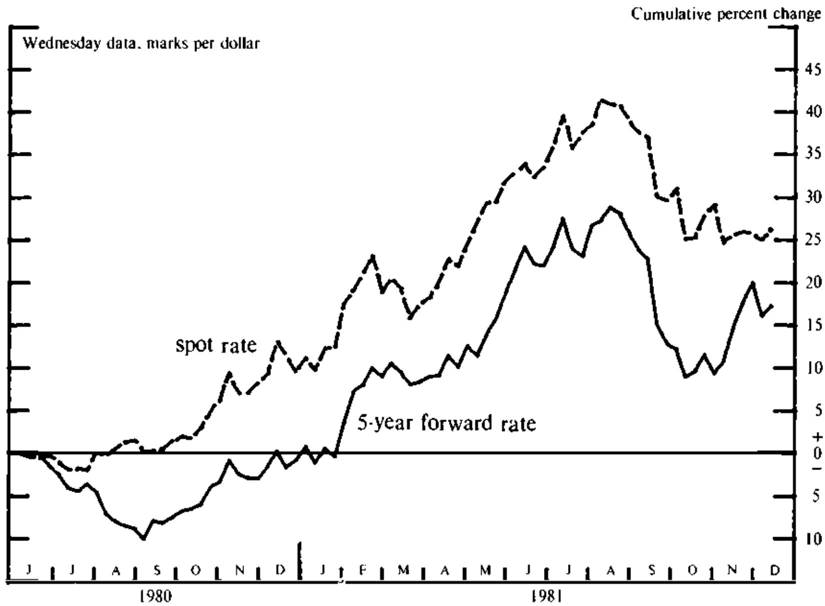

Fig. 2.3

the strength of economic activity was not transmitted through only one variable.

This last point may have useful implications for econometric modeling. Information about both the timing and magnitude of activity surprises can be increased by pooling a number of activity indicators rather than relying on a single indicator that is only sampled once a month. This is largely because every indicator of activity contains noise that market participants must sift out by focusing on a cross section or sequence of indicators, and partly because focusing on a cross section of indicators increases the frequency with which new information can be received. The same argument for pooling applies to econometric attempts to measure unexpected shifts in price variables, etc.

The second major swing in the five-year forward rate—the 10 percent appreciation between early September and early November 1980—cannot be clearly attributed to major surprises about the state of the U.S. or German economy. The U.S. economy showed mixed signs of strength and weakness in early September and continued to show mixed signs in early November. The key events during the period were the national elections in both countries. Since the reelection of German Chancellor Schmidt on October 5 was widely expected all along, the appealing hypothesis is that the rise of the forward dollar during these two months mainly reflected shifts in the perceived probability of a Reagan victory.

Reagan was perceived as good for the dollar in the sense of being more firmly committed than Carter both to reducing inflation (through fiscal policy and support for tight monetary policy) and to stimulating U.S. competitiveness (through tax incentives, removal of regulations, etc.). In addition, the perception that Reagan was more committed to reducing U.S. budget deficits may have had implications for the risk premium. At the beginning of September, Reagan and Carter were fairly even in the polls. As time passed, and particularly after the polls began to focus on electoral votes, the probability that Carter could defeat Reagan appeared to shrink fairly progressively.[14]

It is an exaggeration to say that the five-year forward rate looks like a step function during 1981, but it is striking that the major shifts in the forward rate occurred during four brief intervals, suggesting that there were four major doses of news that were transmitted and digested fairly quickly. The first three major doses of news during 1981 concerned the outlook for U.S. budget deficits. The news was conveyed, in particular, by Reagan's January 29 press conference and February 5 television address; by his April 28 speech to Congress and the surprising margin of victory with which the budget proposals sailed through the House of Representatives on May 7; and by large upward revisions in estimated budget deficits that were officially announced in mid-August, followed by mounting political opposition to further large budget cuts. The second swing, from late April through early June, may also have reflected spillover effects of the French elections on German economic prospects as well as upward revisions in expectations about the size of future German budget deficits. The beginning of the fourth swing, in early November, coincided with announcements indicating a stronger-than-expected recession in U.S. activity: in particular, with the announcements on October 29 of a 2.7 percent September decline in the leading indicators and on November 6 of a jump in unemployment to an 8.0 percent rate in October following a 7.5 percent rate in September.[15]

Why should the dollar strengthen in response to a downward shift in the expected path of U.S. budget deficits? One view is that a lower deficit reduces the likelihood that the Federal Reserve will monetize debt in excess of its money growth targets (or in excess of some prespecified

14. Even though Carter's predicted shares of the national and electoral votes edged up between early October and the Carter-Reagan debate on October 28, the fact that time was running out appears to have progressively reduced the perceived probability of a Carter victory.

15. The activity surprise may have generated a downward revision in long-term U.S. inflation expectations. (This hypothesis would be consistent with the Hoey data in table 2.2 if U.S. inflation expectations had been revised upward during September.) In addition, expectations of the long-run real value of the dollar might conceivably have been revised upward during November in response to the activity announcements, consistent with the behavioral model suggested by condition (16).

notion of an appropriate long-run money growth path); accordingly, the prospect of reduced deficits may lower inflation expectations. A second view is that lower U.S. budget deficits are likely to imply a slower growth of the supply of dollar-denominated public debt relative to the supply of public debt denominated in other currencies. Accordingly, the risk premium on the dollar should decline, as was discussed in section 2.7. Given both the expected long-run level of the exchange rate and the interest differential, a lower risk premium on the dollar implies that markets clear at a lower expected rate of appreciation of the dollar, and hence implies higher spot forward values of the dollar.

The five-year forward dollar appreciated by nearly 25 percent against the mark between mid-January and mid-June of 1981, and by another 5 percent through mid-August. Under the assumptions that the real exchange rate was expected to converge to its equilibrium level within five years and that expectations were rational, how much of the appreciation can plausibly be associated with revisions in each of the three expectational terms in the accounting framework?

It seems difficult to argue that the expected long-run real exchange rate was revised substantially in a direction that strengthened the dollar during this period. The monthly and quarterly data on U.S. and German trade and current account flows fluctuated erratically but did not appear to reveal any persistent surprises. Perhaps the Reagan program was perceived to have supply-side effects that would allow U.S. businesses to compete more successfully in world markets at any given level of the real exchange rate, but it is difficult to associate more than a 5 percent appreciation of the dollar with such an explanation.

A much larger part of the dollar's appreciation can be associated with revisions in expectations about the long-term inflation differential. As was shown in table 2.2, the Hoey survey suggests that the expected five-year U.S. inflation rate per annum declined by 1.6 percentage points between early October 1980 and early September 1981; the Michigan Survey of Consumer Attitudes suggests a 1.5 percentage point decline between August 1980 and August 1981. Such revisions can "explain" an appreciation of 7½ to 8 percent in the five-year forward rate. Forecasts of German inflation over a one- or two-year horizon were revised upward over the same period by 1 or 2 percentage points per annum, although the increase in German inflation seems generally to have been viewed as transitory. Thus, revisions in long-term German inflation expectations may also have "explained" as much as a 7½ percentage appreciation of the five-year forward dollar, but not much more.

The accounting arithmetic associates the remaining 10 percent appreciation of the dollar with revisions in the expected five-year premium for bearing exchange risk. Is this plausible? To the extent that investors are not rational optimizers, a 10 percentage point change in the risk premium would have no meaning beyond that of a residual in the accounting framework, and the question of plausibility would not be meaningful. To the extent that investors do optimize, section 2.7 has argued that a 2 percentage point change in the risk premium is plausible, based on an oversimplified representation of the portfolio optimization problem. It is an open question whether a better analytic framework and a reassessment of parameter values could establish the plausibility of a 10 percentage point change in the risk premium.

The point that seems most clear about the behavior of the mark/dollar rate during 1981, as has been illustrated in figure 2.3, is that shifts in the fiscal policy outlook were a major component of the news.[16] This has important implications for how the news of 1981 must be quantified if regression analysis is to be useful for telling the story and helping to separate the effects that were channeled through inflation expectations from the effects channeled through the risk premium. Some commonly employed methods for capturing revisions in expectations are inadequate for the 1981 experience. In particular, long-term inflation expectations cannot be adequately represented by long-term nominal interest rates; long-term dollar interest rates rose by 1 percentage point from late January to mid-February and by another percentage point from late April to mid-May, while the fiscal policy news presumably led to downward revisions in U.S. long-term inflation expectations. Moreover, the fiscal policy news was not accompanied by contemporaneous jumps in price levels, activity variables, monetary aggregates, or budget deficits, so that structural or autoregressive models of expectations based on current and historically observed data are inadequate. Thus, to adequately capture the revisions in long-term inflation expectations would seem to require either a time series of direct survey evidence on inflation expectations or at least a crude time series of future budget expectations or projections. And a crude time series on the budget outlook also seems to be required if regression analysis is to have any hope of adequately capturing revisions in the risk premium.

2.10 Summary

The evidence is clear that empirical exchange rate models of the seventies provide poor explanations of exchange rate behavior out of

16. When the unexpected components of week-to-week changes in monetary aggregates are integrated over 1981, it is not clear that the net changes provided any significant news. Alternatively stated, the below target growth of adjusted M1-B and the above target growth of M2 can be viewed to suggest that monetary policy, on balance, was neither easier nor tighter than expected over the period as a whole. This is not to suggest that monetary policy had no influence on exchange rates. The dollar would have been weaker had the Federal Reserve pursued higher monetary growth targets; and dollar exchange rates did in fact fluctuate week to week in response to surprises about the weekly money supply numbers. The suggestion that, on balance, there was no surprise about U.S. monetary growth, moreover, does not imply that there was no surprise about the path of dollar interest rates.

sample (see Meese and Rogoff 1983 and in this volume). Such evidence is not surprising in view of the limited attempts that have been made to model the news, given the strong presumption that exchange rate movements are predominantly unexpected or, equivalently, are predominantly a reflection of revisions in expectations in response to news (see Mussa 1979).

The first part of this paper has developed a framework of approximate accounting identities that describe observable spot and forward exchange rates in terms of three expectational terms: an expected long-run real exchange rate, an expected long-term inflation differential, and an expected premium for bearing exchange risk. Under the commonly adopted assumptions of time invariant expectations of the long-run real exchange rate (PPP level) and the risk premium, it is evident from the accounting framework that the substantial historical short-run variability of observed spot exchange rates can only be explained by the hypothesis that expectations about long-term inflation differentials have varied substantially relative to observed long-term nominal interest differentials. This point raises the question of how long real interest differentials are expected to persist, and some limited evidence has been presented suggesting that the answer is longer than two years but perhaps no longer than five years. An implication is that during periods in which the term structure of nominal interest differentials changes shape, exchange rate movements may be highly correlated with changes in long-term interest differentials but not as highly correlated with changes in short-term interest differentials, other things equal, which challenges the tradition of modeling exchange rates in terms of short-term interest differentials.

In principle, all three of the expectational terms in the accounting framework should be treated as variables—or as transmission channels for the news—and the second part of the paper has discussed some issues in modeling expectations of the long-run real exchange rate, the long-term inflation differential, and the long-term risk premium. The third part of the paper has discussed the major observed swings in mark/dollar exchange rates (spot and five-year forward) during 1980–81, using the accounting framework to draw inferences and conjectures on the extent to which revisions in each of the three expectational terms "explained" the exchange rate movements. The following summarized points have been argued:

It is difficult to model the long-run real exchange rate without some notion of a constraint on the long-run balance of payments; but given an hypothesis about the specific nature of the long-run balance of payments constraint, it is straightforward conceptually to model how expectations of the long-run real exchange rate (or PPP level) are revised rationally in response to news that revises expectations about whatever variables or parameter values enter the long-run balance of payments constraint.

Quantitative discussions of exchange rate volatility can benefit from focusing on the length of the horizon over which real interest differentials are expected to persist, or on the related question of how long it is expected to take the real exchange rate to converge to its long-run level. If it is expected to take T years for the real exchange rate to converge to its long-run level, then the percentage change in the spot exchange rate that should be associated with a shift in the term structure of nominal interest differentials, other things equal, is roughly T times the percentage point per annum change in the T-year interest differential.

During 1981, major swings in the exchange value of the dollar coincided strikingly with major shifts in the outlook for U.S. budget deficits. The fiscal policy news may have been transmitted to the long-term forward rate through both revisions in long-term U.S. inflation expectations and changes in the expected premium for bearing exchange risk. Long-term nominal dollar interest rates did not move in the same direction as long-term U.S. inflation expectations in response to the fiscal policy news, nor was the fiscal policy news accompanied by contemporaneous jumps in prices, activity levels, money supplies, or budget deficits. Accordingly, the influence of fiscal policy news on inflation expectations cannot be captured adequately without either survey measures of long-term inflation expectations or models linking inflation expectations to measures of expected future budget deficits (and/or money supplies) that are not generated from autoregressions.

Available survey data on long-term U.S. inflation expectations suggest that a major part of the fiscal policy news during 1981 was transmitted to the exchange rate through revisions in expected long-term inflation differentials. There is also a reasonable presumption, however, that the five-year risk premium "explained" changes of at least 2 percent in mark/dollar exchange rates in response to swings of at least $100 billion in the expected cumulative flow of U.S. budget deficits over a five-year horizon. The sequence of budget news that arrived during 1981 may provide enough short-run variability in asset stock variables to capture the risk premium with a structural model, but existing structural models must first be refashioned into a rational expectations framework that looks forward at expected future asset stocks. Moreover, autoregressive models are inadequate for capturing revisions in expectations about future asset stocks in response to the fiscal policy news that arrived during 1981.

A final point is that news about prices, activity, the balance of payments, the stance of monetary policy, and most other classes of variables that enter exchange rate models is transmitted through multiple indicators drawn from each class of variable. Extracting news from pools of indicators enables market participants to filter out noise and to obtain more frequent observations, and econometric techniques that did likewise might prove more efficient.

Appendix The Accounting Framework as a Basis for Forecasting

There is an analogy between explaining the observed behavior of exchange rates ex post and forecasting exchange rates ex ante in a context in which changes in exchange rates are associated with revisions in expectations in response to news. The ex post problem is to test a structural equation using either direct or proxy measures of expectations or behavioral models of how expectations respond to the news. The ex ante problem requires predictions of how much expectations will be revised in response to the news.

A forecasting methodology can be illustrated using the accounting framework and focusing on the risk neutral case for simplification. It is necessary to distinguish between "average market expectations" held at time t, E_t, and the forecaster's expectations or predictions at time t, $\tilde{E}_t$. It is also useful to define

$$\tilde{E}_t \Delta E_{t+1} = \tilde{E}_t E_{t+1} - \tilde{E}_t E_t, \tag{A1}$$

where the forecaster may or may not be able to observe E_t at time t. Condition (9) of the accounting framework, under the maintained assumption of risk neutrality, implies

$$\begin{aligned} E_t s_{t+1} = E_t[&(p^A - p^B)_{t+1} + (r^B - r^A)_{t+1,t+T} \\ &+ s\text{real}_{t+T}]. \end{aligned} \tag{A2}$$

A similar condition can be written with $\tilde{E}_t$ replacing E_t. Combining both of these conditions with definition (A1) and the risk neutrality assumption $E_t s_{t+1} = f_{t,t+1}$, and also using $\tilde{E}_t E_{t+1} s_{t+1} = \tilde{E}_t s_{t+1}$, it can be shown that

$$\begin{aligned} \tilde{E}_t s_{t+1} - f_{t,t+1} = \tilde{E}_t \Delta E_{t+1}[&(p^A - p^B)_{t+1} \\ &+ (r^B - r^A)_{t+1,t+T} + s\,\text{real}_{t+T}], \end{aligned} \tag{A3}$$

where T exceeds the length of time that it is expected to take for the real exchange rate to converge to its long-run equilibrium level. Condition (A3) states that the time t forecast of the spot rate at horizon $t+1$, if constrained to be consistent with the accounting framework, will equal the one-period market forward rate at time t adjusted for time t forecasts of the extent to which "average market expectations" about "explanatory variables" will be revised between times t and $t+1$. The relevant explanatory variables are the relative price level at $t+1$, the $(T-1)$ period real interest differential at $t+1$, and the long-run real exchange rate.

Coming up with numbers to plug into condition (A3) as estimates of $E_t(p^A - p^B)_{t+1}$, $E_t(r^B - r^A)_{t+1,t+T}$, and $E_t s\,\text{real}_{t+T}$ may require some crude sampling and extrapolation of private inflation forecasts. Time t forecasts for nominal interest differentials at $t+1$ are implicit in the observable market yield curves and, together with forecasts of the relative price level and long-term inflation differential, can be used to infer $E_t s \, \text{real}_{t+T}$ from condition (A2) and the observed one-period forward rate, $f_{t,t+1}$. The predictions of what market participants will expect next period, the $\tilde{E}_t E_{t+1}$ terms, involve more extensive ad hoc assumptions. When the forecaster is provided with a macroeconomic model, an arbitrary but appealing set of predictions is that market participants as of time $t+1$ will have come to expect the outlook for inflation rates, interest rates, and the long-run real exchange rate that the model is predicting at time t.

The latter assumption is particularly appealing in a context in which the model forecaster has more advanced information than other market participants about prospective data releases or policy announcements, but it loses appeal to the extent that it may be unrealistic to assume that market participants base their expectations on the same model (or that market participants will come to believe in the forecasting model before the date to which the forecast applies). The forecasting exercise gets much more complicated once the possibility of two different models is admitted, and questions then arise about how rapidly the models should be assumed to adjust toward each other (or some true model) in response to forecast errors.

Such considerations make clear the difficulty of avoiding some strong ad hoc assumptions in any exchange rate forecasting exercise. Nevertheless, a belief that the structure of an exchange rate equation is correct and that market expectations of variables that "explain" exchange rates are predictably wrong—or likely to change in a predictable direction—provides some hope that exchange rate forecasts can be more accurate predictions than forward rates.

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Comment Sebastian Edwards

Peter Isard has provided us with an interesting paper. His analysis clearly points out some of the most important shortcomings of the present vintage of exchange rate models. I will confine my comments to some aspects of the model, without elaborating on Isard's interpretation of the recent movements of the dollar/mark rate.

Isard's model is based on two nonobservable variables. Both his "anchor"—the expected long-run real exchange rate—and his "rope"—the expected long-term interest rate differential—are nonobservables. Undoubtedly, this introduces some difficulties in any efforts to try to empirically test the model in its present form. At the same time, this difficulty in testing the model possibly explains why the empirical analysis presented in the paper is based, almost exclusively, on casual observation. However, I will argue that the model can be manipulated in a simple way that would yield interesting, testable hypotheses.

Dating Isard's equation (9), and using $E_t(X_{t+k})$ as the expected value of X in period $t + k$, *conditional* on all information available at period t, it is possible to write:

$$(9') \qquad s_t = p_{At} - p_{Bt} + E_t(r_{Bt+j}) - E_t(r_{At+j}) + E_t(s\text{real}_{t+j}) - E_t(\text{risk}_{t+j}),$$

where the expectations refer to some future period $t + j$. Assuming risk averse agents, Isard's equation (A2) can be written as:

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$$(\text{A2}') \quad f_{t-i,t} = E_{t-i}(p_t^A) - E_{t-i}(p_t^B) + E_{t-i}(r_t^B) - E_{t-i}(r_t^A) + E_{t-i}(s\text{real}_t) - 2E_{t-i}\text{risk}_t),$$

where $f_{t-i,t}$ is the forward rate determined in period $t-i$ for delivery in period t. By subtracting (A2′) from (9′) it is possible to obtain an expression for the market forecasting error, or difference between the forward rate determined in $t-i$ and the actual spot rate in t:

$$\begin{aligned}(\text{A2}'')\ s_t - f_{t-i} = -E_{t-i}(\text{risk}_t) &+ [p_t^A - E_{t-i}(p_t^A)] - [p_t^B - E_{t-i}(p_t^B)] \\ &+ [E_t(s\text{real}_{t+j}) - E_{t-i}(s\text{real}_t)] \\ &+ [E_t(r_{Bt+j}) - E_{t-i}(r_{Bt})] \\ &- [E_t(r_{At}) - E_{t-i}(r_{At})] \\ &+ [E_{t-i}(\text{risk}_t) - E_t(\text{risk}_{t+j})].\end{aligned}$$

Equation (A2″) is very interesting, since it explicitly indicates that the actual spot rate at t will differ from the forward rate set in $t-i$ for delivery in t, by the seven terms on the right-hand side. While the first term is the usual risk premium, the rest of these terms explicitly reflect the role of *new information*, or news, on the forecasting error $(s_t - f_{t-i})$. The presence of this news may explain why, during the recent floating period, forward exchange rates have been poor predictors of future spot rates (see Frenkel and Mussa 1980).

Notice that (A2″) suggests that news about a number of variables affects exchange rate behavior. Furthermore, to the extent that p_t, $E_t(s\text{real}_{t+j})$, $E_t(r_{At+j})$, $E_t(r_{Bt+j})$, and $E_t(\text{risk}_{t+j})$ are jointly determined, equation (A2″) indicates that there are multiple channels through which particular news (increases in the price of oil, for example) is transmitted to the exchange rate. This interpretation of the role of news contrasts with recent empirical work that has concentrated on analyzing the effect of news with respect to one variable on exchange rates.

There are at least three ways to empirically test (A2″): (1) We can directly incorporate unexpected changes of exchange rate determinants to the right-hand side of the traditional market efficiency equation. This has been done by Frenkel (1981*a*), who used the residuals from a forecasting equation for nominal interest rate differentials as an additional independent variable in market efficiency equations. Dornbusch (1980), on the other hand, has included unexpected changes in the current account and real output—computed as deviations from OECD forecasts—as a measure of news in his regression analysis. (2) Use nonlinear, full-information methods, testing *simultaneously* for market efficiency and rational expectations. This has recently been done by Hartley (this volume) in the context of the simple monetary model. (3) Use seemingly unrelated regressions (SURE) methods that recognize that the unexpected changes of exchange rate determinants that appear on the right-hand side of (A2″) correspond to the error terms in forecasting equations for these determinants. The use of this method would be useful in testing the adequacy of Isard's model in the context of an exchange rate market efficiency analysis.

In table C2.1, I report the SURE results of estimating a variant of (A2″) which incorporates news about real interest rates, real income, and money at home and abroad. In these equations the dependent variable is the spot rate and the independent variable is the previous month forward rate. Table C2.2, on the other hand, presents the ordinary least squares (OLS) results for the same currencies. As may be noted, the use of SURE improves the estimate. In particular, while the market efficiency hypothesis is rejected for the lira/dollar rate when OLS is used, it is not rejected at the conventional level when SURE is used. For the cases of the pound/dollar and mark/dollar rates, the market efficiency hypothesis is not rejected under either method. However, for the franc/dollar rate it is rejected under both estimation procedures. Further empirical work in this direction—explicitly incorporating the role of news from equation (A2″)—should prove useful in testing the adequacy of the model proposed by Isard.

I now turn to the analysis of PPP in the context of the present model. Isard's equation (9) provides an explicit, and presumably testable, expression for deviations from PPP. According to this equation, deviations from PPP ($s - p_A + p_B$) would be equal to the real interest rate differential ($r_B{}^e - r_A{}^e$), plus the expected real exchange rate ($s\text{real}^e$) and the risk premium. It seems to me that this formulation provides an interesting point of departure for future empirical analyses that try to explain the "collapse" of PPP during the recent period with floating rates.

In section 2.6 Isard discusses the expected long-term PPP level. Equation (16) provides an expression for the steady-state level of the real exchange rate or "anchor." This condition is derived from the following equilibrium condition for the balance of trade:

Table C2.1 **Tests of Market Efficiency Incorporating Cross-Error Structure between Forecasting Equations and the Exchange Rate Equation (SURE: monthly data) $s_t = a + bf_t + u_t$**

Rate	Period	Constant	f_t
pound/ dollar	7/73–9/79	−.033 (.0179)	.957 (.0248)
franc/ dollar	7/73–12/78	−.568 (.1792)	.816 (.0583)
mark/ dollar	7/73–9/79	.026 (.0271)	.967 (.0320)
lira/ dollar	7/73–12/78	.246 (.1553)	.962 (.0234)

Table C2.2 **Exchange Rate Market Efficiency Tests: OLS Estimates (monthly data)**

Rate	Period	Constant	f_t	f_{t-1}	R^2	S.E.	F	D.W.
pound/ dollar	7/73–9/79	−.036 (.0182)	.953 (.0253)	—	.952	.028	3.52	1.703
pound/ dollar	7/73–9/79	−.037 (.018)	1.069 (.115)	−.118 (.114)	.952	.028	—	1.930
franc/ dollar	7/73–12/78	−.526 (.1883)	.830 (.0612)	—	.742	.032	7.67	2.144
franc/ dollar	7/73–12/78	−.482 (.196)	.743 (.121)	.101 (.121)	.744	.032	—	1.976
mark/ dollar	7/73–9/79	.022 (.0274)	.971 (.0324)	—	.926	.032	.78	2.106
mark/ dollar	7/73–9/79	.022 (.028)	.970 (.109)	.002 (.110)	.926	.033	—	2.103
lira/ dollar	7/73–12/78	.333 (.1586)	.949 (.0239)	—	.961	.031	4.56	1.954
lira/ dollar	7/73–12/78	.332 (.160)	.922 (.121)	.027 (.120)	.961	.032	—	1.895

NOTE: Standard errors are in parentheses. R^2 refers to the coefficient of determination. S.E. is the standard error of the regression. F is the joint test for $a = 0$ *and* $b = 1.0$. D.W. is the Durbin-Watson statistic.

$$X_t = S\text{REAL}_t\, M_t\ .$$

SREAL$_t$ in this expression is equal to the ratio of the price of imports in domestic currency to the price of exports also in domestic currency.

$$S\text{REAL}_t = \frac{S_t P^*_{Mt}}{P_{xt}}\ .$$

It follows, then, that the log of this expression will be equal to $s$real in Isard's equation (3) *only* if $P^*_{Mt} = P_{Bt}$ and if $P_{xt} = P_{At}$. This means that Isard's "anchor" (16) implicitly assumes that both countries fully specialize in production and consumption. This is, indeed, a highly restrictive assumption. However, if it is assumed that in both countries P_x and P^*_M is the only one of many goods that enters the price level, Isard's equation (16) can be modified as follows:

$$(16') \qquad \overline{s\text{real}} = \frac{(a_0 - b_0) + (b_1 - a_1)\bar{r} + \log\,(\overline{Y/Y^*}\,)}{(a_2 + b_2 - 1)} + \log\frac{P_x}{P_A} + \log\frac{P_B}{P^*_M}\ ,$$

where $\overline{s\text{real}}$ is indeed the long-run equilibrium real exchange rate (i.e., $s\text{real} = s + p_B - p_A$), and log (P_x/P_A) and log (P_B/P^*_M) are long-run steady-state relative prices.

This expression has the desirable property that, in addition to relating the long-run real exchange rate to variables like interest rates and real income, it explicitly incorporates relative prices. This is particularly important since, traditionally, deviations from PPP have been related to changes in the relative prices of tradables to nontradables (Balassa 1964). Recently, on the other hand, Frenkel (1981*b*) has attributed the large deviations from PPP between the dollar and the franc to changes in relative prices in France. Equation (16′) will tend to predict, for example, that an increase in the expected relative price of nontradable goods at home, other things equal, will lead to an appreciation of the real expected long-term exchange rate.

Peter Isard's paper is a positive contribution to the understanding of exchange rate behavior. His analysis points out some of the major limitations of our recent models. However, the paper falls short of providing further insights on how these shortcomings could be avoided. As I have argued, the general framework proposed by Isard can be extended to test in a more formal way the role of news in exchange rate behavior.

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Comment Jeffrey A. Frankel

So many of our theories depend crucially on some concept of a long-run equilibrium that we are always approaching, but never able actually to observe, because it is a moving target. I regard Peter Isard's paper as a very worthwhile attempt to bring the expected equilibrium exchange rate out of the mists of the future and into the more tangible and observable present. He does this by using five-year interest rates to construct a five-year forward rate. In the monetary theory of the exchange rate we do not worry about risk premiums, so this five-year forward rate should equal the five-year expected spot rate.[1] Even for versions like Dornbusch's (1976) overshooting model that allow large short-run deviations from equilibrium because of sticky prices, five years should be long enough for the spot rate to be expected to return most of the way back to equilibrium. Thus we know what the equilibrium exchange rate is expected to be in five years. If we assume no changes in the long-run equilibrium real exchange rate (long-run PPP), then we need only some measure of what changes in price levels are expected over the next five years to get a measure of the equilibrium today that we can actually reach out and touch.

For the 1977–80 period, Isard gets his data on expected price changes from OECD forecasts. Since the forecasts look only one year into the future, he is forced to try the argument out by hoping that one year is long enough to get back to equilibrium. He finds (table 2.1) that when this measure of the equilibrium spot rate is compared to current price levels, the "residual changes" are large, usually positive for Japan and the European countries, contradicting the null hypothesis that in equilibrium

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1. The risk premium can be easily integrated into the monetary equation of exchange rate determination (Hooper and Morton 1982; Frankel 1983).

the spot rate should match the relative price levels. He concludes, I think correctly, that the problem is that one year is not a long enough horizon for the forward rate to equal the expected equilibrium rate, and that it is not necessary on this evidence to invoke changes in either (1) the long-run real exchange rate or (2) the risk premium.

On the issue of the speed of convergence to equilibrium, a variety of evidence exists. First, studies of PPP show a high serial correlation of deviations; something like 37 percent of a deviation can be expected to remain after one year (Genberg 1978). Second, the existence of a real interest differential indicates that the exchange rate is currently deviating from its equilibrium path and is expected to return toward it. The coefficient of the real interest differential in an exchange rate regression is the inverse $1/\theta$ of the expected speed of return to equilibrium. A coefficient like 1.5 for three-month interest rates implies that 48 percent of the deviation is expected to remain after a year ($.48 = [1 - 1/4 \times 1.5]^4$; see Frankel 1981). So I think it is clear that one year is not long enough to get back to equilibrium.

When he moves on to the 1980–81 period, Isard has additional information on changes in expected inflation, and thus feels freer to go beyond the one-year horizon to the five-year horizon in computing his future equilibrium exchange rate. It seems safe to assume that very little of a deviation from PPP persists after five years (for example, $.37^5 = .007$ and $.48^5 = .026$).

The five-year forward rate computed in table 2.3 (last column) and graphed in figure 2.2 for early 1980 fluctuates sharply. The question is: Can the fluctuations be explained by changes in the expected five-year inflation rate? If not, we would have to admit fluctuations in either (1) the long-run real exchange rate or (2) the risk premium. I think Isard does an excellent job of explaining the movements in the forward rate by the news that was coming out at the time on U.S. inflation: unfavorable in February and then favorable from March on. There is no need to invoke option (1) or (2). And when we look at the *spot* value of the dollar, we see a very close correspondence with the real interest differential—both rising throughout the winter, peaking sharply in April, and declining in midyear—which fits the sticky-price monetary model very well.

Figure 2.3 shows the five-year forward rate for late 1980 and 1981. Once again it can be explained by developments on the inflation front, both the decline in June–September 1980, attributable to the ending of the recession, and the subsequent large one-year rise, attributable to the Federal Reserve renewing monetary restraint and to Reagan taking office. Throughout 1981 the spot rate story has been almost identical to the forward rate story, because European and U.S. interst rates have moved pretty much in tandem.

The positive correlation between the real interest differential and the value of the dollar over the last two years is as clear if one uses short-term interest rates as if one uses five-year interest rates. A major assertion of the paper (section 2.3) is that long-term rates are more reliable indicators than short-term rates. But an opposing argument can be made. To begin with, assume that when the expected inflation rate rises, the rise becomes increasingly reflected in the short-term interest rate with the passage of time. For example, the stickiness of the price level prevents the real money supply from falling in the short run, and thus the existence of the money demand equation prevents the interest rate from rising in the short run. Second, assume the expectations hypothesis on the term structure of interest rates: the long-term interest rate is the average of the current short-term rate and expected future short-term rates. It follows from these two propositions that changes in the long-term rate lie in between changes in the short-term rate, which reflect the tightness of the real money supply and changes in the expected inflation rate.[2] In principle, the short-term/long-term interest rate differential, the long-term interest rate/expected inflation differential, and the short-term interest rate/expected inflation differential should all be monotonically related; they should be equally acceptable indicators of how tight monetary policy is or of how overvalued the currency currently is relative to its equilibrium value.

Isard would argue that the virtue of using the long-term interest rate instead of the short-term rate is that it does not require imposing assumptions about the term structure that may not be true. While we can be pretty sure—on the basis of perceptions of the Reagan Administration, survey data (table 2.2), and actual inflation numbers—that the expected U.S. inflation rate fell in 1981, the long-term interest rate actually *rose* (while the short-term rate did not). The only possible conclusion seems to be that the expectations hypothesis of the term structure of interest rates does not hold. Investors are reluctant to buy long-term bonds, having been burned so many times before on predictions that short-term rates would fall. They now require a risk premium, which explains why long-term rates have remained high even though expected inflation has declined. Suggestions have been made that the increased risk premium on long-term bonds can be modeled as an increase in risk aversion or in perceived uncertainty, attributable to the experience of the last ten years, or as an increase in the supply of government bonds to the market, arising out of Reagan's budget deficits that are perceived (correctly) by Wall Street to be growing rather than shrinking.

2. The argument that the long-term interest rate is a linear combination of the current short-term rate and expected inflation is formalized in Frankel (1982).

Isard's history of the mark/dollar rate in 1981 concludes that, though a 1½ percentage point decline in expected U.S. inflation and a similar *rise* in expected German inflation may account for a 15 percent appreciation of the dollar, the remainder of the 25 percent appreciation can perhaps only be explained by the risk premium. This would require that the relative risk premium paid on dollar bonds (i.e., the U.S.-German interest differential less expected dollar depreciation) fell over the period, so that the high real interest rates that held up the value of the dollar represented even greater discipline on the part of U.S. authorities than one would otherwise realize. He argues that the dollar risk premium had reason to fall in early 1981, because when Reagan took office people expected the government budget deficit to fall. He even has a calculation (equation [17]) of the effect on the risk premium of a 10 percent reduction in the expected stock of U.S. public debt over a five-year horizon.

While it is perfectly possible that the prominent media coverage given to the novel claims of supply-side economics led the public in 1981 to expect that reduced budget deficits would follow from Reagan's policies, the obvious question is where this leaves the explanation of why long-term interest rates rose rather than fell. And even if we take the high U.S. interest rates as somehow given, as Isard does, so that the reduced U.S. risk premium takes the form of lower expected dollar appreciation, how can the expectation of a reduced supply of dollar debt in the *future*, as opposed to an actual reduction in the present, raise the *current* value of the dollar more than its expected future value? Indeed, given the negligible actual changes in nominal debt levels that can occur in a few months and given the ex post 30 percent appreciation of the dollar, the share of dollar debt in global private holdings of dollar plus mark debt must have *risen* from 80 percent to 85 percent, not fallen, requiring by equation (17) an *increase* in the dollar risk premium, not a fall. This would be consistent with the high U.S. interest rates, but what started the process?

The problem lies not with Isard's accounting framework but with the apparently inconsistent paths in 1981 of the four key U.S. variables: the short-term interest rate, expected inflation, the exchange rate, and the long-term interest rate. The evidence is inescapable that expected inflation fell and that the high short-term interest rate represented an increased *real* interest rate brought on by tight monetary policy. Surveys of expectations and actual inflation numbers both show declines, and the effects of a high real interest rate on the economy are evident: depressed real activity (especially in interest-sensitive sectors), a sluggish stock market, and a very strong dollar. But then how can one explain the rise in the long-term rate? One can bring in risk. But the more one tries to argue that the U.S. risk premium fell in 1981 (due to a fall in perceived risk or government debt) to reconcile the gloomy outlook in long-term bond markets with the rosy outlook in the foreign exchange market, the harder it is to explain the rise in long-term interest rates relative to short-term rates. And the more one tries to argue that the U.S. risk premium *rose* in 1981 (due to a rise in perceived risk or government debt) to explain the upward tilt in the interest rate term structure, the harder it is to explain the strength of the dollar. One is tempted to be satisfied with short-term interest rates when trying to explain the exchange rate and to leave the behavior of the long-term rate as a puzzle for economists studying the term structure of interest rates.

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