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The Dazzling Dollar

THE REMARKABLE appreciation of the dollar since 1980 rivals the oil shocks of the 1970s as the most dramatic relative price change in the post-World War II world economy. It is widely agreed that the source of the increase in the price of the dollar is an increase in the attractiveness of dollar assets to investors around the world. But what makes U.S. assets more attractive? At the risk of being uncontroversial, I continue to believe that the increase over the last five years in the differential between real interest rates in the United States and those in other countries is the major identifiable factor. The idea is that higher interest rates attract foreign capital into the country, causing the dollar to appreciate until it has become so "overvalued" relative to its long-run equilibrium value that the market expects a future depreciation sufficient to offset the interest differential. As table 1 shows, the long-term real interest differential between the United States and a weighted average of trading partners stood at between 2.7 and 3.5 percentage points as of February 1985, depending on which of three measures of expected inflation is used. Based on the middle estimate, the differential was 2.9 percentage points, up 5.0 points from a differential of about −2.1 percentage points in 1980. Figure 1 shows the three measures of long-term real interest differential monthly from 1979 to 1984.

The proposed explanation for the shift in international asset demands could be broadened from "real interest differential" to "differential in expected rates of return on U.S. and foreign assets generally." But which assets? Short-term interest differentials have risen by less than

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Table 1. Real Interest Rates: Three Alternative Measures, 1980 Average and February 1985[a]

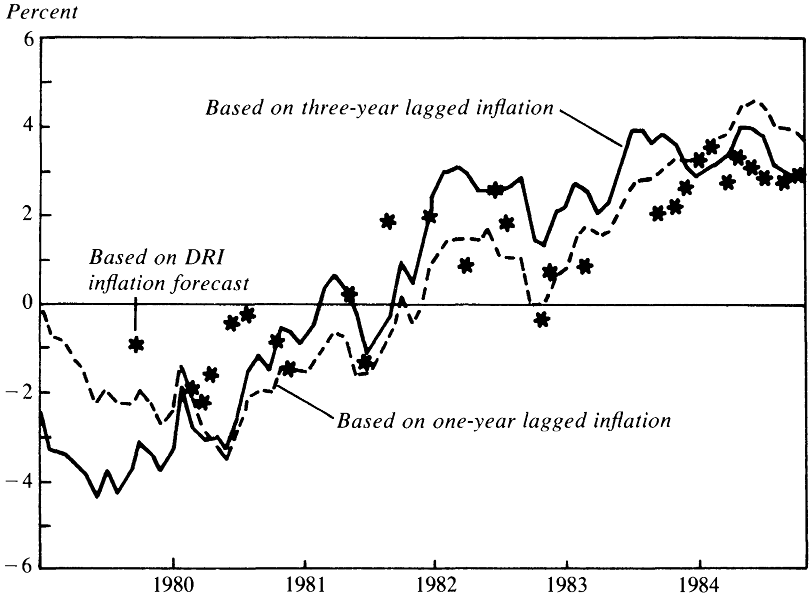
Percent

Item	*1980 Average*			*February 1985*			*Change*		
	United States	*Weighted average of trade partners*	*Differential*	*United States*	*Weighted average of trade partners*	*Differential*	*United States*	*Weighted average of trade partners*	*Differential*
Long-term government bond rate	11.39	11.34	0.05	11.70	9.33	2.37	0.31	−2.01	2.32
One-year lagged inflation	13.54	11.38	2.16	3.54	4.07	−0.53	−10.00	−7.31	−2.69
Real interest rate 1	−2.16	−0.05	−2.11	8.16	5.25	2.90	10.31	5.30	5.01
Three-year distributed lagged inflation	11.67	9.35	2.32	3.83	4.92	−1.08	− 7.83	−4.43	−3.40
Real interest rate 2	−0.28	1.99	−2.27	7.87	4.41	3.46	8.15	2.42	5.72
DRI three-year forecasted inflation	9.84	8.63	1.21	4.16	4.49	−0.33	− 5.68	−4.14	−1.54
Real interest rate 3	1.55	2.71	−1.16	7.54	4.84	2.70	6.00	2.14	3.86

Source: International Monetary Fund, *International Financial Statistics* for bond rates (series 61) and consumer prices, and Data Resources, Inc. (DRI) for forecast inflation. GNP weights are from *OECD Economic Outlook* (Paris: OECD, July 1984).

a. One-year inflation is calculated by year over year changes in monthly CPI; three-year distributed lagged inflation uses weights 0.5, 0.3, 0.2 on year over year changes in monthly CPI for successive past years; weighted average of trading partners uses GNP weights of West Germany, France, Italy, Canada, Japan, and the United Kingdom from 1980; DRI forecasted inflation is the average of various forecasted increases in CPIs.

Figure 1. Average Real Interest Differentials, January 1979–November 1984[a]



Sources: International Monetary Fund, *International Financial Statistics*, and Data Resources, Inc. (DRI). DRI forecast for inflation not available for periods other than the ones shown.

a. U.S. minus foreign rate, based on long-term bond rate and alternative inflation expectations shown in table 1.

long-term differentials. Such measures of the rate of return to equity capital as dividend-price ratios and earnings-price ratios have also behaved differently from real interest rates, as is their habit, though in table 2 they too show an increase in the differential between the United States and its trading partners.[1]

A good argument for singling out the long-term real interest rate differential is that the ten-year differential can be thought of as reflecting how much the market expects the dollar to depreciate, in real terms, on average over the next ten years. A term of ten years, unlike one year, is probably long enough to assure a return of the real exchange rate to long-run equilibrium, whatever that may be. It follows that the market's current estimation of the "overvaluation" of the dollar relative to that long-run equilibrium can be estimated at ten times the ten-year real interest differential. Thus the 2.9 point differential implies that the

1. Figures for real interest rates and dividend-price ratios similar to those computed in tables 1 and 2 are reported for the United States and five individual trading partners in Olivier J. Blanchard and Lawrence H. Summers, "Perspectives on High World Real Interest Rates," *BPEA, 2:1984*, pp. 273–324, tables 1–4 and 6.

Table 2. Return on Equity Capital, 1980 Average and February 1985
Percent

Item	1980 Average[a]			February 1985			Change		
	United States	Europe and Far East	Differential	United States	Europe and Far East	Differential	United States	Europe and Far East	Differential
Dividend yield	5.6	4.5	1.1	4.3	2.6	1.7	−1.3	−1.9	0.6
Earnings-price ratio	12.6	11.0	1.6	9.2	6.1	3.1	−3.4	−4.9	1.5

Source: *Capital International Perspective* (Geneva, Switzerland, March 1985) and previous issues.
a. Average of the four end-of-quarter figures.

market considers the dollar to be about 29 percent above its long-run real equilibrium, or 25 percent above it on a continuously compounded logarithmic basis. Compared with the 33 percent logarithmic real appreciation that the weighted dollar has experienced relative to its 1973–79 average, this 25 percent figure suggests that most of the real appreciation is attributable to an increase in the real interest differential. Relatively little seems attributable to a change in the long-run equilibrium real exchange rate.[2]

One good argument against this framework, a model originally developed by Peter Isard,[3] is that dollar bonds may not be close substitutes for foreign bonds because of risk, with the result that the interest differential may not equal the expected rate of dollar depreciation. Risk may also explain why long-term bonds may not be close substitutes for short-term bonds, and why the long-term interest rate may not equal the average of expected future short-term rates. Risk would also account for the diversity in expected rates of return on bonds and equity capital. This problem is addressed further below. For now, I will assume that

2. Any such calculation is sensitive, not just to the measure used to estimate expected inflation, but also to the term of maturity chosen. In theory, the twenty-year (for example) interest differential should be half the ten-year differential and thus when multiplied by twenty, should give the same result. But the five-year interest differential, even in theory, could be more than twice the ten-year interest differential; this would just mean that five years is not long enough to guarantee a complete return to equilibrium.

3. Peter Isard, "An Accounting Framework and Some Issues for Modeling How Exchange Rates Respond to the News," in Jacob Frenkel, ed., *Exchange Rates and International Macroeconomics* (University of Chicago Press, 1983), pp. 19–66. The framework was applied to the current episode of dollar overvaluation in the *Economic Report of the President, February 1984,* pp. 52–54.

investors are risk-neutral or, alternatively, that the real exchange rate ten years in the future is certain, which would justify the use of the ten-year differential for exchange rate analysis.

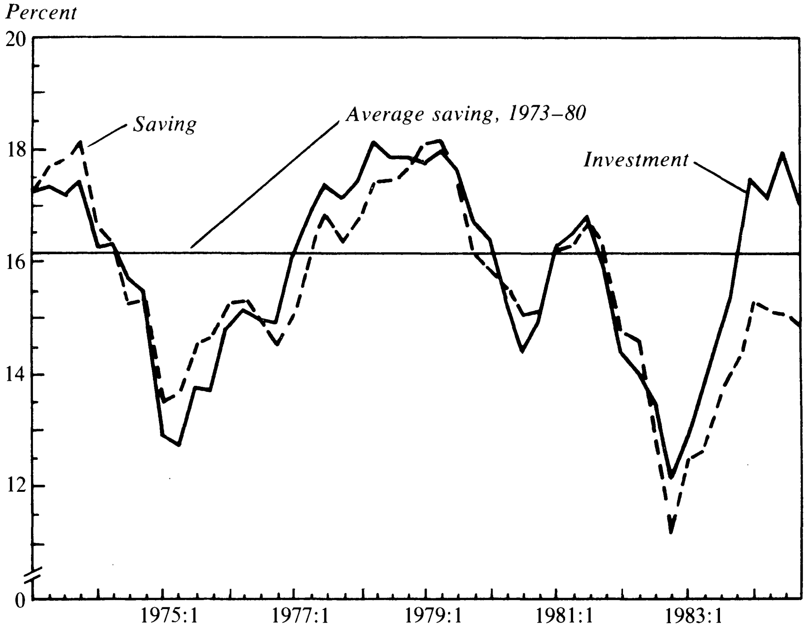
Saving, Investment, and Net Capital Flows

If the increase in U.S. real interest rates since 1980 is the explanation for the real appreciation of the dollar, what is the explanation for the increase in real interest rates? There are two major competing hypotheses. Think of domestic investment as depending negatively on the real interest rate, and think of national saving—private saving plus public saving, which is the government budget surplus—as depending, presumably positively, on the real interest rate. The first hypothesis is that there has been a backward shift of the national saving function in the form of an increase in the federal budget deficit that, for whatever reason, has not been offset by an increase in private saving. The second hypothesis is that there has been an outward shift of the domestic investment function, attributed to more favorable tax treatment of capital as a result of the 1981 Economic Recovery Tax Act and the 1982 Tax Equity and Fiscal Responsibility Act, or more generally to an improved business climate. Either shift would drive up the real interest rate. To choose between them, one must look at the level of national saving and investment. A decline would support the first explanation; an increase, the second.

As figure 2 shows, U.S. national saving relative to GNP declined sharply from 1980 to 1982. Domestic investment fell too, but by less. The difference between the two is the decline in the current account position. The U.S. trade and current account deficits have repeatedly hit record levels in recent years, with the real appreciation of the dollar the major proximate cause. One could think of the 1980–82 fall in public saving as causing the decline in investment, the capital inflow, and the decline in the current account, all by means of the increase in real interest rates.

From the trough of the recession in November 1982 to the end of 1984, the situation was precisely the reverse. Saving and investment both increased with exceptional speed during the first two years of recovery, with investment leading the way. At present it seems that the capital

Figure 2. Saving and Investment as Percentage of GNP, 1973:1–1984:4[a]



Source: National income and product accounts.
a. Gross national saving and gross private domestic investment.

inflow is financing both an investment expansion and the federal budget deficit.

It is normal for both the saving rate and investment rate to decline in recessions and to expand in booms. To ascertain the driving force behind the episode of high real interest rates and the high dollar, we should look at the average level of saving and investment over the complete business cycle. From 1981 through 1984, gross national saving averaged 14.5 percent of GNP, down from 16.1 percent in the period 1973 to 1980. Gross investment averaged 15.4 percent of GNP, also down from 16.1 percent in the period 1973–80. (Saving and investment rates were equal during the period 1973 to 1980, which is to say that the current account was zero, on average, over this period.) It appears to be weak saving, rather than strong investment, that dominates the recent period.

Some have questioned whether the observed real interest rates provide a satisfactory way of thinking about exchange rate movements—the four-year ascent of the dollar as well as the prospect of reversal. I now consider two alternative approaches that have been proposed. One is the view that the appreciation of the dollar has been the result of a speculative bubble, rather than being attributable to fundamentals. Another is a model in which portfolio preferences, in particular attitudes about risk, are central to determining the exchange rate. In both cases, the theoretical insights are not intended to be original, but in both cases, some quantitative illustrations are offered that have novel implications.

Is the Dollar on a Bubble Path?

As early as 1982, Rudiger Dornbusch applied the notion of stochastic rational bubbles, first developed by Olivier Blanchard, to the current episode of dollar appreciation.[4] Assume that at any time, t, there is a probability P_t that in the coming month the bubble will burst and the spot exchange rate S_t will return to the long-run equilibrium level $\bar{S}_t$ that is determined by fundamentals. Then a small short-term interest differential, equal to the forward discount FD_t because of covered interest parity, is sufficient to support a large continuing overvaluation, measured by $\ln(\bar{S}_t/S_t)$, provided that the bubble path, on which the spot rate will remain for one more period with probability $1 - P_t$, constitutes continued appreciation at an exponential rate a_t, satisfying the following equation:

$$(1) \qquad FD_t = P_t \ln(\bar{S}_t/S_t) + (1 - P_t)(-a_t).$$

(Here S is defined as the price of foreign currency.) We can solve for the implicit probability of collapse,

$$(2) \qquad P_t = \frac{FD_t + a_t}{\ln(\bar{S}_t/S_t) + a_t}.$$

FD_t was about 3 percent per annum (0.25 percent per month) for the dollar against the deutsche mark or yen as of March 1985. Under the (extreme) hypothesis that all of that real appreciation has been due to a

4. Rudiger Dornbusch, "Equilibrium and Disequilibrium Exchange Rates," *Zeitschrift für Wirtschafts-und Sozialwissenschaften,* vol. 102, no. 6 (1982), pp. 573–99; Olivier Blanchard, "Speculative Bubbles, Crashes and Rational Expectations," *Economics Letters,* vol. 3, no. 4 (1979), pp. 387–89.

bubble, the dollar-mark exchange rate in fundamental equilibrium, $\overline{S}_t$, lies about 64 percent below its actual value.[5] On this assumption, we can estimate P_t as a function of a_t.

Almost all the models of stochastic bubbles have assumed a constant probability of collapse P_t. But empirically we can construct a different P_t for each month of recent history. It is necessary only to assume a_t constant at $\overline{a}$ and to estimate $\overline{a}$ by regressing $\ln S_t$ against a time trend. In an explicit bubble model of the level of the exchange rate, the rate of appreciation in the event of noncollapse would be a parameter determined by the derivative of the demand for the currency with respect to the expected rate of return.[6] A regression for the period January 1981–March 1985 shows an exponential time trend of 7.80 percent a year (0.65 percent a month).

Table 3 uses the estimated values of $\overline{S}$ and $\overline{a}$ to calculate P_t for each month. Note that this model has the counterintuitive implication that, as a currency appreciates and thus has farther to fall in the event of a collapse, the probability of collapse must be smaller in order to give the same expected rate of depreciation as in equation 1. As of March 1985, the probability of collapse is $(0.0025 + 0.0065)/(0.6400 + 0.0065) = 1.4$ percent. To find the probability that the bubble could have lasted T periods, we simply take the product of $(1 - P_t)$ for t running from 1 to T; this cumulative probability of noncollapse is also reported in table 3.[7]

5. The appreciation of the dollar against a trade-weighted average of trading partners' currencies is considerably less, especially to the extent that Japan and Canada are given large weights based on U.S. trade. But, somewhat counterintuitively, a smaller overvaluation estimate would make a sustained bubble *less* probable in the calculations that follow, in order to satisfy equation 2.

6. The errors in the time trend regression would have to be attributed to transitory fluctuations in fundamentals or in the coefficient on the exponential bubble term. If such fluctuations are thought to be permanent, the econometrics could be performed in first difference form. Furthermore, most bubble models specify a constant elasticity of currency demand rather than derivative, implying that it is the log of the exchange rate rather than the level that grows exponentially on a bubble path (relative to fundamentals). Richard Meese uses first differences of logs in his test for recurring stochastic bubbles; see "Testing for Bubbles in Exchange Markets: The Case of Sparkling Rates," *Journal of Political Economy* (forthcoming). Robert P. Flood and Peter M. Garber, "Market Fundamentals versus Price-Level Bubbles: The First Tests," *Journal of Political Economy*, vol. 88 (August 1980), pp. 745–70, showed how to test for the presence of a deterministic bubble.

7. Note that no special assumption of independence is needed in order to multiply the probabilities. Each P_t is the market's evaluation of the probability of collapse during the coming period conditional on the bubble having lasted to period t.

The probability that a bubble could have lasted to March 1985 is only 16 percent. Although this is evidence against the hypothesis that a bubble in fact explains the appreciation of the dollar,[8] it is not as low a probability as would be required to reject a hypothesis in a formal statistical test.

One might think that a more plausible alternative to a hypothesis attributing all of the dollar's real appreciation to a bubble is a hypothesis that attributes part to a bubble and part to the real interest rate or other fundamentals. But it turns out that this alternative hypothesis is *less* likely to be true. This is the consequence of the property of the model that, with the forward discount rate little changed over the period, P_t is larger the nearer the exchange rate is to equilibrium. For example, consider the hypothesis that at each point in time, half the real appreciation has been due to a bubble. Then to satisfy equation 2, P_t would have to be almost twice as high. As of March 1985 the probability of collapse would be 2.8 percent. The cumulative probability of noncollapse from January 1981 through March 1985 would be only 2 percent. Thus we can "reject at the 95 percent confidence level" the hypothesis that half the real appreciation is due to a bubble. We could reject at even higher confidence levels the hypothesis that one-quarter or any smaller (but finite) fraction of the appreciation has been a bubble. The possibility of recurring shorter term bubbles, however, remains.

Implications of Mean-Variance Optimization

Even if the appreciation of the dollar is not attributed to a speculative bubble but rather to the increase in the real interest differential or to other fundamentals, there remains the key question of how long it can continue. So far this paper has assumed that investors are indifferent between holding dollar assets and foreign assets that pay the same expected rate of return. But if investors around the world consider dollar assets to be imperfect substitutes for foreign assets, then a given expected rate of return will not be adequate to induce them to hold ever growing quantities of dollar assets at an undiminished value for the dollar, let

8. The probability that the bubble could have lasted until March 1985 is of course much higher if one assumes that it did not appear until later. For example, if we begin at August 1982, then the cumulative probability of noncollapse is 38 percent. (The exponential time trend is 9.76 percent a year.)

Table 3. Implicit Probability of Collapse in Deutsche Mark-Dollar Rate under Bubble Hypothesis, January 1981–March 1985

Month	*Nominal appreciation of dollar* $-\ln S_t$ (*percent*)[b]	*Real "overvaluation" of dollar* $-\ln (S_t/\bar{S}_t)$ (*percent*)[b]	*Forward discount* FD_t (*percent per year*)	*Probability of collapse*[a] P_t	*Cumulated probability of no collapse* $\prod_{t=1}^{T} (1-P_t)$
January 1981	−13.09	8.61	10.88	0.168	0.83
February 1981	−6.80	15.17	5.75	0.071	0.77
March 1981	−8.26	13.69	2.68	0.061	0.73
April 1981	−5.69	16.24	3.83	0.057	0.68
May 1981	0.13	22.51	7.04	0.053	0.65
June 1981	3.78	26.61	5.85	0.042	0.62
July 1981	6.52	29.87	7.14	0.041	0.59
August 1981	8.90	32.68	6.79	0.036	0.57
September 1981	2.75	27.04	5.12	0.039	0.55
October 1981	−1.67	22.43	4.69	0.045	0.53
November 1981	−2.81	21.09	2.78	0.041	0.50
December 1981	−1.32	22.56	2.33	0.036	0.49
January 1982	0.14	23.64	3.79	0.040	0.47
February 1982	3.38	26.87	5.32	0.040	0.45
March 1982	3.92	27.32	5.83	0.041	0.43
April 1982	4.71	28.27	6.34	0.041	0.41
May 1982	0.97	24.77	6.57	0.047	0.39
June 1982	5.96	29.88	6.38	0.039	0.38
July 1982	7.43	31.76	5.28	0.034	0.37
August 1982	8.02	32.61	2.61	0.026	0.36
September 1982	9.02	33.43	3.81	0.028	0.35
October 1982	10.06	34.35	3.58	0.027	0.34
November 1982	11.14	35.00	2.89	0.025	0.33
December 1982	5.59	28.77	3.32	0.032	0.32
January 1983	4.32	27.40	3.78	0.034	0.31
February 1983	6.00	28.99	3.36	0.031	0.30
March 1983	5.16	28.33	4.49	0.035	0.29
April 1983	6.44	30.01	4.61	0.034	0.28
May 1983	7.51	31.41	3.99	0.031	0.27
June 1983	10.81	34.69	4.61	0.029	0.26
July 1983	12.42	36.37	5.31	0.030	0.25
August 1983	15.64	39.57	5.10	0.027	0.25
September 1983	15.39	39.56	4.27	0.025	0.24
October 1983	12.91	37.32	4.24	0.026	0.23
November 1983	15.94	40.35	3.92	0.024	0.23
December 1983	18.35	42.66	4.06	0.023	0.22
January 1984	20.60	45.05	4.10	0.022	0.22
February 1984	16.64	41.24	4.09	0.024	0.21
March 1984	12.68	37.44	4.93	0.028	0.21
April 1984	14.51	39.58	5.32	0.027	0.20
May 1984	18.38	43.69	5.63	0.025	0.20
June 1984	18.03	43.31	5.95	0.026	0.19

Table 3 (*continued*)

Month	*Nominal appreciation of dollar* $-\ln S_t$ (*percent*)[b]	*Real "over-valuation" of dollar* $-\ln(S_t/\bar{S}_t)$ (*percent*)[b]	*Forward discount* FD_t (*percent per year*)	*Probability of collapse*[a] P_t	*Cumulated probability of no collapse* $\prod_{t=1}^{T}(1-P_t)$
July 1984	21.92	47.68	6.44	0.025	0.19
August 1984	23.23	49.56	6.59	0.024	0.18
September 1984	28.03	54.75	6.28	0.021	0.18
October 1984	29.40	55.84	5.15	0.019	0.17
November 1984	26.87	53.14	3.94	0.018	0.17
December 1984	30.53	56.72	3.22	0.016	0.17
January 1985	32.63	58.42	2.67	0.015	0.17
February 1985	36.61	62.40	2.62	0.014	0.16
March 1985	38.60	64.39	3.07	0.014	0.16

a. From equation 2, with trend logarithmic appreciation of 7.80 percent per year.
b. 1973–79 = 0.

alone at ever higher values for the dollar. We know that either the return differential will have to rise to induce investors to hold the growing quantities of dollars, or the value of the dollar will have to decline, or both. How important are these factors quantitatively? How much is it asking of investors to accept an additional $100 billion of dollar assets into their portfolios every year?

Efforts to estimate the degree of substitutability by regression of asset quantities and rates of return are seldom successful. As a source of additional information on the parameters in investors' asset-demand functions, there is little practical alternative to the theory of mean-variance optimization.

It can be shown that investors who maximize a function of the mean and variance of end-of-period wealth will allocate their portfolios according to

$$X_t = A + [\rho\Omega]^{-1} R_t, \tag{3}$$

where X_t is the share of the portfolio allocated to foreign assets (or a vector of shares allocated to the various foreign currencies); R_t is the expected return differential on foreign and dollar assets (or a vector of such differentials); Ω is the variance of the return differential (or a variance-covariance matrix); and ρ is the coefficient of relative risk aversion, which is assumed constant. Intuitively, an increase in the expected return on a particular asset will induce investors to shift more of their portfolios into that asset; but the more important investors consider risk diversification (that is, the larger is ρ or Ω), the less they will shift their portfolios in response to a given change in expected returns. In the special case where the prices of the goods in an investor's consumption basket are nonstochastic when expressed in the currency of the producing country, R_t reduces exactly to the exchange risk premium, defined as the expected logarithmic depreciation of the dollar, minus the interest differential:

$$R_t = s_t^e - FD_t, \tag{4}$$

and the constant term becomes:

$$A = \alpha\left(1 - \frac{1}{\rho}\right) + \frac{1}{2\rho}, \tag{5}$$

where α is the share of foreign goods in the consumption basket (or a vector of such shares).[9]

Equation 3 has implications for three questions of relevance. First, how must the preceding calculations in this paper, in particular the attribution of the real dollar appreciation to an increase in the long-term real interest differential, be modified to take into account the existence of the risk premium R_t? Second, in the absence of a forthcoming change in the U.S. monetary-fiscal policy mix, could foreign exchange intervention succeed in reducing the value of the dollar? Finally, in the absence of a forthcoming change in policy of any sort, could the present pattern

9. Derivations appear in Rudiger Dornbusch, "Exchange Rate Risk and the Macroeconomics of Exchange Rate Determination," in Robert G. Hawkins, Richard M. Levich, and Clas G. Wihlborg, eds., *The Internationalization of Financial Markets and National Economic Policy* (JAI Press, 1983), pp. 3–27, for the two-asset stochastic-price case; Paul Krugman, "Consumption Preferences, Asset Demands, and Distribution Effects in International Financial Markets," Working Paper 651 (National Bureau of Economic Research, March 1981), for the two-asset nonstochastic-price case; Jeffrey Frankel and Charles M. Engel, "Do Asset-Demand Functions Optimize over the Mean and Variance of Real Returns? A Six-Currency Test," *Journal of International Economics*, vol. 17 (November 1984), pp. 309–23, for the *n*-asset stochastic-price case; and Frankel, "In Search of the Exchange Risk Premium: A Six-Currency Test Assuming Mean-Variance Optimization," *Journal of International Money and Finance*, vol. 1 (December 1982), pp. 255–74, for the *n*-asset nonstochastic-price case.

of fiscal deficit, current account deficit, and dollar appreciation continue indefinitely?

THE NEGLIGIBLE MAGNITUDE OF THE RISK PREMIUM

The lure of technical sophistication has in the past blinded researchers, including myself, to a basic fact: equations such as (3) have strong implications for the magnitude of the risk premium R_t that transcend the particular econometric technique used for estimating variances and covariances. The unconditional monthly variance of the relative return on dollars—measured by appreciation plus the forward discount or interest differential—has been on the order of 0.001.[10] The conditional variance, which is what should matter for investor behavior, must be less than or equal to the sample variance. Thus we may take 0.001 as an upper-bound estimate of Ω in equation 3. (It is generally thought that very little of the unconditional variance can in fact be anticipated, so that the unconditional variance does not overstate the conditional variance by much.)[11] The coefficient of relative risk aversion, ρ, is thought to be in the neighborhood of two.[12] Taking the product ($\rho\Omega$), it follows from equation 3 that if an increase in the supply of foreign assets X_t equal to 1 percent of the portfolio is to be held willingly, it will have to increase the risk premium R_t by about 0.002 percent on a monthly basis, or a mere 0.024 percent per annum—just 2.4 basis points.

10. The precise figures are 0.00080 against the pound, 0.00099 against the franc, 0.00113 against the mark, and 0.00099 against the yen, for the period August 1973 to August 1980. The analysis in this section of the paper is from Jeffrey Frankel, "The Implications of Mean-Variance Optimization for Four Questions in International Finance," Conference on Implications of International Financial Risk, Arizona State University, March 15–16, 1985 (*Journal of International Money and Finance*, forthcoming).

11. See Jacob A. Frenkel and Michael L. Mussa, "The Efficiency of Foreign Exchange Markets and Measures of Turbulence," *American Economic Review*, vol. 70 (May 1980, *Papers and Proceedings, 1979*), pp. 374–81. Estimates of the conditional variance around inferred investor expectations are computed in Frankel and Engel, "Do Asset-Demand Functions Optimize?," and Frankel, "In Search of the Exchange Risk Premium."

12. Two important sources of evidence on the coefficient of risk aversion are Irwin Friend and Marshall E. Blume, "The Demand for Risky Assets," *American Economic Review*, vol. 65 (December 1975) pp. 900–922; and David M. Newberry and Joseph E. Stiglitz, *The Theory of Commodity Price Stabilization: A Study in the Economics of Risk* (Oxford University Press, 1981). The first is evidence from a cross-section of portfolio holders; the second is primarily evidence from producers.

Inverting equation 3 gives the risk premium directly as a function of the other parameters and X:

$$R_t = -\rho\Omega A + \rho\Omega X_t. \quad (6)$$

Because equation 5 shows $A < 1$, the constant term in the risk premium in equation 6 is even smaller in magnitude than the coefficient on X_t, $(\rho\Omega)$. Thus the risk premium is altogether quantitatively negligible in comparison with interest differentials on the order of 300 basis points. The implication is that it is perfectly legitimate to infer from the forward discount that, in the market's view, the dollar will depreciate at about 3 percent per year in expected value terms. This argument strengthens the rationale for using interest differentials in the Isard model and the bubble calculations described earlier in this paper. The mean-variance optimization theory also implies that the degree of substitutability between long-term bonds and short-term bonds or between bonds and equities, just as that between U.S. and European financial assets, is so high as to render risk premiums negligible.[13]

A closed-economy finance economist might wonder how capital mobility could be so high in the sense that it forces uncovered nominal interest parity to hold to within a few basis points, as explained above, and yet could be so low in the sense that it allows real interest differentials as large as 290 basis points, as shown in table 1, to persist for several years. We need not search far for the answer. For uncovered nominal interest parity to imply real interest parity, it is necessary that relative purchasing power parity hold so that the rate of currency depreciation is expected to equal the inflation differential. It is well known that purchasing power parity does not in fact hold empirically, even approximately and even over ten-year horizons.

It is sometimes claimed that if capital were perfectly mobile, a decline in national saving that put incipient upward pressure on the real interest rate would attract a sufficiently large capital inflow to prevent any observed rise in the real interest rate or crowding out of domestic

13. In the closed-economy context, the same argument implies that an increase in the supply of government debt of 1 percent of U.S. household wealth raises the risk premium on long-term government bonds by only 0.84 basis point over the short-term interest rate. See Frankel, "Portfolio Crowding Out Empirically Estimated," *Quarterly Journal of Economics,* forthcoming. Olivier Blanchard and Lawrence Summers agree that these numbers are small and thus that substitutability is high. See Blanchard and Summers, "Perspectives," p. 312.

investment.[14] But results from international finance imply that the observed high correlation of domestic saving and investment and the observed failure of real interest parity have little to do with world capital markets and much to do with world goods markets. International portfolio investors have reason to arbitrage away gaps in countries' nominal rates of return when expressed in a common numeraire; but they have no reason to arbitrage away a gap between the domestic rate of return expressed in terms of domestic goods and the foreign rate of return expressed in terms of foreign goods. One could say that the U.S. real interest rate is high because the dollar is overvalued and is expected to depreciate in real terms (because expected dollar inflation in U.S. goods is lower than in foreign goods), as easily as that the dollar is overvalued because the U.S. real interest rate is high.

The Effect of Foreign Exchange Intervention

If the high real value of the dollar is indeed attributable to the high real interest differential, and if the high real interest differential is attributable to the monetary-fiscal policy mix in the United States relative to abroad, the prospects for an early reversal might appear dim. If we take it as a constraint that the monetary-fiscal policy mix will be such as to keep interest rates from falling, does foreign exchange intervention offer an alternative way of bringing down the value of the dollar?[15]

14. Martin Feldstein and Charles Horioka, "Domestic Saving and International Capital Flows," *Economic Journal*, vol. 90 (June 1980), pp. 314–29; and Blanchard and Summers, "Perspectives," p. 297.

15. The subject of foreign exchange intervention is particularly topical because two recent events, a declaration by a G-5 finance ministers' meeting in Washington on January 17, 1985, and the turnover of top officials in the U.S. Treasury Department, were interpreted by the financial press as perhaps marking an increased willingness of U.S. authorities to intervene. Subsequent dollar sales (most on February 27 and the following two days) have been estimated at between $4 billion and $5 billion, some of it by the Federal Reserve, but most by European central banks (*Wall Street Journal*, March 4 and 11, and Associated Press, March 8). This would represent an increase in the supply of dollar assets of about 0.3 percent. (Gross U.S. federal debt outstanding at the end of 1984 was $1,577 billion, from *Economic Indicators*, February 1985; this includes monetized debt but excludes dollar debt issued by foreign governments.) It also represents a decrease in the supply of foreign assets of the same magnitude, so that the total effect on the relative asset supply is larger than 0.3 percent.

The difficulty of finding a statistically significant risk premium supports the proposition that domestic and foreign bonds are close substitutes. It is tempting to reason that as the degree of substitutability becomes very high and the effect of intervention on the risk premium becomes very small, the effect of intervention on the level of the exchange rate must also vanish. But this is one of those cases in which there may be no such thing as being "just a little bit pregnant." Theory says that the limiting case of perfect substitutability and a zero risk premium would hold only in the case of risk neutrality, or the netting out of all assets as being "inside." If this limiting case holds, then it is indeed true that intervention has no effect on either the risk premium or the exchange rate. But, as I have just shown, effects on the risk premium are extremely small in magnitude even in a more realistic model where bonds are outside assets and there is a conventional degree of risk aversion.

It is true that with high substitutability, it requires very small changes in interest rates to accommodate changes in supplies of assets without changing exchange rates. On the other hand, in the absence of any changes in interest rates, under conventional assumptions about asset demands, changes in supplies would require nonnegligible changes in exchange rates. I now illustrate this point more formally.

The share of the total portfolio W allocated to foreign assets F, with dollar value SF, is defined as

$$X = SF/W, \tag{7}$$

where X depends on the risk premium R as specified in equation 3. The share allocated to dollar assets D is

$$(1-X) = D/W. \tag{8}$$

Taking the ratio of equation 7 to equation 8, we can represent the spot rate in terms of relative asset supplies and relative asset demands:

$$S = \frac{D}{F} \frac{X(R)}{1-X(R)}. \tag{9}$$

When the relative supply of dollar assets D/F is increased with interest rates held constant, the dollar will depreciate.[16] If there is no effect on

16. Intervention that holds the interest rate constant is equivalent to sterilized intervention, which holds the money supply constant, only in the special case (as in an IS-

the expectations term contained in R, so that $X(R)$ is constant, then the effect on S will be proportionate to the change in D/F. If, instead, expectations are altered by the increase in dollar assets, the effect will be larger. If the increase in D leads rational investors to expect further increases in D in the future, then they will expect further depreciation in the future and respond by decreasing today the share of their portfolio they wish to allocate to dollars; the effect on S will be *more* than proportionate. For example, if the expected permanent rate of growth of D/F goes up as little as 0.1 percent per annum, our 0.02 estimate of $(\rho\Omega)$ implies that the demand X will go up by 5.0 percent of W and that S will go up by at least 20.0 percent.[17] This reflects the great sensitivity of asset demands to expected rates of return in the model when ρ is as low as 2.0. If the degree of substitutability is less than the value implied by the mean-variance optimization theory, the effect will be smaller.

The implication of this analysis is that a one-shot intervention can affect exchange rates, but, by conventional measures, the dollar amounts of intervention would have to be very large. On the other hand, a credible policy of increasing the expected permanent growth rate of dollar assets relative to foreign assets can have substantial effects, although it may have other undesirable consequences, for example, for inflation. If asked for recommendations on how to bring the dollar down, we are left with little practical alternative to a shift in the monetary-fiscal mix to decrease the real interest rate.

LM model) where money demand depends on the interest rate but not on the supply of bonds, and where the price level does not respond to the exchange rate. In a full portfolio-balance model, intervention would have to increase the supplies of both bonds and money to keep the interest rate constant. But the issue of how the demand for dollar assets divides up between money and bonds cannot be answered by the framework of mean-variance optimization. This is why I simply assume that monetary policy is whatever it must be to keep interest rates constant.

17. Taking logs in equation 9 and differentiating, we have

$$\begin{aligned} \mathrm{d} \ln S/\mathrm{d}s^e &= \mathrm{d} \ln [X(R)]/\mathrm{d}s^e - \mathrm{d} \ln [1 - X(R)]/\mathrm{d}s^e \\ &= \left(\frac{1}{X} + \frac{1}{1-X}\right) \mathrm{d}X(R)/\mathrm{d}s^e, \end{aligned}$$

where s^e is the expected rate of currency depreciation, equal to the expected rate of change of D/F in the steady state. If initially $X = 1 - X = \frac{1}{2}$, then the percentage effect on S is four times the effect on X. Otherwise it is even greater.

Is the Present Course Sustainable?

Even if there is neither a change in macroeconomic policy nor a bubble collapse, the flows presently created by the government deficit and current account deficit may themselves bring the dollar down. A \$200 billion budget deficit works to depreciate the dollar at a rate proportionate to the rate of increase in dollar debt, if equation 9 holds and the risk premium does not change. But foreign governments are creating debt at similar rates. Assume that the two factors roughly cancel out, so that D/F is unchanged. There is still the fact that the U.S. current account deficit is reducing the wealth of U.S. residents at the rate of \$100 billion a year and transferring this wealth to foreign residents. Foreign residents have a much lower propensity to hold wealth in the form of dollar assets than do U.S. residents, on the assumption that equation 5 holds, that foreign residents consume more foreign goods than U.S. residents do, and that everyone has a coefficient of risk aversion ρ greater than one. In equation 5, if α is close to zero for U.S. residents and close to one for foreign residents and ρ is two, then the difference in A for the two classes of residents is close to one-half. If R is unchanged in equation 3, the effect of a current account deficit equal to 1 percent of world wealth is to depreciate the dollar by close to $\frac{1}{2}\{[1/X] + [1/(1-X)]\}$ percent, half the effect of a budget deficit of equal magnitude. If world wealth is calculated (extremely conservatively) at twice U.S. federal government debt,[18] then $X = \frac{1}{2}$, and a \$100 billion current account deficit that redistributes 3.2 percent of world wealth annually should depreciate the dollar by close to $\frac{1}{2} \times 4 \times 3.2 = 6.4$ percent annually.

The foregoing calculation is predicated on the assumption of no change in the risk premium R, either in the interest differential or in the

18. The outstanding stock of general government debt of the seven largest countries in 1984 is projected at roughly \$3,888 billion; central government debt in 1982 is projected at about \$2,465 billion. See *OECD Economic Outlook*, no. 35 (Paris: OECD, July 1984), table 4, p. 20, and table 9, p. 29; and *OECD Historical Statistics 1960–1982* (Paris: OECD, 1984), p. 14. The numbers would be higher if other countries' debts were included and if equities and other real assets were included. Equities alone are valued at \$2,941 billion for the total of twenty countries, as of December 31, 1984. See *Capital International Perspective* (Geneva, Switzerland, January 1985). The effect of the U.S. government deficit and current account on the exchange rate would diminish proportionately.

expected rate of depreciation. In the short run, anything can happen, depending on what happens to expectations: if investors' expected rate of dollar depreciation declines over time, then it could offset the adverse flow factors, and the dollar could in fact remain strong. But would such a path for the expected and actual exchange rate be realistic in the long run? Or must it become obviously unjustifiable, and increasingly so, as time passes?

Our estimate of $\rho\Omega = 0.02$ suggests that the 6.4 percent effect of the \$100 billion current account deficit could be absorbed without any decline in the dollar, if instead R were forced up at 0.13 each year. The interest differential could easily go up by 13 points each year; the number is so small as to be not even noticeable at first. But it does seem a situation that cannot proceed forever, especially if one considers that the U.S. budget and current account deficits would grow with interest payments. This suggests strongly that the dollar must come down eventually. One would then expect that investors' perceptions of the long-run fate of the dollar would bring about the event in the shorter run.