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# SIX POSSIBLE MEANINGS OF "OVERVALUATION": THE 1981-85 DOLLAR

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# Six Possible Meanings of "Overvaluation": The 1981-85 Dollar

## 1 Introduction

There is near-unanimity that for several years the dollar has been greatly overvalued. As early as 1982, Bergsten (p. 1) warned:

> The dollar is overvalued by at least 20 percent. . . . These imbalances are as great as those in the final, breakdown stage of the Bretton Woods system of fixed exchange rates. They add significantly to national growth problems, both in countries with overvalued currencies (which suffer competitive losses) and countries with undervalued currencies (which are driven to adopt restrictive monetary policies).

According to more recent calculations of Williamson (1985, pp. 85-86),

> The peak overvaluation of the dollar in late February and early March 1985 was more than 40 percent, . . . about double the estimated overvaluation of the dollar which brought the collapse of the Bretton Woods system of fixed parities in the early 1970s.

What does this word "overvalued" mean? Economists have an instinctive aversion to it. But it is clear that the value of the dollar during the first half of the 1980s was indeed very high, not only relative to its past history but relative to such long-term fundamentals as relative price levels or money supplies and income levels. This fact is documented in section 2 below.

This essay proposes six possible and very distinct definitions of the words "overvaluation" and "undervaluation," or the equivalently ambiguous term "disequilibrium," and uses them as an organizing principle to discuss recent theoretical and empirical research in the economics of exchange rates.

First, these words could refer to *nonclearing of financial markets*, where, because of barriers to capital movements, the exchange rate is at a level at which the supply of foreign exchange does not equal the demand.

Second, "overvaluation" could mean that a currency's private supply exceeds its private demand and that *foreign-exchange intervention* by one or more central banks is supporting the value of the currency at a level higher than it would be in a completely free market. These two definitions are discussed in section 2.

I would like to thank Kenneth Froot for extremely efficient research assistance; Charles Engel and Steven Kohlhagen, in addition to the participants at a General Accounting Office seminar on exchange rates in Washington on February 18, 1983, for useful comments and suggestions; the National Science Foundation (under grant number SES-8218300) and the Institute for Business and Economic Research at the University of California, Berkeley, for research support; and Laura Knoy of the Institute for International Economics for data.

Third, "overvaluation" could describe a currency with a value that is higher than dictated by long-term fundamentals because it is determined by short-term macroeconomic fundamentals such as the real interest rate. This is the phenomenon of *overshooting* discussed in section 3.

Fourth, "overvaluation" could mean that speculators can expect to make money by selling the currency forward. This is the possibility of *irrational expectations* discussed in section 4.

Fifth, "overvaluation" could mean that, even if expectations are rational, the exchange rate nevertheless diverges from the equilibrium determined by fundamentals, short-run as well as long-run. This is the possibility of *speculative bubbles* discussed in section 5.

Sixth, "overvaluation" could pertain to the real effects of the exchange rate rather than to its determinants. Under this interpretation, the loss in competitiveness by domestic industries that export or that compete with imports is undesirable. Or the reverse effects in foreign countries are undesirable for them. The possibility of overvaluation in a *normative* sense is addressed in section 6.

A distinction that proves to be necessary throughout is between long-term swings and short-term volatility in exchange rates. Both have been large. To anticipate the conclusions in the essay regarding long-term swings, the 1980-85 real appreciation of the dollar is attributed primarily to an increase in the U.S. real interest rate relative to foreign real interest rates, as in the overshooting model of exchange rates. The increase in the U.S. real interest rate is in turn attributed to two causes, corresponding to the two halves of the period: first, the sharp tightening of U.S. monetary policy that was first signaled in October 1979 and that ended in mid-1982, and, second, the emergence of record federal budget deficits that were a source of growing concern from 1982 to 1985. Two other possibilities, irrational expectations and rational speculative bubbles, are rejected as major explanations for the dollar overvaluation. This still leaves to each a possible role in causing short-term exchange-rate volatility.

As to welfare effects, discussed in section 6, high short-term exchange-rate volatility which generates uncertainty must have a resource cost, but there is no evidence that it is large. The welfare effects of longer-term swings are more controversial. An argument is presented that by reallocating output among sectors, each of which is characterized by its own concave supply curve, a large real appreciation can affect the terms of the aggregate tradeoff between output and inflation. When a country adopts contractionary monetary policies to fight inflation, as the United States did in 1980-82, the tendency of the currency to appreciate has a favorable effect on the tradeoff. It serves to balance the contraction between the sectors producing traded and nontraded goods, mitigating the loss in total output for any given level of inflation. But when a real appreciation is the result of an expansionary fiscal policy, as has been the case for the United States in recent years, the resulting squeeze on the traded-goods sector produces a "lopsided recovery," with a lower level of total output for any given level of inflation.

## 2 Long-Term Monetary Fundamentals

The monetarist model is a useful starting point for considering the determination of exchange rates on the basis of fundamental variables (see, e.g., Frenkel, 1976). One component of this model views the bonds of different countries as essentially perfect substitutes in investors' portfolios and views barriers to instantaneous adjustment of portfolios as low. As a consequence, uncovered interest-rate parity holds: international arbitrage equates the nominal-interest-rate differential to the expected rate of depreciation. The second component of the model views the goods of different countries as essentially perfect substitutes and views barriers to instantaneous adjustment in goods markets as low. As a consequence, purchasing-power parity holds: the exchange rate is given by the ratio of domestic to foreign price levels. The price levels are in turn given by nominal money supplies relative to real money demands, the latter usually modeled as functions of real income levels and rates of return.

The empirical evidence of the last ten years is all against the assumption of purchasing-power parity, and in turn against the monetarist model, even as an approximate description of short-run or medium-run reality. Two episodes in the recent history of the dollar stand out.

In 1977-78, the dollar depreciated sharply against the yen, the mark, and other European currencies. Contrary to the purchasing-power-parity doctrine, the change in the exchange rate was not at all matched by a change in relative price levels. That is, the dollar depreciated in real terms. Nor did the change in the exchange rate correspond to a change in relative money supplies. Indeed, central banks in Europe and Japan were allowing their money supplies to grow at a substantially *faster* rate than in the United States. While one could always explain the fall in the dollar's value tautologically as a fall in relative U.S. money demand, real income (the most important conventional determinant of money demand) was actually increasing faster in the United States than abroad. The first column of Table 1 shows the relevant numbers.

From 1980 to 1985, the entire process was reversed. The dollar appreciated sharply against the yen, the mark, and other European currencies. The change in the exchange rate was again not matched by a change in relative price levels. The dollar appreciated enormously in real terms. Nor did the change in the exchange rate correspond closely to a change in relative money supplies. While U.S. money growth in the 1980-82 period did drop below the

TABLE 1
CHANGES IN THE VALUE OF THE DOLLAR AND
ITS MONETARY DETERMINANTS, 1976-84
*(percentage rate of change in the annual average)*

| | *1976-78* | *1978-80* | *1980-82* | *1982-84* |
|---|---|---|---|---|
| Effective exchange value of the dollar:[a] | | | | |
| Nominal | − 6.5 | − 2.7 | +15.5 | +9.0 |
| Real | − 6.9 | − 0.3 | +14.8 | +7.4 |
| Consumer price index: | | | | |
| U.S. | 7.1 | 12.4 | 8.2 | 3.8 |
| Average of trading partners | 7.4 | 9.4 | 8.8 | 5.4 |
| Difference | − 0.3 | + 3.0 | − 0.6 | −1.7 |
| Money supply: | | | | |
| U.S.[b] | 7.9 | 6.9 | 6.8 | 9.0 |
| Average of trading partners | 13.8 | 5.8 | 9.1 | 8.8 |
| Difference | − 5.9 | − 1.1 | − 2.3 | −0.2 |
| GNP: | | | | |
| U.S. | 5.3 | 1.3 | 0.2 | 5.3 |
| Average | 3.6 | 3.1 | 1.1 | 2.7 |
| Difference | + 1.7 | − 1.8 | − 0.9 | +2.6 |

[a] Federal Reserve Board's multilateral exchange rate.

[b] M1 (from *International Economic Conditions*, Federal Reserve Bank of St. Louis).

NOTE: Numbers for trading partners are an average of six countries (Canada, France, Italy, Japan, United Kingdom, and West Germany) using 1980 GDP weights (from OECD *Economic Outlook*).

SOURCES FOR OTHER STATISTICS: IMF *International Finance Statistics* and International DRI FACS financial data base.

growth rate for an average of its trading partners, the difference was only a small fraction of the size of the dollar appreciation, as shown in the third column of Table 1. And from mid-1982 until March 1985, the dollar continued to appreciate even though money growth was as rapid in the United States as abroad. Dornbusch (1982, p. 6) put the nail in the coffin: "By now there are, I believe, no more serious claims for the empirical relevance [of the simple monetarist model]."

The large swings that exchange rates have experienced in the absence of corresponding movements in the fundamentals have led some economists to conclude that exchange rates are not determined by fundamentals. The very high real value of the dollar over the most recent four years is considered to be unjustified.

The numbers clearly support the claim that the dollar is overvalued in some sense. It is no good giving the noninterventionist's automatic reaction that whatever rate the market comes up with must by definition be the correct rate. But when we use the term "overvalued," we must be prepared to explain what we mean by it. Let us consider further the first two meanings of that term or of the similar term "disequilibrium."

First, "disequilibrium" is often used in economics to mean that the price does not equate current supply and demand. But given the very low levels of transactions costs, capital controls, and other barriers to capital movements among the United States, Canada, Germany, the United Kingdom, and now Japan,[1] such a disequilibrium can be ruled out. Individuals are holding the portfolios they desire. (Exceptions should be made for France and other countries with effective capital controls.) If there is any sense in which the rate can be said to be out of equilibrium, it must be in the alternative mathematical sense of equilibrium in which the exchange rate is not changing over time or at most is changing at a long-run steady-state rate.

According to the second possible meaning of currency overvaluation, the central bank is intervening in the foreign-exchange market, adding to the market demand for the currency in order to keep its price at a higher level than it would otherwise be. Under a system of fixed exchange rates, the central bank is committed to maintain the price by buying up as much of the currency as is necessary, which is the excess supply left over from the private components of the balance of payments. A balance-of-payments deficit is often referred to as a disequilibrium, and it is one in the sense that the situation cannot persist indefinitely, because the central bank will eventually run out of foreign-exchange reserves.

Under floating exchange rates, the overall balance-of-payments deficit is a much less useful concept. It has usually been U.S. policy not to intervene in the foreign-exchange market except to calm disorderly markets, which implies an overall balance of payments equal to zero. While many foreign central banks have continued to intervene in the market, it is no more accurate to say that they are accommodating or financing an imbalance exogeneously determined by the private sector than to say that their exogeneous intervention is what allows the private sector to run an imbalance. In any case, intervention in recent years, when it has taken place, has generally been "leaning against the wind." Central banks have fought the 1980-85 appreciation of the dollar by selling dollar reserves in exchange for foreign currencies, rather than the reverse. (This includes Japan; it is ironic that the Japanese government has sometimes been accused of manipulating the yen downward.) It fol-

[1] Contrary to some perceptions, Japan removed most of its controls on capital inflow in 1979. Frankel (1984) analyzes U.S. pressure, from October 1983 to May 1984, to induce Japan to accelerate liberalization of its financial markets, with the supposed goal of reducing the "undervaluation" of the yen.

lows that the United States has technically been running a *surplus* on the overall balance of payments, defined as the sum of the current-account balance and private capital-account balance—not a deficit, as popularly supposed.[2] Foreign countries are the ones running overall balance-of-payments deficits, financed by central banks' purchases of their currencies. If the dollar is considered currently to be overvalued, then the intervention definition cannot be the one that is meant.

Having thus dismissed the first two possible meanings of overvaluation, the remainder of this essay will consider the other four in more detail, beginning with overshooting and finishing with the normative question. Along the way, we will have the opportunity to visit many of the sites where recent theoretical and empirical research on the economics of exchange rates has been taking place.

## 3 Overshooting: Overvaluation Due to Short-Term Fundamentals

The third possible meaning of overvaluation is that one can predict on the basis of economic fundamentals that the currency will in the future decline toward some long-run equilibrium. In other words, the exchange rate is subject to dynamics that reflect the influence of short-run fundamentals. This is the phenomenon of overshooting.

Our third definition of overvaluation corresponds to Williamson's (1985, pp. 13-17) definition of misalignment: "a deviation of the market rate from fundamental equilibrium." Williamson intends the definition to connote the criterion for a devaluation under the Bretton Woods system:

> Although the term was never formally defined, the IMF's (1970) report on the exchange-rate system implied that fundamental disequilibrium was a situation in which a country could not expect to generate a current account balance to match its underlying capital flow over the cycle without, on the one hand, depressing its income below "internal balance" or imposing trade controls for payments purposes or, on the other hand, importing inflation. . . . [This concept] is also what people usually have in mind when they describe rates as "overvalued" or "undervalued." . . . (pp. 13-14)

The deviation from fundamental equilibrium is seen to hold even though the exchange rate is in "market equilibrium" (there is no intervention, that is, no

[2] The overall balance of payments obtained by adding the reported current-account deficit to the reported private capital-account surplus has been a large negative number in recent years. However, the statistical discrepancy, almost all of which belongs in the private balance of payments rather than under official reserve transactions, has been approximately as large. In 1982 the statistical discrepancy was the larger of the two, that is, central banks reported net losses of dollar reserve assets. This has not been true continuously. In 1984 central banks reported a slight net acquisition of dollar reserve assets. But this is explained by interest earned by foreign central banks on their dollar reserves. Thus it remains true that central banks have sold dollars, not bought them. Such foreign-exchange intervention has been increasingly evident in 1985.

overvaluation under our second definition). It is also seen to hold even though the exchange rate is very possibly in what Williamson calls "current equilibrium," in that it is properly valued given such temporary factors as interest rates and net foreign-asset positions (the short-run fundamentals that drive the exchange rate away from its fundamental equilibrium, that is, make it overvalued under our third definition).

Overshooting is associated with volatility of the exchange rate. But it is consistent with market efficiency, at least in the sense that one cannot expect to make excess (risk-adjusted) profits out of the dynamics. This will be the case when the expected future depreciation is fully reflected in a positive forward discount and interest-rate differential (with or without a risk premium), which is usually true in the overshooting models. It is another question whether overshooting is consistent with efficiency in the sense that the market rate signals a desirable allocation of real resources in the economy, given macroeconomic policy.

There are two major directions in which the simple monetarist model discussed above can be altered to make it more realistic and give it dynamics that arise from fundamentals so as to produce overshooting. In each case, the dynamics must come from a variable that is not free to jump at a moment in time—so that all the impact of, say, a decrease in the money supply is reflected in the exchange rate instead—but that does adjust gradually over time, thus reversing the initial change in the exchange rate.

*Sticky Prices and the Degree of Overshooting*

The first direction is to relax the assumption of purchasing-power parity. The variable that is not free to jump is the price level. With sticky prices, a decrease in the nominal money supply is in the first instance a decrease in the real money supply. It raises the real interest rate, inducing an incipient capital inflow and an appreciation of the currency. Both the high real interest rate and the loss in competitiveness reduce the demand for goods and labor. If the market is foresighted, it realizes that the slack economy will reduce prices below their previously expected path, eventually undoing the contraction in the real money supply and with it the overvaluation of the currency. Under the rational-expectations hypothesis, this expectation of future depreciation must be sufficient to offset the interest-rate differential, so that investors cannot expect to make excess profits by holding the assets of one country or the other. The fact that the currency initially appreciates to a level in excess of what is expected in the long run is referred to as exchange-rate overshooting.

This is exactly what happened in the U.S. economy, beginning in 1980. As a result of a reduced rate of growth of the money supply, interest rates rose. The U.S. long-term government bond rate, for example, averaged 13.3 percent over the 1981-82 period, a two-point increase relative to 1980.

It is often difficult to measure the real interest rate, because the expected inflation rate is not directly observable. For this reason, real interest rates are calculated in Table 2 under a wide variety of alternative assumptions. By all four available measures of expected inflation, the expected U.S. inflation rate fell sharply during the 1981-82 period of monetary stringency, so that the real interest rate rose even more than the nominal rate. Nominal and real interest rates also rose among U.S. trading partners, but not by as much. The *differential* between the U.S. real interest rate and a weighted average of those of trading partners (the United Kingdom, France, West Germany, and Japan) rose by 2 to 3 percent in 1981-82, as we can see by various measures in the lower third of Table 2. Furthermore, the differential between the rate of return on equity capital in the United States and abroad also rose sharply, measured by either the dividend/price ratio or the earnings/price ratio in Table 2. In response to the shift in real rates of return, foreigners' demand for U.S. assets increased and the dollar began its steep ascent. Because U.S. producers lost competitiveness on world markets as the dollar rose, the burden of the monetary contraction was not borne exclusively by residential construction, business investment, and other interest-sensitive sectors but was transmitted to the tradable-goods sector as well. Partly as a result, the 1981-82 recession was the deepest of the postwar period.

The overshooting story (Dornbusch, 1976, and Frankel, 1979) is by now a very familiar one. It can be used to explain not only large medium-term swings but also high short-term volatility, as new information about interest rates and other variables comes in every day. However, one point that is occasionally missed is that the instability implied by overshooting is *not* a consequence of "speculation" per se, that is, of the introduction of expectations into the model. Rather, it is solely a consequence of slowly adjusting goods markets.

Let us consider the volatility issue, first by going back to the old elasticity-pessimism view according to which export and import elasticities are so low that the Marshall-Lerner condition fails. If a floating exchange rate were called upon to equilibrate the trade balance by itself, the system would be unstable. A depreciation would raise the cost of imports and cause an initial trade deficit, which is an excess demand for foreign exchange, causing further depreciation, and so on. The empirical evidence is that trade elasticities are in fact high enough to imply technical stability, once some time has been allowed to elapse. But one still needs to introduce capital mobility to get the country through the short run, say the first year. Foreigners will lend to the country to finance its transitory trade deficit. In this sense, capital mobility stabilizes the foreign-exchange market.

What about *speculative* capital flows, considered to be destabilizing by Nurkse (1944) and others since? Speculation presumably refers to investors

TABLE 2

INTEREST-RATE DIFFERENTIALS BETWEEN U.S. AND FOREIGN ASSETS, AND OTHER MEASURES OF THE EXPECTED RATE OF DOLLAR DEPRECIATION, 1976-85

*(percent per annum)*

| | *1976-78* | *1979-80* | *1981-82* | *1983-84* | *1985* |
|---|---|---|---|---|---|
| Expected nominal rate of depreciation: | | | | | |
| 1.1 One-year interest-rate differential[a] | −0.48 | 2.29 | 3.00 | 1.73 | 1.15 |
| 1.2 One-year forward discount | 0.18 | 2.57 | 3.34 | 1.85 | 1.32 |
| 1.3 Ten-year interest-rate differential | −0.50 | 0.56 | 1.91 | 2.47 | 2.92 |
| 1.4 *Economist* survey[b] | na | na | 8.57 | 8.60 | 7.12 |
| 1.5 American Express survey[c] | 0.64 | na | 6.67 | 6.99 | na |
| Expected inflation-rate differential: | | | | | |
| 2.1 One-year lag | −1.01 | 3.54 | 0.88 | −0.35 | 0.06 |
| 2.2 Three-year distributed lag | −1.96 | 2.70 | 1.89 | −0.18 | −0.16 |
| 2.3 DRI three-year forecast[d] | na | 2.20 | 0.96 | 0.23 | 0.15 |
| 2.4 OECD two-year forecast[e] | 1.42 | 2.24 | 0.62 | 0.61 | −0.20 |
| 2.5 American Express survey[f] | −0.75 | na | 4.11 | 2.68 | na |
| Expected real rate of depreciation: | | | | | |
| 1.1 − 2.1 One-year interest-rate differential | 0.53 | −1.24 | 2.12 | 2.09 | 1.08 |
| 1.3 − 2.2 Ten-year with distributed lag | 1.47 | −2.15 | 0.02 | 2.64 | 3.08 |
| 1.3 − 2.3 Ten-year with DRI forecast | na | −1.64 | 0.95 | 2.24 | 2.77 |
| 1.3 − 2.3 Ten-year with OECD forecast | −1.92 | −1.68 | 1.29 | 1.86 | 3.12 |
| 1.5 − 2.5 American Express survey | 1.39 | na | 2.56 | 4.31 | na |
| Dividend/price ratio[g] | na | 1.10 | 1.79 | 1.65 | 1.80 |
| Earnings/price ratio[g] | na | 1.60 | 3.99 | 2.60 | 3.09 |

[a] Calculated as log $(1 + i)$. 1985 contains data through June. Rates for Japan are not available for 1976-77.

[b] Available at 24 survey dates (see Table A-1 in Frankel and Froot, 1985). From *Economist Financial Report*.

[c] Available at 11 survey dates (see Table A-2 in Frankel and Froot, 1985). From *American Express Bank Review*.

[d] Averages of same 24 dates as in footnote b, from DRI forecasts.

[e] 1976-78 is only December 1978. 1985 is June 1985, from OECD *Economic Outlook*.

[f] Available at same 11 survey dates as footnote c, for the United States, United Kingdom, and West Germany. Available at only 4 survey dates (1976-78) for France.

[g] End-of-quarter averages. 1979-80 includes data only for 1980. 1985 is end of quarter I, 1985. Foreign ratios represent the aggregate of Europe, Australia, and the Far East, from *Capital International Perspective*, Geneva.

NOTE: The foreign variables are GNP-weighted averages of France, Japan, United Kingdom and West Germany, unless otherwise specified.

SOURCES FOR OTHER STATISTICS: IMF *International Financial Statistics* and Data Resources, Inc., International DRI FACS financial data base.

acting in response to expectations of future changes in the exchange rate. But, given slow adjustment in goods markets and rapid adjustment in asset markets, the introduction of expectations turns out to *reduce* exchange-rate volatility. A decrease in the money supply must be met, one way or another, by a decrease in the demand for money. The Mundell-Fleming model of perfect capital mobility had no role for expectations. The domestic interest rate was completely tied to the foreign interest rate. In that model, a decrease in the money supply had to produce an appreciation large enough to induce a fall in output sufficient to lower money demand. As Niehans (1975) pointed out, the fact that trade elasticities are low in the short run means that the requisite change in the exchange rate would have had to be enormous. Introducing the possibility of expected future depreciation allows the domestic interest rate to rise above the foreign interest rate, thus producing some of the necessary fall in money demand—it need not all come from reduced output. If output need not fall as much, then the currency need not appreciate as much. Thus rational speculation is stabilizing.

As the upper third of Table 2 shows, U.S. interest rates, both long-term and short-term, rose relative to foreign interest rates in 1981-82. The differential between long-term nominal interest rates (row 1.3) continued a relatively steady upward trend in 1983-85. The short-term differential (row 1.1) came back down some, but it too remained positive throughout the 1981-85 strong-dollar period. Equivalently, reflecting covered interest-rate parity, the dollar has consistently sold at a discount on the forward market, as is also reported in Table 2 (row 1.2). This implies that investors have consistently held expectations of future depreciation. If investors are acting on the basis of these expectations, then speculation is subtracting from the demand for the dollar and thus reducing the extent of overvaluation today.

### *Portfolio Balance and the Effect of the Current Account*

Besides relaxing the assumption of purchasing-power parity that follows from perfect substitutability of domestic and foreign goods in consumption, the simple monetarist model can be altered in a second major direction. We relax the assumption of uncovered interest-rate parity that follows from perfect substitutability of domestic and foreign bonds in investors' portfolios. This immediately invalidates the use in Table 2 of nominal interest-rate differentials to measure expected depreciation. There is a gap between the two variables, which is usually identified as a risk premium. However, there are other ways to measure exchange-rate expectations. The *Economist Financial Report* has surveyed 13 leading international banks six times a year since 1981, and American Express has conducted a survey of 250 to 300 central and private bankers, corporate treasurers, and economists more irregularly since 1976. Table 2 reports the weighted average of one-year expected depreciation of the dollar against the four major foreign currencies in rows 1.4 and 1.5. (Both surveys also cover the Swiss franc, but it is excluded from the calculations for purposes of comparability with the other lines in Table 2.) These numbers show an even greater increase in expected depreciation than do the interest-rate differentials. The American Express data show that the rate of expected depreciation of the dollar was close to zero in the period 1976-78 [3] but turned sharply positive in the 1980s. Both measures show an expected rate of depreciation in excess of 6 percent since 1982. Thus we need not rely on the interest-rate differential or forward discount to make the argument that in the 1980s speculation has worked to reduce the value of the dollar relative to what it would otherwise have been, rather than to increase it as is widely believed.

When we relax the assumption of perfect substitutability, investors are seen to balance their portfolios among all sorts of assets, including different countries' bonds, on the basis of expected returns. In the portfolio-balance approach, the variable that is not free to jump at a moment in time is not the price level but the level of domestic claims on foreigners or, more generally, the worldwide distribution of wealth. A decrease in the money supply in this case leads to a fall in domestic demand for foreign assets, both because it constitutes a fall in the overall supply of domestic assets and because it increases the domestic interest rate. With the supply of foreign assets fixed at a moment in time, the fall in demand must induce a fall in their price, the exchange rate. The loss in competitiveness from the change in the exchange rate will mean a fall in exports and an increase in imports. A current-account deficit means that the level of domestic claims on foreigners declines over time, eventually undoing the initial excess supply of foreign assets and with it the appreciation of the domestic currency. Once again, the initial response of the exchange rate turns out to have been an overshooting of its long-run equilibrium. And once again, to the extent that the market foresees the future depreciation, speculation will reduce the current demand for domestic assets and thus mitigate rather than exaggerate the initial appreciation.[4]

One virtue of the portfolio-balance approach may be the important role it gives the trade balance. The neglect of trade flows by the early monetary models was a by-product of the excitement accompanying the dethroning of the old flow approach to international monetary theory, and it is appropriate

[3] The dollar was expected to appreciate against the pound and the French franc. It was expected to depreciate against the mark and yen even in the 1970s.

[4] Kouri (1976) introduced rational expectations into the international portfolio-balance model. (Kouri used the term "momentary equilibrium" where Williamson uses "current equilibrium" and this essay uses "the overshooting definition of overvaluation.") If the degree of speculation is defined not as the magnitude of expected depreciation but as the degree of responsiveness to expected depreciation (i.e., the degree of bond substitutability), its effect on exchange-rate volatility depends on the source of the disturbance (see, e.g., Driskill and McCafferty, 1980.)

that the pendulum has swung back since then. The approach is less useful for explaining why the dollar appreciated from 1980 to 1985, a period when the U.S. trade and current-account deficits reached enormous levels, than for thinking about why the dollar might come down in the future. It is believed that foreign (and domestic) residents will reach a point where they are unwilling to allocate ever-larger shares of their portfolios to dollar assets. As the demand for dollars begins to fall and the supply continues to rise, the price of dollars will begin to decline.

It is worth noting that the portfolio-balance model is neither sufficient nor necessary to imply a role for the current account. It is not sufficient because, if exchange risk is the reason why investors view domestic and foreign bonds differently, then it is the "supply of foreign bonds" that matters, and this is given by the cumulated foreign-government deficit (corrected for foreign-exchange intervention, if any), not by the cumulated domestic current-account surplus. On the other hand, the cumulated current account *will* determine the worldwide distribution of wealth. It will thus still affect the exchange rate, via the *demand* for foreign assets rather than the supply, provided domestic residents have a lower propensity to hold foreign assets than do foreign residents.

Dooley and Isard (1980, 1985) argue that the primary reason for imperfect substitutability may be political and country risk rather than exchange risk. Bonds are identified by country of issuer rather than currency of denomination, with the implication that the current account again plays a key role. To the extent that political risk matters, the relevant "supply of foreign bonds" is the sum of positive and negative claims on foreigners. But the exchange rate can no longer be determined by the valuation effect, because foreign assets may not be denominated in foreign currency. Instead, the exchange rate is determined so as to give rise to a current-account deficit equal to the rate at which foreigners wish to acquire claims on the domestic country. Dooley and Isard (1985) argue that a significant part of the 1981-85 appreciation of the dollar can be explained by an increase in foreigners' desired claims on the United States, where the claims are perceived to be less likely to be confiscated either formally or informally. This is the famous "safe haven" explanation. Dooley and Isard (1985), Marris (1985), and Krugman (1985) each estimate the future U.S. current-account deficits implied by the path of the overvalued dollar under the assumption that it depreciates no faster than 3 percent, in line with the forward discount. Krugman and Marris consider the increase in U.S. indebtedness implied by that assumption too large to be sustainable; they predict a more rapid fall, or even crash, of the dollar. Dooley and Isard, on the other hand, are not willing to conclude that the implied increase in U.S. indebtedness is too large to be inconsistent wih a safe-haven shift of foreigners' portfolio preferences into claims on the United States. In their view, the political or country-risk framework is consistent with rational overshooting of the dollar.

The portfolio-balance model is not necessary to imply a role for the current account because it is not difficult to find other ways of getting the current account into the monetary model. Even if perfect bond substitutability is assumed, the current account can be viewed as an indicator of changing factors, such as productivity, that determine the long-run real exchange rate. Or the cumulated current account acting as a component of domestic wealth will still affect the exchange rate if wealth is a determinant of the demand for money. There is one aspect of these models that may or may not be attractive: while like the portfolio-balance model they imply a role for the current account, unlike the portfolio-balance model they rule out any effect of sterilized foreign-exchange intervention. Sterilized foreign-exchange intervention changes the supplies of domestic-denominated vs. foreign-denominated bonds, but not the supplies of money. Yet there is little empirical evidence that such intervention in fact affects the exchange rate. For example, an intervention study by a working group formed after the Versailles Summit of 1982 reported "broad agreement" that sterilized intervention did not generally have a lasting effect (*Report of the Working Group on Exchange Market Intervention*, 1982, p. 72).

### *Econometric Troubles*

To try to discover whether exchange-rate movements are caused by the sorts of fundamentals discussed here, we naturally turn to the econometric models. Certain basic empirical regularities, such as the high degree of volatility of nominal and real exchange rates, are very much in line with the theoretical models. Indeed, the models were originally developed to fit these properties.

When it comes to prediction, we must be careful. From the beginning, it has been an implication of the asset-market models that most changes in the exchange rate cannot be predicted. The argument is that if a change could have been foreseen, it would already have been incorporated in the previous exchange rate. (This is the point about the "news" emphasized by Dornbusch, 1980, and Frenkel, 1981.) But there is danger of a "cop-out" here. We do not want to say that it would be consistent with the models if we could not explain *any* exchange-rate movement empirically. In the first place, we might hope to be able to predict, based on past information, the component of an exchange-rate change that is rationally reflected in the forward discount or interest-rate differential (perhaps corrected for a risk premium). In the second place, we would certainly hope to be able to explain *ex post*, using *contemporaneous* information, a good part—ideally all—of an exchange-rate movement.

In some empirical studies of the first five years of floating, it seemed possible to track exchange-rate movements closely using contemporaneous values of the variables that appear in the models, such as money supplies, real income levels, nominal interest rates, and inflation rates. But there were always errors, and they tended to have a high degree of serial correlation that was never adequately explained. More important, the models began subsequently to veer seriously off track. It is disquieting to have to make alterations in the model to fit each new episode. Econometricians' worst fears were confirmed by Meese and Rogoff (1983a), who found that the monetary models are not as good as the lagged spot rate at predicting the current spot rate out of sample, a state of affairs they attribute to chronic structural change. All in all, the record with such regression equations must be pronounced discouraging.

The most damaging aspect of the regression studies is that parameter estimates appear statistically insignificant, or even significant and incorrect in sign. The problem is common with the coefficients on asset supplies: money supplies in the monetary models and net government-debt supplies in the portfolio-balance models. (See Frankel, 1983a, for dismal econometric results of this sort, and for a general survey of asset-market models of exchange-rate determination.) The reason for such results is not hard to see: simultaneity problems are endemic. For example, in the 1977-78 episode of dollar depreciation, foreign central banks leaned strongly against the wind, that is, they fought against the appreciation of their currencies by intervening in the foreign-exchange market to buy up large quantities of dollars. To the extent that this intervention was not sterilized, it swelled foreign money supplies. This explains the perverse movement in the exchange rate and relative money supplies that we already noted in Table 1. To the extent that the intervention was sterilized, and much of it was, it swelled foreign debt supplies, yielding an empirical relationship opposite from that predicted by the portfolio-balance model. The 1980 turnaround in the dollar constituted the reversal of the process. Foreign central banks fought depreciation of their currencies by selling dollar reserves. To the extent that the intervention was not sterilized, foreign money supplies fell relative to the U.S. money supply, again giving us a perverse movement at times from the viewpoint of the monetary model. To the extent that the intervention was sterilized, it reduced relative foreign debt supplies, yielding a perverse relationship from the viewpoint of the portfolio-balance model as well.

### *Monetary/Fiscal Mix as the Explanation for the Dollar*

If leaning against the wind accounts for the perverse movement of the aggregate asset supplies, what accounts for the wind? The Federal Reserve was following a fairly expansionary monetary policy in the late 1970s. The consequences predicted by mainstream macroeconomic theory in fact occurred:

real interest rates were low, output and employment were relatively high, and inflation was rising. All the exchange-rate theories mentioned above, and probably any other serious exchange-rate theory that one could imagine, predict a currency depreciation resulting from a monetary expansion.

The second episode was more dramatic. As we have seen, the Federal Reserve tightened policy sharply. This policy switch was formalized by a change in operating procedures in October 1979 and began to take hold seriously in the second quarter of 1980. Real interest rates rose sharply, output and employment fell, and inflation began to decline.[5] Again, all exchange-rate theories predict the result that occurred—the sharp appreciation of the dollar.

Beginning in mid-1982, the Federal Reserve eased up on money growth, as reflected in Table 1. Yet the differential between real interest rates did not fall. Indeed, it continued to rise in 1983-84 by most of the measures in Table 2. As of March 1985, the U.S. long-term real interest rate stood about 3 percent above the weighted average of the four trading partners. Why have real-rate-of-return differentials been higher throughout the 1981-85 period than in 1980, not only during the first two years of tight monetary policy and recession but also during the following three years of recovery? The question is a subject of some controversy, and two explanations are often given. Think of investment as depending negatively and national saving as depending positively on the real interest rate. National saving is defined as private saving plus (usually negative) public saving, that is, it is the amount of saving left over after financing the government budget deficit. 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 in the investment function, attributed to more favorable tax treatment of capital since 1981 (accelerated depreciation allowances and the investment tax credit) and, more generally, to an improved business climate. Either shift would drive up the real interest rate. If we are to choose between them, we must look at the saving and investment levels: a fall would support the first explanation; a rise would support the second.

National saving and investment both fell sharply as a share of GNP in the period 1980 to 1982. But this is the usual pattern in recessions; national saving and investment both rose rapidly during the subsequent recovery. It is more relevant to look at the average levels of saving and investment over one complete business cycle. From 1981 to 1984, gross national saving averaged 14.5

[5] There is always danger of oversimplification. Other factors such as the decline in oil prices played a role in the reduction in inflation. On the other hand, one can view the decline in the dollar price of oil as another effect of the U.S. monetary contraction, via both a fall in worldwide income and the appreciation of the dollar.

percent of GNP, down from 16.1 percent in the period 1973 to 1980. Gross investment was also down to 15.4 percent of GNP (from the same 16.1 percent in the preceding period). On balance, the period is better described as low national saving dragging investment down with it via the higher interest rates than as high investment pulling saving up with it via the higher interest rates.

We can use the phrase "monetary/fiscal mix" to embrace the tight-money explanation for high real interest rates and a high dollar during the 1980-82 period, as well as the loose-budget explanation during the 1983-85 period. It is true that the statistical relationships among these variables are far from perfect. But the 1980-85 period represents the clearest test ever of the theory of exchange rates under conditions of high capital mobility that was developed twenty years ago by Mundell and Fleming and enshrined in textbooks. In the past, monetary policy has tended to be at least partly accommodating of fiscal policy in the United States, and even more so in other countries, preventing clear tests of the theory. The 1980-85 period is the first in which monetary and fiscal policies have run strongly in opposite directions, with the predicted effects on real interest rates and the dollar. Simultaneity bias and other econometric problems should not blind us to consistency of our theories with the gross facts.

If the theories have some merit on this sort of gross long-term level, one would expect some predictive power on a long-term basis. To do meaningful long-term out-of-sample testing when the total data set spans only ten years, it is necessary to specify parameter estimates *a priori* rather than use up most of the data to estimate them. In light of the simultaneity problems and perverse regression estimates discussed above, this is just as well. Meese and Rogoff (1983b) pursue this strategy and find that the predictive performance of some structural models does improve slightly for horizons longer than a year. At the three-year horizon, the sticky-price monetary model does about 50 percent better than the random walk in terms of root mean square error and mean absolute error for plausible parameter values (although the structural models still do worse than the random walk for some other possible parameter values). In a subsequent paper, Meese and Rogoff (1985) show that adding the 1981-84 strong-dollar period to the sample improves the out-of-sample performance of the monetary models relative to the random walk. For example, the models have some ability to predict direction of change, especially at longer horizons.

The possibility of this sort of long-term explanatory power is of little comfort to the econometrician (not to mention the speculator or businessman!). It leaves out large quarterly and monthly, or even daily and hourly, fluctuations that he ideally would like to be able to explain *ex post*, if not predict *ex ante*. One would like more empirical evidence before accepting the mainstream macroeconomist's world view on faith. For example, how do we know that the high nominal interest rates of 1980-82 in fact represented tight monetary policy and high real interest rates, as opposed to loose monetary policy and high expected inflation rates?

One useful piece of empirical evidence comes from a specific selection of those short-term fluctuations that are normally so troublesome. Every week, the Federal Reserve announces what the money stock was in the preceding week. (In 1981 and 1982, the announcements were made at 4:10 P.M. on Friday afternoons and referred to the money stock nine days earlier.) When the figure is higher than the market had anticipated, the interest rate jumps up.

Does this mean that the market has no confidence in the ability of the Federal Reserve to stick to its money-growth targets—that the market interprets the news as indicating higher future rates of money growth and inflation, which are then built into a higher nominal interest rate? Or, to the contrary, does it mean that the market trusts the Federal Reserve to stick to its targets, recognizes that the monetary aggregates can fluctuate as a result of disturbances in the banking system or in the private economy, and expects the Federal Reserve to correct the deviation in the future, in anticipation of which today's real (and nominal) interest rate rises? The foreign-exchange market contains the information that enables us to choose between these two competing hypotheses. If the cause is an expectation of looser monetary policy, the exchange-rate models predict that the dollar will fall on the news. If the cause is an expectation of tighter monetary policy, the models predict that the dollar will rise on the news. Empirically, the answer is the latter expectation, and to a statistically significant degree. This finding supports both the sticky-price model and the view that the high interest rates were high real rates, if any further evidence was needed (see Engel and Frankel, 1984). Similarly, statistically significant positive reactions of the dollar to Federal Reserve announcements of industrial production and many other indicators of cyclical activity (see Hardouvelis, 1985) support the monetary model, in all forms, against the old flow approach in which the higher imports caused by higher income were believed to depreciate the currency.

The announcement example is nice because it is one case where the econometrics are free from simultaneity bias. The factors that go into the Friday-to-Monday change in the exchange rate are likely to be independent of the error in the market's earlier prediction of the money supply. But the systematic reaction to an announcement does not last long, and it is only one of many fluctuations that occur throughout the week. What causes the others? More important, what causes the monthly fluctuations that our "reduced form" exchange-rate equations are utterly unable to track? Surely they are not all related to fundamentals. We turn now to two other possible meanings of disequilibrium: irrational expectations and speculative bubbles.

## 4 Overvaluation Due to Irrational Expectations

### *The Theoretical Argument against Destablizing Speculation*

We have already seen that speculation, defined as capital flows in response to expected exchange-rate changes, is normally stabilizing, not destabilizing, if the expectations are rational. This is the powerful argument against the existence of destabilizing speculation originally made by Friedman (1953). Assume some natural oscillation in the exchange rate due only to fundamentals such as seasonal agricultural fluctuations or the fluctuations in the money supply considered above. If speculation were destabilizing, it would have to add to the demand for foreign currency when its price was high anyway, in order to make its price higher, and add to the supply of foreign currency when its price was low anyway, in order to make its price lower. But then the speculators would be buying high and selling low, hardly a good prescription for making money! Friedman's argument was that such speculators would soon go out of business.

But let us now consider the possibility that irrational speculators do exist, even if they are on average losing money. Perhaps there *is* a sucker born every minute. Certainly there is by now a large literature devoted to testing this possibility econometrically.

### *Testing Forward-Market Efficiency*

There are many technical pitfalls in testing the hypothesis of market efficiency—the joint hypothesis that the market's expectation is rational given available information and that no barriers prevent the forward rate from reflecting the market's expectation.[6] Even when the econometric problems have been dealt with, however, the forward rate often still deviates systematically from the future spot rate (see, e.g., Hansen and Hodrick, 1980). The final, and hitherto most daunting, pitfall has been that this finding could be due to a risk premium that separates the forward rate from the market's expected future spot rate rather than to irrational expectations that separate the market's expectation from the rational one. Some, like Cumby and Obstfeld (1981), assume that it is due to a risk premium; others, like Bilson (1981a), assume that it is due to a failure of rational expectations.

If the finding is due to a risk premium, one might expect deviations to be systematically related to variables on which the risk premium theoretically

[6] Overlapping contracts can create the illusion of serial correlation in expectational errors. A small probability of a large change in the exchange rate can skew the error distribution and bias standard errors (the "peso problem"). Variation in the purchasing power of domestic currency can introduce the illusion of bias due to Jensen's inequality. Fortunately, each of these econometric problems can be handled. For one paper addressing each problem, see Hansen and Hodrick (1980), Krasker (1980), and Engel (1984), respectively. The Appendix to this essay offers a way of rejecting the hypothesis that rational expectations and "peso problem" conditions describe the 1981-85 appreciation.

depends—asset supplies and asset demands, the latter being functions of the worldwide distribution of wealth and the variances and covariances of returns. However, the econometric evidence seems to be that there is no such systematic relationship. More telling still, even assuming that the risk premium in fact exists, the hypothesis that investors optimize their portfolios with respect to the mean and variance of their wealth implies that fluctuations in the risk premium must be extremely small. Using plausible values for the coefficient of risk aversion and other relevant parameters, it is possible to show that an increase in the supply of dollar securities equal to 1 percent of world wealth cannot drive up the risk premium by much more than 0.02 percent (2 basis points). Any incipient change in expected rates of return larger than that would induce investors to shift their desired portfolios so as to eliminate it; risk would not be sufficient to discourage investors from doing so. If the fluctuations in the risk premium are indeed this small, systematic differences between the forward rate and future spot rate can be attributed only to a failure of rational expectations.[7]

On the other hand, it is possible that investors do not maximize a simple function of the mean and variance of their wealth, or even a more general expected-utility function. Some statistical tests are able to reject the constraints imposed by these optimization hypotheses.[8] If the survey data reported in Table 2 are to be believed, the rate of dollar depreciation expected by the market differs significantly from the rate embodied in the forward discount or interest-rate differential. This would imply that risk premiums are substantial, the theory of expected-utility maximization notwithstanding.

### *The Implications of Irrational Expectations for Exchange-Rate Volatility*

It might seem that as soon as we admit the possibility of irrational expectations, the Friedman argument about stabilizing speculation is untenable. Could "irrational expectations" account for fluctuations in exchange rates, and in particular the recent overvaluation of the dollar?

In tests of rational expectations, not enough attention has been paid to the alternative hypothesis. One common test is to regress actual realized changes in the exchange rate against the forward discount. With market efficiency and risk neutrality, we would expect a unit coefficient. Instead, the coefficient often turns out to be significantly less than 1.[9] Similar results are found in regressions against the expected rate of depreciation as measured by the

[7] The *a priori* argument that the risk premium must be small is made in Krugman (1981) and Frankel (1985). The latter paper also gives references to the empirical literature.

[8] Frankel and Engel (1984) statistically reject the constraints imposed by the hypothesis of mean-variance optimization. Hodrick and Srivastava (1984) reject constraints imposed by the hypothesis of intertemporal expected-utility maximization.

[9] Regressions against the forward discount were run by Tryon (1979) and Bilson (1981b), followed by many others. The finding in Meese and Rogoff (1983a) and elsewhere that the forward

*Economist* and American Express survey data (Frankel and Froot, 1985). Bilson (1981b) urged us to consider the alternative hypothesis seriously. It says that investors' expectations tend to put too much weight on factors other than the contemporaneous spot rate, such as the long-term fundamentals, a situation he called "excessive speculation." In the context of the overshooting model, however, it turns out that such speculation will move the spot rate closer to the equilibrium path determined by long-run fundamentals, and thus *reduce* exchange-rate volatility. When the value of the currency lies above its long-run equilibrium path and investors overestimate the speed at which it will depreciate toward that path, because they are concentrating on the fundamentals, they will reduce their demand for the currency, and thus reduce its price, by more than if their expectations were rational. If the 1981-85 expectation of future dollar depreciation was too great, as suggested by the measures in the top third of Table 2, then the dollar must have been overvalued less than it would otherwise have been.[10]

There are other ways in which expectations might fail to be rational. But those that have been detected empirically do not necessarily imply greater volatility for the exchange rate. Perhaps some sort of failure of rational expectations does explain those short-term fluctuations in the spot rate that our models are incapable of explaining. But it seems less likely that irrational expectations can explain large swings like the 1980-85 appreciation of the dollar. If one accepts the positive interest-rate differential or forward discount as reflecting a market expectation of future dollar depreciation (that is, one accepts the absence or small size of the risk premium), the conclusion seems inescapable that speculators are damping the dollar overvaluation, relative to a situation in which they do not expect the exchange rate to change. If one believes that the interest-rate differential misstates the rate of expected depreciation (because of a risk premium) in the direction indicated by the expectations survey data, the argument follows even more strongly.

## 5 Overvaluation Due to Speculative Bubbles

### *The Theory of Bubbles with Crashes*

Our consideration of whether the market overestimates the speed with which the spot rate moves toward long-run equilibrium left aside the possibility that

rate is often no better a predictor than the lagged spot rate is closely related to the finding that the regression coefficient described in the text is less than 1.

[10] In Frankel (1983b), I demonstrate formally, in the Dornbusch overshooting model, that if the market overestimates the future rate of change of the exchange rate, the degree of volatility is less than it would be under rational expectations. A smaller increase in the current value of the currency becomes sufficient to generate the expected future depreciation necessary to offset a given interest differential, so overshooting is less extreme.

the market might expect the spot rate to move in the *opposite* direction from long-run equilibrium. Such expectations could even be rational if they are self-validating. This is the possibility of the speculative bubble.

Theorists have long been nettled by the saddle-path stability problem, a mathematical property of solutions to perfect-foresight models. Because of self-confirming expectations, there are an infinite number of paths that satisfy the condition that expectations are correct, only one of which constitutes a stable path toward the equilibrium that is based on fundamentals alone. The typical strategy has been to rule out the explosive solutions by assumption.[11] This strategy has seemed justified by the observation that there have in fact been relatively few episodes in history that one would want to nominate as "speculative bubbles," and none that did not eventually come to an end. As soon as one admits that any bubble must eventually burst, rational expectations would seem to prevent it from ever getting started in the first place.

But there has been an interesting theoretical development in this area—a recognition that one can easily build in at each point in time a probability of the collapse of the bubble and the return to fundamentals equilibrium (see Blanchard, 1979). As the probability of collapse during any given month is small, there will be some rate of appreciation in the event of noncollapse that, together with the interest-rate differential, is sufficient to persuade speculators to continue to hold the currency despite the possibility of collapse. When a bubble actually collapses, the market price can in theory jump to any of an infinite number of other rational-expectations paths. But if each speculator is always guessing which path all the *other* speculators are expecting, it seems likely that only two paths have finite probabilities at each point in time: whatever path the asset price has previously been following (a continuation of the bubble path, in the event of noncollapse) and the stable path (to which the price returns in the event of collapse).

What is exciting about this development is that it allows us to think about speculative bubbles regularly getting started and bursting in the real world. Even if the probability of collapse is taken as exogenous and constant, it is a fact that every Blanchard bubble will come to an end eventually. Furthermore, one might attempt to model the probability of collapse endogenously, and to model the actual collapse as the outcome that occurs when speculators (rationally) see the probability of collapse rise above some arbitrarily specified critical level. (The stochastic element would have to come in through asset supplies or through nonspeculative components of asset demands.) If one in-

[11] In the literature on exchange-rate determination, examples are Mussa (1976) for the flexible-price monetary model, Dornbusch (1976) for the sticky-price monetary model, and Kouri (1976) for the portfolio-balance model. Obstfeld and Rogoff (1983) show that speculative bubbles can be ruled out if the government fractionally backs its currency by standing ready to redeem each dollar for a small amount of gold or real capital, or even if it does so with only small (nonzero) probability.

troduced risk aversion into the model, one might even be able to get the appealing result that the current probability of collapse is greater the longer the bubble has gone on, because the risk of holding the currency is greater the farther from fundamental equilibrium the currency has diverged.

These considerations suggest the possibility that small-scale speculative bubbles are going on all the time. These may be the "runs" that market participants report on an hourly or daily basis. Speculative bubbles would seem to be the ultimate counterexample to Friedman's proof that destabilizing speculation cannot exist: the variance of the exchange rate is higher in a bubble world, and yet speculators are on average neither earning nor losing money. Bubbles may even be the large and continuing deviations that are not explained by fundamentals in econometric models using monthly data.

*Long-Term Overvaluation or Short-Term Volatility?*

Could a speculative bubble explain the high 1981-85 value of the dollar? For an asset price to be subject to a single prolonged bubble, it is not normally enough that it be overvalued; it must be increasingly overvalued over time. Furthermore, the overvaluation must *accelerate* over time if there is a perceived probability of collapse, in order to counterbalance the increasingly large distance that the price might fall. However, it may be difficult to spot such a trend with the naked eye. In the first place, even if there is an obvious trend in the value of the currency, it could be due to fundamentals. One would have to perform a test like the bubbles test of Flood and Garber (1980).[12] In the second place, and more relevant, a positive interest-rate differential could take the place of a trend, as Dornbusch (1983a, pp. 15-16) ingeniously points out. This could be the case if the interest-rate differential is as large as the expected depreciation of the currency (the probability that the bubble will burst times the distance the currency will fall if the bubble does burst). In the Appendix to this essay, I show that we can reject this possibility with some confidence, given the actual sizes of the appreciation and the interest-rate differential in the 1981-85 period. The appreciation has gone on far too long to represent a single rational bubble.

There is another objection to the hypothesis that the long appreciation of the dollar could be a single speculative bubble. A single bubble is in theory a smooth path, whereas exchange rates are observed to undergo wild short-term fluctuations. Of course, a stable path based on a single set of fundamentals is also in theory smooth, but it is easy to posit a perpetual inflow of bits of

[12] Flood and Garber conclude that the German hyperinflation of 1921-23 was due to fundamentals—excessive and accelerating money growth—not a speculative bubble. Note, incidentally, that the sort of test used by Meese (1986, forthcoming), rather than that of Flood and Garber, would be needed to detect a situation in which bubbles are frequently forming and collapsing.

information, pertaining to monetary policy or other fundamentals, that displace that path. In the case of a single speculative bubble, it would seem that any event that jolted the asset price off its previous smooth path would send it crashing all the way to the stable fundamentals path.[13] This does not mean that bubbles do not occur, perhaps frequently. It just means that they are more promising as an explanation of short-term movements in the neighborhood of the fundamentals path than as an explanation of prolonged overvaluation.

Thus we are led to the same conclusion regarding rational speculative bubbles that we reached regarding irrational expectations. They may exist and they may account for some of the short-term fluctuations that have characterized floating rates and that introduce large monthly error terms into exchange-rate equations, but they do not account for large medium-term swings. For that we are left with models based on the real interest rate and other fundamentals. For the remainder of this essay, I will adopt the view that the strength of the dollar from 1981 to 1985 has been due to an unusual monetary/fiscal policy mix, as in the models of section 3.

## 6 The Welfare Effects of Overvaluation

Each of the possible interpretations of overvaluation considered so far has dealt with the *determination* of exchange-rate movements. None addressed the question of the *effects* of exchange-rate movements. Indeed, the literature has lavished attention on the former question to the relative neglect of the latter. We now turn to the "value judgment" implicit in the term "overvaluation," that is, to the welfare effects of exchange-rate variability.

If we rule out the first and fourth definitions of overvaluation, barriers to portfolio adjustment and irrational expectations, we have the property of market efficiency. But the proposition that financial markets are efficient in this technical sense tells us nothing about whether resources are efficiently allocated in the economy. Even if we were also to rule out speculative bubbles, which would leave us with dynamics based only on Dornbusch overshooting or other short-run fundamentals, there would still be no guarantee that these exchange-rate movements are desirable. Whenever we admit macroeconomic considerations like sticky goods prices, all optimality theo-

[13] If we argue that after a disturbance the exchange rate jumps to another nearby bubble path, we must abandon the framework in which the choice at each point in time is between whatever path we have previously been on and the fundamentals path. In that case, what determines which of the infinite number of bubble paths the market jumps to? We can imagine some variable that is fundamentally irrelevant but that speculators pay attention to nonetheless. Each new bit of information about that variable will then displace the asset price to a new, nearby bubble path. Until someone convincingly models such a process, however, it seems more realistic to assume that when a bubble bursts the asset price returns to the fundamentals path.

rems derived from the theory of competitive markets are void. Given inefficiencies in goods markets, we cannot even argue that welfare is necessarily higher with "efficient" capital markets than without them. In defense of an interest-rate-equalization tax, Dornbusch (1983a, p. 26) writes:

> [Such an argument] mistakes the short-term money market rate for the social productivity of capital. Suppose a country reduces money growth and this leads (as it will) to an increase in the interest rate on financial assets. Incipient capital flows will lead to currency appreciation and a current account deterioration financed by borrowing abroad. It is hard to argue that the current account deficit is a reflection of enhanced investment opportunities or increased time preference that, in an efficient and integrated capital market, would call for a redirection of lending toward the home country. On the contrary, the decline in demand will have reduced the profitability of domestic real capital. It therefore would not be optimal for capital to flow toward the country with a tightened monetary policy. Policy intervention, in these circumstances, could well enhance the efficiency of capital allocation in the world.

Thus the desirability of market-produced exchange-rate changes must be evaluated; there is no automatic appeal to optimality.

### *The Effects of Short-Term Uncertainty*

A distinction is generally made between the effects of short-run exchange-rate variability and the effects of longer-run swings of overvaluation or undervaluation. We consider first short-term variability. Before floating exchange rates became a reality, the major argument against them was that they would make international trade and investment riskier. For example, the importer with an obligation to pay a certain amount of foreign currency in ninety days would not know immediately how much it was going to cost him in domestic currency. This essay has devoted much attention to exchange-rate volatility because of this risk argument. One counterargument is that the importer could buy the foreign currency on the forward-exchange market if he wished to protect himself against exchange risk. Friedman (1953) correctly predicted that under floating rates an active forward-exchange market would develop in response to the need. The volume handled by the forward-exchange market and the number of currencies covered have indeed increased. But transactions costs, as represented by the bid-ask spread, have also increased, because of the increased risk faced by any bank that takes an open forward position even for a few hours (see, e.g., Young, 1984).

The other component of the cost of forward exchange—the risk premium that separates the forward rate from the expected future spot rate—has probably also gone up. But, as we have seen, the risk premium may be too small to matter empirically. Note that if importers in the United States must pay a forward price for pounds greater than the expected future spot price as the cost of hedging their future pound payments, importers in Great Britain will be paying a forward price for dollars *less* than the expected future spot price as the cost of hedging their future dollar payments.[14] If the risk premium is a negative factor for U.S. imports, it is a positive factor for British imports, so the net effect on trade may not be negative.[15] But the risk premium is determined in a market equilibrium in which somebody must be compensated for taking an open position. The forward price for dollars will be less than the expected future spot price only if some participants in the market are prepared to take and hold positive open dollar positions. Under the old trade-flow approach, this must be the case if Britain runs a positive trade surplus.[16] But if Britain runs a surplus, the U.S. imports for which the risk premium is a negative factor are larger than the British imports for which the risk premium is a positive factor. In this sense, exchange risk discourages trade, which is the result we would expect.

Hooper and Kohlhagen (1978) conclude that increased short-term exchange-rate uncertainty has not had a significant negative effect on the volume of world trade. More recent studies by Akhtar and Hilton (1984), Young (1984), and Kenen and Rodrik (1986, forthcoming) do find something of a negative effect on trade, holding other variables constant. The subject deserves further study. But current detractors of floating rates seem to be less concerned with short-term exchange-rate uncertainty than with the large medium-term swings that exchange rates have experienced, such as the dollar overvaluation. Kenen believes that "there has been too much emphasis on short-term instability. . . . The medium-term swings in exchange rates, nominal and real, have done more damage" (in Bergsten *et al.*, 1982, p. 38). Dorn-

[14] The term "expected future spot price" is ambiguous owing to Jensen's inequality: in the case where the dollar/pound forward rate is greater than the expected future dollar/pound spot rate, the pound/dollar forward rate will be less than 1 over the expected future dollar/pound spot rate, but not necessarily less than the expected future pound/dollar rate as claimed in the text. There are two ways around this problem. We can measure expected values in terms of purchasing power over a basket of goods assumed common to residents of both countries. Or, in the more realistic case in which residents of each country have a preference for their local currency, we can assume that the risk premium is large enough to outweigh Jensen's inequality, which will be the case if the coefficient of risk aversion exceeds 1 (see, e.g., Krugman, 1981).

[15] I have assumed here that exports are denominated in the currency of the producing country. To the extent that they are denominated in the currency of the importing country, it is the exporter who must hedge by selling foreign exchange forward. If U.S. exporters are able to sell pounds at a forward price greater than the expected future spot price, so that the risk premium is a positive factor for U.S. exports, it will go the other way for British exporters. Thus the two effects on trade still go in opposite directions.

[16] In the modern stock approach, some participants must be prepared to hold positive open dollar positions in market equilibrium if the net supply of dollar-denominated debt is large relative to pound-denominated debt. This could be interpreted as a positive *cumulative* trade surplus for Britain rather than *flow* trade surplus, assuming Americans deal in assets or liabilities denominated only in dollars. More generally, the net supplies of outside assets—government debts corrected for foreign-exchange intervention—matter most. But cumulated current accounts also enter to the extent that residents of each country prefer to hold their local currency (Dornbusch, 1983b; Krugman, 1981; and Frankel, 1985).

busch (1983a, p. 29) sees "no very good case why small noise in the market should be smoothed" in contrast to a "massive disturbance such as the dollar appreciation."

*The Effects of Long-Term Overvaluation*

Even if we consider only the welfare effects of long-term fluctuations, there is an enormous amount to be said. I will focus on one particular aspect: effects on the allocation of resources between sectors and their implication for the aggregate output/inflation tradeoff.

Let us begin with the 1980-82 dollar appreciation and take as given that its cause was a contractionary monetary policy initiated in the United States at the end of 1979 in order to fight inflation. (I do not here pass judgment on whether the contraction was worth the cost.) The price of bringing down inflation will be lost output and high unemployment. Clearly, the appreciation of the dollar hurt output and employment in U.S. export and import-competing industries. The question is whether the appreciation made the terms of the aggregate U.S. tradeoff between output and inflation better or worse than it would otherwise have been.

The appreciation of the dollar also meant higher import prices for U.S. trading partners. To avoid losing ground in their own fight against inflation, foreign governments felt it necessary to match the U.S. contraction part way with a monetary contraction of their own, as measured, for example, by real interest rates. They complained that the dollar appreciation made them worse off. Thus a second question is whether the dollar appreciation made the terms of the aggregate foreign tradeoff between output and inflation better or worse.

It has been suggested that the rise of the dollar after 1980 is an example of undesirable competitive appreciation: countries would do better to expand cooperatively, but each holds back in an effort to keep its currency strong (see, for example, Oudiz and Sachs, 1984). According to such arguments, currency appreciation is a "negative externality" internationally because it is a means of exporting inflation to trading partners. It should be pointed out that in other times, such as the 1930s and to a lesser extent the 1970s, the argument has gone in the opposite direction: competitive *depreciation* is considered the negative externality because it is a means of exporting unemployment. In any case, it is not clear that the dollar appreciation was a deliberate consequence of a U.S. slow-growth policy or that U.S. policy-makers have refrained from expanding for fear of a depreciation.

Dornbusch (1982, pp. 595-596) has made the claim, "There is no sensible argument that tightening the money should involve as a desirable side effect a loss of exports [and] an increase in imports. . . . Because these side effects are undesirable, both here and abroad, we should attempt to the maximum possible extent to immunize the world economy against these spillovers." But a sensible argument *can* be made that, given the U.S. monetary contraction, *welfare was higher, both in the United States and in foreign countries, with an appreciation of the dollar than it would have been if the exchange rate had not changed, in the sense that in each country the terms of the output-inflation tradeoff were more favorable.* The argument is formalized in Frankel (1983c), but an intuitive account is easily made.

The key assumption needed to derive the conclusion is that within each of two domestic sectors, an exportable sector and a nontradable sector, the tradeoff between inflation and output is concave: at high levels of unemployment and excess capacity, demand expansion goes relatively more into output and less into the rate of price increase; at lower levels of unemployment, demand expansion goes relatively more into the rate of price increase and less into output. If we are interested in maximizing aggregate output and minimizing average inflation throughout the economy, it follows that a change in the level of demand is best shared equally by the two sectors. If we decide to contract to fight inflation, we should contract the two sectors equally. If we contract the nontradable sector more, an imbalance will develop in which the marginal benefit to contraction in exportables, in terms of the reduction in inflation per unit of lost output, will be greater than the marginal benefit to contraction in the nontradable sector.

This imbalance is precisely what would have occurred if the United States had contracted in 1980-82 without allowing the dollar to appreciate. High real interest rates would have cut demand for housing and other nontraded goods and services even more than they actually did, but manufacturing, agriculture, and other exportable sectors would have been relatively buoyed by foreign demand. Allowing the dollar to appreciate meant that the exportable sector shared equally in the misery.

Now for the effect on other countries. It is not enough merely to observe, as many have done, that floating rates will not fully insulate them from a U.S. contraction, or to identify the impact on them when their policies are passive.[17] Foreign governments will react to the disturbance by resetting their policies so as to return as closely as possible to their chosen combination of output and inflation. If the exchange rate had somehow been kept fixed when the United States contracted, foreigners would have suffered a loss in export demand and found themselves at lower levels of output and inflation than desired (assuming that they were previously at their optimum). They would have responded with policies to increase expenditure.

The other countries' expansion would necessarily be concentrated relatively more in the nontradable sector. To achieve a better balance between

[17] See Mussa (1979) for a review of the role of capital mobility and other possible complications in invalidating the old view that floating rates insulate a country from foreign disturbances.

the two sectors, foreign currencies would have to depreciate against the dollar to make the exportable sector more competitive. Fortunately, as we have seen, this is exactly what is best for the U.S. tradeoff as well, and it is what in fact happens anyway when the foreign-exchange market is left undisturbed! [18]

Of course, there is no guarantee that the actual dollar appreciation will be optimal. It could be too big or too small. To compare the actual and optimal changes in the exchange rate, it would be necessary to specify a complete model of exchange-rate determination, to make assumptions about foreign-exchange intervention practices and the monetary/fiscal policy mix, and to come up with estimates for the parameters of the model and of the elasticities of demand for tradables and nontradables. The relatively model-free argument made here has the more modest objective of establishing that at least *some* degree of appreciation is desirable. Economic analysis must go beyond lamenting the cost of the strong dollar to export and import-competing industries. It must evaluate the desirability of our current exchange-rate system, not the desirability of current macroeconomic policy. To do so, it must use as its hypothetical standard of comparison a situation in which we suffer from the same macroeconomic policy *without* the strong dollar, not a utopia where we suffer from neither.

We now consider the continued—indeed increasing—appreciation of the dollar during the period 1983 to 1985, the years after the tight U.S. monetary policy and accompanying recessions ended. I have argued that the high real interest rates and strong dollar of this period are more readily explained by the high budget deficit than by the leading alternative proposed, an increase in investment: it seems more accurate to say that national saving has pulled national investment down than to say that national investment has pulled national saving up.

Either way, the gap between national saving and national investment has grown, with a capital inflow from abroad making up the difference. The capital inflow is, of course, the counterpart to the trade or current-account deficit; the rest of the world lends to the United States to finance the gap. The U.S. trade deficit reached a record level of $108 billion in 1984 ($123 billion if imports are counted on a c.i.f. basis). Of the roughly $50 billion deterioration in the U.S. trade deficit between 1983 and 1984, over 60 percent can be attributed to the continued real appreciation of the dollar (at an annual rate of 13 percent over the preceding several years) and the resulting loss of com-

[18] If the dollar appreciates enough, the proper policy response for foreigners is not to increase expenditure but to decrease it, as they did. Much attention has been devoted in recent years to the case for international macroeconomic coordination. Oudiz and Sachs (1984) provide an excellent appraisal, with references. There would appear to be a strong case for shifts in the monetary/fiscal *mix*, toward fiscal contraction in the United States and fiscal expansion in Europe and Japan, whether coordinated or not.

petitiveness of U.S. producers on world markets. The remaining 40 percent can be attributed to the recovery: because the growth of real income in the United States exceeded that among trading partners (by 6.8 percent vs. 3.5 percent for the rest of the OECD), U.S. imports from the rest of the world increased much faster than the rest of the world's imports from the United States. With U.S. growth forecast in 1985 and 1986 to be no more rapid than in the rest of the OECD, the appreciation of the dollar and its (lagged) effects are the only remaining factors widening the trade deficit.[19] There has also been a large loss in U.S. net exports to Latin America since 1981 as a result of the international debt problem, but the worst of this shift ($20 billion) was completed in 1983. Thus the cause of the increasing trade deficit can be traced primarily to the high levels of the real interest rate and the dollar.

The U.S. current-account deficit and associated capital inflow attained a record $102 billion in 1984. Like the trade deficits, the current-account deficits represent a loss of output and employment in industries that export or compete with imports. But, at the same time, the capital inflow is keeping U.S. real interest rates below what they would be in its absence. Thus it has allowed investment and the other interest-sensitive sectors to grow faster, given the level of saving, than they otherwise would. Foreigners in effect financed over half the U.S. federal budget deficit in 1984, making that much more saving available for investment, and they are expected to do the same in 1985 and 1986. This is the safety valve that prevents the federal budget deficit from crowding out investment one-for-one.

What are the implications of such a continued imbalance for the terms of the overall tradeoff between output and inflation? The model described above is not directly applicable because it disaggregates into only two sectors: a traded-goods sector that is relatively more responsive to the exchange rate and a nontraded-goods sector that is relatively more responsive to other factors like the interest rate. We need a more complex model that has at least a third sector that is relatively more responsive to fiscal policy. One possible disaggregation is into four sectors corresponding roughly to the $C + I + G + X - M$ model of standard Keynesian textbooks. The four sectors are those facing demand that is especially sensitive to (1) tax cuts (consumption goods, $C$), (2) interest rates (investment goods, $I$), (3) government expenditure (military equipment, health, education, etc., $G$), and (4) the exchange rate (exports, $X$). Taking as given high levels of production in sectors $C$ and $G$ as the result of expansionary fiscal policy, the question would then be: what is the optimal way to distribute the remaining demand between sectors $I$ and $X$ so

[19] The decomposition of the deterioration in the U.S. trade balance assumes conventional estimates of trade elasticities with respect to relative prices (1.3) and incomes (2.0). The 1983 base is imports of $260 billion and exports of $200 billion. The figures for real growth in the U.S. vs. the rest of the OECD are from the *OECD Economic Outlook*, June 1985.

as to obtain the lowest possible aggregate inflation rate for a given level of aggregate output (or the highest possible level of aggregate output for a given aggregate inflation rate)? In the spirit of the previous model, convexity in each sector would imply that the answer is to balance demand as equally as possible between the remaining two sectors.

We are taking as given that the *C* and *G* sectors are crowding out spending in the rest of the economy, presumably via the increase in the real interest rate. Imagine that we are somehow able to keep the dollar from appreciating, for example by using capital controls to limit the inflow of capital that would otherwise be attracted by high U.S. real interest rates. A lower value for the dollar will stimulate output in the *X* sector. But the capital inflow is currently helping to keep the U.S. real interest rate lower than it would otherwise be. The cost of shutting off the increased demand for U.S. assets will be a higher real interest rate than we are currently experiencing. Thus the interest-sensitive sector *I* will suffer a loss in demand.

Indeed, the loss in output in the *I* sector would have to be sufficient to offset the gain in output in the *X* sector if aggregate output is constrained to prevent "overheating" of the economy. (For example, some observers suggest that the Federal Reserve is, or should be, targeting aggregate GNP.) Because the *I* sector is producing at a point far down its concave inflation/output curve, the overall inflation rate will be higher than if the same level of aggregate output were distributed more evenly among the sectors. This argument was a rationale underlying warnings from Martin Feldstein, Chairman of the Council of Economic Advisers in 1983 and 1984, that the recovery, though strong, was nevertheless alarmingly "lopsided" (see, e.g., the 1984 *Economic Report of the President*, p. 57).

The "lopsidedness" effects of interest-rate and exchange-rate crowding out are inherently "second order." How important are they quantitatively for the terms of the aggregate tradeoff between output and inflation? The answer depends on two factors: (1) the extent to which the increase in the real interest rate or real value of the dollar redistributes demand from some sectors to others, and (2) the concavity of the price-output supply relationship within each sector (that is, the extent to which the slope at high demand levels exceeds the slope at low demand levels). One can get an idea of the first factor by comparing actual growth rates in different sectors since 1980. Industries do not in fact neatly sort themselves into internationally traded sectors that are highly sensitive to the exchange rate and nontraded sectors that are not. But manufacturing and mining are generally taken to be primarily traded, and construction and services to be primarily nontraded.

It would be interesting to perform such an analysis separately for the 1980-82 period of monetary contraction and the 1983-85 period of fiscal expansion in order to test two separate propositions: (1) that the appreciation of the dollar in the first period allowed a more even balance among sectors of the economy than would otherwise have occurred, given the increase in real interest rates; and (2) that the appreciation in the second period exacerbated the imbalance. The problem is that those sectors of the economy that tend to be most sensitive to real interest rates and the exchange rate—manufacturing and agriculture as opposed to services—tend also to be most sensitive to the aggregate level of economic activity. Manufacturing contracted more sharply than services in 1980-82 and expanded more rapidly in 1983-84 simply because it is more procyclical.

To avoid cyclical complications, Table 3 shows changes over the entire period of dollar appreciation, from 1980 to August 1985. We see that employment in construction, government, and services increased by 12.9 percent, but employment in manufacturing and mining actually *shrank* by 4.5 percent. It has been argued that the shift of employment away from manufacturing toward the private service-producing sector can be explained entirely by long-term structural trends in productivity and demand patterns, and that no special overvalued-dollar effect is present (Kling, 1985, and Solomon, 1985, p. 10). If this argument is correct, it simply means that the manufacturing and services sectors cannot properly be identified with traded and nontraded goods. Given a trade deficit equal to 3 percent of GNP, it is necessarily true that firms which are sensitive to foreign demand have been hurt, whatever sector they may be in. Nor should we be surprised that some of those adversely affected are producers of services. Internationally traded services that are of importance to the United States include transportation, banking, insurance, engineering, higher education, and medical services. Furthermore, even producers of nontraded services will be hurt if their usual customers earn *their* incomes on international markets; think of a restaurant in Peoria, Illinois.

TABLE 3

U.S. EMPLOYMENT IN NONTRADED VS. TRADED SECTORS, 1980-85

*(in millions)*

| | *1980* | *August 1985*[a] | *Percentage Change* |
|---|---|---|---|
| Construction | 4,346 | 4,678 | + 7.6% |
| Government | 16,241 | 16,338 | + 0.6 |
| Private services-producing | 48,507 | 56,641 | +16.8 |
| Total "nontraded" | 69,094 | 77,657 | +12.9 |
| Manufacturing and mining (total "traded") | 21,312 | 20,353 | − 4.5 |
| Total nonfarm employment | 90,406 | 98,010 | + 8.4% |

[a] Preliminary.

SOURCE: *Employment and Earnings*, U.S. Department of Labor, Bureau of Labor Statistics, September 1985, Table B.1, p. 43.

The effect of the traded/nontraded imbalance on the overall level of output and inflation depends on the concavity of the supply relationships in the individual industries. But even if that concavity is no larger than is implied by a constant elasticity of supply with respect to price (call it $1/\epsilon$), for a given level of overall inflation it can be shown that if a proportion $b$ of output is allocated to nontraded goods instead of the optimal proportion $\beta$, aggregate output will be equal to a fraction $\{\beta(b/\beta)^{1/\epsilon} + (1-\beta)[(1-b)/(1-\beta)]^{1/\epsilon}\}^{\epsilon}$ of what it would otherwise be. (The fraction is less than 1 if $1/\epsilon > 1$.) If the elasticity of supply is high, particularly if it becomes higher at low levels of demand, there could be a nonnegligible output loss from the current U.S. allocation of demand away from traded goods.

## 7 Conclusion

Of the six possible meanings of overvaluation, two are immediately and clearly not applicable to the 1980-85 dollar: the nonclearing of financial markets and foreign-exchange intervention. Two more—irrational expectations and rational speculative bubbles—though interesting concepts, particularly as possible explanations for shorter-term exchange-rate movements, have been argued here to be unpromising ways of explaining the dollar overvaluation. Even if we allow for expectations that are not rational, speculation since 1980 must have been a force acting to reduce the value of the dollar below what it would otherwise have been. This follows from the investors' expectation of future dollar depreciation that shows up in the nominal-interest-rate differentials, the forward discounts, and the survey data. And for all or part of the dollar appreciation to have been attributable to a single rational speculative bubble, the implicit probability each month of the bubble's bursting would have had to be high enough to make it improbable that the bubble could have lasted for more than fifty months without actually bursting.

The meaning of overvaluation that appears to be most relevant is overshooting. The exchange rate is in "market equilibrium": there are no barriers to portfolio adjustment and there is no intervention in the foreign-exchange market. Nevertheless, the value of the dollar is far above the level dictated by long-term fundamentals such as purchasing-power parity. It has been driven up by short-term fundamentals such as the real-interest-rate differential. The increase in the real-interest-rate differential can in turn be attributed to the macroeconomic policy mix, specifically the tighter monetary policy of 1981-82 and the growing structural federal budget deficit of 1983-85.

The last meaning of overvaluation, and the one of ultimate concern to policy-makers, is the normative one that no matter which factor explains the value of the currency, that value is higher than optimal from the standpoint of its effect on the economy. The welfare effects of a distorted allocation of resources between traded and nontraded goods may be undesirable. It can be argued that, given a monetary contraction to fight inflation, an appreciation of the currency reduces this distortion: it allocates the loss of output and employment equally among sectors relative to what would happen if the exchange rate were somehow held fixed. But by 1985 the dollar appreciation had long since passed the point where it was helping to balance growth among sectors. Instead, the U.S. economy had become split into a strong nontraded-goods sector and a weak traded-goods sector, with unfavorable implications for the health of the aggregate national economy.

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## APPENDIX
### WAS THE DOLLAR APPRECIATION A RATIONAL SPECULATIVE BUBBLE?

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 its long-run equilibrium level $\bar{S}_t$ that is determined by fundamentals. Then a short-term interest-rate differential $(i-i^*)_t$ is sufficient to support a large continuing overvaluation, measured by $(\bar{s}-s)_t$ in log form, if the bubble path, on which the spot rate will remain for one more period with probability $1-p_t$, involves continued appreciation at a rate $a_t$ , such that

$$(i-i^*)_t = p_t(\bar{s}-s_t) + (1-p_t)(-a_t) . \qquad \text{(A-1)}$$

In other words, the interest-rate differential, which must equal the expected depreciation, is a weighted average of what will happen if the bubble bursts and what will happen if it does not. Even if $a_t = 0$, as in the Dornbusch (1983a) example, an interest-rate differential of 3 percent per year, or 0.25 percent per month, is sufficient to sustain a continuing overvaluation $(\bar{s}-s)$ of 25 percent with a probability of collapse of 0.01 per month.

The dollar has in fact experienced, not a constant overvaluation relative to PPP, but rather continuing appreciation $a_t$ , at a rate of 7.80 percent per year (0.65 percent a month) against the mark between January 1981 and March 1985. One can solve equation (A-1) for the implicit market-perceived probability of collapse at any given time:

$$p_t = \frac{(i-i^*)_t + a_t}{(\bar{s}-s_t) + a_t} . \qquad \text{(A-2)}$$

As of March 1985, the interest-rate differential between the United States and Germany was 3.07 percent a year, or 0.26 percent a month, and the real mark/dollar rate had increased 64 percent relative to 1980. If all the real appreciation of the dollar is attributed to a bubble, implying that the appreciation will all be instantaneously reversed in the event that the bubble bursts, it follows that the perceived probability of collapse in the month of March was (0.0025 + 0.0065)/(0.6400 + 0.0069) = 1.4 percent.

We can repeat this calculation for every month during the four years of dollar appreciation, solving for the implicit probability of the bubble bursting during the month in question as a function of the interest-rate differential and how much real appreciation has already taken place. Table A-1 reports these calculations under the extreme form of the bubble hypothesis, namely that all the real appreciation of the dollar against the mark is attributable to a bubble. It is also assumed that the rate of appreciation in the event of noncollapse $(a_t)$

TABLE A-1

PROBABILITY OF COLLAPSE IN MARK/DOLLAR RATE UNDER BUBBLE HYPOTHESIS

*(trend logarithmic appreciation a = 7.80 percent per year)*

| | | | | All Real Appreciation Due to Bubble | | Half Real Appreciation Due to Bubble | |
|---|---|---|---|---|---|---|---|
| Month | Nominal Appreciation of Dollar $(-\ln S_t)$ 1973-79 = 0 | Real "Overvaluation" of Dollar $[-\ln(S_t/\bar{S}_t)]$ 1973-79 = 0 | Forward Discount $(FD_t)$ | Probability of Collapse $(p_t)$ | Cumulated Probability of Noncollapse $\left[\prod_{t=1}^{T}(1-p_t)\right]$ | Probability of Collapse $(p_t)$ | Cumulated Probability of Noncollapse $\left[\prod_{t=1}^{T}(1-p_t)\right]$ |
| Jan 81 | −13.09% | 8.61% | 10.88% | 0.168 | 0.83 | 0.314 | 0.69 |
| Feb 81 | − 6.80 | 15.17 | 5.75 | 0.071 | 0.77 | 0.137 | 0.59 |
| Mar 81 | − 8.26 | 13.69 | 2.68 | 0.061 | 0.73 | 0.117 | 0.52 |
| Apr 81 | − 5.69 | 16.24 | 3.85 | 0.057 | 0.68 | 0.110 | 0.46 |
| May 81 | 0.13 | 22.51 | 7.04 | 0.053 | 0.65 | 0.104 | 0.42 |
| June 81 | 3.78 | 26.61 | 5.85 | 0.042 | 0.62 | 0.082 | 0.38 |
| Jul 81 | 6.52 | 29.87 | 7.14 | 0.041 | 0.59 | 0.080 | 0.35 |
| Aug 81 | 8.90 | 32.68 | 6.79 | 0.036 | 0.57 | 0.072 | 0.33 |
| Sep 81 | 2.75 | 27.04 | 5.12 | 0.039 | 0.55 | 0.076 | 0.30 |
| Oct 81 | − 1.67 | 22.43 | 4.69 | 0.045 | 0.55 | 0.088 | 0.28 |
| Nov 81 | − 2.81 | 21.09 | 2.78 | 0.041 | 0.50 | 0.079 | 0.25 |
| Dec 81 | − 1.32 | 22.56 | 2.33 | 0.036 | 0.49 | 0.071 | 0.24 |
| Jan 82 | 0.14 | 23.64 | 3.79 | 0.040 | 0.47 | 0.077 | 0.22 |
| Feb 82 | 3.38 | 26.87 | 5.32 | 0.040 | 0.45 | 0.078 | 0.20 |
| Mar 82 | 3.92 | 27.32 | 5.83 | 0.041 | 0.43 | 0.079 | 0.18 |
| Apr 82 | 4.71 | 28.27 | 6.34 | 0.041 | 0.41 | 0.080 | 0.17 |
| May 82 | 0.97 | 24.77 | 6.57 | 0.047 | 0.39 | 0.092 | 0.15 |
| June 82 | 5.96 | 29.88 | 6.38 | 0.039 | 0.38 | 0.076 | 0.14 |
| Jul 82 | 7.43 | 31.76 | 5.28 | 0.034 | 0.37 | 0.066 | 0.13 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Aug 82 | 8.02 | 32.61 | 2.61 | 0.026 | 0.36 | 0.051 | 0.13 |
| Sep 82 | 9.02 | 33.43 | 3.81 | 0.028 | 0.35 | 0.056 | 0.12 |
| Oct 82 | 10.06 | 34.35 | 3.58 | 0.027 | 0.34 | 0.053 | 0.11 |
| Nov 82 | 11.14 | 35.00 | 2.89 | 0.025 | 0.33 | 0.049 | 0.11 |
| Dec 82 | 5.59 | 28.77 | 3.32 | 0.032 | 0.32 | 0.062 | 0.10 |
| Jan 83 | 4.32 | 27.40 | 3.78 | 0.034 | 0.31 | 0.067 | 0.09 |
| Feb 83 | 6.00 | 28.99 | 3.36 | 0.031 | 0.30 | 0.061 | 0.09 |
| Mar 83 | 5.16 | 28.33 | 4.49 | 0.035 | 0.29 | 0.069 | 0.08 |
| Apr 83 | 6.44 | 30.01 | 4.61 | 0.034 | 0.28 | 0.066 | 0.08 |
| May 83 | 7.51 | 31.41 | 3.99 | 0.031 | 0.27 | 0.060 | 0.07 |
| Jun 83 | 10.81 | 34.69 | 4.61 | 0.029 | 0.26 | 0.057 | 0.07 |
| Jul 83 | 12.42 | 36.37 | 5.31 | 0.030 | 0.25 | 0.058 | 0.06 |
| Aug 85 | 15.64 | 39.57 | 5.10 | 0.027 | 0.25 | 0.053 | 0.06 |
| Sep 83 | 15.37 | 39.56 | 4.27 | 0.025 | 0.24 | 0.049 | 0.06 |
| Oct 83 | 12.91 | 37.32 | 4.24 | 0.026 | 0.23 | 0.052 | 0.05 |
| Nov 83 | 15.94 | 40.35 | 3.92 | 0.024 | 0.23 | 0.047 | 0.05 |
| Dec 83 | 18.35 | 42.66 | 4.06 | 0.023 | 0.22 | 0.045 | 0.05 |
| Jan 84 | 20.60 | 45.05 | 4.10 | 0.022 | 0.22 | 0.043 | 0.05 |
| Feb 84 | 16.64 | 41.24 | 4.09 | 0.024 | 0.21 | 0.047 | 0.05 |
| Mar 84 | 12.68 | 37.44 | 4.93 | 0.028 | 0.21 | 0.055 | 0.04 |
| Apr 84 | 14.51 | 39.58 | 5.32 | 0.027 | 0.20 | 0.054 | 0.04 |
| May 84 | 18.38 | 43.69 | 5.63 | 0.025 | 0.20 | 0.050 | 0.04 |
| June 84 | 18.03 | 43.31 | 5.95 | 0.026 | 0.19 | 0.051 | 0.04 |
| Jul 84 | 21.92 | 47.68 | 6.44 | 0.025 | 0.19 | 0.048 | 0.03 |
| Aug 84 | 23.23 | 49.56 | 6.59 | 0.024 | 0.18 | 0.047 | 0.03 |
| Sept 84 | 28.03 | 54.75 | 6.28 | 0.021 | 0.18 | 0.042 | 0.03 |
| Oct 84 | 29.40 | 55.84 | 5.15 | 0.019 | 0.17 | 0.038 | 0.03 |
| Nov 84 | 26.87 | 53.14 | 3.94 | 0.018 | 0.17 | 0.036 | 0.03 |
| Dec 84 | 30.53 | 56.72 | 3.22 | 0.016 | 0.17 | 0.032 | 0.03 |
| Jan 85 | 32.63 | 58.42 | 2.67 | 0.015 | 0.17 | 0.029 | 0.03 |
| Feb 85 | 36.61 | 62.40 | 2.62 | 0.014 | 0.16 | 0.027 | 0.03 |
| Mar 85 | 38.60 | 64.39 | 3.07 | 0.014 | 0.16 | 0.028 | 0.03 |

is constant at 7.80 percent a year. (The calculations are not very sensitive to how $a_t$ is estimated.)

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 $T$. No assumption of a normal probability distribution is needed; we overcome the "peso problem" by brute force. Nor is any special assumption of independence 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 cumulative probability of noncollapse is reported in the fifth column of Table A-1. The probability that a bubble could have lasted to March 1985 without bursting is only 16 percent. This is evidence against the hypothesis that a single rational bubble in fact explains the whole appreciation of the dollar, though it is not as low a probability as would be required to reject a hypothesis in a formal statistical test.

It might seem that assigning all of the 64 percent increase in the real mark/dollar rate to a speculative bubble is an unnecessarily extreme form of the hypothesis. Let us consider the alternative hypothesis, which appears more plausible, that part of the appreciation is attributable to a bubble and part to fundamentals. It turns out that this alternative hypothesis is *less* likely to be true, given the observed data. This counterintuitive result follows from the property of equations (A-1) and (A-2) that to get the same expected depreciation, $p_t$ must be larger the nearer the exchange rate is to equilibrium. For example, suppose that at each point in time, half the real appreciation has been due to a bubble. Then, to satisfy equation (A-2), $p_t$ would have to be almost twice as high. The last two columns of Table A-1 present the implicit probabilities under this scenario. 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 3 percent. Thus we can reject at the 95 percent confidence level the hypothesis that half the real appreciation is attributable to a rational bubble. We can reject at even higher confidence levels the hypothesis that one-quarter or any smaller (but finite) fraction of the appreciation is attributable to a rational bubble.

It should be noted that the emphasis in the rejected hypothesis is on the word "rational" rather than the word "bubble." For example, the same low probability would attach to the hypothesis that investors for four years rationally expected a collapse of the dollar attributable to a sudden change in the monetary/fiscal policy mix or other fundamentals, in place of a collapse attributable to a bubble bursting. But the finding still leaves the possibility of an *irrational* bubble. There is no reason a bubble could not have continued for four years if the true probability of bursting was less than the probability in speculators' expectations. The proposition that speculators made the same prediction error repeatedly is not an attractive one from the standpoint of rational-expectations theory, but it nevertheless seems to follow inescapably from a continuous four-year history of expected dollar depreciation—as reflected in either the forward discount or the expectations survey data—with no *ex post* depreciation materializing (see Marris, 1985, or Frankel and Froot, 1985).

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