The Budget Deficit and the Dollar

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Source: *NBER Macroeconomics Annual*, 1986, Vol. 1 (1986), pp. 355-392

Published by: The University of Chicago Press on behalf of the The National Bureau of Economic Research

Stable URL: https://www.jstor.org/stable/3585179

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# *The Budget Deficit and the Dollar*

The dramatic surge in the dollar's value relative to major European currencies was probably the most important economic event of the period between 1980 and 1984. The dollar's value rose from 1.8 German marks in mid-1980 to a peak of more than 3.3 marks in February 1985. More generally, the multilateral trade-weighted real value of the dollar rose by 70 percent between 1980 and the first quarter of 1985.

The rise of the dollar produced an unprecedented merchandise trade deficit that increased to 3 percent of GNP by 1985, hurting a wide range of American industries and creating a political receptivity to protectionism that still threatens to reverse the progress of the past half-century in liberalizing world trade. The trade deficit and the associated current account deficit transformed the United States from a net capital exporter in 1980 to a country that by 1984 had a large enough capital inflow to finance 55 percent of the nation's total net fixed investment. In addition, the sharp rise in the dollar not only increased Americans' real incomes but also contributed significantly to the decline of inflation.[1]

In Europe and Japan, exports rose sharply and the current account moved into substantial surplus; for the European Economic Community as a whole, the trade balance with the rest of the world improved by more than $50 billion between 1980 and 1984. But at the same time, the rise in the dollar induced foreign central banks to increase their interest rates in order to prevent their currencies from falling even further.[2] On balance, despite the increase in exports, the induced rise in interest rates may have depressed aggregate demand in Europe by enough to make the dollar's rise a net contributor to the stubbornly high level of unemployment.

1. On the impact of the dollar's rise on U.S. inflation, see Sachs (1985) and Sinai (1985).
2. This idea of an induced monetary policy response is discussed in Feldstein (1985, 1986a). This provides an alternative to the Blanchard and Summers (1985) explanation of the high level of world interest rates.

The present study focuses on the real exchange rate between the dollar and the German mark from the beginning of the floating exchange rate regime in 1973 through 1984. The mark is not only very important in its own right but is representative of the exchange rate between the dollar and the other European countries, since the mark is the dominant currency in the European Monetary System.

## 1. *Alternative Explanations of the Dollar's Rise*

The basic cause of the dollar's sharp increase still remains a very contentious subject. I have argued since 1982 that the dollar's rise could be traced primarily to the increase in current and expected structural deficits in the federal budget and to the shift to an anti-inflationary monetary policy.[3] This view was also elaborated in the *Economic Reports of the President for 1983 and 1984.*

Increases in the federal budget deficit raise real long-term interest rates and these higher rates attract funds to the United States. The dollar's rise is necessary to create the trade deficit and associated current account deficit that permits the desired net inflow of foreign capital. Moreover, to achieve portfolio equilibrium, the dollar must rise by enough so that its expected future fall just offsets the nominal yield differential between dollar securities and foreign assets. This is discussed in Branson (1985) and Frenkel and Razin (1984). The budget deficit may also raise the dollar more directly by changing the relative demand for U.S. and foreign goods (Dornbusch 1983, Obstfeld 1985).

The effect on the dollar of the rising level of structural budget deficits was reinforced by the change in monetary policy that began in October 1979. The contractionary shift of Federal Reserve policy caused a short-term spike in real interest rates that temporarily increased the attractiveness of dollar securities. More fundamentally, the new Federal Reserve policy also caused a more sustained increase in the confidence of investors worldwide that the value of the dollar would not soon be eroded by a return to rising inflation in the United States. This reduction in the risk of dollar investments reinforced the attractiveness caused by the deficit-induced rise in the expected real interest rate.

Other economists and policy officials have offered quite different explanations of the rise in the dollar. The *Economic Report of the President for 1985* concludes that the most important reason for the rise in the dollar between 1980 and 1982 was the rise in the after-tax return on new busi-

3. See, e.g., Feldstein (1983).

ness investment caused by the combination of the Economic Recovery and Tax Act of 1981 and the reduced rate of inflation. The tight money policy is also seen as a cause of the dollar's rise in this period. But the authors conclude that although expanding budget deficits in this period "may also have raised the level of U.S. real interest rates and helped to strengthen the dollar . . . the extent of upward pressure on real interest rates and on the dollar through this channel is uncertain, and numerous studies have failed to uncover significant effects" (p. 105).

The report's authors also note that after 1982 the differential between U.S. three-month real interest rates and a trade-weighted average of three-month real interest rates in six other industrial countries (calculated using OECD inflation forecasts) narrows to zero and is occasionally negative. They conclude from this that "other factors have continued to push up the demand for dollar assets" and suggest that the dollar's strength since 1982 has been due to "the combination of increased after-tax profitability of U.S. corporations, demonstrated strength of the U.S. recovery, reversal of international lending outflow from U.S. banks, and generally more favorable longer run prospects for the U.S. economy. . . ." (pp. 105–6).

Another commonly expressed opinion is that the rise in the dollar since the summer of 1980 reflected growing confidence in the United States as a "safe haven" for investments by foreigners who believed that the election of Ronald Reagan would make their assets safer in the United States than elsewhere in the world. There is also the view, identified most strongly with Ronald McKinnon (e.g., 1984), that the strong dollar does not reflect any "real" phenomena (budget deficits, increased profitability, alternative tax rules) but is solely an indication that monetary policy in the United States is too tight.

At a more fundamental level, any role for the budget deficit in explaining the rise of the dollar must be rejected by those economists who believe that deficits do not raise real interest rates because they induce an equal offsetting rise in private saving (e.g., Barro 1974). Evans (1986) extended the procedure of Plosser (1982) to study the relation between unexpected changes in budget deficits and the dollar and concluded the dollar exchange rate is not affected by changes in the budget deficit. I return below to the deficiencies of this type of analysis.

Although there may be some element of truth in each of the alternative explanations of the dollar's rise, my own judgment is that they are not as important as the increase in expected structural budget deficits and the shift to a less inflationary monetary strategy. This is supported by the econometric evidence presented in sections 4 through 6. The estimated effects of the expected deficits and of the rate of growth of the money supply are economically important and statistically significant. In contrast, the increase in profitability induced by the tax changes in the first half of the 1980s did not have a significant effect on the exchange rate in the equations presented below. The strong statistical evidence of a link between the expected structural budget deficits and the value of the dollar is direct evidence against the Barro hypothesis that budget deficits have no real impact. The implied impact of the expected budget deficits also contradicts the McKinnon hypothesis that the rise of the dollar was due only to a tight monetary policy.

Before I turn to that econometric evidence, I think it will be useful to consider some further reasons for rejecting the arguments of those who claim that neither increased real interest rates nor budget deficits was responsible for the dollar's rise.

The evidence presented in the *1985 Economic Report of the President* (and elsewhere) that there is no longer a difference between the three-month real interest rate in the United States and in other industrial countries is essentially irrelevant since the theory implies that the equilibrium relation between the exchange rate and the difference in *long-term* real rates is much larger than the relation with the difference in *short-term* real rates. It is easy to see why this is true. Consider the situation in which the U.S. three-month real rate is four percentage points above the three-month rate on foreign securities but there is no interest differential for intervals beginning after three months. Thus the six-month interest rates differ by only two percentage points, the one-year rates differ by one percentage point, and so on. The value of the dollar can be one percentage point above its equilibrium value since the interest rate differential is enough to compensate for a one percent decline in the dollar, regardless of whether this happens in three months, six months, a year, or longer. But with the differential in real rates concentrated only in the three-month maturity, any greater overvaluation of the dollar would imply an expected future decline not compensated by the difference in interest rates.

In contrast, consider the situation in which the real interest rate on the U.S. 10-year bond is 4 percentage points above the real yield on foreign 10-year bonds with no interest differential for intervals after ten years. Then the real value of the dollar can fall by 4 percent a year for ten years and still leave an investor indifferent between having purchased dollar bonds and foreign bonds. This implies that a 4 percent real interest differential on 10-year bonds can support a 48 percent initial overvaluation of the dollar.

It is noteworthy therefore that, although the three-month real yield differential reached zero by the end of 1982 and hovered around that level thereafter, the long-term real interest differential at the end of 1983 was in the range of two to four percentage points, depending on the method of forecasting future inflation.[4] The observed real interest differential was therefore quite consistent with the observed rise in the dollar's real value. I will return later to the more formal evidence on the link between the dollar and the real interest differential.

While the change in U.S. monetary policy after October 1979 may have reduced the inflation risk in U.S. fixed-income securities, the notion that the dollar rose in the 1980s because the United States capital market is a *political* safe haven for foreign funds seems doubtful. Although the United States does offer a politically safe environment, it is hard to see a rise in U.S. political stability vis-à-vis Switzerland or other major countries between the late 1970s and the early 1980s. Moreover, if there had been a shift in the worldwide portfolio demand in favor of U.S. assets, U.S. interest rates would have declined. The sharp rise in real rates suggests that any "safe haven" increase in the demand for dollar assets was overwhelmed by the increased supply of those assets. It is also doubtful that the declines of 25 percent or more between February 1985 and February 1986 in the value of the dollar relative to the German mark, the Swiss franc, and the Japanese yen reflects any deterioration in the relative political stability and security of the United States.

Those who point to the reduced lending of U.S. banks to the Latin American debtor nations after fall, 1982, as an example of the safe haven effect misconstrue the portfolio effect of that lending. That change in lending did not represent a change in U.S. demand for assets denominated in foreign currencies since those loans were all denominated in dollars. Moreover, the loan proceeds were used by the borrowers either to purchase imports or, through capital flight, to make deposits or purchase assets in the United States.

There are two problems with the argument that the dollar rose because the strength of the recovery attracted investments seeking to share in U.S. profitability. First, the real value of the dollar rose through the recessions of 1980 and 1981 and was 36 percent higher at the trough of the second recession (in the final quarter of 1982) than it had been in 1980. Real interest rates and projected budget deficits were rising during this period even though the economy was sagging. Second, most of the capital inflow to the United States was in the form of bank deposits or pur-

4. This is shown on p. 52 of *The Economic Report of the President for 1984.*

chases of short-term fixed income securities and only about one-third was in the form of portfolio equity purchases or direct investment. In 1982 and 1983 combined, there was a $192 billion increase in foreign private assets in the United States but direct investments were only $27 billion and stock purchases were only $33 billion.

In short, there are good reasons to reject the arguments of those who say that the dollar's rise cannot be due to higher real rates because the interest differential disappeared long ago and who attribute the dollar's rise to the attractiveness of U.S. financial markets as a safe haven for foreign investors and as a place in which equity investments can participate in the profitable recovery. Although the improved tax climate for investment should in principle have raised the value of the dollar, the evidence presented below indicates that this effect is too weak to discern statistically.

The study by Evans (1986) is unpersuasive for quite a different reason. Evans's basic procedure is to relate quarterly movements in the exchange rate to the quarterly "surprises" in the deficit, in government spending, in monetary policy, and the like. These "surprises" are calculated as the residuals from vector autoregression predictions of the deficit and other variables. The fundamental problem with this procedure is that it assumes that the deficit variable that might influence the exchange rate is the concurrent deficit, when theory implies that it is the sequence of expected future deficits that influences the long-term real interest rate and the exchange rate.[5] There is no reason for the surprises in actual current quarterly deficits to be related to the expected future deficits.[6]

Finally, the evidence presented below supports the importance of the increased budget deficits as the primary cause of the rise in the dollar and thereby refutes both the Ricardian-equivalence proposition that budget deficits have no real effects and the position of McKinnon and others who attribute all of the dollar's rise to tight monetary policy in the United States.

## 2. *Studies of the Dollar and the Interest Differential*

Except for the study by Evans (1986), the empirical research on the determination of exchange rates has focused on the relation between the

5. The importance of expected future deficits was emphasized in Feldstein (1983) and analyzed more formally in Frenkel and Razin (1984), Blanchard (1985), and Branson (1985).
6. The same criticism also applies to Plosser's (1982) claim that budget deficits do not influence the level of interest rates.

exchange rate and the real interest differential.[7] Although the equilibrium relation between the exchange rate and the interest differential is a fundamental characteristic of portfolio balance in foreign exchange markets (Dornbusch 1976, Frankel 1979), there are four serious problems in estimating an equation relating the exchange rate to the real interest differential in order to understand the causes of variations in the real exchange rate and, more specifically, to assess the role of the budget deficit as a cause of changes in the exchange rate.

First, the critical interest rate variable is very difficult to measure with any accuracy. The difference in real long-term interest rates is equal to the difference in nominal long-term interest rates minus the difference in expected long-term inflation rates. It is clearly very difficult to measure with any accuracy the difference between the long-term expected inflation rates in the two countries. These expectations depend not only on the history of inflation in the two countries but also on the credibility of government and central bank policies. The critical real interest differential is therefore subject to substantial measurement error that will tend to bias the coefficient toward zero and to reduce the statistical significance of its effect.[8]

Second, changes in the level of the real interest rate in each country

7. Although measures of the money stock, inflation, and real activity have sometimes been included among the regressors, neither the budget deficit nor the effect of changes in tax rules has been included. See Frankel (1979) for a relatively early study of this form and Hooper (1985), Meese and Rogoff (1985) and Sachs (1985) for more recent examples; Obstfeld (1985) provides a very useful survey of recent research on this subject. Hooper allows budget deficits and tax rules to affect the exchange rate as part of a large econometric model but the estimated effect is only through their impact on the real interest differential. Moreover, since Hooper uses only the current budget deficit (rather than expected future deficits) it is not surprising that he estimates only a relatively small effect of the deficit on the exchange rate.

After this paper was written, I received a copy of Hutchinson and Throop (1985); the authors provide a very careful analysis that shows that the trade-weighted real value of the dollar can be explained by an equation that combines the real interest differential between the United States and the seven major industrial countries and a corresponding one-year expected structural budget deficit differential. Both the interest rate and the deficit differential are significant in this formulation. They present no evidence about monetary policy or tax policy.

8. A review of the papers that use a "real interest differential" to explain exchange rate variations shows the potential seriousness of this problem. For example, Frankel's 1979 paper used the short-term German-U.S. interest differential instead of the long-term differential and measured the difference in expected long-term inflation rates (a separate variable in his formulation) by the difference in long-term bond rates. Meese and Rogoff (1985), in an otherwise very sophisticated paper, also generally use the three-month interest rates; when they do use long-term bonds, they take inflation during the most recent twelve months as a proxy for long-term expected inflation. Hooper's analysis is perhaps most satisfactory but uses only a three-year moving average of inflation rates.

reflect changes in the risk premium required to get investors to hold the debt denominated in that currency. These changes reflect variations in the perceived risk of fluctuations in the interest rate and the exchange rate as well as variations in the relative quantities of the assets denominated in that currency. An increase in the level of the real interest rate from a change in the risk premium can occur with no change in the exchange rate.

Third, the real interest rates in the two countries are endogenous variables, responding to changes in the exchange rate in a way that causes the direct structural effect of the interest rates on the exchange rate to be underestimated. Thus, a strong dollar implies a reduction in net exports, which depresses aggregate demand in the United States and therefore tends to lower the U.S. real interest rate. In addition, the strong dollar reduces U.S. net exports, thereby increasing the net capital inflow to the United States; the increase in the current and projected net capital inflow also tends to lower U.S. real interest rates. The stronger dollar may at times induce a more lax monetary policy than would otherwise prevail, temporarily reducing the real interest rate. These inverse effects of the dollar on the level of interest rates attenuates the measured direct effect of the interest rate on the level of the dollar.

An increase in the dollar-DM rate also tends to raise the real interest rate in Germany through the same three channels that cause it to lower the real interest rate in the United States. The weaker mark increases economic activity in Germany and this raises the real interest rate. The current and projected outflow of capital from Germany that accompanies the trade surplus raises the equilibrium real interest rate. And recent experience indicates that a fear of the inflationary consequences of a declining mark caused the Bundesbank to tighten monetary policy as the mark fell relative to the dollar.[9]

In the econometric estimates of the relation between the exchange rate and the interest rate presented in section 6, I use an instrumental variables procedure that treats the interest differential as endogenous. The instrumental variables are the budget deficits of the two countries, the past growth of the monetary base, and the past rates of inflation. The use of the instrumental variable procedure may also reduce the bias that results from the difficulty of measuring expected inflation. However, despite its desirable large-sample properties, the instrumental variable procedure is of only limited comfort with the small sample available in the present study.

9. On the induced change in Bundesbank policy, see Feldstein (1986a) and Feldstein and Bacchetta (1986).

In addition to the statistical problems of estimating the direct effect of exogenous shifts in the real interest differential on the exchange rate, there is the more fundamental issue that evidence on the dollar's response to changes in the real interest rate does not resolve the issue of the relative importance of changes in the budget deficit, in tax policy, and in monetary policy. Although that could in principle be obtained by estimating a separate equation relating the real interest rate to the budget deficit, tax, and monetary variables,[10] that two-equation specification implicitly assumes that these variables affect the exchange rate only through the real interest differential. At a minimum, changes in monetary, tax, and budget policies may affect the expected rate of inflation and the uncertainty about future real interest rates in ways that are not captured by the measured values of the real interest rates. In addition, as Dornbusch (1983) has noted, the budget deficit can have a direct effect through the relative demand for domestic and foreign goods.

This article therefore focuses on estimating a reduced-form specification that relates the dollar-DM exchange rate to four key variables: expected future budget deficits; tax-induced changes in the profitability of investment in plant and equipment; past inflation; and changes in monetary policy. The specification is also extended to include other variables such as the net U.S. stocks of international investment and the rate of growth of real GNP. A dummy variable is also used to evaluate whether the dollar's exchange value was higher in the period 1980–84 for some other unmeasured reason such as an increased attractiveness of the United States as a "safe haven" for foreign funds or international investors' greater faith in the Reagan administration. In addition to these reduced-form equations, the paper also reports estimates of equations relating the dollar-DM exchange rate to a measure of the real interest rate differential, using an instrumental variable procedure to reduce the statistical bias that might otherwise result from the endogeneity of the interest rates and the errors of measurement.

The next section describes these key variables and their construction in more detail. The estimated equations are then discussed and presented in sections 4 and 5.

## 3. *The Key Variables of a Reduced-Form Specification*

The dependent variable of the equations presented below is the real exchange rate between the dollar and the German mark calculated as the nominal exchange rate multiplied by the ratio of the GNP deflators. The

10. This is done in Feldstein (1986b).

exchange rate is stated as the number of German marks per U.S. dollar; a rise of the dependent variable is thus a rise in the real value of the dollar.

The key variables of the reduced-form specification described above cannot be observed directly but must be constructed. Here I describe the rationale for these variables and the way that they have been constructed for the current study. The regression equations reported later are estimated with annual observations for the period 1973 through 1984. The analysis uses annual observations because quarterly or monthly observations on variables like the expected future budget deficits and the tax-induced changes in profitability would probably contain much more measurement error with little or no increase in actual information.

### 3.1. EXPECTED U.S. BUDGET DEFICITS

It is the path of expected future budget deficits rather than simply the current year's deficit that influences the level of real interest rates and the exchange rate. In 1983 testimony (Feldstein 1983) I emphasized this link of the exchange rate to expected future budget deficits as follows:

*That is the essential explanation of the strong dollar: the high real long-term interest rate in the United States, combined with the sense that dollar investments are relatively safe and that American inflation will remain low, induces investors worldwide to shift in favor of dollar securities. Moreover, the unusually high real long-term interest rate here relative to the real rates abroad is now due primarily to the low* projected *national savings rate caused by the large* projected *budget deficits [emphasis added].*

To clarify the importance of the long-term projected deficits rather than just the current year's deficit, I noted:

*Net national saving fell from its customary 7 percent of GNP to only 1.5 percent of GNP in 1982 and 1.5 percent of GNP in the first three quarters of 1983. Moreover, and of particular importance in this context, the large budget deficits that are projected for the next five years and beyond if no legislative action is taken means that our net national saving rate will continue to remain far below the previous level.*

If government borrowing is high for only a single year, the additional government debt can be absorbed by temporarily displacing private investment with little effect on long-term interest rates. In contrast, the expected persistence of budget deficits in the future implies a larger increase in the stock of debt that must be sold to the private sector and a persistent displacement of private investment that must be achieved to accommodate the government's borrowing. Future budget deficits also mean future increases in potential aggregate demand that will lead to higher future short-term interest rates and therefore to higher current long-term rates. All of these considerations imply that the dollar exchange rate should be more sensitive to expected future deficits rather than to the current year's budget deficit.

Blanchard (1985) emphasized the importance of expected future deficits in the determination of current long-term interest rates and Frenkel and Razin (1984, 1986) and Branson (1985) emphasized the importance of expected future deficits in exchange rate determination.

The expected persistence of structural budget deficits also increases the risk that political pressures will lead to an inflationary monetary policy. To this extent, expected high future deficits may raise nominal interest rates but reduce the exchange value of the dollar by making dollar-denominated fixed income securities more risky.

Neither of the studies that explicitly looks at budget deficits considers the expected sequence of future budget deficits. I have already commented on the fact that Evans's (1986) procedure is based on the difference between the budget deficit in the current quarter and the deficit predicted by a VAR equation for the current quarter. There is no attention to expected future deficits. Hooper's (1985) analysis is also in terms of the current quarter's budget deficit with no attention to expected future deficits. As a result, I am not inclined to give any weight to Evans's negative conclusion or to Hooper's conclusion that budget deficits had only a small effect on the dollar exchange rate.

The variable used in this study to represent the anticipated future budget deficit (DEFEX) is an estimate of the average ratio of the budget deficit to GNP for five future years. Since the five-year deficit forecast is used as a proxy for the long-term expected deficit, it is appropriate to eliminate the cyclical component of the deficit and focus on the structural component of the deficit relative to an estimate of potential or full-employment GNP. The structural deficit is calculated from the observed or projected deficit and an estimate of the difference between the actual GNP and potential GNP. The details of this calculations and of the derivation of potential GNP are described in Feldstein (1986b).

Although five-year forecasts of the deficit and of GNP have been made in recent years, they are not available for the entire sample period. The analysis therefore assumes that, for the years for which it is observable, the actual deficit and the actual GNP are the best estimates of the values that financial market participants previously anticipated. For the years 1985 and beyond, the expected deficit and expected GNP are measured by the projections published in July 1985 by Data Resources, Inc. The

Data Resources deficit projections reflect anticipated policy developments as well as existing tax and spending rules; they are therefore taken as an indication of the view of sophisticated financial market participants. The actual and projected deficits are then adjusted to obtain structural deficits and full-employment GNP. Note that this implies that for recent years the expected deficit variable is a combination of actual deficits and projected deficits; e.g., the 1983 expected future deficit variable includes the observed deficit and GNP variables for 1983 and 1984 but the DRI projections for 1985 through 1987.

The anticipated deficit variable has been constructed in a way that, as far as possible, avoids discretionary decisions in order to eliminate any suspicion that the deficit variable has been modified to obtain a variable that can explain the variations in the exchange rate. Avoiding discretion can, however, lead to implausible assumptions and several people commenting on an earlier draft of this article said that they were concerned about the implication that the financial markets anticipated the unprecedented growth of budget deficits in the 1980s even before the 1980 election of Ronald Reagan and the presentation of his 1981 budget.

I have therefore constructed an alternative expected deficit variable that differs from the standard expected deficit variable for the years 1977 through 1980. For those years, the alternative expected five-year average deficit ratio is calculated by assuming that the 1980 ratio of structural deficit to GNP persists. For example, the five-year average for 1978 consists of an average of the deficit-GNP ratios for 1978, 1979, and 1980 with 1980 getting 60 percent of the weight. This variable will be denoted DEFALT (alternative deficit variable). The empirical analysis shows that substituting this for my standard expected deficit variable improves the explanatory power of the equation but does not alter the estimated coefficient.

### 3.2. EXPECTED GERMAN BUDGET DEFICITS

Although the exchange rate between the dollar and the German mark might at first seem to depend symmetrically on the budget deficits of the United States and Germany, this is true only if the two countries are symmetric in all other relevant ways. There are, however, two major differences between the United States and Germany that imply that changes in German deficits have smaller effects on the exchange rate than changes U.S. deficits.

First, the German economy is less than one-third the size of the U.S. economy. An increase in the German deficit by 1 percent of GNP is therefore only one-third as large as 1 percent U.S. GNP deficit increase.

More important, the close links among the European economies, now formalized by the European Monetary System, means that European investors will frequently act as if exchange rates among the major European countries are fixed. To the extent that this is true, what matters is not the change in the German budget deficit as a percentage of German GNP but the change in the combined European (or EMS) budget deficits as a percentage of the combined GNPs of those countries. Although this idea will be the subject of further attention in a future study, the current article uses only the ratio of the German budget deficit to German GNP.

The German expected deficit-GNP ratio variable (DEFEXG) is constructed to be as close as possible in concept to the U.S. expected deficit variable, although differences inevitably remain. The basic source of the data is an OECD study of structural budget deficits (Price and Muller 1984) that provides estimates of the ratio of the structural budget deficit to potential GNP for each year from 1973 through 1984. Forecasts for 1985 and 1986 are obtained from the *OECD Economic Outlook* for December 1985. For the years through 1982, these data can be used to construct a five-year average by assuming that financial markets expected the deficit-GNP ratios that were subsequently observed (or, for 1985 and 1986, that were subsequently forecast by the OECD). For 1983 and 1984, we lack the necessary forecasts of the deficit-GNP ratio in the more distant future; we therefore assume that investors project the deficit-GNP ratio at the 1984 level.

It should be noted that there is a serious problem in defining the structural deficit for Germany since the German unemployment rate (defined to approximate U.S. standards) rose from less than 1 percent in 1973 to nearly 8 percent in 1984. There is substantial controversy about how much of this increase is cyclical and how much is structural. Although the present analysis adopts the deficit implicit in the OECD measure of the structural deficit, it is clear that there is substantial possible error in this variable.

### 3.3. TAX-INDUCED CHANGES IN PROFITABILITY

The after-tax profitability of new corporate investments in plant and equipment determines the corporate demand for funds. If the domestic supply of funds to the corporate sector is relatively inelastic, an increase in the corporate demand for funds will put upward pressure on real interest rates and attract an inflow of capital from abroad. In contrast, if the corporate sector is a relatively small part of the domestic capital market, an increase in the corporate demand for funds can probably be satisfied without a significant rise in the real rate of return and therefore with little effect on international capital flows and the dollar.

The difference between pretax and after-tax profitability depends on the corporate tax rate, the depreciation rules, the investment tax credit, and the rate of inflation. All of this can be summarized by the "maximum potential real net return" (MPRNR) that the firm can afford to pay to the suppliers of capital on a standard project.[11] In an economy without taxes, the MPRNR on a project would be the traditional real internal rate of return. With taxes and complex tax depreciation rules, the MPRNR is the maximum real return that the firm can afford to pay on the outstanding "loan" (of debt or equity or a combination of the two) used to finance the project and have fully repaid the "loan" when the project is exhausted.

The standard project for which this calculation is done is a "sandwich" of equipment and structures in a ratio that matches the actual equipment-structures mix of the nonresidential capital stock. Because the tax law specifies depreciation rules and interest deductibility in nominal terms, the expected real net return depends on the expected rate of inflation; a maximum potential nominal return is obtained using an expected inflation series generated by a "rolling" ARIMA forecast (described below) and then the real MPRNR is calculated by subtracting the average expected inflation rate from this maximum potential nominal return. Full details of the calculation are provided in Feldstein and Jun (1986) in which it is also shown that variations in the MPRNR have had a substantial effect on corporate investment in the past quarter-century.

The MPRNR represents a potential *net* return that the firm can provide in the sense that it takes into account the deductibility of interest payments. From the portfolio investor's point of view, what matters is not the MPRNR but the maximum market rate of return that the corporation can provide. This differs from the MPRNR essentially in the fact that the portfolio investor receives gross interest while the MPRNR reflects interest net of the corporate deduction for that interest cost. The maximum real return depends on the mix of debt and equity that the firm uses to raise marginal increments to its capital stock. If we assume an average ratio of two-thirds equity and one-third debt and incorporate the average historical standard difference in the net returns of equity and debt, we can calculate "the maximum potential real interest return" (MPRIR).[12]

The MPRNR measure of real net profitability remained at approximately 6.0 percent during the years 1973 through 1984 and then rose to approximately 7.3 percent in the early 1980s. The behavior of the

11. This MPRNR measure is very closely related to the MPNR and MPIR values calculated in Feldstein and Summers (1978) and updated with some improvements in Feldstein and Jun (1986).
12. See Feldstein (1986b) for an explanation of how the related nominal MPIR is calculated. The MPRIR is obtained from the MPIR by substracting the same average projected inflation rate used to generate the MPNR and MPIR values.

maximum potential real interest rate was quite different. Since nominal interest rates are deductible in calculating the taxable profits of the corporation, a one percentage point decline in expected inflation reduces the maximum potential nominal interest rate by more than one percentage point and therefore reduces the maximum potential real interest rate. The MPRIR measure of the maximum real net interest rate rose significantly between 1973 and 1981 (because of the rising expected rate of inflation) and then came down significantly in the 1980s. Both variables are studied in the empirical section.

### 3.4. EXPECTED INFLATION

The expected inflation rate has no direct role in a simple model of exchange-rate determination since the exchange rate depends only on the difference in real rates. However, as Frankel (1979) has emphasized, a rise in expected inflation may temporarily depress real interest rates (because nominal rates do not adjust rapidly enough) and therefore the exchange rate. In addition, financial investors may regard a higher inflation rate as inherently more uncertain; a government that has allowed its inflation rate to get to (say) 10 percent may be less able to control it in the future than a government that has kept its inflation rate under 5 percent. The uncertainty of future inflation makes the future value of the currency more uncertain and therefore depresses the demand for the currency.

The expected rate of inflation is not only unobservable but depends on a large number of variables: past rates of inflation; past increases in monetary aggregates; projected structural budget deficits; changes in energy prices; the current level of capacity utilization; etc. Although it is not possible to combine all of these factors to obtain a single operational measure of expected inflation, the exchange-rate equations presented below include many of these variables. The proper interpretation of the projected structural budget deficit variable, for example, is therefore a combination of the direct effect of the deficit on real interest rates and any effect that operates through expected inflation and inflation uncertainty. It is not possible to identify these separate effects but only to quantify the net impact of expected deficits on the exchange rate.

Although this approach is satisfactory as a general way of dealing with the effect of expected inflation on the dollar's value, it cannot be used for quantifying the effect of the tax-inflation interaction on the maximum potential real interest rate. For that purpose, we require an explicit year-by-year forecast of inflation over the future life of the standard investment project. To do that, we estimate a series of first-order ARIMA models using quarterly data on the GNP deflator with observations through each year and use these models to forecast future inflation rates for the 30-year life of the standard investment project. The algorithm calculates nominal values of MPNR and MPIR using the entire set of thirty years of inflation rates. These nominal returns are then converted into real returns by subtracting a weighted average of the projected future inflation rates.

This "projected inflation variable" (INFEX) is also used as a separate explanatory variable in the exchange-rate regressions to summarize the past rates of inflation. As an alternative, equations are also presented with a polynomial distributed lag on past rates of change of the GNP deflator.

### 3.5. OTHER VARIABLES

The other variables that are included in some or all of the estimated exchange-rate equations can be easily described.

The basis measure of U.S. monetary policy in this study is the rate of change of the monetary base (MBGRO). As an alternative, equations are also estimated with the rate of change of M1 (M1GRO). Variables such as the ratio of money to GNP or the interest rate would clearly be endogenous in a way that would be inappropriate for the current specification.

For Germany, equations are presented with the rate of change of the Central Bank money stock (MBGROG). There is, however, a problem of interpreting this variable if, as I believe, the Bundesbank altered the growth of its monetary base in response to variations in the dollar-DM ratio. A strong dollar and declining mark created potential inflationary pressures that caused the Bundesbank to reduce the growth of the monetary base, thereby introducing an offsetting negative correlation between the growth of the German monetary base and the strength of the dollar.

Much of the financial market discussion of short-term changes in exchange rates focuses on changes in the pace of economic activity, presumably as an indicator of future changes in real interest rates. Dornbusch (1983) and Obstfeld (1985) also show how changes in domestic demand can alter the exchange rate by changing the relative demand for domestic and foreign goods. The current analysis uses the change in real GNP (GNPGRO) as a measure of economic activity.

Some of the equations also include a dummy variable for the period beginning in 1980 (DUM80+) to see whether the effects attributed to the rising budget deficit are due simply to some other unidentified or unmeasured character of the period since 1980, such as the altered nature of monetary policy or the strengthened political "safe haven" quality of the dollar.

Finally, some of the equations include the net international investment position (NIIP) of the United States, i.e., the excess of U.S. investments abroad over foreign investments in the United States. If U.S. securities are not a perfect substitute for foreign securities, an exogenous increase in the net international investment position of the United States should strengthen the dollar by reducing the demand for additional foreign securities by U.S. investors. Similarly, an exogenous rise in the foreign holding of U.S. securities (a decrease in the U.S. net international investment position) should reduce the value of the dollar by reducing the demand for dollar securities.

Since the NIIP of the United States reflects past current account deficits, the level of the NIIP will not be exogenous if the residual in the current account equation or in the equation for the exchange rate is serially correlated. For example, an increased taste for investing in dollar securities will strengthen both the dollar and, after a lag, reduce the U.S. net international investment position. Since the taste shift is unobservable, the coefficient of the NIIP of the United States will be biased downward toward zero. Although it would be desirable to develop a more complete analysis of this issue with which to model the process of portfolio satiation, the current research settles for only a very simple extension of the basic specification to include the NIIP variable.

## 4. *A Summary of the Reduced-Form Estimates*

It is useful to begin with a summary of the estimated reduced-form equations and a commentary on the magnitude of the estimated coefficients. The individual estimated equations are presented and discussed in section 5. The equations relating the exchange rate to real expected interest rates in the United States and Germany are discussed in section 6.

The dependent variable of all of the estimated equations is the real dollar-DM exchange rate, defined as the number of German marks per dollar, adjusted for the level of the GNP deflator of the two countries and normalized to 1.0 in 1980. This variable declined erratically from 1.21 in 1973 to 0.97 in 1979 and then climbed to 1.72 in 1984. Individual annual values are shown in appendix table A-1, together with the annual values of all other variables used in this study.

The basic equation relates the real dollar-DM exchange rate to the expected structural deficits as a percentage of GNP (DEFEX), the maximum potential real interest rate that can be supported by a standard investment project given the concurrent tax rules and expected inflation (MPRIR), the rate of growth of the monetary base (MBGRO), and the average future GNP inflation projected by a rolling ARIMA model

(INFEX). To test the sensitivity of the estimated effect of the expected deficit variable to the specification of the exchange rate equation, a large number of variants of this basic specification have been estimated. These variations omit some of the basic variables, replacing the basic variables with other closely related variables (e.g., replacing INFEX by a polynomial distributed lag on past changes in the GNP deflator) and adding additional variables.

Several results are very robust with respect to alternative specifications. The coefficient of the expected future budget deficits is always positive, substantial, and almost always statistically significant. The point estimate generally varies between 0.25 and 0.40. To appreciate the magnitude of this coefficient, it is useful to recognize that DEFEX rose from 1.58 (percent of GNP) in 1978 and 1.79 to 3.38 in 1983 and 3.33 in 1984. Comparing the average of the first two years with the average of the last two years implies an increase of 1.67 percent of GNP. A coefficient of 0.25 implies an increase of the dollar-DM exchange rate index of 0.42 while a coefficient of 0.40 implies an increase of the dollar-DM index of 0.67. Since the dollar-DM index rose from 0.99 in 1978–79 to 1.61 in 1983–84, the rise in the expected budget deficit can account for between two-thirds of the dollar's rise (0.42/0.62 = 0.677) and slightly more than 100 percent of the dollar's rise (0.67/0.62 = 1.08).

The coefficient of monetary base growth is always negative and generally statistically significant. A negative coefficient implies that a faster growth of the monetary base depresses the value of the dollar. This may be because an increase in the monetary base temporarily increases the liquidity of the banking system and therefore reduces interest rates or, more generally, because it causes nominal interest rates to decline. Alternatively, more rapid growth of the monetary base may raise expected inflation or inflation uncertainty, thereby making dollar securities more risky.

The value of the coefficient of the annual growth rate of the monetary base is approximately −0.06. Although the implied effect of monetary policy can explain relatively little of the dollar's rise from 1980 to 1984, it does indicate an important effect during the early part of the period. The annual rate of growth of the monetary base fell from 8.8 percent in 1978 and 1979 to a low of 6.4 percent in 1981. The coefficient of 0.06 implies a rise in the DM-dollar exchange rate index of 0.144 between these years. Since the actual exchange rate index rose from 0.99 to 1.31, the tighter money can account for nearly one-half of the observed rise (0.144/0.32 = 0.45) from 1978–79 to 1981. However, since the expected budget deficit increased during the same years from 1.68 percent of GNP to 2.82 percent of GNP, the implied rise in the DM-dollar index was about twice as large as the rise implied by the change in monetary policy and the two together account for more than the entire rise, implying that other factors depressed the dollar's value during this period.

By 1984, the annual rate of increase of the monetary base was back up to 8.1 percent, implying that the change since 1978–79 could only explain about 0.05 points of the 0.73 point rise in the real dollar-DM ratio.

The coefficient of the MPRIR tax variable was frequently insignificant and generally had the wrong sign (implying that increases in the maximum potential real interest rate that resulted from changes in ex ante effective tax rates depressed the value of the dollar). The coefficient of the MPRNR variable also generally had the wrong sign but was almost always insignificant. While a negative coefficient cannot be reconciled with the theoretical expectations, the insignificant coefficients are consistent with an earlier finding (Feldstein and Summers 1978) that shifts in the MPIR had only a small effect on market interest rates, a result that was obtained more recently (Feldstein 1986b) in an even stronger form. The small and insignificant effect of the MPRIR and MPRNR on the financial variables stands in sharp contrast to their powerful effects on real investment reported in Feldstein (1982) and Feldstein and Jun (1986).

The insensitivity of the real interest rate and the real exchange rate to the rate that corporate borrowers can afford to pay on a standard investment project may simply reflect the fact that corporate borrowers represent only a small part of the funds raised in credit markets. Between 1980 and 1984, corporate borrowing was only 20.5 percent of the total funds raised in the credit markets by all of the public and private nonfinancial borrowers combined. Even a substantial shift in the demand curve represented by this 20 percent need not cause an appreciable rise in the interest rate if the additional funds are easily attracted from the other borrowers, from potential savers, or from the rest of the world.

Negative coefficients of the MPRIR and MPRNR variables cannot be given a structural interpretation. They may represent the correlation of this variable with other omitted variables that depress the value of the dollar. While this leaves some residual doubt about the actual impact of the tax changes, it is important to note that including, excluding, or changing the specification of the tax variable does not alter the conclusions about the expected budget deficit variables.

The inflation variables had a negative coefficient, implying that a higher rate of predicted (or past) inflation depressed the relative value of the dollar. This may reflect a failure of the nominal interest rate to adjust quickly enough to changes in the expected rate of inflation. Alternatively, if there is a positive correlation between the inflation level and inflation uncertainty, the higher level of predicted inflation may make the dollar a riskier asset for investors and therefore an asset of lower value.

Although the inflation coefficient was always negative, the magnitude of the coefficient varied substantially from one specification to another and was not always statistically significant. In interpreting the coefficient, it should be borne in mind that INFEX rose from 6.7 percent in 1978–79 to 8.1 percent in 1981 and fell to 5.5 percent in 1984. A coefficient of −0.04 on this variable would imply a decline of 0.06 points on the dollar-DM index between 1978–79 and 1981, followed by a rise of 0.10 points between 1981 and 1984. This increase represents about one-fourth of the rise in the dollar-DM index during those years.

The estimated coefficients of the expected German budget deficits are always insignificant. This may reflect the difficulty in measuring the German structural deficit accurately or it may reflect the fact that the close links among the European economies mean that the dollar-DM ratio is not sensitive to German deficits per se. Only future work will clarify this. It is important to note, however, that the inclusion or exclusion of this variable has essentially no effect on the coefficient of the U.S. budget deficit variable.

## 5. *The Estimated Reduced Form Equations*

Table 1 presents the basic reduced-form equation and a number of variations on this specification. In equation (1.1) the coefficient of the expected deficit variable (DEFEX) is 0.375 with a standard error of 0.071, implying that each percentage point increase in the ratio of expected structural deficit to GNP raises the real dollar-DM index by 0.375 points. As noted above, the real dollar-DM index rose from 0.99 in 1978–79 to 1.72 in 1984 while the expected deficit rose from 1.68 percent of GNP to 3.35 percent of GNP. The coefficient of 0.375 implies that the rise in DEFEX accounts for 63 points of the 73-point rise in the index.

The coefficient of the tax variable, the maximum potential real interest rate (MPRIR) supportable by a standard project, has the wrong sign. I will return later to this and to its sensitivity to specification.

The coefficient of the ARIMA inflation projection (INFEX) is negative but is only −0.010 and much smaller than its standard error of 0.029. It is useful to reiterate a point made earlier that this ARIMA variable should not be regarded as equivalent to inflation expectations since inflation expectations at any time will also reflect the growth of the monetary base, the size of projected budget deficits, and many other political and economic factors.

Table 1 EFFECTS OF EXPECTED BUDGET DEFICITS AND OTHER VARIABLES ON THE DM-DOLLAR EXCHANGE RATE: BASIC SPECIFICATIONS

| Equation | *DEFEX* (1) | *DEFALT* (2) | *MPRIR* (3) | *MPRNR* (4) | *MBGRO* (5) | *INFEX* (6) | *PDLINF* (7) | *CONST.* (8) | $U_{-1}$ (9) | $U_{-2}$ (10) | $\bar{R}^2$ (11) | *DWS* (12) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.1 | 0.375 | | −0.095 | | −0.061 | −0.010 | | 1.47 | | | 0.78 | 1.68 |
| | (0.071) | | (0.038) | | (0.042) | (0.029) | | | | | | |
| 1.2 | | 0.385 | −0.093 | | −0.044 | 0.005 | | 1.21 | | | 0.95 | 1.76 |
| | | (0.031) | (0.017) | | (0.019) | (0.014) | | | | | | |
| 1.3 | 0.387 | | −0.102 | | −0.058 | | | 1.39 | | | 0.81 | 1.72 |
| | (0.059) | | (0.031) | | (0.038) | | | | | | | |
| 1.4 | 0.254 | | −0.016 | | −0.068 | | −0.098 | 1.99 | | | 0.84 | 1.78 |
| | (0.118) | | (0.077) | | (0.050) | | (0.082) | | | | | |
| 1.5 | 0.234 | | | | −0.036 | −0.048 | | 1.32 | | | 0.64 | 0.76 |
| | (0.056) | | | | (0.052) | (0.032) | | | | | | |
| 1.6 | 0.236 | | | | −0.060 | −0.020 | | 1.34 | 1.23 | −0.68 | 0.84 | 2.22 |
| | (0.193) | | | | (0.023) | (0.017) | | | (0.33) | (0.45) | | |
| 1.7 | 0.223 | | | | −0.057 | | | 1.21 | 1.21 | −0.69 | 0.83 | 2.13 |
| | (0.161) | | | | (0.024) | | | | (0.29) | (0.38) | | |
| 1.8 | 0.343 | | | −0.110 | −0.054 | −0.070 | | 2.07 | | | 0.64 | 1.11 |
| | (0.123) | | | (0.111) | (0.055) | (0.039) | | | | | | |
| 1.9 | 0.246 | | | 0.023 | −0.043 | −0.027 | | 1.09 | 0.72 | | 0.73 | 0.87 |
| | (0.201) | | | (0.108) | (0.041) | (0.033) | | | (0.53) | | | |
| 1.10 | 0.283 | | | −0.106 | −0.097 | | −0.084 | 2.63 | | | 0.86 | 2.48 |
| | (0.075) | | | (0.108) | (0.052) | | (0.046) | | | | | |
| 1.11 | 0.367 | | −0.081 | | | −0.000 | | 0.86 | | | 0.75 | 1.59 |
| | (0.076) | | (0.040) | | | (0.030) | | | | | | |
| 1.12 | 0.339 | | −0.053 | | −0.027 | −0.023 | | 1.10 | | | 0.76 | 1.16 |
| | (0.079) | | (0.046) | | (0.023) | (0.036) | | | | | | |

The dependent variable is the real DM-dollar exchange rate (DMs per dollar, adjusted for GNP deflators) normalized at 1.0 = 1980. Equations estimated for 1973 to 1984. Standard errors are shown in parentheses. See text for explanation of variables. In equation (1.12), the growth of the monetary base is replaced by the growth of M1.

Finally, the rate of growth of the monetary base has a coefficient of −0.06 (with a standard error of 0.042), implying that a faster rate of monetary growth depresses the value of the dollar.

The adjusted $\bar{R}^2$ of 0.78 implies that the equation explains the variations in the dollar-DM ratio quite well and the Durbin-Watson statistic of 1.68 indicates that there is little serial correlation of the residuals.

Equation (1.2) replaces the basic DEFEX variable with the alternative DEFALT variable (described in section 3.1) that was constructed to avoid the assumption that financial market participants anticipated the large budget deficits before 1981. The coefficient of DEFALT is 0.385 and therefore almost identical to the 0.375 coefficient of DEFEX reported in equation (1.1). The standard error of DEFALT is, however, only 0.031 or less than half of the standard error of the coefficient of DEFEX, reflecting the fact that the alternative variable has far less "noise" in it. This is also seen in the sharp rise of the corrected $\bar{R}^2$ from 0.78 in equation (1.1) to 0.95 in equation (1.2). The other coefficients are not changed in any substantial way. Although DEFALT seems clearly to be a better variable than the DEFEX variable, the latter does have the virtue that its construction involved less discretion and I will continue to present results for DEFEX.

Because the coefficient of the inflation variable is much smaller than its standard error, it is desirable to conserve the very scarce degrees of freedom by reestimating the equation with the INFEX variable omitted. This is done in equation (1.3). None of the remaining coefficients or standard errors changes appreciably.

Instead of omitting the rolling ARIMA forecast variable, equation (1.4) replaces it with a polynomial distributed lag on the annual changes of the GNP deflator. The distributed lag coefficients are constrained to satisfy a third-order polynomial on six lagged values of the annual rate of change of the GNP deflator with no restriction on the final weight. The sum of the implied coefficients is −0.098 with a standard error of 0.082. The monetary base variable remains essentially unchanged with this respecification. The coefficient of MPRIR drops to −0.016 and is completely insignificant (standard error 0.077); this is reassuring since an insignificant coefficient is quite plausible while a significantly negative one cannot be justified. Finally, the coefficient of DEFEX drops to 0.254 but remains both statistically significant and economically very powerful. The corrected $\bar{R}^2$ statistic of 0.84 shows that the polynomial distributed lag specification has slightly greater explanatory power than the more constrained INFEX specification.

Since the MPRIR variable is either insignificant or significant with the wrong sign, it is useful to see the implications of omitting it from the specification. This is done in equation (1.5). The coefficient of the DEFEX variable is 0.234, indicating that the decline in the coefficient value observed in equation (1.4) was due to the small size of the MPRIR coefficient rather than to the change in the inflation variable per se. This specification is clearly inferior to the previous ones, with a much lower corrected $\bar{R}^2$ and a very much lower Durbin-Watson statistic.

To deal with the low Durbin-Watson statistic, equation (1.5) was reestimated with a first-order transformation. Since this still had a low Durbin-Watson statistic, a second-order autocorrelation correction was used. This is shown in equation (1.6). The DEFEX coefficient has remained essentially unchanged at 0.236 and the MBGRO coefficient has returned to $-0.060$. The inflation coefficient is now the same size as its standard error. This variable is dropped in equation (1.7) where the other coefficients remain essentially unchanged.

The specification of the MPRIR variable requires assuming a particular marginal debt-equity ratio and a particular yield difference between equity and debt. An alternative measure of the effect of changes in tax rules and in the tax-inflation interaction is to use the less restricted variable MPRNR, the maximum potential real net return. This alternative is used in equations (1.8) through (1.10).

Equation (1.8) parallels (1.1) except for the substitution of MPRNR for MPRIR. The DEFEX variable is essentially unchanged (0.343 with a standard error of 0.123) while the MPRNR is statistically insignificant. MBGRO is similar to its earlier value ($-0.054$) and the INFEX variable is now nearly twice its standard error ($-0.070$ with a standard error of 0.039). A first-order autocorrelation correction actually lowers the Durbin-Watson statistic.

A far better specification is obtained by substituting the polynomial distributed lag for the INFEX variable (equation 1.10). This combination of variables has the highest corrected $\bar{R}^2$ statistic (0.86) of all the regressions that include the DEFEX variable and a Durbin-Watson statistic of 2.48. The coefficient of the DEFEX variable is 0.283 with a standard error of only 0.075. MBGRO and PDLINF are both negative and nearly twice their standard errors while the coefficient of MPRNR is satisfactorily less than its standard error.

Equation (1.11) is similar to (1.1) but constrains the monetary base growth not to appear in the equation. Although the resulting specification is not very satisfactory, the coefficient of DEFEX remains almost unchanged from equation (1.1).

Finally, equation (1.12) substitutes the rate of growth of M1 for the rate of growth of the monetary base. The coefficients are generally similar to those of equation (1.1) but the overall goodness of fit is slightly worse.

A variety of additional sensitivity tests are presented in table 2. These

Table 2 EFFECT OF ADDITIONAL VARIABLES ON THE ESTIMATED EFFECT OF THE EXPECTED BUDGET DEFICITS ON THE DM-DOLLAR EXCHANGE RATE

| *Equation* | *DEFEX* (1) | *MPRIR* (2) | *MPRNR* (3) | *MBGRO* (4) | *INFEX* (5) | *PDLINF* (6) | *DUM80+* (7) | *GNPGRO* (8) | *NIIP* (9) | *CONST.* (10) | $\bar{R}^2$ (11) | *DWS* (12) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2.1 | 0.525 | −0.073 | | −0.065 | −0.012 | | −0.283 | | | 1.17 | 0.84 | 1.77 |
| | (0.099) | (0.034) | | (0.035) | (0.025) | | (0.147) | | | | | |
| 2.2 | 0.539 | −0.081 | | −0.061 | | | −0.281 | | | 1.07 | 0.86 | 1.77 |
| | (0.089) | (0.028) | | (0.032) | | | (0.138) | | | | | |
| 2.3 | 0.454 | −0.059 | | −0.057 | | −0.032 | −0.224 | | | 1.31 | 0.86 | 2.33 |
| | (0.185) | (0.078) | | (0.047) | | (0.091) | (0.167) | | | | | |
| 2.4 | 0.484 | | | −0.048 | −0.037 | | −0.386 | | | 0.95 | 0.77 | 1.46 |
| | (0.119) | | | (0.042) | (0.026) | | (0.170) | | | | | |
| 2.5 | 0.553 | | −0.084 | −0.062 | −0.055 | | −0.365 | | | 1.54 | 0.76 | 1.43 |
| | (0.142) | | (0.092) | (0.045) | (0.033) | | (0.173) | | | | | |
| 2.6 | 0.343 | | | −0.067 | | −0.094 | −0.174 | | | 1.73 | 0.87 | 1.72 |
| | (0.107) | | | (0.043) | | (0.037) | (0.146) | | | | | |
| 2.7 | 0.429 | | −0.173 | −0.077 | −0.029 | | | 0.034 | | 2.09 | 0.71 | 1.05 |
| | (0.122) | | (0.107) | (0.051) | (0.043) | | | (0.021) | | | | |
| 2.8 | 0.365 | | −0.183 | −0.103 | | −0.054 | | 0.017 | | 2.72 | 0.86 | 2.34 |
| | (0.111) | | (0.133) | (0.053) | | (0.055) | | (0.017) | | | | |
| 2.9 | 0.642 | | −0.147 | −0.085 | −0.014 | | −0.368 | 0.634 | | 1.56 | 0.87 | 1.56 |
| | (0.110) | | (0.072) | (0.034) | (0.029) | | (0.127) | (0.014) | | | | |
| 2.10 | 0.547 | −0.069 | | −0.072 | −0.022 | | −0.301 | 0.022 | | 0.88 | 0.89 | 1.63 |
| | (0.085) | (0.029) | | (0.030) | (0.028) | | (0.125) | (0.012) | | | | |
| 2.11 | 0.241 | | | −0.069 | | −0.113 | | 0.004 | | 2.01 | 0.84 | 1.51 |
| | (0.070) | | | (0.050) | | (0.038) | | (0.016) | | | | |
| 2.12 | 0.346 | | −0.100 | −0.049 | −0.068 | | | | 0.003 | 1.92 | 0.59 | 1.12 |
| | (0.135) | | (0.147) | (0.070) | (0.045) | | | | (0.027) | | | |

The dependent variable is the real DM-dollar exchange rate (DMs per dollar, adjusted for GNP deflators) normalized at 1.0 = 1980. Equations estimated for 1973 to 1984. Standard errors are shown in parentheses. See text for explanation of variables.

tests involve adding several new variables as well as considering some of the variations discussed in table 1. All of the results again support the conclusion that the coefficient of the expected deficit is statistically significant and economically powerful.

Equation (2.1) starts with the basic specification of equation (1.1) and adds a dummy variable equal to one for the years 1980 through 1984 and zero for the previous years. The purpose of the dummy variable is to test whether the dollar was strong in the 1980s for any of a variety of otherwise unspecified reasons (the new monetary policy regime that began in October 1979; the Reagan presidency; the increased importance of the United States as a political safe haven for foreign capital). If some combination of omitted variables did indeed raise the dollar in the 1980s above what it would otherwise have been, the equations of table 1 might have imputed this to the large expected deficits or to some other variable that distinguished the 1980s from previous years. Including a specific dummy variable should eliminate this source of bias.

Rather surprisingly, the coefficient of the dummy variable for the 1980s (DUM80+) is negative, about twice its standard error and quite large in absolute size (about −0.25). This implies that the unspecified factors at work in the 1980s had the effect of lowering the dollar relative to the German mark in comparison to the earlier years. Faced with the negative coefficient, it is of course possible to identify possible explanations. For example, the decline in OPEC financial assets during most of the 1980s reduced the demand for dollar securities relative to DM securities. The conservative political victories in Germany and Britain, and the switch in French economic policy, may have revived the demand for portfolio investment in Europe.

The important point to note about these arguments is that they imply that the actual rise of the dollar in the 1980s is even more surprising and that the combined role of those factors that systematically raised the dollar was even stronger. The other coefficients of equation (2.1) show that the primary effect of including DUM80+ is to raise the coefficient of DEFEX from 0.375 to 0.525.

The DUM80+ variable appears in most of the specifications of table 2. Its coefficient is almost always about twice its standard error and it has the effect of raising the coefficient of DEFEX to 0.5 or above. Although it is of course possible that the DUM80+ variable is spurious, it is not necessary to decide this question in order to say whether the rise in the expected budget deficit was an important cause of the increase in the dollar. That is clearly an implication of the specifications of tabel 1 without the DUM80+ variable as well as of the equations in table 2 with the DUM80+ variable.

Equation (2.2) drops the INFEX variable and equation (2.3) replaces it with the polynomial distributed lag. Equation (2.4) omits the tax variable while equation (2.5) switches to the relatively unconstrained MPRNR specification. Equation (2.6), with no tax variable and with the distributed lag specification of the inflation variable is one of the few specifications in which the coefficient of the DUM80+ variable is only slightly greater than its standard error. In this specification, the coefficient of the DEFEX variable is reduced to the level of 0.343, approximately its value in the equations without the DUM80+ variable.

Equations (2.7) through (2.11) include the annual growth of real GNP (GNPGRO) as an additional explanatory variable. When the DUM80+ variable is not present (equations 2.7 and 2.8), the GNPGRO variable is only slightly greater than its standard error. The DEFEX coefficients are raised by a small amount and the inflation variables are insignificant. When the DUM80+ variable is present, the GNPGRO coefficients are quite significant and the DEFEX coefficients are increased to more than 0.5.

Finally, equation (2.2) adds the net international investment position of the United States as a percent of GNP (NIIP). Its coefficient is very much less than its standard error and the remaining coefficients are very similar to the coefficients of equation (1.8) (which has the same specification except for the NIIP variable). The statistical insignificance of this coefficient should not be overinterpreted. As I noted above, the net stock of accumulated assets may not be truly exogenous since the decline in NIIP in the 1980s has been the cumulative result of the high value of the dollar and the resulting current account deficits.[13]

Table 3 extends the analysis of tables 1 and 2 to include the German deficit and monetary base variables. For reference, the basic specification of equation (1.1) is repeated in equation (3.1). Adding the variable that measures the ratio of expected German deficits to GNP (DEFEXG) and the growth of the German monetary base (MBGROG) does not alter the other coefficients subtantially but does cause the standard errors to become quite large (equation (3.2)). The additional variables also leave the corrected $\bar{R}^2$ unchanged.

The increased standard errors are perhaps not surprising since equation (3.2) has six coefficients and a constant term to estimate with only twelve observations. Dropping the German monetary base variable

13. When equation (2.12) was estimated with the stock of foreign private assets in the United States as a percentage of GNP instead of NIIP, its coefficient had the wrong sign (positive) and was statistically significant. This again no doubt reflects the fact that foreign private investment in the United States grew in the 1980s because of the high dollar.

Table 3 EFFECTS OF US AND GERMAN EXPECTED BUDGET DEFICITS AND OTHER VARIABLES ON THE DM-DOLLAR EXCHANGE RATE

| *Equation* | *DEFEX* (1) | *DEFALT* (2) | *MPRIR* (3) | *MBGRO* (4) | *INFEX* (5) | *DEFEXG* (6) | *MBGROG* (7) | *CONST.* (8) | $U_{-1}$ (9) | $U_{-2}$ (10) | $\bar{R}^2$ (11) | *DWS* (12) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3.1 | 0.375 | | −0.095 | −0.061 | −0.010 | | | 1.47 | | | 0.78 | 1.68 |
| | (0.071) | | (0.038) | (0.042) | (0.029) | | | | | | | |
| 3.2 | 0.344 | | −0.100 | −0.081 | 0.028 | −0.055 | 0.040 | 1.22 | | | 0.78 | 1.85 |
| | (0.491) | | (0.044) | (0.046) | (0.051) | (0.217) | (0.030) | | | | | |
| 3.3 | 0.323 | | −0.093 | −0.062 | −0.007 | 0.022 | | 1.58 | | | 0.75 | 1.64 |
| | (0.521) | | (0.047) | (0.047) | (0.047) | (0.218) | | | | | | |
| 3.4 | | 0.414 | −0.092 | −0.045 | 0.010 | 0.007 | 0.009 | 1.06 | | | 0.94 | 1.76 |
| | | (0.103) | (0.018) | (0.025) | (0.023) | (0.055) | (0.509) | | | | | |
| 3.5 | | 0.202 | | −0.029 | | −0.173 | | 1.15 | 1.73 | −0.94 | 0.95 | 2.11 |
| | | (0.058) | | (0.012) | | (0.087) | | | (0.11) | (0.09) | | |
| 3.6 | | 0.212 | | −0.034 | −0.016 | −0.067 | | 1.21 | 1.60 | −0.91 | 0.96 | 1.84 |
| | | (0.070) | | (0.016) | (0.013) | (0.154) | | | (0.37) | (0.15) | | |

The dependent variable is the real DM-dollar exchange rate (DMs per dollar, adjusted for GNP deflators) normalized at 1.0 = 1980. Equations estimated for 1973 to 1984. Standard errors are shown in parentheses. See text for explanation of variables.

(equation (3.3)) leaves the coefficients of the four U.S. variables very similar to the basic specification of equation (3.1) but with very large standard errors. The coefficient of the German deficit variable is small and only about one-tenth of its standard error.

In an attempt to reduce the problem of the large standard errors, these equations are repeated with the standard U.S. DEFEX variable replaced by the alternative DEFALT variable in which the observations for 1977 through 1980 are modified to assume that the 1980 deficit-GNP ratio was projected forward until after the 1980 election. Equation (1.2) indicated that this substitution leaves the coefficient of the deficit and other variables essentially unchanged while reducing their standard errors. The effect is similar in equation (3.4). The coefficient of DEFALT is 0.414 with a standard error of 0.103. The coefficients of MPRIR and MBGRO are very similar to their values in equation (3.1) but with smaller standard errors. The coefficient of INFEX remains very much smaller than its standard error. The coefficients of the two German variables are again much smaller than their standard errors.

Dropping the insignificant MBGROG and INFEX variables and the MPRIR variable which has an inadmissible sign lead to equation (3.5) in which the three remaining variables are statistically significant and have the correct sign. In this equation, which is estimated after a second-order autocorrelation transformation, the coefficient of DEFALT is 0.202 (with a standard error of 0.058) and in which the coefficient of the German deficit variable is −0.173 with a standard error of 0.087.

This coefficient structure is, however, quite fragile. Adding the INFEX variable produces a coefficient of −0.016 with a standard error of 0.013 while the coefficient of the German deficit variable drops to −0.067 and less than half of its standard error.

In short, it seems from table 3 that the German deficit variable does not have a significant or stable relation to the dollar-DM ratio and that the decision of whether or not to include it does not alter the point estimate of the U.S. deficit variable. Future work will be needed to assess whether some combination of German and other European deficits is significant and whether its presence alters the coefficient of the U.S. budget deficit variable.

It is, of course, unfortunate that the history of the floating rate period gives us only twelve years of experience to analyze. Although more data points could be created by using quarterly observations, I believe very little (if any) additional information on DEFEX and MPRIR would actually result. Instead, there would be more measurement error in the "expectations" variables (DEFEX, INFEX, MPRIR) relative to the actual variation. Looking back before 1973 is inappropriate because the quasifixed rate system that existed then would imply very different exchange-rate dynamics and might be expected to have very different monetary policy responses as countries tried to maintain their currencies at the fixed parities. Expectations would also be formed differently in a regime in which governments were committed to maintaining fixed exchange rates and in which the United States appeared willing to accumulate overseas investments or run down its assets in order to maintain that fixed rate system.

## 6. *Effects of the Interest Differential*

I have already commented (in section 2) on the difficulty of assessing the structural relation between the exchange rate and the difference in expected real interest rates. The expected inflation rate, which is a very critical component of the calculation, is difficult to measure and the real interest rates themselves are endogenous variables.

Despite these difficulties, it is worth devoting some attention to the estimation of a structural equation linking the exchange rate to the real interest differential because it is the operational link between budget deficits and the exchange rate in several analytic models. The problems of measurement and of endogeneity can be mitigated by using an instrumental variable procedure with the DEFEX, MBGRO, and INFEX variables as the instruments. The results indicate that the use of an instrumental variable procedure is important and that, when it is used, the evidence shows a substantial effect of the real interest differential on the exchange rate.

Equation (4.1) of table 4 presents an ordinary-least-squares regression of the exchange rate index on the difference between the real long-term interest rate in the United States and a corresponding real long-term interest rate for Germany. The nominal U.S. rate is the yield on Treasury bonds with five years to maturity. The real rate is calculated by subtracting the ARIMA projection (INFEX) from this nominal rate. The nominal German rate is a rate on long-term German government bonds.[14] The real rate is calculated by subtracting an ARIMA estimate of future German inflation calculated by the same process used for the U.S. ARIMA forecast of inflation. Annual values of these variables are shown in appendix table A-2.

The coefficient of the real interest rate differential is 0.042 with a standard error of 0.025. The Durbin-Watson statistic is very low and the

14. The German interest rate was provided by Data Resources, Inc. and is identified by Data Resources as RMGBL@GY.

Table 4 REAL INTEREST* DIFFERENTIALS AND THE DM-DOLLAR EXCHANGE RATE

| | | | Interest Rates minus Predicted Inflation | | | | | | $\bar{R}^2$ | |
|---|---|---|---|---|---|---|---|---|---|---|
| Equation | Estimation Method | Interval | RUS-RG (1) | RUS (2) | RG (3) | Constant (4) | $U_{-1}$ (5) | $U_{-2}$ (6) | (SER) (7) | DWS (8) |
| 4.1 | OLS | 1973–84 | 0.042 | | | 1.24 | | | 0.14 | 0.41 |
| | | | (0.025) | | | | | | (0.21) | |
| 4.2 | OLS | 1973–84 | 0.032 | | | 1.32 | 0.81 | | 0.63 | 0.90 |
| | AR1 | | (0.023) | | | | (0.19) | | (0.13) | |
| 4.3 | OLS | 1973–84 | 0.034 | | | 1.26 | 1.27 | −0.59 | 0.74 | 2.13 |
| | AR2 | | (0.022) | | | | (0.29) | (0.31) | (0.11) | |
| 4.4 | IV | 1973–84 | 0.082 | | | 1.25 | | | NA | 0.53 |
| | | | (0.035) | | | | | | (0.23) | |
| 4.5 | IV | 1973–84 | 0.054 | | | 1.26 | 0.75 | | NA | 1.18 |
| | AR1 | | (0.023) | | | | (0.18) | | (0.15) | |
| 4.6 | OLS | 1973–84 | | 0.051 | 0.003 | 1.08 | | | 0.23 | 0.48 |
| | | | | (0.024) | (0.037) | | | | (0.19) | |
| 4.7 | OLS | 1973–84 | | 0.038 | 0.011 | 1.10 | 1.38 | −0.75 | 0.80 | 2.08 |
| | AR2 | | | (0.019) | (0.034) | | (0.28) | (.028) | (0.10) | |
| 4.8 | IV | 1973–84 | | 0.080 | −0.005 | 1.17 | | | NA | 1.05 |
| | | | | (0.034) | (0.061) | | | | (0.16) | |
| 4.9 | IV | 1973–84 | | 0.046 | −0.037 | 1.23 | 0.74 | | NA | 1.05 |
| | AR1 | | | (0.024) | (0.024) | | (0.18) | | (0.16) | |

*Real interest is interest minus ARIMA predictions of inflation.

The dependent variable is the real DM-dollar exchange rate (DMs per dollar, adjusted for GNP deflators) normalized at 1.0 = 1980. Standard errors are shown in parentheses. See text for explanation of variables.

equation is therefore reestimated with an autocorrelation transformation. A first-order transformation (equation (4.2)) is inadequate so the final result (presented in equation (4.3)) has a second-order autocorrelation correction. In this form, the coefficient of the interest differential is 0.034 with a standard error of 0.022.

When the equation is estimated by an instrumental variable procedure (equation (4.4)), the coefficient of the interest rate differential becomes much larger (0.082) and more than twice its standard error. The Durbin-Watson statistic is, however, very small (0.56). When Fair's method is used to obtain an instrumental variable estimate with a first-order autocorrelation correction, the coefficient falls to 0.054 with a standard error of 0.023. In short, the instrumental variable procedure results in a slightly larger coefficient than the OLS procedure. It might also be noted that these coefficient estimates are similar to the estimates of approximately 0.06 obtained by Sachs (1985) and Hooper (1985).

Before looking at any further equation estimates, it is helpful to consider the implications of a coefficient of approximately 0.04 to 0.06 on the interest rate differential. In 1978–79, the estimated real long-term U.S. rate exceeded the corresponding German rate by 0.7 percent; by 1983 the differential was 1.4 percent and by 1984 it was 2.8 percent. Even a coefficient of 0.06 implies a rise in the dollar-DM real exchange rate of 0.042 between 1980 and 1983 and of 0.126 between 1980 and 1984. Since the actual exchange rate rose by 0.72 points over this period, the equation can account for at most one-fifth of the actual rise.

The estimated coefficient is far less than theory suggests. An increase of one percentage point in the difference between U.S. and German 10-year real interest rates should increase the dollar-DM exchange rate by about twelve percentage points, not the four to six percentage points estimated here and in previous studies. This implies that the coefficient may be grossly underestimated because of the measurement and simultaneity problems referred to above.

When the interest differential is split into two separate interest rates and the equation estimated by ordinary least squares, only the coefficient of the U.S. rate is statistically significant. This remains true when the equation is reestimated with a second-order autocorrelation correction (equation (4.7)) and by an instrumental variable procedure (equation (4.8)).

However, the combination of instrumental variable estimation and a first-order autocorrelation correction (Fair's method) does result (equation (4.9)) in coefficients for the U.S. and German interest variables that are both absolutely about 0.04 but with the appropriate opposite signs. More specifically, the coefficient of the real U.S. rate is 0.046 (with a standard error of 0.024) while the coefficient of real German rate is −0.037 (with a standard error of 0.024).

As an alternative to the rolling ARIMA procedure, I have also used a simpler method that may correspond more closely to the way that market participants used past inflation experience to form judgments about the future. In place of the ARIMA estimate of inflation, I use a weighted average of inflation, giving a weight of 0.5 to the most recent year's inflation, of 0.33 to the inflation of the previous year's inflation and of 0.17 to the inflation of the year before that. On that basis, the expected inflation came down gradually in Germany from 4.5 percent in 1980 to 4.3 percent in 1981 and 1982, 3.8 percent in 1983, and 2.8 percent in 1984, and real German long-term rates in the 1980–84 period stayed between 4.0 and 5.0 percent except for a 6.1 percent rate in 1981.

Table 5 presents the results based on this simpler specification of expected inflation. The OLS estimates (equations (5.1) and (5.2)) are similar to the estimates with the ARIMA inflation forecast: a coefficient of 0.055 with a standard error of 0.035. The instrumental variable estimates (equations (5.3) and (5.4)) show a more substantial coefficient and a smaller standard error of regression measures than the ARIMA forecast. With the AR1 correction (i.e., using Fair's method), the coefficient of the interest differential is 0.081 with a standard error of 0.031. This is approximately twice the typical estimate based on the ARIMA inflation forecast. Dividing the interest differential into a real U.S. rate and a real German rate (equation (5.5)) results in a coefficient of 0.072 (with a standard error of 0.025) for the U.S. real rate but a very small and statistically insignificant coefficient of 0.003 (with a standard error of 0.032) for the German real rate, possibly because there was very little variation in the measured real rate for Germany.

In short, the different specifications of the real interest differentials and the different estimation methods indicate that each percentage point difference in real interest rates raises the real exchange rate by between 0.04 and 0.08 points, an impact that accounts for only a small part of the rise in the exchange rate that actually occurred in the 1980s and also only a small part of the rise in the exchange rate that is predicted by the changes in the expected budget deficits and in monetary policy. It is difficult to tell whether this is because the real interest differential is measured very badly (causing a substantial underestimate of the true coefficient) or because the budget deficit and monetary policy have direct effects on the exchange rate that are not channeled through the real interest differential.

Table 5 REAL INTEREST* DIFFERENTIALS AND THE DM-DOLLAR EXCHANGE RATE

| | | Interest Rates minus Predicted Inflation | | | | | | |
|---|---|---|---|---|---|---|---|---|
| *Equation* | *Estimation Method* | *RUS-RG (1)* | *RUS (2)* | *RG (3)* | *Constant (4)* | $U_{-1}$ | $\bar{R}^2$ (*SER*) | *DWS* |
| 5.1 | OLS | 0.055 | | | 1.31 | | 0.45 | 0.84 |
| | | (0.035) | | | | | (0.16) | |
| 5.2 | OLS | 0.055 | | | 1.32 | 0.69 | 0.62 | 1.36 |
| | AR1 | (0.035) | | | | (0.78) | (0.14) | |
| 5.3 | IV | 0.097 | | | 1.32 | | NA | 0.91 |
| | | (0.029) | | | | | (0.17) | |
| 5.4 | IV | 0.081 | | | 1.33 | 0.58 | NA | 1.50 |
| | AR1 | (0.031) | | | | (0.24) | (0.15) | |
| 5.5 | IV | | 0.072 | 0.003 | 1.04 | 0.75 | NA | 0.83 |
| | AR1 | | (0.025) | (0.033) | | (0.17) | (0.12) | |

*Real interest is interest minus distributed lag inflation.

The dependent variable is the real DM-dollar exchange rate (DMs per dollar, adjusted for GNP deflators) normalized at 1.0 = 1980. Equations estimated for 1973 to 1984. Standard errors are shown in parentheses. See text for explanation of variables.

## *7. Concluding Comments*

The findings of the current research can be summarized briefly. The estimated reduced-form equations for the dollar-DM real exchange rate imply that the rise in the expected future deficits in the budget of the U.S. government had a powerful effect on the exchange rate between the dollar and the German mark. Each one percentage point increase in the ratio of future budget deficits to GNP increases the exchange rate by about thirty percentage points.

Changes in the growth of the monetary base also affect the exchange rate, but the estimated effect of the deficit does not depend on whether this is taken into account in the estimation procedure.

The analysis also indicates that the changes in tax rules and in the inflation-tax interaction that altered the corporate demand for funds did not have any discernible effect on the exchange rate. The presence or absence of alternative tax variables did not alter the estimated effect of the budget deficit.

The estimated effect of the budget deficit is also relatively insensitive to the other variables that were included in the regression equation.

As I have emphasized elsewhere in a different context (Feldstein 1982), all models are "false" in the sense that they involve substantial simplifications that can lead to incorrect inferences. It is impossible to relax all of the specification constraints or include all of the plausible variables in any single model. We learn about reality only by examining a variety of alternative false models to see which implications of these models are robust. In the present study, I was eager to focus on the question of whether changes in the expected budget deficit could account for shifts in the real exchange rate and, if so, whether this was a spurious relation that was really reflecting a more fundamental relationship between the exchange rate and tax rules, monetary policy, inflation, German budget deficits, or unobservable characteristics of the 1980s that strengthened the dollar. Although any econometric study leaves room for doubt and uncertainty, I believe that the current evidence shifts the burden of proof to those who would claim that deficits do not matter or that tax, monetary, or "confidence" variables were the real reasons for the dollar's strength since 1980.

There are of course a number of things that have been omitted from the analysis that deserve attention in future studies. It would be good to model the changing behavior of expected European budget deficits or, even more generally, the changing balance between the supply and demand for funds in Europe. There are a number of difficulties in doing so, including the problem of establishing the "full employment" level at which to estimate structural deficits in the face of Europe's rapidly rising unemployment and the much larger and more ambiguous role of public investment in Europe.

U.S. budget deficits have been defined without correction for the inflation erosion of the public debt on the implicit assumption that, at the observed rates of inflation, individuals did not adjust their saving but treated the inflation component of the interest on the public debt as income.

Shifts in the price of oil were ignored in the present study although they presumably affected the equilibrium exchange rate between the DM and the dollar. It should be possible to extend the analysis to include the price of oil and other raw materials.

Finally, in future work I plan to extend the analysis to include 1985 and the decline of the dollar. The sharp rise in the dollar-DM ratio that climaxed in the early spring of 1985 may have had some unsustainable speculative element (as Krugman's 1985 analysis implies) but the decline of more than 20 percent in the dollar-DM ratio between mid-1984 and the present time is, I believe, quite in line with what would have been expected on the basis of the fall in expected future budget deficits.

As participants in financial markets studied the action of Congress in the spring and early summer of 1985, there was growing confidence that some significant action would be taken to reduce future budget deficits. The Congressional Budget Office summarized this in August when it contrasted the current services deficits of 5.1 percent of GNP each year from 1986 to 1990 with the results of the Congressional Budget Resolution that brought the projected deficits onto a path that declined to 3.0 percent of GNP in 1988 and 2.1 percent in 1990. The Gramm-Rudman amendment gave the markets even greater confidence that budget deficits would continue to decline in the future.

The estimated ratio of the expected 5-year structural deficit to potential GNP has declined from 3.3 percent in 1984 (the last observation in the sample) to about 2.6 percent in early 1986. An estimated coefficient of 0.25 to 0.40 would imply a decline in the dollar from this source alone of between 18 and 28 points. In fact, as of mid-February 1986, the dollar-DM ratio was down 23 points in comparison to its 1984 average value and 32 points from its high in early 1985.

There is substantial room for additional research on the determinants of the exchange rate. But the massive fiscal experiment of the past six years should have convinced us that sustained shifts in the federal government's deficit have powerful effects on the value of the dollar.

Table A-1 TIME SERIES REGRESSION VARIABLES

| *Year* | *DM-Dollar Index* (1) | *DEFEX* (2) | *DEFALT* (3) | *MPRIR* (4) | *MPRNR* (5) | *MBGRO* (6) | *MIGRO* (7) | *INFEX* (8) | *GNPGRO* (9) | *NIIP* (10) | *DEFEXG* (11) | *MBGROG* (12) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1973 | 1.208 | 1.802 | 1.802 | 3.500 | 5.800 | 8.348 | 5.756 | 4.500 | 5.198 | 11.659 | −1.220 | 10.637 |
| 1974 | 1.189 | 1.829 | 1.829 | 4.100 | 5.000 | 8.091 | 4.761 | 7.500 | −0.539 | 10.893 | −1.820 | 6.121 |
| 1975 | 1.166 | 1.808 | 1.808 | 5.300 | 5.100 | 7.681 | 5.014 | 9.700 | −1.257 | 11.171 | −2.180 | 7.843 |
| 1976 | 1.211 | 1.651 | 1.651 | 4.400 | 6.000 | 7.520 | 6.141 | 5.800 | 4.887 | 10.251 | −2.000 | 9.245 |
| 1977 | 1.140 | 1.519 | 1.623 | 4.400 | 6.000 | 8.045 | 8.122 | 6.000 | 4.666 | 8.453 | −2.040 | 8.975 |
| 1978 | 1.015 | 1.577 | 1.615 | 4.600 | 5.900 | 9.302 | 8.222 | 6.400 | 5.293 | 6.793 | −1.960 | 8.468 |
| 1979 | 0.968 | 1.790 | 1.636 | 5.500 | 6.100 | 8.368 | 7.532 | 7.000 | 2.478 | 6.053 | −1.520 | 8.485 |
| 1980 | 1.000 | 2.335 | 1.753 | 6.000 | 5.900 | 8.169 | 7.477 | 7.600 | −0.166 | 5.626 | −0.720 | 4.831 |
| 1981 | 1.310 | 2.821 | 2.821 | 8.300 | 7.200 | 6.432 | 5.134 | 8.000 | 1.936 | 5.243 | 0.220 | 4.421 |
| 1982 | 1.430 | 3.247 | 3.247 | 7.700 | 7.500 | 6.852 | 8.747 | 7.000 | −2.549 | 4.801 | 1.240 | 4.933 |
| 1983 | 1.511 | 3.377 | 3.377 | 7.100 | 7.500 | 9.483 | 10.387 | 5.600 | 3.449 | 3.116 | 1.960 | 7.309 |
| 1984 | 1.716 | 3.330 | 3.330 | 4.900 | 7.300 | 8.142 | 5.221 | 5.500 | 6.619 | −0.036 | 2.400 | 4.769 |

Table A-2 INTEREST AND INFLATION TIME SERIES OBSERVATIONS

| *Year* | *IUS* *(1)* | *IG* *(2)* | *INFPUS ARIMA* *(3)* | *INFPG ARIMA* *(4)* | *INFPUS PAST* *(5)* | *INFPG PAST* *(6)* |
|---|---|---|---|---|---|---|
| 1973 | 6.868 | 9.323 | 4.500 | 4.869 | 5.093 | 6.313 |
| 1974 | 7.802 | 10.383 | 7.500 | 5.494 | 7.037 | 6.555 |
| 1975 | 7.766 | 8.483 | 9.700 | 6.101 | 8.535 | 6.405 |
| 1976 | 7.179 | 7.800 | 5.800 | 6.125 | 7.173 | 4.982 |
| 1977 | 6.990 | 6.158 | 6.000 | 5.603 | 6.193 | 4.062 |
| 1978 | 8.318 | 5.733 | 6.400 | 5.284 | 6.500 | 3.990 |
| 1979 | 9.518 | 7.425 | 7.000 | 4.902 | 7.770 | 4.053 |
| 1980 | 11.478 | 8.500 | 7.600 | 4.812 | 8.725 | 4.462 |
| 1981 | 14.236 | 10.383 | 8.000 | 4.495 | 9.324 | 4.288 |
| 1982 | 13.006 | 8.950 | 7.000 | 4.050 | 7.751 | 4.320 |
| 1983 | 10.796 | 7.892 | 5.600 | 4.048 | 5.520 | 3.802 |
| 1984 | 12.241 | 7.775 | 5.500 | 3.874 | 4.159 | 2.771 |

IUS = yield on 5-year government bonds;
IG = yield on long-term German government bonds;
INFPUS (ARIMA) = U.S. inflation predicted by ARIMA method;
INFPG (ARIMA) = German inflation predicted by ARIMA method;
INFPUS (PAST) = U.S. inflation predicted by average of past values;
INFPG (PAST) = German inflation predicted by average of past values.

I am grateful to Andrew Berg for help with this work and to Rudiger Dornbusch, Jeffrey Frankel, Paul Krugman and Jeffrey Sachs for discussions about this subject.

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