

# Interest Rates and Exchange Rates— What is the Relationship?

*By Craig S. Hakkio*

During much of the 1970s, U.S. interest rates and the foreign exchange value of the dollar moved in opposite directions. This relationship was particularly pronounced from 1976 to 1979, when short-term interest rates doubled, while the trade-weighted value of the dollar fell 17 percent. In the 1980s, however, the relationship between interest rates and the exchange rate appears to be considerably different. Indeed, for much of this period, U.S. interest rates and the value of the dollar have been positively correlated.

A key question is whether the apparent change in the relationship between interest rates and exchange rates represents a significant structural change in their linkages or whether the change in the relationship can be explained by using standard economic models. The answer to this question has important implications for policymakers. Interest rates and exchange rates are crucial elements in the transmission of monetary and

fiscal policy actions to economic activity. If the channels through which policy actions affect the economy have been altered, policymakers may find the design of policy to be more difficult and the consequences of policy actions more unpredictable. Thus, models of interest rate and exchange rate linkages that worked well during the 1970s may not be appropriate in the 1980s.

This article argues that much of the apparent instability in the interest rate-exchange rate relationship can be readily explained in terms of standard economic models. The change from a negative correlation between interest rates and exchange rates in the 1970s to a positive correlation in the 1980s is due to changes in the relative importance of factors underlying interest rate and exchange rate movements. Thus, changes in inflation and expected inflation were the dominant influences causing high interest rates and a lower dollar in the 1970s. In the 1980s, in contrast, changes in real interest rates have been the dominant factor responsible for the positive correlation between interest rates and the dollar.

The article is divided into four sections. The first section briefly reviews recent interest rate

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and exchange rate movements. The next section discusses the fundamental determinants of interest rates and exchange rates. The third section reviews the linkages between interest rates and exchange rates and shows how they can be positively or negatively correlated. The final section applies this analysis to interpreting the behavior of interest rates and the dollar over the 1974-86 period.

### **Interest rates and exchange rates: the evidence since 1974**

The changing relationship between interest rates and the value of the dollar is illustrated in Chart 1. The interest rate used in this chart is the 10-year constant maturity Treasury bond rate. The exchange rate is the effective exchange rate—a weighted average of ten bilateral exchange rates between the dollar and other major currencies. The data in the chart have been smoothed to remove the influence of short-run factors and to highlight basic trend behavior.<sup>1</sup>

As shown in Chart 1, interest rates and exchange rates appear to have been negatively correlated in the 1970s. From 1975 to 1977, for example, interest rates fell while the dollar rose. Then, from 1977 to 1980, while interest rates rose sharply, the value of the dollar declined.

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<sup>1</sup> The exchange rate is the effective exchange rate—a weighted average of ten bilateral exchange rates with Germany, Japan, France, the United Kingdom, Canada, Italy, the Netherlands, Belgium, Sweden, and Switzerland. The long-term U.S. interest rate is the 10-year constant maturity U.S. Treasury bond rate. The data in Charts 1-5 have been smoothed, to reduce the influence of short-run factors. A six-month moving average was used to smooth the data: if  $x_t$  equals the original data, and  $s_t$  equals the smoothed data, then  $s_t = (x_t + x_{t-1} + \dots + x_{t-5})/6$ . The discussion in the text refers to the smoothed data and not the original data. Smoothing the data usually causes the peaks and troughs to occur later than with the original data. In Chart 1, for example, the exchange rate peaks in June 1985, but in the original data the peak occurs in February 1985. Using the 3-month CD rate produces a similar chart.

The basic relationship between interest rates and the dollar appears to have changed in the 1980s, however. As the chart shows, during the 1980-81 period, interest rates and the dollar moved in the same direction rather than in opposite directions; interest rates and the dollar trended upward, after abstracting from the sharp movement in interest rates in 1980 due to credit controls. In 1982, however, the relationship reverted to the 1970s pattern, with a drop in interest rates associated with a rising dollar. Then, from 1983 to 1986, a positive correlation reappeared and interest rates and the dollar again moved up and down together.

Chart 1 shows that there is no simple relationship between interest rates and the dollar. This does not imply, however, that the relationship is unstable or that the structure of the relationship broke down in the 1980s. As argued in the following sections, much of the behavior of interest rates and exchange rates over the 1974-86 period can be explained by the behavior of their underlying determinants.

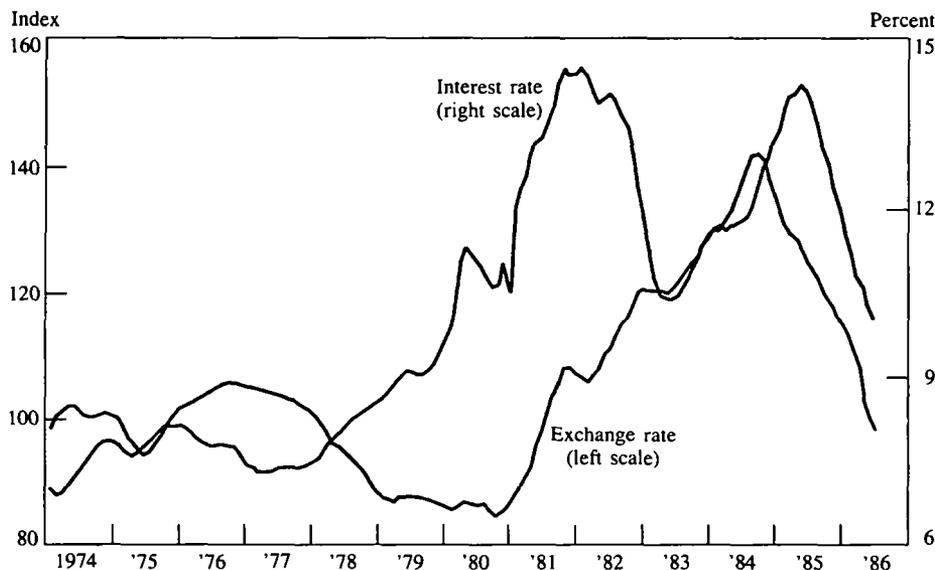
### **Determinants of interest rates and exchange rates**

The interest rate and exchange rate shown in Chart 1 are rates quoted in financial markets, that is, they are nominal rates. To understand their behavior over the 1974-86 period, it is useful to distinguish between real and nominal interest rates and between real and nominal exchange rates. This section develops this distinction and identifies common factors affecting interest rates and exchange rates.

#### *Real and nominal interest rates*

The distinction between real and nominal interest rates has become familiar in analyses of inflation during the 1970s. While the nominal interest rate is the rate quoted by banks and the

**CHART 1**  
**U.S. long-term interest rate and the exchange rate**



Source: Board of Governors of the Federal Reserve System

financial press, the real rate adjusts the nominal rate for the influence of inflation. According to the "Fisher equation," the nominal interest rate  $i$  is equal to the real interest rate  $r$  plus the expected rate of inflation  $p^e$ :

$$(1) \quad i = r + p^e.$$

Thus, for example, when a lender receives a 10 percent nominal interest rate but expected inflation is 7 percent, the real interest rate is only 3 percent.<sup>2</sup> Although the lender receives 10 percent more dollars, he can buy only 3 percent more goods and services because inflation has increased the price of goods and services.

In this framework, nominal interest rates

<sup>2</sup> The tax deductibility of interest payments changes this statement slightly, but the basic concepts are the same.

change either because of a change in the underlying real rate of interest or because of a change in expected inflation. For example, nominal interest rates could increase because of an increase in the real rate, with no change in expected inflation. Similarly, nominal interest rates could decline because of a decline in inflationary expectations, with no change in the real rate. A number of factors can cause variation in the underlying real rate or expected rate of inflation.

The real rate of interest is determined by the demand for and supply of funds in the economy. The supply of funds in the domestic economy comes from the saving of individuals and firms plus funds provided by the banking system. The demand for funds comes from firms making investment decisions, consumers borrowing in excess of current income, and government financing a budget deficit. In an open economy, other

countries may provide an additional net demand for or supply of funds.

The real interest rate tends to rise or fall as the demand for funds grows faster or slower than the supply of funds. The demand for funds increases, for example, if the government borrows to finance an increase in the deficit.<sup>3</sup> The government's increased demand for funds crowds out private investors, driving up the real interest rate. By paying a higher real interest rate, the government ensures that it, rather than others, obtains the funds it needs. In this way, an increase in the demand for funds puts upward pressure on the real interest rate.

Expectations of inflation can also change for several reasons. On the one hand, such special factors as one-time changes in the price of energy or food can have a temporary effect on the inflation rate. Since this shock may take several years to work its way through the economy, expectations of inflation can be affected for some time even though the shock has no permanent effect on the inflation rate. On the other hand, inflation expectations can change because of events leading to a continuously rising or falling price level. Such an effect might be associated with an excessive or deficient rate of money growth.

### *Real and nominal exchange rates*

While the concept of the real interest rate has been widely discussed in recent years, the concept of a real exchange rate may be somewhat less familiar. As in the case of interest rates,

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<sup>3</sup> Some have argued that the federal budget deficit also leads to an equal increase in the amount of savings, since individuals take into account the future tax liabilities associated with the budget deficit. Others, however, believe that the supply of funds does not increase equally, so that there is a net increase in the demand for funds. For a discussion of these arguments and a review of the empirical evidence, see Charles Webster, "The Effects of Deficits on Interest Rates," *Economic Review*, Federal Reserve Bank of Kansas City, May 1983, pp. 19-28.

however, the distinction between a nominal exchange rate and a real exchange rate makes it possible to distinguish real or relative price effects from changes in the general price level.

The nominal exchange rate quoted in the financial press is the price of the dollar in terms of foreign currency. For example, the exchange rate between the dollar and the Japanese yen might be quoted as 160 yen per dollar. In contrast, the real exchange rate is not a rate of currency exchange. Rather, it is the relative price of U.S. goods in terms of foreign goods. As such, the real exchange rate reflects the underlying terms of trade between U.S. and foreign goods.

Equation 2 shows the relationship between the nominal exchange rate and the real exchange rate:

$$(2) \quad e = q P^*/P.$$

In this equation,  $e$  is the nominal exchange rate,  $q$  is the real exchange rate,  $P$  is the U.S. price level, and  $P^*$  is the foreign price level. The nominal exchange rate,  $e$ , can be viewed either as the price of the dollar in terms of foreign currency or, equivalently, as the foreign price of U.S. goods relative to the dollar price of U.S. goods.<sup>4</sup> In contrast, the real exchange rate,  $q$ , is the price of U.S. goods in terms of foreign goods. Rearranging equation 2, it can be shown that the real exchange rate is simply the nominal exchange rate deflated by the ratio of foreign to domestic prices ( $q = e/[P^*/P]$ ).

From equation 2, it is clear that the nominal exchange rate can change either because of a change in the real exchange rate or because of a change in the general price levels in the United States or abroad. An increase in the real exchange

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<sup>4</sup> For further elaboration on the determinants of the nominal exchange rate, see Craig S. Hakkio, "Exchange Rate Volatility and Federal Reserve Policy," *Economic Review*, Federal Reserve Bank of Kansas City, July/August 1984, pp. 18-31.

rate or the foreign price level causes the nominal exchange rate to appreciate, while an increase in the domestic price level causes the nominal exchange rate to depreciate.

A variety of factors can cause the real exchange rate to change. For example, there may be a change in tastes away from domestically produced goods to foreign goods. Suppose that Japanese consumers decide to buy more U.S. goods rather than domestic products. This shift in demand will tend to raise the relative price of U.S. goods, leading to a rise in the real exchange rate. Then, if domestic and foreign price levels do not change, the nominal exchange rate will also rise. The reason is that since Japanese consumers need more dollars to purchase U.S. products, they will sell yen and buy dollars, causing the foreign exchange value of the dollar to increase.

Another reason for changes in real exchange rates comes from international investment and savings decisions. In addition to buying U.S. goods, Japanese investors might buy U.S. financial assets. A decision to buy more U.S. assets could result from the view that the real return on U.S. assets exceeds the real return on comparable Japanese assets. If Japanese investors buy more U.S. assets, the real exchange rate will rise. Since this decision requires the purchase of additional dollars in the foreign exchange market, the nominal exchange rate will also appreciate.

Changes in domestic and foreign price levels are the second factor influencing nominal exchange rates. Equation 2 shows that exchange rate movements are influenced by differences in foreign and domestic price levels. When prices in the United States rise faster than prices abroad, the nominal exchange rate depreciates because foreigners reduce their purchases of more expensive U.S. goods and thus reduce their demand for dollars in foreign exchange markets. In contrast, when foreign prices rise faster than U.S. prices, the nominal exchange rate appreciates because U.S. citizens tend to import fewer of

the more expensive foreign goods. As a result, the demand for foreign currencies falls and the foreign exchange value of the dollar rises.

### **The linkages between interest rates and exchange rates**

The preceding section identified key factors underlying the behavior of nominal interest rates and exchange rates. This section examines the channels linking interest rate and exchange rate movements and shows how changes in the relative importance of the underlying factors can result in patterns of positive or negative correlation between interest rates and exchange rates.

#### *Inflation effects on interest rates and exchange rates*

One simple channel linking interest rates and exchange rates is through the effects of inflation. Since nominal interest rates depend on expected inflation while nominal exchange rates depend on relative rates of foreign and domestic inflation, an inflation shock will affect both nominal interest rates and exchange rates.

Inflation shocks can usually be expected to lead to a negative correlation between nominal interest rates and exchange rates. Suppose, for example, that an increase in the price of energy or faster money growth leads to an increase in U.S. inflation. To the extent that higher inflation is built into inflation expectations, nominal interest rates in the United States will tend to rise. And, if U.S. inflation exceeds foreign inflation, the nominal exchange rate will tend to fall.

Similarly, disinflationary policy could lead to a negative relationship between interest rates and exchange rates. A reduction in U.S. inflation that led to lower inflation expectations would tend to reduce nominal interest rates in the United States. And, if the U.S. inflation rate is lower than foreign inflation rates, U.S. products would

become more attractive in international markets and the dollar would tend to appreciate.

**Real effects on interest rates and exchange rates**

Nominal interest rates and exchange rates are also linked through movements in real interest rates. As discussion of the Fisher relationship showed, changes in real interest rates are translated directly into changes in nominal interest rates. In addition, changes in real interest rates, by altering the relative attractiveness of domestic and foreign investment opportunities, cause movements in real and nominal exchange rates.

To see the connection between real interest rates and the exchange rate, consider a foreign investor with a choice of investing in U.S. or domestic assets. The choice depends partly on a comparison of relative real interest rates. But because assets in different countries are denominated in different currencies, changes in the real exchange rate also affect the relative returns. Any expected appreciation of the real value of the dollar represents an expected capital gain and adds to the U.S. real return. Likewise, any expected depreciation of the real value of the dollar represents a capital loss and lowers the U.S. real return.

Generally, market forces should equalize the real returns to investment in the two countries. As a result, the real return to investment in the United States—the U.S. real interest rate plus the expected appreciation of the real exchange rate—should equal the foreign real interest rate:

$$(3) \begin{array}{ccccc} \text{U.S. real} & + & \text{expected} & = & \text{foreign real} \\ \text{interest} & & \text{appreciation} & & \text{interest} \\ \text{rate} & & \text{of real} & & \text{rate} \\ & & \text{exchange} & & \\ & & \text{rate} & & \end{array}$$

That is, if the U.S. real interest rate is higher than the foreign real interest rate, the market must be expecting the real exchange rate to depreciate.

In this way, the expected depreciation of the real exchange rate offsets the higher U.S. real interest rate and the total U.S. real return equals the foreign real return. Viewed differently, the expected appreciation or depreciation of the dollar is directly related to the real interest rate differential in the two countries.

In this framework, an increase in the U.S. real interest rate will lead to an increase in the real exchange rate and the nominal exchange rate. A higher U.S. real interest rate increases the attractiveness of U.S. assets, leading to an increase in the demand for dollar-denominated assets and an appreciation of the real exchange rate. Then, for given price levels at home and abroad, the nominal exchange rate also tends to rise.

There is another way to see that an increase in the U.S. real interest rate leads to an increase in the real exchange rate. Because the total real return in the United States must equal the foreign real interest rate, as shown in equation 3, a rise in the U.S. real interest rate relative to the foreign real interest rate must lead to an expected depreciation of the real exchange rate. Therefore, if the real exchange rate is assumed to be constant in the long run, the only way for the market to expect the real exchange rate to depreciate in the future is for the real exchange rate to appreciate today. That is, an increase in the real interest rate leads to an increase in the current real exchange rate and an expected depreciation of the real exchange rate. As William Branson put it, "What must go down in the future [an expected depreciation], must go up today [the current real exchange rate]."<sup>5</sup>

<sup>5</sup> See William H. Branson, "Causes of Appreciation and Volatility of the Dollar," *The U.S. Dollar—Recent Developments, Outlook, and Policy Options*, proceedings of a conference sponsored by the Federal Reserve Bank of Kansas City, August 21-23, 1985, and Craig S. Hakkio and J. Gregg Whittaker, "The U.S. Dollar—Recent Developments, Outlook, and Policy Options," *Economic Review*, September/October 1985, Federal Reserve Bank of Kansas City, pp. 3-15.

Unlike inflation shocks, real interest rate shocks can be expected to result in a positive correlation between nominal interest rates and exchange rates. A rise in U.S. real interest rates resulting from higher budget deficits, for example, will directly cause a rise in nominal interest rates. In addition, the higher real interest rate in the United States will tend to raise both the real exchange rate and the nominal exchange rate. Similarly, a reduction in real rates in the United States will tend to lower nominal rates in the United States directly. And if the U.S. real interest rate falls relative to foreign real rates, there will be a corresponding fall in the real and nominal value of the dollar.

### **Interest rates and the exchange rate— explaining the evidence**

Chart 1 showed that the relationship between nominal interest rates and the foreign exchange value of the dollar appeared to change in the 1980s. Interest rates and the exchange rate were negatively related until 1980. For most of the period since 1980, however, interest rates and the dollar have tended to move in the same direction.

The preceding section presented a theoretical framework in which inflation and real interest rate shocks can cause different patterns in the interest rate-exchange rate relationship. This section examines data on expected inflation, real interest rates, inflation differentials, and real interest rate differentials to see whether the theoretical framework provides a consistent explanation of the empirical evidence.

#### *Interest rates and exchange rates: 1974 to 1979*

According to the analysis presented in this article, the negative relationship between interest rates and the exchange rate during the 1970s,

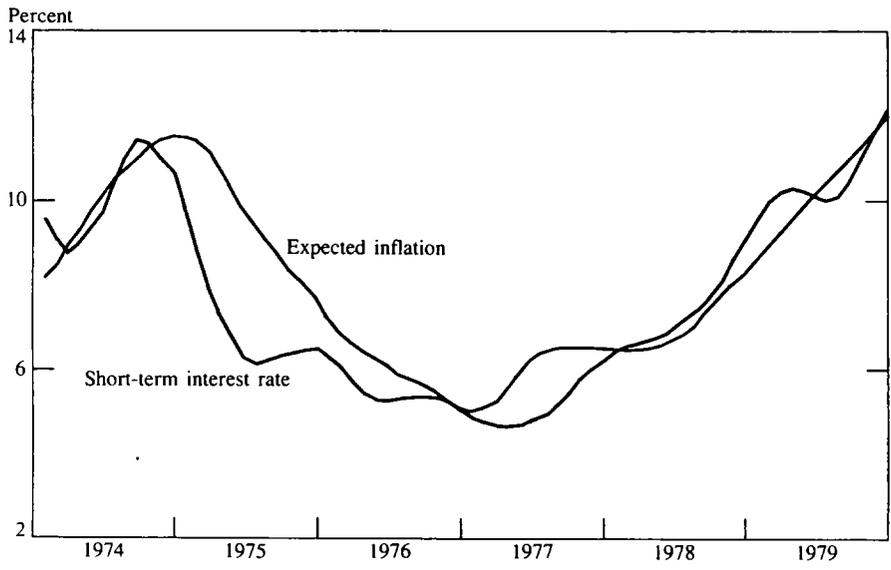
shown in Chart 1, is consistent with the view that inflation shocks dominated interest rate and exchange rate movements. Casual evidence supports this view. Oil and food prices increased dramatically in the early 1970s. After rising only 5 percent in 1972, food prices increased at an annual rate of 15 percent during the first three quarters of 1973. Then, as a result of OPEC, retail energy prices jumped 44 percent from the end of 1973 to the middle of 1974, after rising only 8 percent in the three previous quarters. Inflation rose again in the late 1970s, as food price increases in 1977-79 and oil price increases in 1978-79 occurred during a period of rapid growth in the money supply.

More direct evidence in support of an inflation explanation of interest rate and exchange rate movements can be obtained by looking at their underlying determinants. To the extent that inflation in the United States is built into inflation expectations, nominal interest rates will tend to rise and fall with inflation expectations. Thus, a high positive correlation between nominal interest rates and expected inflation supports the view that real factors were not an important determinant of nominal interest rate changes. If, in addition, there is a strong negative correlation between the dollar and the inflation differential in the United States and abroad, this supports an inflation explanation for exchange rate movements rather than a real explanation.

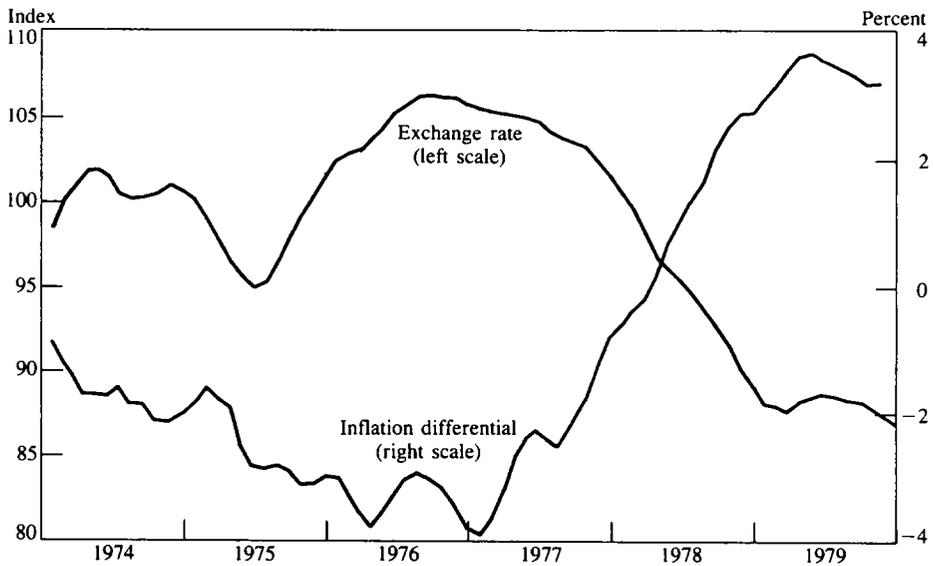
Chart 2, which plots the U.S. 3-month CD interest rate and a measure of expected inflation, shows that interest rates and expected inflation moved together from January 1974 to December 1979.<sup>6</sup> Both rose in the first three quarters of 1974, fell through the first quarter of 1977, and rose again until the end of 1979. Given the close

<sup>6</sup> The Board of Governors of the Federal Reserve System reports a real interest rate that is comparable with the 3-month CD interest rate. The expected rate of U.S. inflation is defined as the CD interest rate minus the real interest rate.

**CHART 2**  
**U.S. interest rates and expected inflation**



**CHART 3**  
**Exchange rate and inflation differential**



Source: Board of Governors of the Federal Reserve System

movement of nominal interest rates and expected inflation during this period, most of the changes in the nominal interest rate appear to be due to changes in expected inflation rather than to changes in real interest rates.

Chart 3, which plots the nominal exchange rate and the difference in U.S. and foreign inflation, supports the inflation explanation of exchange rate movements for the period from January 1974 to December 1979.<sup>7</sup> During the 1974-79 period, the nominal exchange rate and the inflation differential moved in opposite directions and were highly correlated. In 1975 and 1976, the inflation differential fell as foreign inflation exceeded U.S. inflation. During this period the dollar rose. Then, from 1977 to 1979, the inflation differential rose as U.S. inflation exceeded foreign inflation and the dollar fell. Thus, inflation factors appear to have dominated real factors in explaining exchange rate movements during this period.

#### *Interest rates and exchange rates: 1980 to 1986*

Nominal interest rates and the dollar have been positively correlated during much of the 1980s, as shown in Chart 1. Such a relationship is consistent with the dominance of real rather than inflationary shocks to the economy. At first glance, this dominance might seem puzzling. After all, the 1980s have generally been a period of disinflation, with inflation declining from double-digit rates in the late 1970s to the 3 to 4 percent range in the mid-1980s.

Real factors have been important, however. Real interest rates have been significantly higher

in the 1980s than at any other time in the postwar period. The rise in real rates has been attributed to a number of factors: restrictive monetary policy in the 1980-82 period, major changes in tax laws affecting investment spending, an apparent decline in the personal savings rate, and record federal budget deficits.<sup>8</sup>

Again, evidence in support of a real explanation of interest rate and exchange rate movements during the 1980s can be obtained by looking at their underlying determinants. If real factors are important in explaining nominal interest rate movements, real interest rates should have a significant positive correlation with nominal interest rates. Similarly, if real factors are of primary importance in explaining exchange rate movements, there should be a strong positive correlation between the nominal exchange rate and the difference between real interest rates in the United States and abroad.

Chart 4, by plotting the real and nominal 10-year constant maturity bond rate from January 1980 to December 1985, shows that there is a clear positive relationship between nominal and real interest rates over this period.<sup>9</sup> Moreover, since expected inflation declined during most of this period, nominal interest rates should have declined if inflationary factors were dominant.

Movements in the nominal exchange rate and the real interest rate differential, as shown in Chart 5, also tend to support the real explanation of exchange rate movements. From 1980 to mid-1982, the real interest rate differential rose

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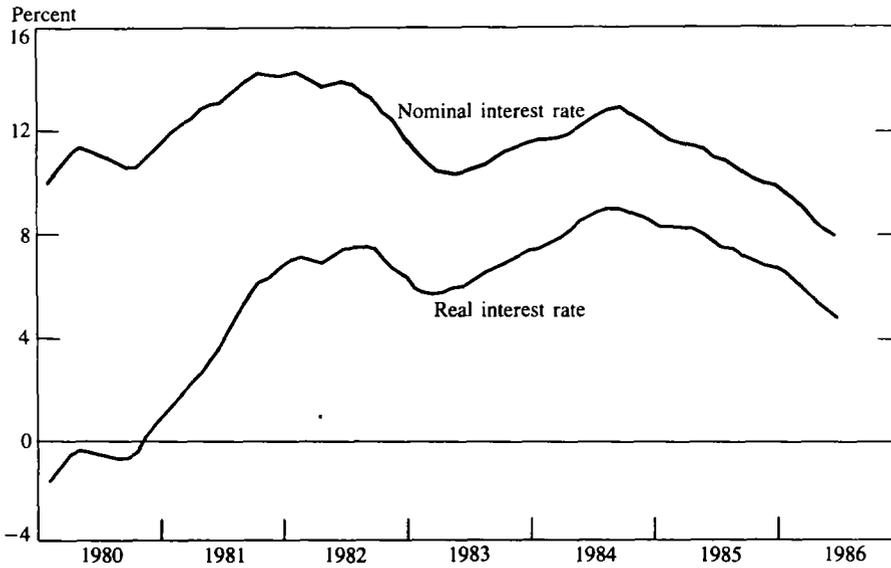
<sup>8</sup> See Stephen Cecchetti, "High Real Interest Rates: Can They Be Explained?" *Economic Review*, Federal Reserve Bank of Kansas City, September/October 1986, for a discussion of the determinants of real interest rates and an analysis of recent movements in U.S. real interest rates.

<sup>9</sup> The Board of Governors of the Federal Reserve System reports a long-term U.S. and foreign real interest rate. The foreign real interest rate is a weighted average of ten corresponding foreign rates.

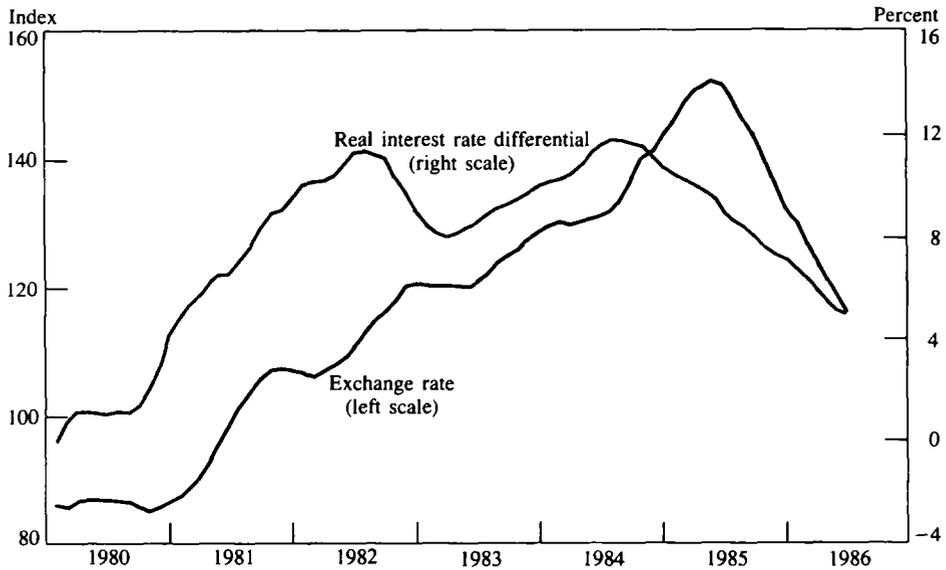
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<sup>7</sup> The Board of Governors reports a foreign weighted average CPI. The foreign rate of inflation equals the percentage change in the foreign weighted average CPI; the U.S. rate of inflation equals the percentage change in the U.S. CPI; the inflation differential equals the U.S. rate of inflation minus the foreign rate of inflation (and is a 12-month moving average).

**CHART 4**  
**U.S. real and nominal interest rates**



**CHART 5**  
**The exchange rate and real interest rate differential**



Source: Board of Governors of the Federal Reserve System

as the dollar appreciated. Then, from mid-1983 to late 1984, both the exchange rate and the real interest rate differential increased together. Finally, from mid-1985 to mid-1986, the dollar and the real interest rate differential moved lower. Thus, for most of the 1980-86 period, movements in the real interest rate differential provide a sensible explanation for exchange rate movements.

During two subperiods, however, real factors do not provide a good explanation for exchange rate movements. From July 1982 to March 1983, the exchange rate rose while the real interest differential fell. During that time, however, the inflation differential declined as U.S. inflation fell faster than foreign inflation. Thus, inflation factors seem to provide a better explanation of exchange rate movements during this period. The second subperiod, from September 1984 to May 1985, however, is not easily explained in the framework of this article. During this period, the real interest differential fell while the inflation differential rose. Either of these factors should have caused the dollar to fall. Instead, the dollar rose. Thus, the behavior of the exchange rate during this period does not seem to fit either the

real or inflation explanation of exchange rate movements.<sup>10</sup>

## Conclusion

This article has sought to explain changes in the relationship between interest rates and exchange rates over the 1974-86 period. In the framework presented in this article, the negative correlation between nominal interest rates in the United States and the dollar during the 1970s is consistent with the view that inflation shocks dominated interest rates and exchange rate movements. In contrast, during the 1980s, the generally positive relationship between interest rates and the dollar is consistent with the view that changes in real interest rates were the dominant influence on nominal interest rates and the dollar.

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<sup>10</sup> See, for example, Richard Meese and Kenneth Rogoff, "Was It Real? The Exchange Rate-Interest Differential Relation, 1973-1974," International Finance Discussion Paper No. 268, Board of Governors of the Federal Reserve System, August 1985.