ECONOMIC REVIEW

Federal Reserve Bank
of San Francisco

Summer 1983
Number 3

Real Interest Rates, Money and Government Deficits

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In the last five years both long- and short-term interest rates have reached levels not seen in U.S. economic history since the Civil War. Yields on long-term corporate bonds never exceeded 7 percent in the one hundred years before 1970 but ratcheted steadily upward after that year, reaching double-digit levels by 1979. Similarly, when the yield on short-term commercial paper reached 10.9 percent in 1979, it exceeded the previous record high which had stood since 1873.

It is generally agreed that these historically high interest rates reflected the unusually rapid inflation experienced during the 1970s. Economic theory and common observation suggest that both borrowers and lenders in loan markets are influenced by the rate of inflation in determining the rate of interest. If the prices of goods and services are rising at ten percent a year and a loan is negotiated at fifteen percent, the true cost of the loan to the borrower—in terms of purchasing power over goods and services—and the true return received by the lender are only five percent. Presumably, it is this inflation-adjusted or *real* rate of interest that borrowers and lenders negotiate. If the rate of inflation were to decline, but all the factors determining the *real* interest rate were to remain unchanged, the *nominal* interest rate offered by borrowers and accepted by lenders would also decline. For example, if the inflation rate were to fall from ten percent to five percent, the nominal rate of interest would decline correspondingly from fifteen percent to ten percent.

Empirical evidence supports these theoretical expectations. Chart 1 shows the nominal yield[1] on 91-day Treasury bills, the rate of inflation over three-month spans as measured by the official consumer price index, and the realized real interest rate computed as the difference between these two series.[2] From this chart, it is clear that in the quarter-century after 1953, variations in the nominal short-term rate were associated closely with changes in the rate of inflation and, thus, the real rate did not vary much from its long-run average level of around one percent.

However, Chart 1 also suggests that the close link between inflation and short-term interest rates may have broken down after 1979. Although the rate of inflation declined in response to the Federal Reserve System's policy of slowing monetary growth after 1979, nominal interest rates remained high. Even after the sharp decline in rates beginning in mid-1982, the nominal Treasury bill yield averaged 8.55 percent in December 1982. As measured by the consumer price index, the rate of inflation during the three-month period beginning in that month was slightly less than one-half of one percent, so that the real yield realized by holders of these bills was just over 8 percent. From Chart 1, we can see that a real rate of 8 percent is extremely high by historical standards.

In this article, we consider a number of factors which economic theory and popular opinion suggest may be important in determining short-term real interest rates and examine whether they are capable of explaining the recent experience of high real rates. The principal conclusion is that, at least over the sample period examined in this study, high real rates appear to have been more closely linked to monetary policy—and to expectations of policy—than to fiscal policies that have produced federal deficits.

Focus on Short-Term Rates

Throughout our study, we focus on *short-term* rather than long-term interest rates for several reasons, some purely practical and others funda-

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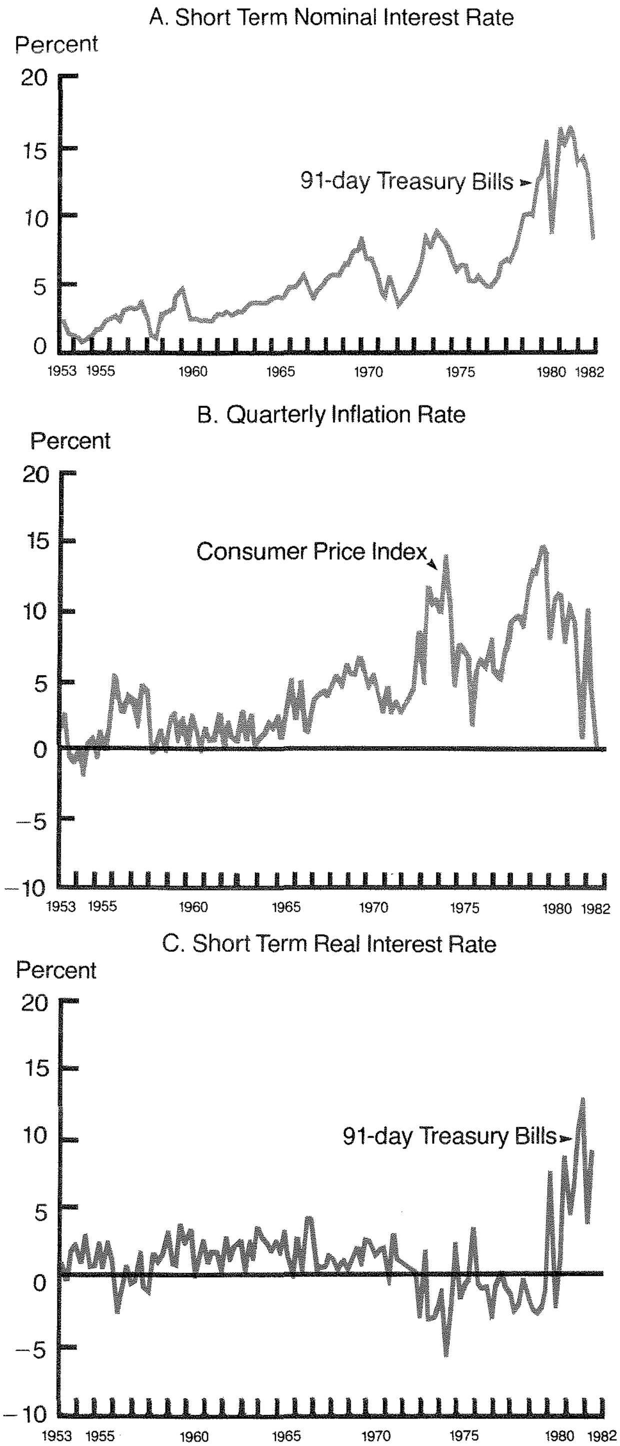
Chart 1

Comparison of Nominal and Real Interest Rates and Inflation (1953–1982)



mental. The principal *practical* reason arises from the fact that in determining the nominal interest rate on a financial asset, investors will take account of the rate of inflation which they *expect* to occur over the life of that asset. That is, the nominal rate will be set so that the real rate which is expected to emerge will adequately compensate investors for holding the asset. However, because those inflation expectations are not observable, the real rate required by investors also is not observable.

This measurement problem, in principle, affects both short-term and long-term securities, but may be less serious for short-term assets. Except in periods when the rate of inflation is changing rapidly, investors should be able to predict the prices of the goods and services they buy and sell over the next three months quite accurately. The differences between predicted and realized rates of inflation should therefore be quite small. By contrast, inflation forecasting over a longer time horizon is a much more difficult undertaking. Divergences between expected and realized inflation rates in such long-term forecasting are therefore likely to be larger. In other words, whereas the realized, or *ex post*, real rate on short-term securities should be a reasonably good approximation of the rate which investors required *ex ante* when they acquired the securities, the same is less likely to be true for longer-term securities. Because of this measurement problem, it is more difficult to test hypotheses regarding the determinants of long-term real rates than it is for those of short-term rates.

Traditionally, economists have argued that changes in the financial side of the economy mainly affect the real side through their effect on *long-term* interest rates. The interest-sensitive components of aggregate demand consist primarily of residential construction and plant and equipment spending. Since these components represent purchases of long-lived physical assets, economists have argued that they should respond to changes in the yield on long-term financial assets because this return represents the appropriate opportunity cost of funds used to purchase such assets. This argument would imply that although hypotheses with regard to short-term rates are easier to test, they are less important to policy-makers than those concerned with long rates.

In fact, however, there are good *fundamental* reasons—in addition to the practical technical reason discussed above—justifying this article's emphasis on short-term rates.

The first reason is that changes in short-term rates tend to be reflected in long rates. A household or business wishing to invest its funds for a long period may, if it wishes, hold a sequence of short-term securities rather than a single long-term security. Conversely, an investor wishing to invest for a short period may purchase a long-term security and resell it before maturity. Hence, long-term and short-term securities are to some extent substitutes, and as a result, their rates of return tend to move together.[3]

A second reason for focusing on short-term rates is that in recent years the share of short-term borrowing in the total of all funds raised in the nation's capital markets has increased. Of the $85 billion raised by private domestic non-financial borrowers (excluding residential mortgages) in 1971, almost 70 percent represented corporate and municipal bonds and non-residential mortgages. Ten years later, the amount raised had risen to $225 billion but the share of long-term financing had declined to 42 percent. Conversely, commercial paper, bankers' acceptances and bank loans increased from 13 percent to 46 percent of the total over this ten-year period.

A final reason for studying short-term rates is that, in some sense, their behavior since 1979 has been more surprising than that of long rates. The failure of nominal long rates to decline in line with inflation may be explained by arguing that, although the *current* inflation rate has declined, investors are still worried about *future* inflation, so that long-term *ex ante real* rates are not particularly high by historical standards. Although this argument is difficult to test empirically[4] because, as noted earlier, long-term inflation expectations and hence *ex ante* real rates are not observable, it is not implausible. This argument cannot, however, be applied to short-term rates because short-term inflation rates clearly have come down substantially. When investors set an 8.55 percent rate of return on 3-month Treasury bills in December 1982, it would have required an expected inflation rate of close to 7 percent for the real rate on those bills to be at its long-run average level. The *realized* inflation rate was almost zero over the 3-month period beginning in December 1982. It seems very unlikely that expectations of inflation were that far off the mark. Thus, it is virtually certain that the *ex ante* real rate was exceptionally high by historical standards. This unusual behavior requires an explanation.

What Determines the Real Interest Rate?

The real interest rate represents the return which investors expect to earn on holdings of securities. Each investor decides how many securities to hold by comparing this return with that available on alternative assets. The principal alternatives are money, which often yields no explicit return, and physical assets, such as business plant and equipment and residential housing, which provide a return in the form of productive services.

Although each investor chooses how to allocate total wealth among these various assets, in the aggregate, all securities outstanding must be held. This means that the interest rate must be such that the entire outstanding stock of securities is willingly held by investors. The rate of interest, therefore, is determined by the *demand* to hold securities and the available *supply* of securities.[5]

Before discussing these factors in detail, one methodological point should be mentioned. In this paper, the interest rate is treated as being determined by the supply of and demand for securities. As we shall see, a variety of macroeconomic variables influence these supplies and demands. But these variables are themselves affected by the interest rate. For example, the demand to hold securities, and hence the interest rate, is influenced by the level of nominal GNP. But conversely, the interest rate affects the level of nominal GNP through its effect on the spending decisions of households and businesses. In turn, the level of GNP influences other macroeconomic variables, such as the government deficit, which may affect interest rates.

In a complete model of the economy, the interest rate would be determined simultaneously with other macroeconomic variables such as income, the government deficit, and the inflation rate. In such a "full equilibrium" model, the level of nominal GNP, for example, both affects and is affected by the level of interest rates. The model used here, however, is a "partial equilibrium" one and seeks to explain the real interest rate in terms of other macroeconomic variables without exploring the feedback effects of changes in interest rates on those variables.

There is ample precedent for this procedure. The well-known IS/LM paradigm, for example, is a complete model of the economy which determines both the level of income and the interest rate. Within this framework, the LM curve is essentially a model which determines the interest rate in terms of income and the IS curve describes the feedback from the interest rate to the level of income. The equations estimated here are analogous to the LM curve since the level of income is taken as one of the determining variables. Factors influencing interest rates via the IS curve (fiscal policy, for example) do so through their effect on the level of income.

Within this broad framework, economists have two ways of approaching the determination of interest rates: The *liquidity-preference approach* which focuses attention on the decision between holding securities and holding money, and the *demand for capital approach* which emphasizes the decision between holding (or issuing) securities and holding productive capital.

In the liquidity-preference approach the rate of interest is regarded as "the reward for parting with liquidity."[6] In this approach, the key characteristic of money is that it is used to make payments so that the demand to hold it is closely related to the level of nominal income. But the demand for money also depends on the opportunity cost of holding it. In equilibrium, this opportunity cost must be such that in the aggregate the stock of money is willingly held. When the stock of money is willingly held, this implies that the same is true of the stocks of other assets.

Until recently, money was distinguished by the fact that it yielded no explicit return, so the cost of holding it was simply the interest rate which could be earned on alternative non-money assets such as securities. This meant that the interest rate on securities had to be such that the public was willing to hold the existing stock of money. If, for example, the level of income were to rise with no increase in the total stock of money, individual investors would seek to increase the level of their money-holdings by selling securities. Since all securities must be held in the aggregate, security prices would fall and interest rates would rise until investors stopped trying to switch out of securities into money. Conversely, if the level of income were to remain unchanged and there were an increase in the supply of money, individual investors would tend to push down interest rates as they sought to reduce their money holdings and to increase their holdings of securities.

Although the recent deregulation of the financial system has eroded the unique characteristic of money as an asset which provides no explicit return, it remains true that the yield on monetary assets is less flexible than that on securities. As a result, rates on securities continue to do most of the adjusting to equate the supply of money to the demand for money.

Whereas the liquidity preference approach emphasizes the choice between holding money and holding securities, the *demand for capital approach* emphasizes the decision between holding productive capital and holding securities, and argues that the nominal rate of interest on securities must be such that wealth holders are willing to hold the existing quantities of these two types of earning assets. If, for example, the expected return to productive capital rises, businesses and households will wish to hold fewer (or issue more) securities in order to hold more capital. Since all outstanding securities must be held, this will tend to drive up yields on securities.

Frequently, this argument is expressed in *flow* rather than in stock terms, and the interest rate is explained in terms of the supply of lendable funds out of current saving relative to the demand for funds to finance private capital formation and the government's deficit. When the demand for funds increases relative to the available supply, their price, which is the interest rate, tends to rise.

The liquidity-preference and productive-capital approaches to interest rates focus on different aspects of the process of interest-rate determination. The liquidity preference approach emphasizes substitutions between money and securities whereas the capital model stresses the choice between securities and physical assets. Each approach suggests that certain variables will have predictable effects on security prices and interest rates. The variables most often considered by both economists and market commentators are changes in the money supply relative to the demand, changes in the inflation rate and changes in the government's deficit.

Consider first the effects of monetary changes, better analyzed in terms of the liquidity preference paradigm. An increase in the demand to hold money with no change in the available supply puts upward pressure on interest rates. To be more specific, the amount of money investors want to hold depends positively on recent levels of nominal income and negatively on short-term interest rates. In a given month, money demand may rise as a result of past or present increases in personal income or as the delayed result of *past* declines in interest rates. If the supply of money does not rise to match such an increase in demand, the *current* interest rate must rise to restore equilibrium in the money market. Conversely, if the supply of money increases by more than the demand, interest rates will decline.

Since the stock of money is a policy variable determined largely by the central bank, the liquidity preference approach implies that the central bank can make a significant impact on the general level of nominal interest rates. A policy-induced increase in the stock of money will, *ceteris paribus*, tend to lower interest rates.

In the short run, the stock of money also may increase as a result of a rise in the amount of commercial bank lending. The public is willing to hold this money for a short while with little or no change in interest rates but will eventually seek to get rid of these excess money holdings.[7] When they do so, interest rates will tend to decline.

The effects of inflation and government deficits on interest rates are better examined in terms of the demand for capital approach since inflation affects the nominal returns to holding productive capital relative to those on securities, while deficits require changes in the supply of securities.

Consider first the effect of a change in the rate of inflation. Since wealth-owners are concerned with the *real* return on their portfolios of securities, the nominal interest rate which they require will be equal to the real rate they demand plus the rate of inflation they expect. Conversely, the return which issuers of securities will pay will be equal to the real rate they offer plus the inflation rate they expect. Hence, if the real rate is constant, a given change in the rate of inflation will cause an equal change in the nominal rate since both lenders and borrowers will accept such a change.[8]

However, inflation also may affect the *real rate* itself. In that case, a change in the rate of inflation would result in a larger or smaller change in the *nominal* rate. In fact, a number of writers on the determinants of real interest rates have found a significant *negative* relationship between the past rate of inflation and the current *real* interest rate on securities. Their finding implies that a given change in the inflation rate leads to a *smaller* change in the nominal rate.

A theoretical argument underlying this empirical finding is that more rapid inflation leads investors to want to hold more of their wealth in the form of tangible capital and less in the form of financial assets because the nominal returns on capital vary with the price level whereas the returns on securities and money are fixed in nominal dollars. This increased demand for capital has the effect of driving up its price and lowering its yield. The shifting of household savings into residences and the resulting steep increase in house prices during the 1970s may have been an example of this phenomenon. More rapid inflation also lowers the real return to holding money, because the nominal return on money is fixed.[9] Finally, since inflation reduces the real rates of return on both money and capital, the real interest rate on *securities* must also decline if investors are to remain willing to hold the existing stocks of money and capital. This argument apparently was first developed by James Tobin[10]; hence the result frequently is called the Tobin effect.

In the years up to 1979, inflation increased sharply; since that year, it has declined dramatically. The Tobin effect would predict that real rates would fall during the 1970s and rise subsequently. Thus, casual observation of the recent behavior of interest rates would support Tobin's argument. There may, however, be other explanations for recent interest rate movements; and we can sort through them only by formal econometric testing.

A prominent alternative explanation for these interest rate movements is that increases in the federal deficit have tended to drive up real interest rates. The sharp rise in real rates since 1980 has coincided with the emergence of federal deficits which are larger and apparently more long-lasting than any in recent U.S. history. This does not, of course, *prove* that the high rates have been caused by the high deficits. Indeed, the reverse may be the case because an important source of these deficits has been a sharp increase in government interest payments.[11] Nonetheless, a theoretical explanation of why deficits will drive up interest rates is readily available. Interest rates must rise in order to induce the public to hold the government securities which the Treasury issues when it runs a deficit.

Suppose, for example, the government reduces tax rates without cutting its outlays. The Treasury must issue securities to make up for its loss of tax revenues. Although the tax reduction means that the public has higher after-tax income, the public may not want to loan all of these additional funds to the Treasury. Hence, the demand for loanable funds by the government rises by more than the supply of funds, causing their price—the interest rate—to rise.[12] In slightly different language, the rise in the interest rate is necessary to induce the public to hold a larger share of its asset portfolio in the form of government securities.

Such a tax reduction also leads to an increase in aggregate demand for goods and services which, through the familiar Keynesian multiplier process, causes an increase in nominal national income. This income effect also will tend to raise interest rates. At higher income levels the transactions demand to hold money is greater and if this demand for money is not accommodated by the Federal Reserve, interest rates must rise to restore equilibrium between the supply of and the demand for money. In addition, at higher levels of income, businesses may become more optimistic about the likely future return on new investment projects and hence more willing to issue securities in order to finance such projects. These additional claims on the nation's capital markets drive interest rates further up. An analogous argument may be made that an increase in government outlays will drive up interest rates.

These last arguments frequently are summarized by saying that interest rates are influenced by the *high-employment* deficit rather than the *actual* deficit. The high-employment deficit is a measure of the setting of fiscal policy. A more expansionary fiscal policy—represented by an increase in the high-employment deficit—tends to raise interest rates through its effect on current and prospective future GNP. However, our earlier argument that actual deficits tend to raise interest rates *does not depend on* their having this effect of raising aggregate demand and hence nominal income. Because an increase in the *actual* deficit must be financed by the issue of more government securities to the public, it causes interest rates to be higher at any *given* level of GNP. If income does rise, this provides a second (logically distinct) reason for expecting interest rates to rise.[13]

Conversely, the argument that only the high-employment deficit matters implies that an increase in the actual deficit which reflects a cyclical decline in GNP rather than a shift in fiscal policy will not raise interest rates. This argument ignores the point that actual deficits—however they arise—must be financed by the issue of securities and hence cause interest rates to be higher than they otherwise would be. In this case, however, the upward pressure on interest rates associated with this deficit-financing tends to be offset by the downward pressure from the decline in GNP.[14]

The sharp increase in the federal deficit since 1979 has been widely blamed for the recent high level of real interest rates. It is important, therefore, for us to test rigorously the hypothesis that, if other things remain unchanged, an increase in government borrowing causes interest rates to rise. An obvious empirical problem in this test is that those other things do not remain unchanged in the actual world. In particular, the size of the deficit both affects and is affected by the level of business activity in the economy, and this activity in turn influences and is influenced by interest rates.

To distinguish those effects of deficits related to financing by the issue of securities to the public from those due to the link between deficits and the level of income, we include the gross national product relative to potential GNP as an additional variable in the empirical equations estimated below. In addition, we measure government borrowing as a proportion of potential GNP in order to adjust for the long-run growth in the economy and, hence, in the supply of private savings available to finance the deficit. The coefficient on the government borrowing variable, therefore, may be interpreted as representing the effect of deficits while holding the level of income constant.

In recent years, high interest payments on the existing federal debt have boosted the size of the federal deficit. In fact, the government has been borrowing in order to pay interest on its outstanding debt. A number of economists[15] have argued that to the extent that these interest payments result from high nominal rates caused by inflation, the additional Treasury borrowing should have no effect on *real* rates. Their reason is that inflation reduces the real value of government debt outstanding and that wealth-owners would be willing to purchase additional securities to maintain the real value of their stocks of securities with no change in their real rate of return.

In the empirical work reported below a crude correction for this effect is made by simply deducting government interest payments from measured Treasury borrowing. This deduction is too large since not *all* interest payments represent inflation, but the actual proportion of interest payments that represent inflation-induced increases in nominal rates cannot be measured precisely.[16]

The upshot of this section is that at any given level of GNP, there are reasons to expect real interest rates to be higher if the money supply is smaller in comparison to demand, if the inflation rate is lower, or if the government deficit is larger. Each of these events has occurred since 1979. Nonetheless, formal empirical tests are required to determine which, if any, of these various effects we have identified was the *primary* cause of high interest rates.

Measuring the Real Rate of Interest

On a given date the real rate of interest on a security is equal to the nominal rate minus the rate of inflation that investors *expect* to materialize over the maturity of the security. Put differently, the nominal rate which is determined in the financial markets is equal to the real rate which investors require *ex ante* when they purchase the security plus the rate of inflation they expect. Symbolically,

$$r = i - p^e \qquad (1)$$

where r is the real rate, i is the nominal rate and p^e is the expected inflation rate.[17] It was the determination of this *ex ante* real rate which the theory of the preceding section sought to explain.

As stressed earlier, the empirical problem with this formulation is that the expected rate of inflation is not an observable variable and hence neither is the required or *ex ante* real rate. After the security matures, of course, the actual inflation rate becomes known and the investor can calculate the real rate actually realized. The realized or *ex post* real rate is written:

$$r^{ep} = i - p \qquad (2)$$

where r^{ep} is the *ex post* real rate and p is the actual rate of inflation.

The difference between the *ex ante* real rate demanded by investors when they set the nominal rate and the *ex post* rate they actually receive is equal to the error investors made in forecasting inflation. By substracting equation (1) from equation (2) we find:

$$r^{ep} - r = p^e - p = u \qquad (3)$$

where u is the error which investors made in their forecast of inflation.

To test the various hypotheses advanced in the last section concerning the determinants of the *ex ante* real rate r, we must solve the problem of having data only on the *ex post* rate, r^{ep}. Fortunately, the theory of efficient markets provides a framework for attacking this problem.[18]

An efficient market is one in which participants use all available information in determining prices. Since the markets for short-term government securities are highly competitive, it is generally assumed that they are efficient in this sense. Participants who did not take advantage of all available information would earn lower profits than, and ultimately be driven out of business by, competitors who did.

This assumption of market efficiency implies that when the nominal interest rate is set, investors use all the information available to them both to determine the real interest rate they demand and to form their expectations of the future inflation rate. What this means is that the inflation-forecast error, u, is a random variable that is independent of all the other variables that determine the real rate. It is independent because the other variables were necessarily *known* when the market set the nominal rate while u reflects information that was *unknown* at that time. By exploiting this implication of the theory of efficient markets, we can investigate the determinants of the *ex ante* real interest rate and test the hypotheses outlined in the previous section, despite the fact that the *ex ante* interest rate is not directly observable.

To illustrate the procedure, let X represent the factors that theory suggests determine the *ex ante* real rate and assume that the relation between X and that rate is a linear one. Then

$$r = a + bX + v \qquad (4)$$

where v is a random error which is independent of X and essentially captures the variables that affect r but that have been inadvertently left out of X.

Combining Equations (3) and (4) gives

$$r^{ep} = a + bX + v + u \qquad (5)$$

The dependent variable in this equation is the *ex post* real rate that is observable. The combined error term, v + u, represents both errors in determining the real rate, v, and errors in predicting inflation, u. Both of these errors are independent of X so that least-squares estimation of Equation (5) will yield unbiased estimates of the parameters of Equation (4). Notice that although the efficient markets hypothesis implies that u is not autocorrelated, it says nothing about the characteristics of v. Hence, in our empirical work, the combined error term is assumed to be autocorrelated.

Empirical Results

Equations have been estimated in the form of Equation (5) for various sample periods. The nominal interest rate is the average rate on 91-day Treasury bills, issued in January, April, July and October, and converted to a bond equivalent basis. The inflation rate is represented by the annualized change in the logarithm of the consumer price index over 3-month spans beginning in those same months. The dependent variable in the estimated equations is the *ex post* real interest rate defined as the difference between the Treasury bill rate and the inflation rate. Notice that both the bill rate and the inflation rate refer to non-overlapping time periods.

The vector X was taken to include the following independent variables: the lagged inflation rate (PLAG), the excess supply of money (XMONEY), a measure of the impact of government deficit spending on credit markets (FEDDEF), and the ratio of current to potential GNP (INCOME). These variables are designed to capture the theoretical considerations outlined earlier.

Lagged inflation refers to the rate of price change over the three-month period ending in the month preceding the interest rate observation (December, March, June, and September). Similarly, the other three variables are quarterly data for the calendar quarters ending in those same months. Thus, market participants would have had information on each of these four variables when the nominal interest rate was set. For example, when the nominal interest rate was set in January, investors would have had information on the rate of inflation over the three months that ended in December, and data on the excess supply of money, the government deficit, and the level of GNP in the fourth quarter of the previous year. The variables, therefore, satisfy the conditions required for the application of the efficient markets hypothesis.

Our theoretical discussion suggested that an increase in the expected rate of inflation will lead to a decline in the real interest rate. As evidence of this Tobin effect, several authors[19] have found a statistically significant inverse relation between the current real interest rate and the past rate of inflation and have interpreted this finding as evidence of this effect. Although, strictly speaking, the Tobin effect implies a relationship between the real interest rate and the *expected future* inflation rate, it is difficult to test this hypothesis in the efficient market framework so that lagged inflation is used as a proxy for expected inflation. We have tried to replicate the results of these other authors before considering other possible influences on the real rate suggested by theory. The relevant equations are shown in Table 1. In an attempt to capture the possible influence of lagged variables, the error terms in these equations were assumed to follow a fourth-order autoregressive process.

The earlier studies generally used a relatively long sample period that encompassed the sixties and seventies. Hence, it is comforting to find that using a similar long period—April 1958-October 1979—we were able to reproduce their conclusion. The estimated equation shown in the first column of Table 1 implies that if the quarterly rate of inflation increases by one hundred basis points, the real rate for the succeeding quarter declines 30 basis points, or, to put the same point slightly differently, if the higher inflation rate is expected to continue in the future, the nominal rate will rise 70 basis points. Clearly, if this result holds up when the sample period is extended beyond 1979 and when additional variables are added to the equation, it will help to explain why falling inflation rates have been associated with rising real interest rates.

The remaining columns of Table 1 show the regression results when the long sample period is divided into two shorter periods—April 1958-January 1970 and April 1970-October 1979, and when the latter period is extended to January 1982. The first of these equations shows only a small, and not statistically significant, effect of inflation on the real rate during the 1958-1970 period. The effect during the 1970s is larger and highly significant, implying that the negative relationship between inflation and the real rate found in other studies (and apparently confirmed by the results in the first column), in fact, represents only the experience of the seventies. Given the much lower inflation rate experienced in the sixties, the result is not surprising. If there are transactions costs associated with rearranging asset portfolios to hold more tangible assets and fewer financial assets, modest changes in the inflation rate may not induce any response.

The last column of Table 1 shows the estimated equation when the sample period is extended to January 1982. Again, the estimates show a negative relation between inflation and the real rate, suggesting that the Tobin effect continued to hold up after the Federal Reserve changed its operating procedures. This result suggests that the decline in the rate of inflation after 1979 may have been at least partially responsible for the upward movement in real rates. However, the structure of the autoregressive process on the residuals was sharply different in this extended sample period, suggesting that some new variable(s) began to influence real rates after 1979.

The theoretical discussion argued that increases in the supply of money relative to the demand to hold it tend to lower interest rates. Our excess supply of money variable is designed to capture this effect. We derived the variable by, first, estimating a demand for money equation in which money demand in any quarter depends on current and past values of the interest rate and of nominal personal income and on the current quarter's increase in outstanding bank loans. The parameters of this equation for various sample periods are shown in Table 2. The inclusion of the bank loans variable is based on the work of Judd and Scadding[20] who

Table 1
Inflation and Real Rates

Independent Variables	Sample Periods: Apr 1958–Oct 1979	April 1958–Jan 1970	Apr 1970–Oct 1979	Apr 1970–Jan 1982
CONSTANT	0.020	0.018	0.011	0.004
	(5.20)	(7.94)	(1.35)	(0.32)
PLAG	−0.30	−0.06	−0.28	−0.24
	(5.17)	(0.79)	(3.19)	(2.06)
RHO1	−0.17	−0.13	−0.21	0.15
	(1.63)	(0.97)	(1.41)	(1.01)
RHO2	0.12	0.05	0.06	0.30
	(1.21)	(0.39)	(0.38)	(2.24)
RHO3	0.30	0.08	0.29	0.62
	(2.90)	(0.64)	(2.06)	(4.36)
RHO4	0.13	−0.22	0.31	0.30
	(1.25)	(1.74)	(2.11)	(1.82)
R-SQUARED	0.395	0.08	0.34	0.53

RHO1, RHO2, RHO3, RHO4 are fourth order autocorrelation coefficients.

argue that when banks increase their lending, members of the public receive additional bank deposits (money), some of which they are willing to hold *temporarily* until they rearrange their portfolios to add to their earning assets. Thus, the demand to hold money also depends on recent increases in bank lending.

In a given quarter, the demand to hold money may rise as a result of past or present increases in personal income or as the delayed result of *past* declines in interest rates. If such a rise in demand is not matched by a corresponding increase in the supply of money, the interest rate must rise to restore equilibrium in the market. Since members of the public do not adjust their money-holdings instantanously, this interest-rate change may be spread over several months. Similarly, to the extent that there is a rise in the stock of money as a result of an addition to the volume of bank lending, the rise will tend to drive down interest rates in later months because members of the public are only willing to hold this additional money temporarily.

To capture these effects of money on interest rates, the estimated coefficients of the money demand equation are used to predict what the quantity of money demanded in a given quarter would have been if the interest rate had remained the same as the preceding quarter and if there had been no change in

Table 2
Quarterly Demand for Money Equations

Independent Variables	Sample Periods: 1956:4–1969:4	1968:4–1979:4	1968:4–1982:4
CONSTANT	0.689 (1.165)	−1.795 (1.70)	0.264 (0.49)
TIME DUMMY^2		−0.00074 (0.406)	−0.0014 (0.71)
TIME DUMMY^3		0.00013 (0.332)	0.00 (0.00)
TIME DUMMY^4		0.00002 (0.728)	0.00001 (0.37)
LOG REAL PERSONAL INCOME*	0.685 (7.58)	1.054 (6.79)	0.750 (8.98)
LOG CONSUMER PRICE INDEX**	0.608 (3.41)	0.656 (7.12)	0.721 (23.7)
LOG COMMERCIAL PAPER RATE*	−0.029 (3.24)	−0.047 (2.86)	−0.033 (3.17)
LOG BANK LOANS (QUARTERLY CHANGE)	0.224 (2.38)	0.048 (0.76)	0.107 (1.30)
RHO	0.943 (20.6)	0.910 (14.6)	0.671 (6.83)

*Coefficients are sums of four-quarter distributed lags.
**Coefficient is sum of eight-quarter distributed lag.

TIME DUMMY = 0, 1956(4) − 1974(3);
= 1,2,3, . . . ,8, 1974(4) − 1976(3)
= 8 1976(4) − 1982(4)

The dummy variable is raised to the second, third and fourth powers to allow the implicit constant term in the equation to vary smoothly.
RHO = First Order Auto Regression Parameter

the volume of bank loans. The difference between this quantity and the actual supply of money is the excess supply of money, XMONEY.[21] Increases in this variable are expected to be associated with declines in the interest rate in the subsequent month. Notice that because the demand for money is made to depend on nominal income, this variable captures the effect of changes in income on interest rates via the transactions demand for money.

Two alternative measures of FEDDEF, the variable representing the impact of government borrowing on credit markets, were used: the overall federal government deficit shown in the national income and product accounts and the total of government and agency securities issued to the public (excluding the Federal Reserve system). Each variable was deflated by potential GNP and each was measured both inclusive and exclusive of Treasury interest payments. The second variable, which measures more directly the impact of federal borrowing on the credit markets, fit the data slightly better. For this reason, only equations using the second definition of this variable are reported below.

The final variable in the estimated equation is the level of GNP relative to potential. This variable captures any effect on interest rates of cyclical variations in real income in addition to those operating through the transactions demand for money. Also, it enables us to interpret the coefficient on FEDDEF as representing only the effect of financing changes

Table 3
Determinants of Real Interest Rates

Independent Variables	Sample Periods: Apr 1958 – Jan 1970		Apr 1970 – Oct 1979		Apr 1970 – Jan 1982	
CONSTANT	0.148	0.149	0.089	0.092	0.550	0.572
	(1.81)	(1.82)	(0.63)	(0.66)	(1.62)	(1.69)
PLAG	0.213	0.216	−0.113	−0.101	0.362	0.369
	(1.85)	(1.88)	(1.10)	(0.97)	(2.13)	(2.17)
FEDDEF1	0.141		0.369		0.027	
	(1.10)		(1.73)		(0.090)	
FEDDEF2		0.137		0.377		−0.011
		(1.09)		(1.78)		(0.038)
XMONEY	−1.006	−1.006	−0.168	−0.147	1.368	1.380
	(3.23)	(3.23)	(0.175)	(0.15)	(1.70)	(1.72)
INCOME	−0.134	−0.133	−0.104	−0.102	−0.576	−0.600
	(1.58)	(1.57)	(0.73)	(0.72)	(1.63)	(1.69)
RHO1	0.083	0.086	−0.112	−0.105	0.713	0.716
	(0.63)	(0.65)	(0.76)	(0.71)	(4.50)	(4.52)
RHO2	0.250	0.248	0.005	0.002	−0.147	−0.150
	(1.94)	(1.93)	(0.39)	(0.01)	(0.80)	(0.82)
RHO3	0.178	0.177	0.307	0.303	0.387	0.385
	(1.40)	(1.39)	(2.40)	(2.36)	(2.11)	(2.09)
RHO4	−0.178	−0.178	0.430	0.426	−0.055	−0.059
	(1.41)	(1.41)	(3.11)	(3.08)	(0.33)	(0.36)
R-SQUARED	0.17	0.18	0.36	0.36	0.48	0.48

FEDDEF1 includes and FEDDEF2 excludes government interest payments.

in the deficit, holding the level of income constant. An increase in real income tends to raise the anticipated return on real assets because businesses become more optimistic. This will tend to drive up interest rates as businesses seek to borrow to finance capital investment. At the same time, however, the supply of savings typically rises during a business cycle upswing and mitigates the upward pressure on interest rates. Thus, the sign of the coefficient on the INCOME variable is not determinate on the basis of economic theory.

Table 3 shows the results of adding these three variables to the equations estimated in Table 1. Since the INCOME variable is defined as the ratio of actual to potential GNP it is equal to one when the economy is operating at potential. Hence, the estimated value of the interest rate when the economy is at full employment and when there is no inflation, no federal borrowing and no excess money is represented by the sum of the constant term and the coefficient on the INCOME variable. This value was close to 1½ percent in the sixties and was negative in the seventies. Over the 1970-82 sample period, this value was even more negative—between −2½ and −3½ percent, implying that the high real rates actually observed were associated with changes in one or more of the independent variables in the equation and not with a shift in the intercept.

Both in the 1960s and in the 1970s, the coefficient on government borrowing is estimated to be positive. Thus, as theory would suggest, increases in federal borrowing at given levels of income were associated with higher real interest rates. The effect was smaller—and not statistically significant—in the earlier sample period when government borrowing was much smaller relative to the size of the economy. These results are hardly affected when government interest payments are excluded from total government borrowing. Apparently interest rates were influenced by total government borrowing, regardless of whether the funds were used to make interest payments on earlier borrowings. This result casts some doubt on the argument that deficits caused by high nominal Treasury interest payments do not drive up the real rate.

The last two columns of Table 3 display the results of extending the sample period to January 1982. Despite the widespread belief that the high levels of real interest rates after 1979 were the result of the sharp increase in federal borrowing, the coefficients on FEDDEF in these equations are small and insignificant. Thus, statistical analysis does not confirm the popular view that high real interest rates in recent years have been due to the increased volume of Treasury borrowing.[22]

A similar lack of stability in the coefficients was found with respect to the inflation and money variables. As the first column of Table 3 shows, during the 1958-1970 period, increases in the excess supply of money had a strongly negative impact on real interest rates: This is the result which traditional Keynesian liquidity-preference theory would predict.

In the subsequent decade, changes in monetary conditions had no perceptible influence on real rates. The estimated coefficient on XMONEY in the second column of Table 3, although negative, is small and not statistically significant. The most plausible explanation of this result is that it reflects the growing recognition by the public of the role of money in the inflation process. As investors come to realize that increases in the money supply lead to higher prices and, if sustained, to faster inflation, the net effect of monetary changes on interest rates becomes ambiguous.

Increases in the inflation rate were associated with increases in the real rate during the first sample period. Our analysis of the Tobin effect would lead us to expect the contrary. Until 1965, however, the average inflation rate was very low so that changes in the rate may not have led the public to alter its inflation expectations. Hence, increases in PLAG may have captured the effect of increases in the *level* of prices, which tend to raise interest rates when the money stock is held constant, rather than of increases in the *expected inflation* rate, which tend to lower real rates via the Tobin effect. During the 1970s, however, the estimated equation indicates that increases in the inflation rate were associated with higher nominal but lower real rates, as the Tobin effect would predict. However, this result is not significant at conventional probability levels when the influences of other variables are incorporated into the equation.

When the sample period is extended beyond October 1979, the estimated coefficients both on PLAG and on XMONEY are significantly positive.

Real rates *rose* when either the inflation rate increased or the supply of money grew faster than the demand. Since this extended period was one in which the Federal Reserve was strictly limiting money growth with a view to ending inflation, this result—which does not accord with the predictions of standard macroeconomic theory—suggests security markets interpreted increases in either money growth or inflation as signals of impending tightening of policy by the Fed; interest rates consequently rose. As previously indicated, the Treasury's borrowing had no significant impact on the real rate during this period when the effects of inflation and monetary policy were controlled for.

Summary and Conclusion

In recent years, real interest rates have risen sharply. It is widely argued that the need to finance increasing government deficits combined with a tight monetary policy on the part of the Federal Reserve System have been the principal reason for this development. In this paper, the formal theory underlying these arguments has been explained. This theory also suggests that a reduction in the rate of inflation will be associated with increased real rates.

An inescapable problem in testing hypotheses about the real interest rate is that when the market sets the nominal interest rate, it does so on the basis of an expected rate of inflation. Wealth-holders determine the nominal interest rate by adding their expected inflation rate to the *ex ante* real rate which they demand. However, the outside observer of the market cannot measure this *ex ante* rate; he can only measure the *ex post* rate that emerges. Nonetheless, by making use of the theory of efficient markets, it is possible to test hypotheses about the determinants of the *ex ante* rate using data on the *ex post* rate.

A number of studies by other authors have found that there was a significant inverse relationship in the post-war period between the rate of inflation and the real rate. Since the inflation rate has fallen since 1979, this relationship—if it continued to hold—would imply that real rates should have risen. However, the empirical results of this paper suggest that this relation only held during the seventies and that even during this decade the effect was less significant when one took account of change in the money supply and the federal deficit that took place at the same time.

Higher levels of federal borrowing were associated with increases in real rates during the 1970s. However, the empirical results do not support the proposition that there is any simple direct causal link between the recent sharp increase in the federal deficit and high real rates. In the equation estimated for the period between April 1970 and January 1982, for example, the estimated coefficient on the federal borrowing variable is small and not statistically significant. In fact, this equation suggests that money shocks and changes in the inflation rate have been more closely related to real rates than has the federal deficit. However, in this period high rates were associated with high inflation and positive monetary shocks rather than the reverse, probably because these factors were interpreted as signals of likely Federal Reserve policy in the near future.

Thus, the statistical analysis in this paper of the various factors which economic theory and popular opinion suggest as possible causes of the post-1979 rise in real rates does not strongly confirm any one of them. The results suggest that there is a great deal more to be learned before we fully understand the causes of the explosion in real rates.

A situation in which a substantial portion of government outlays are financed by borrowing rather than by taxation is unprecedented in peacetime. Hence, we should not be surprised that econometric analysis of data from an earlier period fails to provide a good guide to the current situation. This suggests that in formulating policy, we should be guided by the predictions of economic theory even though that theory has yet to be confirmed by empirical evidence.

1. Throughout this paper, yields are measured on a bond-equivalent basis in order to make them consistent with rates of inflation.

2. Holders of Treasury Bills pay attention to the inflation rate they *expect* to occur over the maturity of the bill. Chart 1 shows the inflation rate which *actually occurred*. Over long periods, however, the rate of inflation which investors expect should not diverge too far from the actual rate. Hence the *realized* real return on bills should be a good proxy for the real rate which their holders *anticipated*.

3. The reader will recognize this argument as a simplified form of the expectations theory of the term structure of interest rates.

4. For one attempt to measure real long-term interest rates, see Charles Pigott, "Measuring Real Interest Rates Using the Term Structure and Exchange Rates," in a forthcoming issue of the **Economic Review**.

5. Notice that both the supply and the demand refer to the *stock* of securities. However, if these stock supplies and demands are equal at two successive dates, then the new securities *issued* between these dates must have been willingly *purchased* by investors. Some economists, and most market commentators, prefer to think of the interest rate as equating the *flow* of new issues by borrowers with the demand by investors to add to their holdings of securities.

6. J.M. Keynes, **The General Theory of Employment, Interest & Money**, New York, Harcourt Brace & Company, 1936, (p. 167).

7. For a more detailed exposition of this argument see John P. Judd and John L. Scadding, "Liability Management, Bank Loans and Deposit 'Market' Disequilibrium," **Economic Review**, Federal Reserve Bank of San Francisco, Summer 1981.

8. If nominal interest incomes are taxable, nominal rates will rise proportionately more than inflation, since investors will demand that their *after-tax* real incomes be protected against the effects of rising prices.

9. Notice that the deregulation of interest rates on monetary assets may weaken this effect in the future.

10. For an exposition of the argument in the context of a complete model of asset markets, see James Tobin, "A General Equilibrium Approach to Monetary Theory," **Journal of Money, Credit and Banking**, Vol 1, Number 1, (February 1969).

11. In the 1982 fiscal year the federal government had an overall deficit of $123.9 billion, while net interest payments were $82.5 billion.

12. Some economists have argued that as long as government *outlays* have not changed, members of the public will recognize that a cut in their *current* tax liabilities will have to be offset by an increase in their (or their children's) *future* tax liabilities. Thus, they will not change their level of consumption and will be willing to invest their increased savings in securities in order to provide for those future tax liabilities. Hence the supply of loanable funds increases by as much as the demand so that the interest rate is unaffected. David Ricardo was an early exponent of this view so that economists who take this position are frequently described as neo-Ricardians. Although there is some empirical evidence for this position, most economists believe the argument assumes a greater degree of rationality and forsightedness than most households possess. For an extensive discussion of this issue, see Robert J. Barro, "Are Government Bonds Net Wealth," **Journal of Political Economy**, Vol. 82, No. 6 (1974).

13. In terms of the traditional IS/LM paradigm, the increase in the interest rate which results from the expansionary effect of an increase in the high employment deficit on nominal income is represented by an upward shift of the IS curve. The increase which results from the fact that actual deficits must be financed by the issue of securities is represented by an upward shift of the LM curve. The public will be willing to hold a larger share of its portfolio in the form of securities (and hence a smaller share in the form of money or physical capital) only if interest rates on securities rise. For an early explanation of this distinction see William L. Silber, "Fiscal Policy in IS-LM Analysis: A Correction." **Journal of Money, Credit and Banking,** Vol. II (November 1970). More extensive discussions of the role of government deficits are provided in L.H. Mayer, "The Balance Sheet Identity, the Government Financing Constraint and the Crowding-Out Effect," **Journal of Monetary Economics** Vol. 1 (January 1975) and Brian Motley, **Money, Income and Wealth**, Lexington, Mass: D.C. Heath and Co., 1977. Chapter 6.

14. An exogenous cyclical downturn is represented by a downward shift of the IS curve, which, by itself, tends to lower interest rates. The upward pressure on rates caused by the associated rise in the deficit to be financed is represented by an upward shift of the LM curve. Hence, the net effect on interest rates cannot be predicted *a priori* on the basis of economic theory.

15. Adrian W. Throop, "Changing Fiscal Policy II," **Weekly Letter**, Federal Reserve Bank of San Francisco, January 16, 1981. Brian Horrigan and Aris Protopapadakis, "Federal Deficits: A Faulty Gauge of Government's Impact on Financial Markets," **Business Review**, Federal Reserve Bank of Philadelphia, March/April 1982.

16. For one attempt to measure the effect of inflation on the Treasury's interest-costs, see Throop, *op. cit.* An alternative approach which directly measures the decline in the real value of the government debt, is used by Horrigan and Protopapadakis, *op. cit.*

17. This formulation assumes that investors are risk neutral and hence do not require a risk premium to cover the fact that the inflation rate is uncertain.

18. For a detailed exposition of this argument, see Frederick S. Mishkin, "The Real Interest Rate: An Empirical Investigation," **Carnegie-Rochester Conference Series on Public Policy,** 15, (1981).

19. See, for example, Frederick S. Mishkin, *op. cit.,* John H. Makin, "Real Interest, Money Surprises and Anticipated Inflation," Working Paper 878, National Bureau of Economic Research, (December 1981).

20. John P. Judd and John L. Scadding, *op. cit.*

21. The stock of money in a given quarter t may be written

$$M^s_t = a_t + b\text{INCOME}_t + c\text{INTEREST RATE}_t + d\Delta\text{BKLOANS}_t + e_t$$

where a_t includes the effects of all lagged variables on money demand as well as the constant term, and e_t is the residual between the actual money stock and the fitted money demand. Then

$$\text{XMONEY}_t = M^s_t - (a_t + b\,\text{INCOME}_t + c\text{INTEREST RATE}_{t-1}) = c\,(\text{INTEREST RATE}_t - \text{INTEREST RATE}_{t-1}) + d\Delta\text{BKLOANS} + e_t$$

22. This result does not, however, mean that real rates would not have been lower if fiscal policy had been less expansionary, but only that—given the level of nominal income which resulted from that policy—the additional impact on interest rates of the associated deficits was small.

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