

NBER WORKING PAPER SERIES

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Working Paper No. 3036

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
July 1989

The authors thank Eric S. Rosengren, James A. Wilcox and participants at seminars at the Reserve Bank of Australia and the University of South Carolina for their helpful comments. Professor Hendershott also thanks the Australian Graduate School of Management of the University of New South Wales for its support while he was in residence as a Fulbright Senior Scholar. This paper is part of NBER's research program in Financial Markets and Monetary Policy. Any opinions expressed are those of the authors not those of the Federal Reserve Bank of Boston, the Board of Governors of the Federal Reserve System, or the National Bureau of Economic Research.

TREASURY BILL RATES IN THE 1970s AND 1980s

ABSTRACT

As is widely recognized, real interest rates in the early 1980s were at peaks not witnessed since the late 1920s. Less well perceived is the sharp decline in real interest rates since 1984. By 1986-88, real interest rates were back at their average levels of the previous quarter century. This paper seeks to identify the underlying determinants of the major movements in real six-month Treasury bill rates.

The rise in real interest rates between the middle 1970s and early 1980s, not surprisingly, results from a variety of factors. First, rates were unusually low in the middle 1970s owing to the first OPEC shock, which lowered investment demand and increased world saving by transferring wealth from the high-consuming developed countries to OPEC. Second, tight money, high inflation, and heightened nuclear fear all contributed to real rates becoming unusually high in the early 1980s. The eventual decline of OPEC surpluses following the second OPEC shock prolonged the period of high real rates. The decline in real rates to more normal levels in the 1986-88 period is also due to multiple factors: lower inflation, declining marginal tax rates, and easy monetary policy.

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As is well known, real interest rates in the early 1980s were at peaks not witnessed since the late 1920s (Clarida and Friedman, 1983; Hendershott, 1986). These rates have generally been attributed to tight monetary policy (Clarida and Friedman), easy fiscal policy (Feldstein, 1985), or a combination of the two (Blanchard and Summers, 1984, and their discussants). Changes in private saving and investment propensities have been given secondary billing. Less well known is the sharp decline in real interest rates after 1984.

Movements in pretax and after-tax ex ante real six-month Treasury bill rates are shown in Figure 1.¹ The high pretax real rates in the 1981-85 period are obvious, as are the subsequent lower rates since then.² Equally obvious are the low real rates in the middle 1970s.³ These low rates might cause one to view recent real rates as still being high. In fact, though, the average real bill rate in the 1986-88 period exactly equals the real rate over the last three decades. On an after-tax basis, the low 1970s rates stand out far more than the high 1980s rates. After-tax real rates were more than a full percentage point below zero throughout the 1974-80 period, while after-tax rates in the 1981-85 period were hardly above their average value for the 1960s. Finally, Figure 1 suggests a strong cyclical pattern in real rates, with the pretax real rate rising by two to three percentage points from trough to peak over each business cycle (the last cycle being a possible exception).⁴

This paper seeks to identify the underlying determinants of the major movements in these real bill rates. Our innovations to the "standard" pre-1980s model are the addition of a new private saving shifter (Slemrod's nuclear fear variable) and lagged values of all variables in the economy's expenditure function (to reflect short-term disequilibrium in the goods

market). We also develop a new measure of monetary policy because customary empirical measures (e.g., the level of the money supply or the acceleration in money growth) lose meaning when deposit rate ceilings are removed and new liquid financial claims are introduced. Most of those who attribute high real rates in the 1980s to tight monetary policy do so by default -- it must be monetary policy because nothing else seems to explain the high rates -- rather than by relating interest rates to a measure of monetary tightness or ease.

The same factors explain the surge in the early 1980s and the subsequent decline in both before-tax and after-tax real interest rates. The erosion of the second OPEC shock, a tightening of monetary policy, a nuclear-fear-induced decline in the propensity to save, and an increase in expected inflation all contributed to the jump in real rates in the early 1980s. The decline in real rates since then is due to a decline in expected inflation and the longest period of monetary ease in the last thirty years.

This paper is divided into four parts. The model is presented in Section I, and the empirical estimates are reported in Section II. An interpretation of the major shifts in real bill rates, both before- and after-tax, is presented in Section III, and our findings are summarized in Section IV.

I. Derivation of the Estimation Equation

The initial interest-rate model is based on a relatively simple specification of IS and LM equations. The goods and money market equilibria can be expressed as

$$(1) Y = E(i^* - \pi, \text{GAP}, \text{DEF}, \text{OPEC}, \text{PSAV})$$

$(-)$ $(-)$ $(+)$ $(-)$ $(-)$

and

$$(2) M/P = L(Y, i^*, \text{OPEC}).$$

$(+)(-)$ $(-)$

Real expenditures depend on the after-tax real interest rate defined as the

after-tax nominal rate less the expected inflation rate ($i^* - \pi$), the real GNP gap (GAP), the full-employment federal budget deficit (DEF), OPEC supply shocks (OPEC), and a private saving shifter (PSAV). Real money demand depends on real income (Y), the after-tax nominal interest rate (i^*), and asset demand shifts associated with the OPEC shocks. The presumed partial derivatives of the expenditure and money demand functions with respect to these arguments are indicated in parentheses. The after-tax nominal interest rate is simply $(1-t)i$, where t is the marginal tax rate on interest income and i is the pretax nominal rate.

Many of the hypothesized responses of planned expenditures in the IS and LM equations are straightforward. Money demand rises with increases in income and falls with an increase in the opportunity cost of holding money, the after-tax nominal interest rate. Increases in the after-tax real interest rate and the real GNP gap (defined as potential minus actual real GNP, divided by potential real GNP) are each hypothesized to reduce real expenditures, while an increase in the full-employment federal budget deficit is hypothesized to increase real expenditures.⁵

The OPEC oil shocks shift both the IS and LM curves. An increase in the relative price of energy would reduce the demand for capital, and hence investment, and thus lower the IS curve (Wilcox, 1983). Such a shock also would transfer real income to oil-exporting countries. If these countries desire to maintain a higher proportion of their wealth portfolios in U.S. financial assets than did those who lost wealth (Japan, Europe and the U.S.), the LM curve will shift downward. Furthermore, because the marginal propensity to save of the oil exporting countries exceeded (at least initially) that of the rest of the world, world saving increased (Sachs, 1981; Peek and Wilcox, 1983). This would lower the IS curve to the extent that a part of the associated decline in aggregate world expenditures represents a

reduction in expenditures on U.S. goods and services.

The private saving shifter is based on Slemrod's (1986) hypothesis that heightened fear of nuclear war reduces private saving. If war is considered imminent, the return to saving is a large negative number. His proxy for nuclear fear is the minutes-to-midnight series published monthly by The Bulletin of the Atomic Scientists. The fewer are the minutes left till midnight, the closer is war, the lower is the incentive to save, and the higher would real interest rates be.

Assuming continuous equilibrium in financial and goods markets, equations (1) and (2) can be combined in a straightforward manner to yield a reduced-form equation for the after-tax nominal interest rate:

$$(3) \quad i^* = F(\pi, \text{GAP}, M/P, \text{DEF}, \text{OPEC}, \text{PSAV}).$$

(+) (-) (-) (+) (-) (-)

The nominal after-tax interest rate would be expected to rise with increases in the expected inflation rate (but by less than percentage point for percentage point) and the full-employment budget deficit. Increases in the GNP gap, the real money supply, real oil prices, and the propensity of private citizens to save would lead to lower interest rates.

Because financial markets adjust quickly, the economy can plausibly be assumed to be continuously on the LM curve. However, temporary disequilibrium in the goods market can result in the economy being off the long-run IS curve. As a result, shifts in either the IS or LM schedule do not immediately move the economy to the new (i^*, Y) equilibrium (Horwich, 1964, pp. 525-528). An outward shift of the IS curve moves the economy gradually (along the LM curve) to the higher interest rate/income equilibrium. Thus, lagged values of the IS shifters should enter equation (3). In contrast, when the LM curve shifts, the interest rate overshoots the new equilibrium. For example, an easing of monetary policy causes the interest rate initially to decline

sharply with little change in income and then to rise (along the new LM curve) with income to the new equilibrium.

The overshoot and reversal can be captured by including the difference between the current growth rate of the money supply and its recent average growth rate (MACC) as a regressor in equation (3) (Peek and Wilcox, 1986). If this accelerated growth rate is maintained, MACC gradually reverts to zero and the overshooting of the interest rate decline is eliminated. We would expect the coefficient on MACC to be negative. The revised interest rate equation is then:

$$(4) \quad i^* = F(M/P, \text{MACC}; \text{current and lagged values of } \pi, \text{GAP, DEF, OPEC, PSAV})$$

$$\quad \quad \quad (-) \quad \quad (-) \quad \quad \quad \quad \quad \quad \quad (+) \quad (-) \quad (+) \quad \quad (-) \quad \quad (-)$$

II. Bill Rate Equations

A. The Basic Data

The interest rate equation estimates are based on semiannual observations corresponding to the frequency of the Livingston survey data on expected inflation rates. April and October monthly averages of daily secondary market six-month Treasury bill rates are taken from the Federal Reserve Bulletin and have been converted from a discount basis to a bond-equivalent yield. The first available observation is for April 1959 (denoted 1959:04, April being the fourth month), and our first set of equations is estimated through the April 1979 observation. The six-month Livingston expected inflation rate series was provided by the Federal Reserve Bank of Philadelphia.⁶ This measure of expected inflation has two advantages over mechanical formulations: it is a truly ex ante expectation, and it reflects whatever sophistication agents use to process information. The tax rate on interest income is an average marginal tax rate constructed from data contained in annual editions of Statistics of Income, Individual Income Tax Returns as described in Peek and Wilcox (1983). The tax rate used for the October observation is an

average of the rate for the current year and the subsequent year.

The GNP gap (GAP) is based on the middle-expansion trend real GNP series calculated by the Bureau of Economic Analysis. GAP is computed as middle-expansion GNP minus actual real GNP, divided by middle-expansion GNP. The average value of the first- and previous fourth-quarter observations of GAP is used to correspond to the April interest rate data. The average of second- and third-quarter values of GAP corresponds to the October observation. The fiscal policy proxy (DEF) is the cyclically-adjusted federal budget deficit as a percentage of middle-expansion GNP and is based on the series constructed by the Bureau of Economic Analysis.⁷ The appropriate measure is the expected cyclically-adjusted deficit, and the expectation should be over the same time span as covered by the interest rate. Because the dependent variable is a six-month interest rate, the average of the cyclically-adjusted federal budget deficit measure for the quarter beginning in April (or October) and the subsequent quarter is used. The use of the actual values of the cyclically-adjusted deficit measure as a proxy for its expected value makes an implicit rational expectations assumption.

The OPEC proxy is measured as the current account surplus of oil exporting countries, taken from International Financial Statistics, divided by middle-expansion GNP. Following the two sharp oil price increases in the 1970s, oil-exporting countries did not immediately purchase imports with their rapidly growing export receipts, causing a temporary surge in their current account surplus. Because this surplus is highly correlated with the relative price of oil, it is also employed as a proxy for the OPEC relative price effect in the model. The real money stock, M/P, is calculated as the narrowly defined nominal money supply (M1) divided by the GNP price deflator for the quarter immediately preceding the interest rate observation (ie., first- and third-quarter values). MACC is calculated as the growth rate of nominal M1

during the previous six months relative to its growth rate during the previous three years (as in Wilcox, 1983).

The natural logarithm of the average of minutes to midnight for the preceding quarter is used as our proxy for the private propensity to save. This variable is denoted as PSAV and has a negative expected sign in the interest rate equation.⁸ Hendershott and Peek (1989) have found some support for this hypothesis from U.S. saving data. In a multicountry study, Slemrod (1989) has found a role for a related variable.

B. Preliminary Estimation

The first two rows of Table 1 contain alternative estimates of the "standard" specification -- equation (3) without PSAV but augmented with MACC (for example, Wilcox, 1983). Row 1 contains the results for the 1959:04-1979:04 period. All of the explanatory variables have the predicted sign with the exception of M/P and DEF, and all except the OPEC shock variable are statistically significant. The positive coefficient on M/P is consistent with the findings of much of the previous empirical literature (e.g., Peek and Wilcox, 1983) and could be caused by the money demand puzzles of the 1970s. Similarly, the negative estimated coefficient of DEF is not surprising, although its significance level is, given the mixed evidence from previous studies (for example, Evans 1985, Makin 1983, Congressional Budget Office 1984) and the problems associated with our empirical measure (see footnotes 5 and 7).

This specification (with or without M/P and DEF) does an excellent job of explaining movements in the after-tax bill rate for the 1959-1979 period. However, the specification (again with or without M/P and DEF) is unable to forecast the sharp rise in after-tax real interest rates in the early 1980s. The actual after-tax real interest rate and the corresponding fitted/forecasted rate using the row 1 estimates are plotted in Figure 2.

Although the difference between these two series never exceeds one percentage point through mid-1979, it jumps to 2.5 percentage points in late 1980, to 5.5 percentage points in early 1982, and does not fall below 2 percentage points until 1986.

Further evidence of the breakdown of the relationship when the 1980s are included is given in row 2 of Table 1. When the sample period is extended through 1988:10, the standard error of the equation rises sharply, the Durbin-Watson statistic plummets, and all but the estimated coefficient on MACC change dramatically.⁹ Figure 3 contains the residuals from the row 2 equation, as well as from the fitted/forecasted series from the row 1 estimates. While the full-sample equation obviously fits the 1980s better, the improved fit comes at the expense of the second half of the 1970s where the equation overpredicts those low rates by over a percentage point on average.

The last row in Table 1 includes both our new proxy for changes in the propensity to save and lagged values of all the IS shifters. The nuclear fear variable contributes marginally, and all five lagged explanatory variables have the expected sign, with the coefficients on both expected inflation and OPEC shocks being statistically significant. Overall, the equation standard error is cut by nearly 20 percent and the Durbin-Watson statistic rises above 1.0. Nonetheless, numerous problems exist with this equation: current values of many variables have little impact, significant autocorrelation of the residuals is evident, and the equation standard error is over three-quarters of a percentage point. Based on these estimates, restrictive monetary policy contributes less than 25 basis points to the sharp increase in real interest rates in the early 1980s, a surprisingly small role given the widespread attribution of high 1980s interest rates to a restrictive monetary policy.

C. Measures of Monetary Policy

The creation of new deposit interest accounts and the deregulation of deposit interest rate ceilings in the late 1970s and early 1980s distorted measures of the money supply and shifted the money demand function (Simpson, 1984). Much evidence suggests that the impacts of M/P and MACC might be different in the 1980s than in the 1970s (see, for example, Friedman 1988). Moreover, the information contained in these measures might need to be supplemented to account for the shifting relationship between money demand and any particular measure of the money supply.

Our alternative proxy for the stance of monetary policy is based on the behavior of the six-month Treasury bill rate, which the Federal Reserve can control over short periods, relative to that of the five-year Treasury bond rate, over which the Federal Reserve has decidedly less control. In general, one might posit the slope of the term structure (R_6/R_{60} , the ratio of the six- to the sixty-month Treasury rates) to be a function of the slope of the inflation rate structure (π_6/π_{60} , the ratio of the six- to the sixty-month expected inflation rates), the current full-employment Federal deficit (DEF) relative to the expected long-run deficit (DEF60), cyclical factors causing short- and long-term real rates to differ (GAP), and monetary policy. We anticipate that a large current deficit relative to outyear deficits would raise short-term rates relative to longer-term rates, as would a strong current economy.

Because we are interested in the impact of monetary policy on the six-month interest rate, it is useful to write:

$$(5) \quad R_6/R_{60} = \Phi(\underbrace{\pi_6/\pi_{60}}_{(+)}, \underbrace{DEF}_{(+)}, \underbrace{DEF60}_{(-)}, \underbrace{GAP}_{(-)}) + MP,$$

where MP is the impact of monetary policy. Solving for MP,

$$(6) \quad MP = R_6/R_{60} - \Phi().$$

That is, MP can be computed directly after the estimation of the Φ function component of equation (5). In the actual estimation of (5), standard monetary variables (a component of MP) would be included in the equation along with the arguments in Φ . MP would then be measured as the estimated contribution of the monetary variables and the equation's residual.

For the rate ratio, we use the six-month bill rate divided by the five-year rate, both on a bond-equivalent basis, for April and October of each year. The five-year rate is the constant maturity series from the Federal Reserve Bulletin.¹⁰ Unfortunately, a five-year expected inflation rate is unavailable, but a one-year rate is obtainable from the Livingston survey. Thus we use the six-month to one-year expected inflation ratio, π_6/π_{12} , as a proxy for π_6/π_{60} .¹¹ We also include as regressors GAP for the current and previous period, proxies for the expected full-employment deficits over the life of the six-month Treasury bill and over the life of the five-year bond, and M/P and MACC.

Empirically, we proxy the expected future deficit variables by the actual deficits during the six months the bill will exist (DEF) and the two years beyond that (DEF24). A two-year rather than five-year horizon is employed because actual future deficits are unavailable for the final observations in our sample and must be projected. A further consideration is that the longer the horizon, the less likely actual deficits serve as an adequate proxy for expected deficits due to major unanticipated changes in fiscal policy. This is particularly important for the sequence of tax law changes in the 1980s, some of which reversed the thrust of prior changes. For the same reason, projections of future deficits based upon today's tax law and expenditure programs are likely to be inappropriate.

Table 2 presents the results for alternative specifications of the rate ratio equation. The equations in the first two rows are estimated only

through April 1979 to avoid possible contamination of the estimated coefficients by the changing monetary relationships associated with the October 1979 change in Federal Reserve operating procedures and the acceleration of the ongoing financial deregulation and innovation in the early 1980s.

In the first equation, M/P and both deficit measures have estimated coefficients with signs opposite those predicted, although the M/P coefficient is not significant. The signs on the deficit variables are puzzling. They may be related to general problems with the deficit measure (see footnotes 5 and 7). Alternatively, recessions might cause both low rate ratios (an upward sloping yield curve) and a relaxation of current fiscal policy (high DEF relative to DEF24). In any event, the deficit variables are certainly not causing the rate ratio to move as the coefficients indicate. Thus, we reestimate the first equation omitting M/P, DEF and DEF24 (row 2). All of the estimated coefficients are statistically significant, with the exception of GAP₋₁. The π_6/π_{12} coefficient is smaller than anticipated, perhaps reflecting the use of π_6/π_{12} in place of π_6/π_{60} .

Rows 3 and 4 contain the estimates for the full 1959:04 - 88:10 period. To allow for a changing impact of M1 in the 1980s owing to deregulation, M/P and MACC are entered for the entire period and again for the 1980s only (M/P80 and MACC80 are equal to M/P and MACC during the 1979:10 - 88:10 subperiod and zero otherwise). M/P and MACC both have the predicted negative signs; the positive and statistically significant M/P80 and MACC80 coefficients indicate a reduced impact on the rate ratio in the 1980s. This would be consistent with our hypothesis of a deteriorating relationship between measures of M1 and other economic variables (including interest rates). GAP₋₁ now has a t-statistic of only about 0.25. The deficit variables again have statistically significant coefficients with signs opposite those predicted.

The π_6/π_{12} coefficient is now much larger. Row 4 presents a reestimation of this equation omitting GAP_{-1} , DEF and DEF24. All of the estimated coefficients are now statistically significant and of the predicted sign. All the equations exhibit significant autocorrelation of the residuals, suggesting that an important explanatory variable has been omitted. This is exactly as expected, the important variable presumably being monetary policy effects not captured by the included monetary variables.

We have constructed monetary policy proxies based on the estimates in rows 2 and 4. Substituting the first four terms of row 2 (three terms of row 4) into equation (6) for $\Phi()$, we can compute the MP series for the entire 1959:04-88:10 period. Thus the alternative proxy for the stance of monetary policy is composed of the movement in $R6/R60$ "explained" by the monetary variables plus the residual from the estimated equation.¹² The two MP variables and $-M/P$ are plotted in Figure 4. The M/P variable has been multiplied by minus one so that it should correlate positively with interest rates.

The MP variables appear to be more reasonable proxies for shifts in monetary policy than M/P even before the 1980s. The easing of monetary policy after the 1966 credit crunch, the subsequent tightening leading to the 1969 credit crunch, and the return to monetary ease are all more apparent. Although both MP and M/P show a tightening in the early 1970s, the subsequent easing of policy and return to a tighter monetary policy are again more striking with MP than with M/P . Finally, both series indicate a dramatic easing of monetary policy in 1983.

The two MP measures move similarly and thus perform similarly in regressions. We report results using the MP variable based upon the pre-1980s data in order to avoid any contamination of the estimated coefficients used to construct the monetary policy variable owing to the changing financial

environment in the 1980s.

D. Final Estimates of the Bill Rate Equation

The first four rows of Table 3 explain after-tax bill rates. Row 1 simply reproduces the last row of Table 1 for comparison purposes. Row 2 adds our new monetary policy proxy to the regressors in row 1. Because MP is measured with error, we use instrumental variable methods in our estimation. The instrument for MP was constructed by arranging the 60 semiannual MP values according to magnitude and collecting them into six groups of ten. The rank, one through six, of each group is used as the value of the instrumental variable for each observation in the group. Including the new monetary policy proxy lowers the equation standard error by over 15 percent, causing the coefficients on the current values of the GAP, OPEC and DEF to be closer to those expected, and raising the Durbin-Watson statistic to 1.29. Row 3 "cleans up" the equation by dropping the M/P variable and the lagged value of DEF, which had a coefficient with the incorrect sign. The remaining coefficients are now all of the correct sign, although the t-statistics in some instances are rather low, reflecting the high correlations (ranging between 0.87 and 0.96) between the pairs of current and lagged values of explanatory variables.

Row 4 reports the estimates with a Cochrane-Orcutt adjustment for autocorrelation of the residuals. These estimates shift half of the lagged-inflation effect to current inflation, while reducing the lagged-OPEC impact.¹³ The most important changes, though, relate to the private saving shifter -- fear of nuclear war -- and federal saving (the deficit). The row 4 estimates allocate a greater impact to changes in nuclear fear, and the current full-employment deficit now has a negative, but statistically insignificant, coefficient. In effect, these estimates attribute more of the high 1980s real rates to reduced private saving and less to reduced federal

saving.

To this point we have said nothing about foreign monetary or fiscal policy. To test for the impact of these factors, we obtained estimates of the OECD full-employment deficit and computed a weighted average monetary acceleration variable for the OECD countries.¹⁴ Because we could only obtain this data for the 1970-87 period, we estimated an equation for this period including these variables and all those appearing in row 3. The coefficients on foreign variables had t-ratios less than 0.7 and that for the foreign deficit was unexpectedly negative. This suggests that foreign fiscal and monetary policies have not had a major impact on U.S. Treasury bill rates.

Figure 5 illustrates how closely the row 3 estimates track the observed real after-tax bill rate. Both the decline throughout the 1970s and the jump in the early 1980s are generally explained, as are the major variations in the 1960s and the decline in the second half of the 1980s. The fitted rate is over a percentage point too high in only two 1970s observations and over a percentage point too low for only two observations in the 1980s. The row 3 estimates are used in the next section of the paper to explain the major shifts in the real after-tax and pretax bill rates over the last three decades.

Much of the previous empirical literature has focused on the pretax, rather than the after-tax, real interest rate. For this reason, we have reestimated the third and fourth equations in Table 3, setting $t = 0$. These estimates, reported in rows 5 and 6, tell much the same story as their after-tax counterparts (given that the dependent variable is roughly 40 percent greater in rows 5 and 6, the coefficients would be expected to be comparably larger than those in rows 3 and 4). Two significant deviations occur in the row 5 analogue to row 3. First, the current federal deficit coefficient is less than that in row 3 and is barely greater than half its standard error (the lagged value had a negative and very insignificant

coefficient and was thus omitted from the equation). Second, the sum of the coefficients on expected inflation are 60 percent greater. Thus an increase in inflation will raise real rates more according to row 5 than to row 3.

Following Peek and Wilcox (1984), we specify the after-tax nominal interest rate as $(1-\theta t)i$ and obtain an equation explaining the pretax nominal interest rate by dividing all explanatory variables in equation (4) by $(1-\theta t)$. For the equation corresponding to row 3, the estimated value of θ was 1.10 with a standard error of 0.45. We take this as evidence that the after-tax, rather than the pretax, Treasury bill rate is determined in financial markets. Nonetheless, for comparison purposes we use both the after-tax and pretax interest rate equations in our analysis of major shifts in the pretax real rate.

III. Determinants of Major Shifts in Real Bill Rates

After-tax real rates have varied widely over the 1959-88 period, falling from 1.5 percent in the 1960s to -1.75 percent in the middle and late 1970s, jumping to 2.25 percent in the early 1980s, and then receding to 0.95 percent during the 1986-88 period. Pretax real six-month Treasury bill rates averaged 2.6 percent during the entire 1959-88 period. Moreover, they averaged 2.7 percent during the initial 1959-70 years and 2.5 percent over the last six observations (86:04-88:10). In the intervening years, however, real rates swung violently, averaging only 0.2 percent in the middle 1970s but then rising to 2.0 percent in 1979-80 and 5.5 percent in 1981-84. This section unravels the contributions of our explanatory variables to these wide swings in real rates.

A. After-Tax Real Rates

The first row of Table 4 contains average rates for the real after-tax six-month Treasury bill rate at each of the peak and trough periods mentioned above. Row 2 lists the change in the after-tax real rate between these

periods. The remaining rows contain the contributions of changes in monetary policy (MP and MACC), fiscal policy (DEF), saving (PSAV and OPEC), the business cycle (GAP) and expected inflation (π) to the changes in the real after-tax rate. These contributions are based on the coefficient estimates in row 3 of Table 3. The impact of expected inflation arises largely because the sum of the coefficients on π and π_{-1} is less than unity (higher expected inflation lowers the after-tax real rate).

The decline in the after-tax real rate from the 1960s to the mid-1970s is attributable to three factors, increases in private saving and expected inflation and, to a lesser extent, a weakening of the economy. All of these were, in fact, largely due to the same single cause: the first OPEC shock. Monetary policy played no role in the decrease. This interpretation is consistent with Wilcox (1983).

The real after-tax rate fell further in 1979-80, in spite of a sharply restrictive monetary policy and a strong economy, owing to the sharp rise in inflation. (Because both subperiods immediately follow oil shocks, the OPEC saving shifter played a much less important role.) After-tax real rates then jumped by over 4 percentage points in 1981-84, not due to a further tightening of monetary policy, but rather to the decrease in expected inflation and a decrease in private saving. Eighty percent of the latter is attributable to the unwinding of the second oil shock (as OPEC surpluses dissipated) and 20 percent to the heightened fear of nuclear war. In fact most of the increase in real rates from the lows in the middle of the 1970s to 1981-84 might be traced to a single cause, the second OPEC shock. The resultant acceleration in inflation caused the restrictive monetary policy, contributed to the election of Ronald Reagan (not only was inflation high and rising, but the spring 1980 inflation numbers led Jimmy Carter to impose consumer credit controls, which triggered the 1980 recession), and led to the disinflation.

The election of Reagan, with his "evil empire" speeches, was likely the cause of the heightened fear of nuclear war. Nearly a percentage point of the peak after-tax real rate is not explained, however.

The decline in after-tax real rates from their peak can also likely be linked to a change in inflation, this time a decline, which led to an easier monetary policy. A strong economy acted to cushion the decline. The failure to explain fully the high 1981-83 after-tax real rate also shows up here in the contribution of unidentified factors of roughly equal (but opposite signed) magnitude.

The subperiods in Table 4 were chosen based on values of the real after-tax interest rate. However, major shifts in the contributing factors can occur within subperiods, and thus changes in the subperiod averages in the Table can understate the importance of short-term movements in the contributions. For example, because monetary policy was still tight at the beginning of the 1974-78 subperiod before easing substantially in 1976, the table understates the shift in monetary policy from 1976-77 to the early 1980s. By our measure, monetary policy raised real after-tax interest rates by 140 basis points between its low point in 1976:04-77:04 and 1979:04-1980:10. This translates into a two percentage point increase in the pretax real rate.

B. Pretax Real Rates

Table 5 is similar to Table 4 except that changes in the pretax real six-month bill rate are now being attributed to our explanatory variables. The periods correspond to those in Table 4 except for single half-year shifts in the starting/ending dates to correspond more closely to observed interest rate peaks and troughs. The contributions of the variables are calculated in two ways, using the coefficient estimates in rows 3 (after-tax bill rate equation) and 5 (pretax equation) of Table 3. The unwinding of the after-tax

equation allows the tax rate contribution to be isolated and included with DEF in the fiscal policy category.¹⁵ Implications of the row 3 estimates are listed first in the table; implications from row 5 are reported in parentheses.

As can be seen, the two sets of coefficient estimates attribute roughly equal impacts to monetary policy, saving shifts, and the business cycle. They obviously give different impacts for fiscal policy, with the fiscal policy contribution from the after-tax equation reflecting the impact of bracket creep in the 1960s and 1970s mitigating the decline in real rates and the substantial tax rate reductions in the 1980s first holding back real rate increases and then making an important contribution to their decline. Differences in the inflation impact and in the residual (unidentified factors) offset the differences in the fiscal policy impact.

The decline in the real rate from the 1960s to the mid-1970s is less than the decline in the after-tax rate because the increase in expected inflation does not act to lower the pretax rate; the sum of the coefficients on π and π_{-1} (divided by $1 - t$ in the after-tax equation) exceeds unity.¹⁶ This leaves an increase in saving and a weakening of the economy as the only factors contributing to the reduction in real rates.

The rise in the real rate to more normal levels in 1979-80 was due primarily to a restrictive monetary policy and a strong economy. The further jump to extraordinarily high real rates in 1981-84 was not due to a further tightening of monetary policy, but rather to a sharp decrease in private saving and to changing inflation. As was the case with after-tax rates, most of the increase in real rates from the lows in the middle of the 1970s to the highs in 1981-84 can be attributed to the direct and indirect effects of the second OPEC shock.

Much of the decline in pretax real rates from their peak can, like the decline in after-tax rates, be tied to a decline in inflation and the

resultant easing of monetary policy. In addition, in the after-tax model a cut in tax rates also plays an important role, alone accounting for a full percentage point of the decline in pretax real rates between 1981-84 and 1986-88.

IV. Summary

We have attempted to uncover the sources of the major changes in real Treasury bill rates, both before- and after-tax, since the middle 1970s. Two major changes have occurred in both before- and after-tax real rates -- a jump in the early 1980s and a partial reversal since then. But pre- and post-tax rates do not always move together. Most clearly, pretax real rates rose by nearly two percentage points from the mid-1970s to 1979-80, while after-tax rates fell by another half percentage point before leaping in 1981-82.

Differences in the movements in these rates stem from different responses to changes in tax rates and expected inflation. If financial markets determine after-tax rates as our model suggests, these rates are independent of changes in tax rates; a reduction in the tax rate causes the pretax rate to rise sufficiently to leave the after-tax rate unchanged. Thus bracket creep in the 1960s and 1970s tended to put upward pressure on pretax real rates while the large tax rate reductions in the 1980s made an important contribution to the recent decline in real rates. The impact of changes in expected inflation is more complicated. We estimate the long-run response of the after-tax nominal rate to expected inflation ($\delta i^*/\delta \pi$) to be 0.80. The response of the after-tax real rate to a single percentage point increase in expected inflation is thus $0.80 - 1 = -0.20$. Because the response of the pretax real rate is $\delta(i-\pi)/\delta \pi = 0.80/(1 - t)$ and t has varied from 0.24 to 0.34, the pretax real rate response has varied from 0.05 to 0.21. However, in the short run the response is negative because most of the

response of nominal rates to increases in expected inflation occurs with a one-period lag.

The other variables estimated to affect real interest rates significantly are monetary policy, the propensity to save (influenced by OPEC shocks and the fear of nuclear war), and the strength of economic activity. Changes in each of these affect pre- and post-tax rates the same way, although the impacts on pretax rates are about 40 percent greater than those on after-tax rates. Swings in monetary policy have altered pretax real rates by as much as two percentage points; cyclical changes in real activity have moved pretax rates by a percentage point; and changes in the propensity to save have changed pretax rates by over two and a half percentage points. Movements in the full-employment deficit, in contrast, are estimated to affect interest rates little.

Our principal conclusion is that the emphasis on the high real interest rates in the early 1980s is overdone. The key to understanding real interest rates in the last quarter century is the extraordinarily low interest rates in much of the 1970s owing to the two OPEC oil shocks, which lowered investment demand and increased world saving by transferring wealth from the high-consuming developed countries to OPEC. Tight money, high inflation, and heightened nuclear fear all contributed to the subsequent sharp rise in real rates, with the eventual decline of OPEC surpluses following the second OPEC shock prolonging this period of higher real rates. While changes in monetary policy explain both the rebound in real rates to normal levels in the 1978-80 period and much of the decline since 1984, by our estimates monetary policy does not account for the jump in real rates between 1978-80 and 1981-84. Monetary policy was not noticeably tighter in the early 1980s than in the 1973-74 period, although the period of tightness, mid-1979 to mid-1983, lasted much longer. Similarly, the recent period of ease has been longer than any in

the last quarter-century. Fiscal policy, on the other hand, had little impact on real interest rates in the early 1980s, with decreasing marginal tax rates offsetting the effects of increasing structural deficits.

FOOTNOTES

¹The data are semiannual, based on April and October monthly averages of the secondary market six-month Treasury bill interest rate. The Treasury bill interest rate has been converted from a discount basis to a bond-equivalent yield. After-tax interest rates are calculated using the marginal tax rate on interest income described in the text. Ex ante real interest rates are calculated using the Livingston survey six-month expected inflation rate.

Thus their movement is not due to misperceptions of inflation. Ex post real rates based on actual inflation rates exhibit even more dramatic movements.

²For the 1980-88 period Drexel Burnham Lambert has been surveying "decision makers" on 10-year inflation expectations. Based upon this series, pretax real 10-year Treasury bond rates have moved roughly like real six-month rates, rising from 2.1 percent in 1980 to 5.8 percent in 1981-mid 85 and then falling to 3.0 percent.

³Wilcox (1983) has attributed these to the first OPEC supply shock.

⁴Even the 1966 slowdown, which many at the time viewed as a minirecession, was accompanied by a decline in real rates. For earlier empirical evidence on the procyclical pattern in real interest rates, see Hendershott (1986, pp. 45-46) and the references cited therein.

⁵Changes in government expenditures are often hypothesized to have a larger impact on aggregate demand than changes in tax revenues (the balanced-budget multiplier argument). On the other hand, to the extent government purchases are good substitutes for privately purchased goods, the impact on aggregate demand of government expenditures would be partially offset by a corresponding reduction in private expenditures. In some instances, changes in tax revenues

financed by changes in government bonds outstanding are hypothesized to have no impact on aggregate demand (Barro, 1974). Because the additional interest payments on the newly issued government bonds represent expected future tax liabilities with a present discounted value equal to the reduction in current taxes, individuals would view the changes in current and future taxes as equivalent and not alter their planned expenditures (Ricardian equivalence). On the other hand, to the extent that individuals are liquidity constrained, their marginal propensity to consume out of disposable income would approach unity. In that instance, tax changes could have substantial effects on aggregate demand.

⁶The Livingston survey data actually represent eight- and fourteen-month rather than six- and twelve-month inflation expectations. For example, in approximately early May, respondents are asked to provide their expectation of the level of the Consumer Price Index for December and for June of the following year. The last reported CPI data would be for April. Thus, the calculated implicit inflation rate would be for April to December and for April to June of the following year. The timing of the interest rate data has been selected to correspond with the approximate date at which respondents form their expectations.

⁷This proxy for fiscal policy effects presents a number of problems, as do alternative measures. On general measurement issues, see, for example, Eisner (1986) and Kotlikoff (1986).

⁸An increase in minutes to midnight would also raise investment and thus interest rates. However, the saving effect should dominate because life-cycle savers are likely to have a longer horizon than firms would have for equipment investment. Firms need capital equipment to continue operating in the immediate future. Individuals need accumulated retirement saving only in the distant future and thus would be more strongly affected by the more likely

possibility of nuclear war at some time in the (perhaps somewhat distant) future. That is, a decrease in minutes to midnight is more likely to effectively shorten the relevant horizon for life-cycle savers by more than for firm investment decisions.

⁹The extended sample period includes the imposition and termination of credit controls in 1980. This caused sharp fluctuations in interest rates and the money supply. The timing of the April and October interest rate observations are such that they avoid the extremes of those fluctuations. However, the MACC variable does reflect the effects of credit controls. Consequently, we included dummy variables for the two 1980 observations. however, we have not included the credit controls dummy variables in the equations here and in the remaining tables because no statistically significant effects were found for the dummy variables and the other estimated coefficients were little affected by their inclusion.

¹⁰We used the five- rather than ten- or twenty-year Treasury rates for two reasons. First, the data on longer-term Treasuries are contaminated because only deep discount bonds existed between 1966 and 1975 (Cook and Hendershott, 1978). Second, only short-term expected inflation series are available prior to 1980.

¹¹Using the decision-makers 10-year expected inflation rate, we can construct a measure of π_6/π_{120} for the 1980s. For the 1980:4-1988:10 period, the simple correlation between π_6/π_{12} and π_6/π_{120} is 0.90 suggesting that π_6/π_{12} may not be a bad proxy for longer horizons.

¹²If the MACC component of equation (5) were not included in MP, only the size and interpretation of the MACC estimated coefficient in the interest rate equation that includes MP as an explanatory variable would be altered. The overall fit of the equation would be unaffected.

¹³When the unadjusted equation (row 3) is re-estimated with the coefficients on the current and lagged expected inflation variables constrained to be equal, the only notable change is a rise in the coefficients on the current OPEC and DEF variables and a decline in those on their lagged values (the estimated equation standard error rises by only a basis point).

¹⁴The budget deficit data were provided by the OECD. The foreign deficit series is a weighted average of the cyclically-adjusted general budget deficit as a percentage of cyclically-adjusted GNP/GDP for the six major countries of OECD excluding the United States (Japan, Germany, France, United Kingdom, Italy, and Canada). The weights are based on the 1982 shares in total OECD GNP/GDP contained in Table 1 of OECD Economic Outlook, 42, December 1987, p. 5. The data were available for the 1970-87 period. A weighted average MACC variable was calculated for the same six countries using the same weights and money supply data from International Financial Statistics.

¹⁵The impact of the variables on the pretax real rate is obtained from the after-tax equation in the following way. The estimated equation is:

$$(1-t)i = \alpha_1\pi + \alpha_2\pi_{-1} + Z,$$

where Z reflects all other variables including the residual. Differencing obtains,

$$(1-t)\Delta i - i_{-1}\Delta t = \alpha_1\Delta\pi + \alpha_2\Delta\pi_{-1} + \Delta Z.$$

Solving for the real rate,

$$\Delta i - \Delta\pi = [\alpha_1\Delta\pi + \alpha_2\Delta\pi_{-1} + \Delta Z + i_{-1}\Delta t]/(1-t) - \Delta\pi.$$

¹⁶When inflation is rising so rapidly that the average value of π significantly exceeds that of π_{-1} , the increase in inflation can temporarily lower the pretax rate.

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Figure 1
Ex Ante Real Treasury Bill Rates

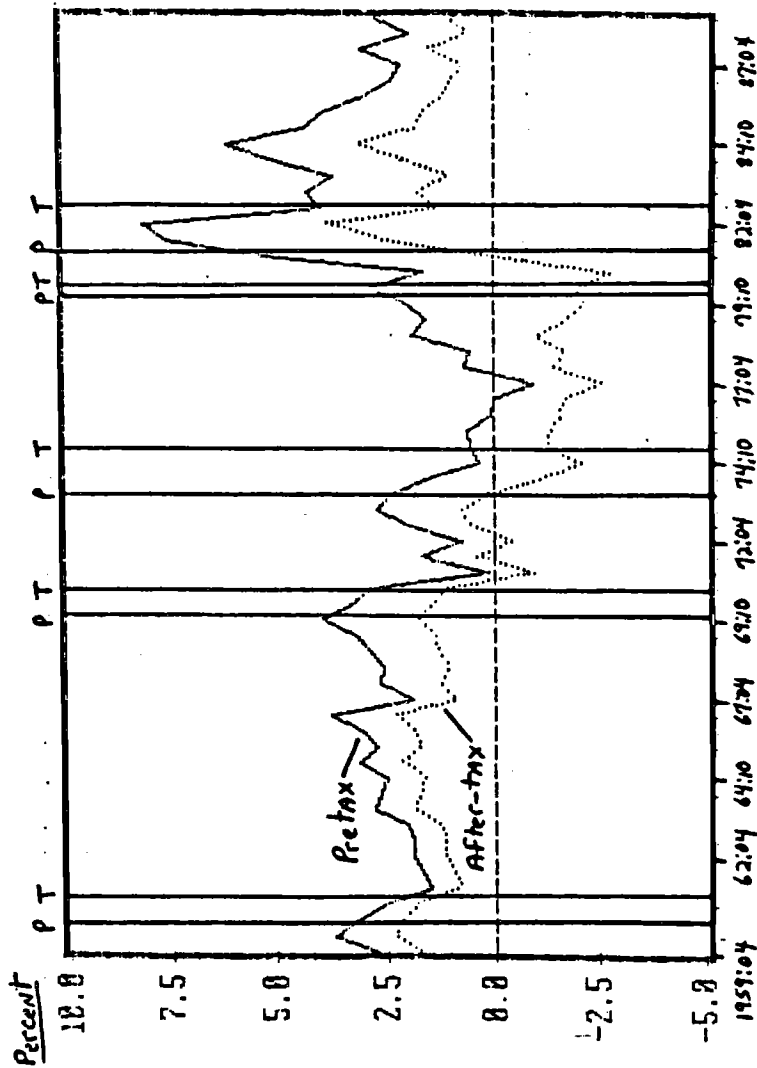


Figure 2

Actual And Fitted/Forecasted After-tax
Real Treasury Bill Rate

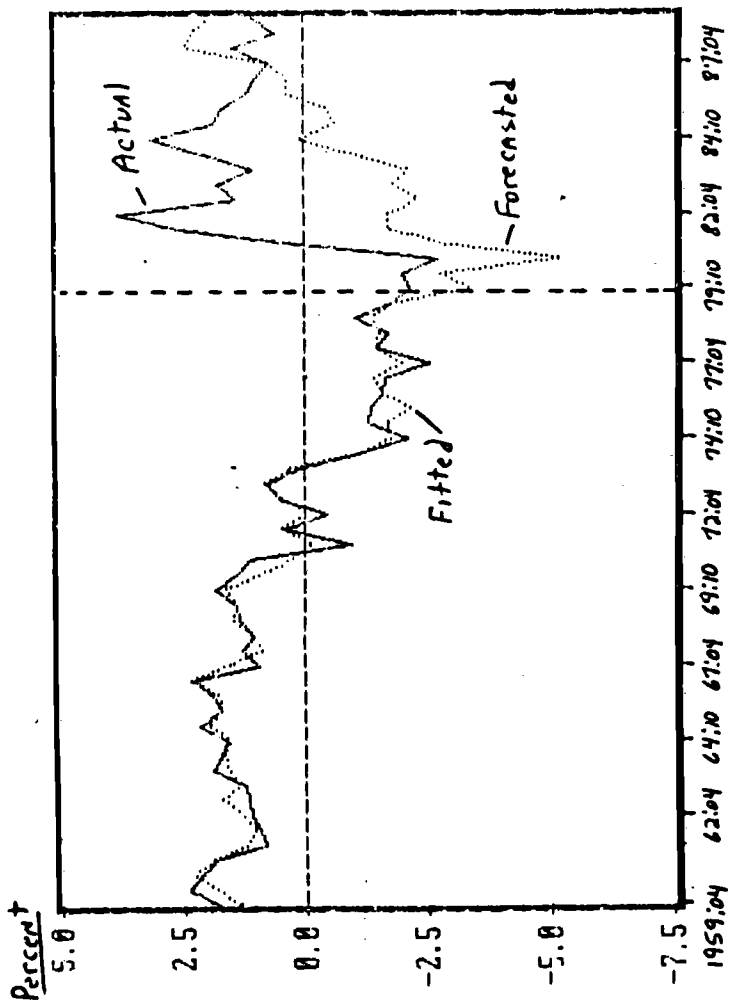


Figure 3
Residuals From After-tax Treasury
Bill Rate Equations

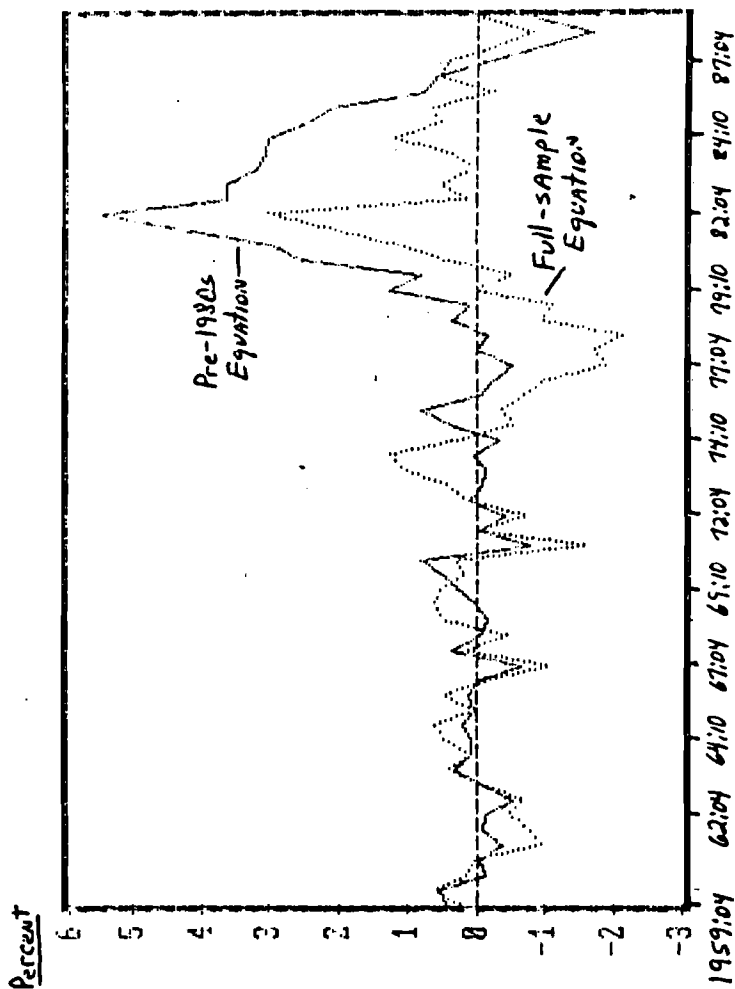


Figure 4
Monetary Policy Proxies

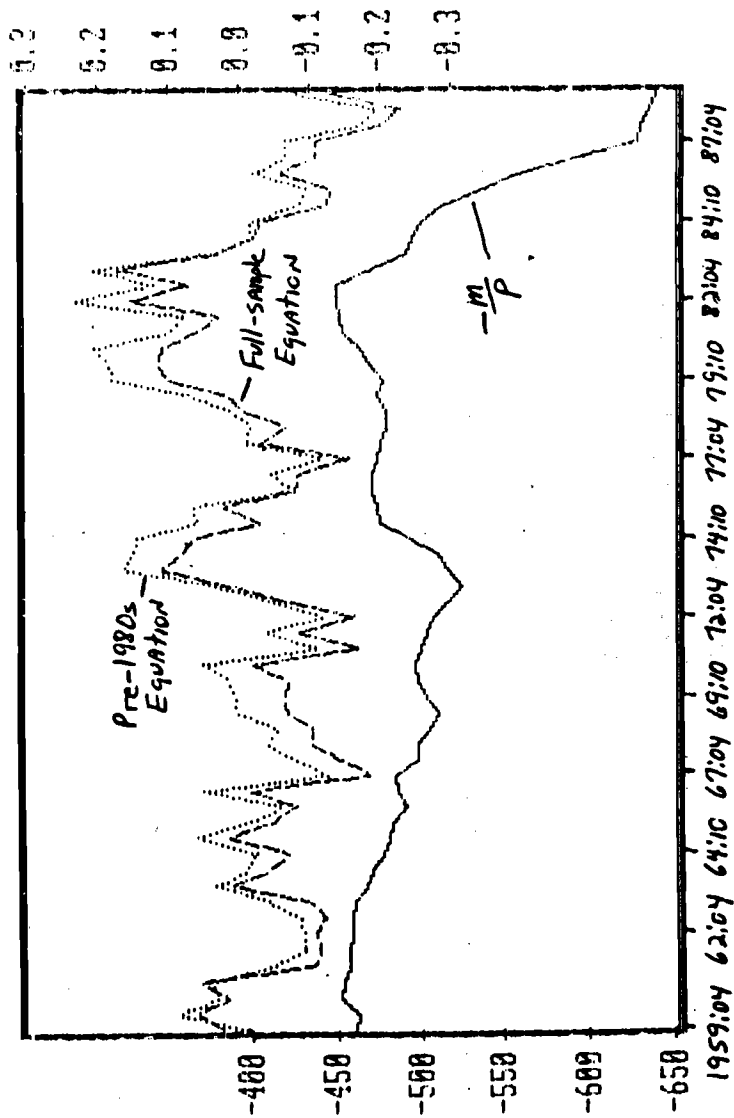


Figure 5
Actual and Fitted Real After-tax
Treasury Bill Rate

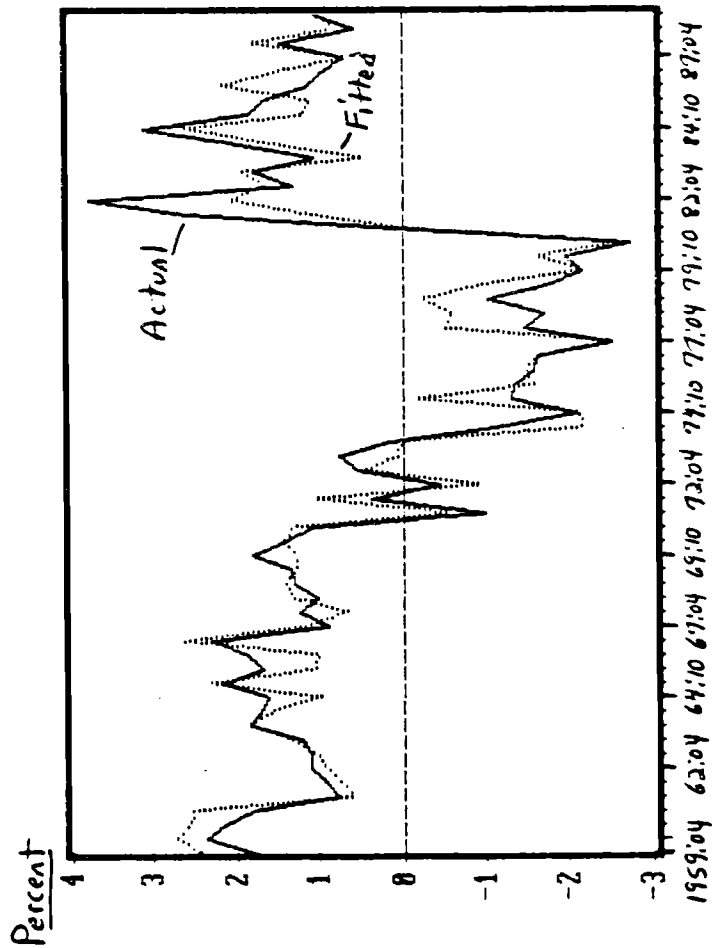


Table 1: Preliminary After-Tax Bill Rate Equations

| Period | CONST | π | GAP | OPEC | DEF | MACC | M/P | PSAV | π_{-1} | GAP ₋₁ | OPEC ₋₁ | DEF ₋₁ | PSAV ₋₁ | \bar{R}^2 | SEE | OM |
|------------|-----------------|--------------|-----------------|-------------------|-----------------|-----------------|-------------------|-----------------|--------------|-------------------|--------------------|-------------------|--------------------|-------------|------|------|
| 1. 1959-79 | -2.59 (1.87) | .46 (.06) | -.149 (.029) | -.0037 (.0111) | -.151 (.068) | -.127 (.034) | .0102 (.0039) | | | | | | | .900 | .385 | 1.87 |
| 2. 1959-88 | 4.34 (1.65) | .87 (.10) | -.029 (.048) | -.0778 (.0200) | .214 (.115) | -.118 (.041) | -.0067 (.0035) | | | | | | | .763 | .937 | .79 |
| 3. 1959-88 | 5.53 (1.90) | .19 (.20) | .020 (.090) | .006 (.033) | .075 (.179) | -.091 (.042) | -.0057 (.0036) | -.732 (.522) | .70 (.22) | -.135 (.082) | -.079 (.033) | .022 (.218) | -.052 (.496) | .837 | .778 | 1.01 |

Table 2: Interest Rate Ratio (6 Month to 5 Year) Equations

| | Constant | GAP | GAP ₋₁ | π 6/12 | DEF | DEF24 | M/P | MACC | M/P80 | MACC80 | \bar{R}^2 | SEE | DW |
|------------|---------------|-------------------|-------------------|----------------|-----------------|----------------|---------------------|-------------------|--------------------|------------------|-------------|------|------|
| 1959-79 1. | .29 (.26) | -.0413 (.0073) | .0143 (.0076) | .158 (.091) | -.032 (.011) | .040 (.016) | .00088 (.00059) | -.0178 (.0057) | | | .767 | .058 | 1.43 |
| 1959-79 2. | .67 (.08) | -.0441 (.0081) | .0140 (.0083) | .217 (.084) | | | | -.0208 (.0061) | | | .707 | .065 | 1.33 |
| 1959-88 3. | 1.06 (.15) | -.0316 (.0071) | -.0018 (.0069) | .342 (.085) | -.042 (.012) | .033 (.014) | -.00102 (.00026) | -.0115 (.0061) | .00016 (.00006) | .0149 (.0073) | .695 | .066 | 1.36 |
| 1959-88 4. | 1.21 (.15) | -.0330 (.0039) | | .326 (.087) | | | -.00133 (.00027) | -.0158 (.0060) | .00014 (.00005) | .0185 (.0070) | .634 | .072 | 1.25 |

Table 3: Bill Rate Equations, 1959-88

| | CONST | π | π_{-1} | GAP | GAP ₋₁ | OPEC | OPEC ₋₁ | PSAV | PSAV ₋₁ | DEF | DEF ₋₁ | MACC | M/P | MP | RHO | \bar{R}^2 | SEE | DW |
|-----------|----------------|--------------|----------------|-----------------|-------------------|-----------------|--------------------|-------------------|--------------------|-----------------|-------------------|-----------------|-------------------|-----------------|--------------|-------------|------|------|
| After-Tax | | | | | | | | | | | | | | | | | | |
| 1. | 5.53 (1.90) | .19 (.20) | .70 (.22) | .020 (.090) | -.135 (.082) | .006 (.033) | -.079 (.033) | -.732 (.522) | -.052 (.496) | .075 (.179) | .022 (.218) | -.091 (.042) | -.0057 (.0036) | | | .837 | .778 | 1.01 |
| 2. | 2.38 (1.73) | .14 (.17) | .65 (.18) | -.051 (.077) | -.049 (.071) | -.012 (.028) | -.061 (.028) | -.563 (.440) | -.030 (.416) | .103 (.150) | .091 (.184) | -.081 (.035) | -.0021 (.0031) | -.312 (.068) | | .885 | .653 | 1.29 |
| 3. | 1.30 (0.66) | .12 (.16) | .68 (.17) | -.062 (.074) | -.035 (.067) | -.014 (.027) | -.059 (.028) | -.515 (.240) | | .116 (.145) | .035 (.162) | -.070 (.030) | -.324 (.065) | | | .889 | .642 | 1.30 |
| 4. | 3.50 (1.14) | .38 (.12) | .37 (.13) | -.090 (.067) | -.024 (.061) | -.013 (.026) | -.038 (.025) | -.668 (.337) | -.480 (.321) | .150 (.130) | .091 (.127) | -.060 (.023) | | -.215 (.055) | .69 (.12) | .924 | .529 | 1.84 |
| PreTax | | | | | | | | | | | | | | | | | | |
| 5. | 1.71 (0.92) | .12 (.24) | 1.16 (0.25) | -.129 (.102) | -.026 (.096) | -.022 (.039) | -.084 (.040) | -.871 (.332) | | .066 (.113) | | -.066 (.041) | | .477 (.093) | | .902 | .940 | 1.26 |
| 6. | 4.99 (1.70) | .55 (.18) | .57 (.19) | -.154 (.097) | -.011 (.088) | -.018 (.038) | -.043 (.036) | -1.024 (0.492) | -.700 (.466) | -.279 (.185) | .106 (.182) | -.081 (.033) | | -.305 (.079) | .73 (.11) | .935 | .765 | 1.80 |

Table 4: Decomposition of Major Shifts in After-Tax Real Rates

| | 59:04-70:10 | 74:4-78:10 | 79:04-80:10 | 81:10-84:10 | 86:04-88:10 |
|--|-------------|------------|-------------|-------------|-------------|
| After-Tax Real 6-Month Treasury Bill Rate | 1.52 | -1.59 | -2.15 | 2.24 | 0.97 |
| Change | -3.11 | -0.56 | 4.39 | -1.27 | |
| Contributions of Changes in: | | | | | |
| Monetary Policy | 0.19 | 0.63 | -0.25 | -0.90 | |
| Fiscal Policy | 0.15 | -0.01 | 0.20 | 0.14 | |
| Saving Shifts | -1.92 | -0.22 | 2.01 | 0.36 | |
| Business Cycle | -0.28 | 0.31 | -0.53 | 0.44 | |
| Expected Inflation | -0.96 | -1.24 | 2.03 | -0.35 | |
| Unidentified Factors | -0.29 | -0.03 | 0.93 | -0.96 | |

Table 5: Decomposition of Major Shifts in Pretax Real Rates

| Real 6-Month Treasury Bill Rate | 59:04-70:10 | 74:10-78:04 | 78:10-80:10 | 81:04-84:10 | 86:04-88:10 |
|------------------------------------|-------------|------------------|------------------|------------------|------------------|
| Change | 2.70 | -2.50 | 1.79 | 1.99 | 3.50 |
| | | | | 5.49 | 2.53 |
| Contributions of Changes in: | | | | | |
| Monetary Policy | | 0.13 (0.13) | 0.93 (0.90) | -0.10 (-0.14) | -1.26 (-1.44) |
| Fiscal Policy | | 0.53 (0.08) | 0.27 (-0.02) | -0.29 (0.08) | -0.78 (0.06) |
| Saving Shifts | | -2.94 (-2.94) | -0.27 (0.25) | 2.14 (2.24) | 0.83 (0.89) |
| Business Cycle | | -0.51 (-0.57) | 0.58 (0.61) | -0.71 (-0.77) | 0.53 (0.65) |
| Expected Inflation | | 0.87 (1.47) | -0.23 (-0.11) | 1.01 (0.82) | -1.00 (-1.66) |
| Unidentified Factors | | -0.58 (-0.67) | -0.03 (0.16) | 1.45 (1.27) | -1.28 (-1.46) |

* Numbers in parentheses are from the pretax equation; the other numbers are from the after-tax equation.