THE BEHAVIOR OF U.S. SHORT-TERM
INTEREST RATES SINCE OCTOBER 1979

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The Behavior of U.S. Short-Term Interest Rates Since October 1979

ABSTRACT

Short-term interest rates in the United States have been "too high" since October 1979 in the sense that both unconditional and conditional forecasts, based on an estimated vector autoregression model summarizing the prior experience, underpredict short-term interest rates during this period. Although a non-structural model cannot directly answer the question of why this has been so, comparisons of alternative conditional forecasts point to the post-October 1979 relationship between the growth of real income and the growth of real money balances as closely connected to the level and pattern of short-term interest rates. This finding is consistent with the authors' earlier conclusion, based on analysis of a small structural macroeconometric model, that the high average level of interest rates has been due to a combination of slow growth of (nominal) money supply and continuing price inflation, which together have kept real balances small in relation to prevailing levels of economic activity.

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Just about all aspects of interest rates in the United States — including their overall levels, their movements, and their relationships to one another — have been extraordinary thus far during the 1980s. Observed nominal interest rates on most instruments traded in the U.S. debt markets have set record highs twice since 1980. The amplitude of interest rate swings over the economy's one-and-a-half business cycles has also been unprecedented in U.S. experience, and the shorter-run volatility of interest rates (month-to-month, day-to-day, or even within the trading day) has increased dramatically. The term-structure "yield curve" was sharply "inverted" during part of this time, although it is no longer, and other yield comparisons (on taxable versus tax-exempt bonds, for example) were and have remained far from their historical norms.

The single aspect of interest rates that has attracted the most attention during this period has been their persistently high level, including a presumed high level of "real" interest rates — that is, observed nominal rates less some presumed expectation of price inflation. During the past few years, nominal interest rates first rose to levels far above the prevailing inflation rate, and more recently the decline in nominal interest rates has lagged well behind the slackening of the pace of inflation.

For two reasons the greatest attention, and also the greatest puzzlement, have focused on the high level of short-term interest rates. First, because inferring market participants' expectations of inflation is typically more difficult as the relevant time horizon is longer, the judgment that interest rates have been unusually high in real terms has been much safer for short than for long maturities. Given the state of and prospects for business activity, the normal cyclical slowing of inflation since 1980 was probably widely

anticipated. By contrast, who is prepared to say what market participants

thought (or think) about the outlook for inflation over the life of a thirty-

year bond?

Second, many of the familiar hypotheses advanced to explain the presumed

high real interest rate levels have made sense only for longer maturities.

Fear that the Federal Reserve System would abandon its anti-inflationary monetary

policy, for example, may have affected expectations about the likely rate of

inflation in subsequent years, but not over three-month horizons. Why, then,

would three-month interest rates have reflected it? The concern that the Reagan

Administration's fiscal policy, combining massive tax cuts with rapidly

increasing military spending, would require high enough real interest rates to

"crowd out" large amounts of private investment is plausible enough — but only

after the economy had recovered from the 1981-82 recession, which involved the

excess private saving also usually associated with weak economic activity.

This concern would not have affected short-term yields either, at least during

the period to 1983. The idea that increased interest rate and asset price

volatility in the financial markets has led to higher risk premia is quite

plausible too, but it again applies only to long-term instruments subject to

substantial capital risk. If anything, the effect of greater volatility should

be to increase the demand for short-term instruments, and hence to reduce their

yields.

Nevertheless, U.S. short-term interest rates certainly have been high in

the recent past, in both nominal and real terms. From 1953 through the third

quarter of 1979 — a familiar break point in recent analysis of U.S. monetary

policy — the average discount on three-month U.S. Treasury bills was 5.27%.

The subsequent average (to midyear 1983) has been 11.67%. For the corresponding

real rate, representing the difference between this nominal rate and the

annualized percentage change in the gross national product deflator, the analogous comparison is 1.39% versus 4.71%. During the earlier twenty-six years the maximum nominal rate observed in any quarter was 9.06% (in 1979:3), while the maximum real rate was 3.24% (in 1953:4) — in both cases below the corresponding recent means. Since October 1979, the nominal rate in every quarter but one has been at least 6% above the corresponding 1953-79 mean. With few exceptions, the real rate since then has also consistently been well above the corresponding 1953-79 mean.

In an earlier paper, the authors (1983) used a small structural econometric model to address two questions: Have U.S. short-term interest rates been "too high," given the relevant historical relationships connecting interest rates and other key aspects of macroeconomic activity? And if so, then why? The basic strategy employed in that paper was to analyze the errors made in forecasting short-term interest rates for 1979:4-1983:2, using a model estimated with data through 1979:3, and to compare them with the analogous errors made for 1976:3-1979:3 using the same model estimated only with data through 1976:2.[1] The conclusions of that analysis were that U.S. short-term interest rates since October 1979 have indeed been "too high" in a meaningful sense, and that the familiar story of too little money for the prevailing levels of economic activity — in particular, the small growth of real balances due to the combination of slow growth of nominal money supply and sluggish deceleration of price inflation — largely accounts for this phenomenon.

The object of this paper is to re-examine the same questions using a different set of empirical tools. A structural model like that used in the authors' earlier paper imposes potentially important restrictions on the way in which the estimated model summarizes the relationships exhibited by prior experience. Any analysis based on a structural model is therefore conditional

on those restrictions. Restrictions that are valid reflections of actual
economic behavior will enable the model to extract the relevant behavioral
relationships more efficiently from the available data, but incorrect or
arbitrary restrictions will distort the representation of these relationships.
An alternative empirical strategy, developed primarily by Sims (1980a, 1980b,
1982), is to forego structural restrictions altogether — that is, apart from
the choice of the variables to be included in the analysis — and instead to
work with unrestricted dynamic representations of the data.

The exercise reported in this paper uses a small vector autoregression
representation of the relationships among key macroeconomic variables in the
United States to study the same 1979:4-1983:2 behavior of short-term interest
rates examined in the authors' earlier paper. Here again, the ability to forecast
interest rates during this period, using a model estimated with data ending in
1979:3, sheds light on the question of whether rates have been "too high." To
anticipate, the answer is again yes. Without a structural model, the analysis
cannot directly address the question of why this has been so. Nevertheless,
further experiments based on a conditional forecasting technique suggested by
Doan et al.(1983) indicate results consistent with the authors' earlier finding
that the scarcity of real balances in relation to prevailing levels of economic
activity has been an important element in the U.S. interest rate experience since
October 1979. In short, the results of the vector autoregression analysis
reported here correspond well with the main conclusions based on the structural
model.

Section I summarizes the vector autoregression model and presents the
model's (unconditional) forecast of U.S. short-term interest rates during 1979:4-
1983:2. Section II briefly describes the conditional forecasting technique and
presents results indicating that no single variable — neither money, the
government deficit, nor any of the other variables included in the analysis —

is sufficient to account for the experience of short-term interest rates during this period. Sections III and IV present further conditional forecasting results, including especially those involving the relationship between real money balances and real economic activity. Section V briefly summarizes the paper's principal conclusions.

I. The Vector Autoregressive Model and Its Unconditional Projections

The analysis below uses a constant-coefficient, linear vector autoregression model to estimate the pre-October 1979 probability structure of the quarterly data for six key U.S. macroeconomic variables: the growth rate of the narrowly defined money stock (M1), the growth rate of total nonfinancial credit, the change in the federal budget deficit, the growth rate of real gross national product, the rate of change of the gross national product deflator, and the change in the three-month Treasury bill rate.[2] The model can be written as

$$\underline{z}_t = \underline{\alpha} + \sum_{s=1}^{5} B(s)\underline{z}_{t-s} + \underline{\varepsilon}_t$$

where $\underline{z}$ is the vector of six variables specific above, $\underline{\alpha}$ is a vector of constants, the $B(s)$ are time-invariant matrices of autoregression coefficients, and $\underline{\varepsilon}_t$ is a vector of independent and identically distributed innovations. Table I reports the results of estimating this system for quarterly data spanning 1962:3-1979:3. Over the sample, money growth "Granger-caused" short-term interest rate changes, but not real income growth. By contrast, both credit growth and interest rate changes did "Granger-cause" real income growth.[3] Correlations among the in-sample innovations (not shown in the table) indicate that the surprises in income growth and in interest rates were positively correlated, while surprises in money growth and in inflation were both negatively correlated with interest rate surprises.

Given the dynamic correlations among the macroeconomic variables summarized by the estimated vector autoregression, it is straightforward to construct a post-October 1979 path that is most likely, in the absence of further information, for any of the model's variables. In particular, obtaining the best linear projection of the post-sample values attained by the variables in each of the fifteen quarters 1979:4-1983:2 simply requires recursively forecasting one step ahead at a time with the autoregressive equations, using the successively forecast values of the variables as the data of the system.

Columns (1) and (2) of Table II compare this projection for the short-term interest rate with the corresponding actual values. The forecast fails to capture any of the variation in short-term interest rates that has attracted so much attention during this period. The mean error of -.62% — that is, an underprediction of short-term interest rates on average — results from a larger underprediction during 1980 and 1981 combined with a substantial overprediction in late 1982 and 1983. The root-mean-square error is 2.38%.

Analogous comparisons for the system's other five variables, shown in summary form in Table III, confirm several familiar conjectures about the post-October 1979 macroeconomic experience. Over the twelve quarters 1979:4-1982:3, for example, money growth was consistently slower (while the short-term interest rate was consistently higher) than projected. For the seven quarters 1981:4-1983:2, both income growth and inflation were also consistently slower than projected. Nonetheless, money growth was substantially faster (and the interest rate lower) than projected for the more recent quarters 1982:4-1983:2. For the eight quarters immediately following October 1979, both income growth and inflation were roughly as projected by the model.

II. Conditional Forecasting with the Vector Autoregression Model

The next step of the analysis is to construct and study the best linear projections of one element of $\underline{z}$ (the short-term interest rate) given knowledge of the history of $\underline{z}$ up to October 1979 and in addition knowledge of various (linear combinations of) elements of $\underline{z}$ during the post-October 1979 period being forecast. In other words, the object is to construct forecasts of the short-term interest rate in each post-October 1979 quarter that will incorporate knowledge of (linear combinations of) other elements of $\underline{z}$ in all post-October 1979 quarters through the end of the forecast period. Recent work by Sims (1982) and Doan et al. (1983) has introduced and successfully employed such conditional projections to evaluate the plausibility of macroeconometric forecasts in light of the historical dynamic correlations among the variables being predicted.

The basis for constructing these constrained projections is the method of Kalman filtering. Clarida and Coyle (1983) have shown that Kalman filtering may be applied to any state space model which combines post-sample observations on a linear combination of a system's variables with that system's historically estimated parameters to yield minimum mean-square linear estimates which optimally incorporate the post-sample observations. They have also established a particularly simple relationship between the unconditional projection of $\underline{z}$ in the s'th post-sample quarter, say, $\hat{\underline{z}}_s$, and the projection $\hat{\underline{z}}_s|\underline{y}$ which incorporates a vector of post-sample observations, $\underline{y}$, on linear combinations of the elements of $\underline{z}$:

$$\hat{\underline{z}}_s|\underline{y} = \hat{\underline{z}}_s + K(\underline{y} - \hat{\underline{y}}).$$

In words, the difference between the conditional and unconditional projection for $\underline{z}$ is then just a linear transformation of the difference between the observed vector $\underline{y}$ and its best linear projection $\hat{\underline{y}}$. The associated transformation

matrix K can be computed directly, and at reasonable cost, from the parameter

and variance-covariance matrices of the estimated vector autoregression.

Columns (3)-(7) of Table II show the results of using the model described

in Section I to generate successive dynamic forecasts of U.S. short-term interest

rates that are each conditional on one variable among the five (other than the

interest rate itself) included in the vector autoregression system. For each

successive conditioning variable, the relevant column reports the fifteen

quarter-by-quarter forecast values, together with the same summary statistics

shown in column (2) for the unconditional forecast.

What is immediately striking in this set of results is that, with the

single exception of the forecast conditional on the price variable, none of

these conditional forecasts represents an improvement over the unconditional

forecast discussed in Section I. The forecast conditional on money growth is by

far the worst among the five, as the model not only fails to capture much of

the movement to unusually high short-term interest rates in 1980 and 1981 but

also incorrectly infers that the speed-up of money growth in 1982 and early

1983 would have led rates to drop to levels last seen in the 1950s. Both the

root-mean-square error and the mean absolute error are much larger than those of

the unconditional forecast. The forecast conditional on credit growth is

roughly similar overall, although less extremely off track than that conditional

on money growth. At least in this context, knowing either money growth (only)

or credit growth (only) would have been less useful than knowing nothing at all.

The forecast conditional on the deficit change captures the high average

short-term interest rate level in 1980 and 1981 with fair accuracy — except for

the immediate post-credit-controls (and post-recession) dip in 1980:3, of

course — but it fails to capture the sharp drop in rates that occurred once the

stance of monetary policy shifted in late 1982. As a result, this forecast

overpredicts short-term interest rates on average during 1979:3-1983:2, in contrast to the average underprediction made by the unconditional forecast or the forecast conditional on either money or credit growth. The mean error here is somewhat smaller (in absolute value) than that of the unconditional forecast, but the root-mean-square error is larger.

Although the summary statistics for the forecast conditional on real income growth and that conditional on the deficit change are almost identical, the quarter-by-quarter forecast values show large dissimilarities. The forecast conditional on real growth underpredicts short-term interest rates on average in 1980 and 1981, but then entirely misses the sharp drop that accompanied the end of the 1981-82 recession and the beginning of the business recovery. The overall result is again overprediction (by the smallest mean absolute error among the five forecasts considered here), and again a root-mean-square error even larger than that of the unconditional forecast.

The forecast conditional on price inflation is the only one among the five to improve unambiguously on the unconditional forecast. The quarter-by-quarter pattern of this forecast is similar to that of the forecast conditional on the deficit change. The forecast conditional on inflation also captures reasonably well the high average level of short-term interest rates in 1980 and 1981 (again, except for 1980:3), and it also fails to capture the drop in rates at the end of 1982. Its mean overprediction is somewhat larger than that of the forecast conditional on the deficit change (it is almost as large as the mean absolute error of the unconditional forecast), but the associated root-mean-square error is smaller than that of any of the other forecasts considered thus far.

On the whole, these dynamic interest rate forecasts conditional on single other variables are not encouraging. They suggest that (with the limited possible exception of inflation) no one macroeconomic variable can tell much of the story

of why short-term interest rates moved as they did during this period.

III. Richer Conditional Forecasts: The Role of Real Balances

As the discussion in Section II explains, the conditional forecasting technique suggested by Doan et al. facilitates using an estimated vector autoregression model not only to generate forecasts conditional on one single variable but also forecasts conditional on several variables or on the sums or differences (more generally, any linear combination) of several variables. In light of the limited success of the short-term interest rate forecasts conditional only on single variables, it is worthwhile to experiment with forecasts conditional on richer information sets. Even so, simply trying in succession all possible combinations among the five other variables included in the vector autoregression hardly makes sense. The approach taken here is instead to focus on a few specific combinations suggested by the authors' previous work, based on a structural model, which concluded that the high level of U.S. short-term interest rates since October 1979 has principally reflected the relationship between real money balances and real economic activity.

Column (3) of Table II already indicates the limited value, from the perspective of the vector autoregression's forecast of short-term interest rates during this period, of the information contained in the growth rate of real income. Column (8) shows a similar result for the growth rate of real money balances, represented in the model by the difference between the (nominal) money growth rate variable and the price inflation variable. The forecast conditional on real money growth underpredicts short-term interest rates, although with a small mean absolute error. Its root-mean-square error, however, is larger than that of the unconditional forecast. In short, neither real income growth nor real money growth (and certainly not nominal money growth) successfully helps the model

to predict short-term interest rates during this period.

By contrast, the two together do just that. Column (9) shows the results of a forecast of short-term interest rates conditional on both real income growth and real money growth. This forecast underpredicts part of the high average interest rate level in 1980 and 1981, and it does not adequately capture the decline in late 1982. On balance it underpredicts short-term interest rates, with a mean absolute error less than half that of the unconditional forecast. More importantly, the root-mean-square error is substantially smaller than that of the unconditional forecast (and also smaller than that of the forecast conditional on the inflation rate).

This result, like any finding based on a non-structural model, cannot by itself lead to any conclusions about what has "caused" the high interest rate levels prevailing in the United States since October 1979. It simply relates interest rates to specific macroeconomic variables — in particular, real balances and real income — and not to elements of macroeconomic behavior like money demand and money supply. Nevertheless, the apparent value in this context of the information contained jointly in real money growth and real income growth is consistent with the authors' earlier explanation (based on a structural model) that the slow growth of nominal money supply and the continuing rapid price inflation combined to render the supply of real money balances small in comparison with the real money demand associated with the prevailing levels of real activity.[4] To put the point the other way around, the alternative finding that real money growth and real income growth jointly contained little information that helped the model to forecast short-term interest rates would have cast doubt on the authors' earlier explanation. Instead of such a negative result, however, the opposite is a better description.

Given this result, it is interesting to determine whether the information

that matters for the model's forecast of short-term interest rates involves real income growth and real money growth separately, or only their difference — that is, the growth of velocity. An analogous forecast conditional on velocity growth (not shown in the table) results in a mean error of .37% and a root-mean-square error of 2.09%, inferior to the forecast conditional on real income growth and real money growth separately, but superior to any of the other forecasts considered.[5] In other words, imposing the restriction represented by combining real income growth and real money growth into velocity growth causes a loss of some, but far from all, of the relevant information contained in these two variables.

Before drawing any firm conclusions on the basis of the superior performance of the short-term interest rate forecast conditional on real income growth and real money growth (or, to a lesser extent, the forecast conditional on velocity growth), it is useful to learn whether the same relative success is also associated with forecasts conditional on other combinations of variables. Once again, simply trying all possible combinations of conditioning variables makes little sense. Nevertheless, two further projections of the short-term interest rate (not shown in the table) each conditional on an information set intuitively corresponding to familiar discussions about recent interest rate levels — real income growth and real credit growth, and (nominal) money growth and the deficit change — generate results that are less satisfactory than even the unconditional projection shown in column (2).

The relationship between the growth of real income and the growth of real balances does stand out, therefore, as apparently bearing a close connection to the recent experience of short-term interest rates. The information contained in these variables improves the model's short-term interest rate forecast in comparison to the corresponding unconditional forecast, in comparison to forecasts

conditional on single variables (including real income growth or real money growth separately), and in comparison to forecasts conditional on other combinations of variables.

IV. Forecasts Conditional on the Full Information Set

The results presented in Sections II and III focus on projections of the most likely post-October 1979 path for U.S. short-term interest rates which incorporate information about various other aspects of the contemporaneous macroeconomic experience. The results indicate that the unprecedented behavior of short-term rates throughout this period is consistent with some features of the recent macroeconomic experience (for example, the relationship between real balances and real income), but not with others (for example, the respective paths of money and the deficit). Column (10) of Table II shows the projection of the most likely recent short-term interest rate path which simultaneously incorporates information on the post-October 1979 behavior of all five of the system's other variables: money growth, credit growth, real income growth, price inflation, and the deficit change.

Given the recent behavior and historical correlations among all of these key macroeconomic variables, the resulting projection substantially and consistently underpredicts short-term interest rates throughout the period since October 1979. The mean error is -2.74%, with underpredictions in eleven of the fifteen quarters. (The only exceptions are 1980:3 and 1982:4-1983:2, episodes already highlighted above.) This "fully informed" projection does forecast short-term interest rates that are quite high in relation to historical experience, with a forecast mean of 8.92% versus comparable averages of 6.12% during the 1970s and 3.45% from the end of the Korean War through the 1960s. Nevertheless, the implications of the "fully informed" projection exercise is clear. The

behavior of short-term interest rates since October 1979 does not appear to be consistent with the relevant historical correlations and the recent macroeconomic experience.

V. Summary of Conclusions

Two questions motivated the analysis in this paper: Have U.S. short-term interest rates been "too high," given the relevant historical relationships connecting interest rates and other key aspects of macroeconomic activity? And if so, then why?

The analysis here gives a yes answer to the first question. An estimated model summarizing the prior experience predicts that short-term interest rates would be high on average after October 1979, but not so high as the average level actually obtained. The model's unconditional forecast underpredicts interest rates in the post-October 1979 period, and so does the corresponding forecast conditional on all five of the other variables included.

A non-structural model cannot directly answer the second question, but comparisons among the conditional forecasting exercises reported here point to the post-October 1979 relationship between the growth of real income and the growth of real money balances as closely connected to the pattern of short-term interest rates during this period. This finding is consistent with the authors' earlier conclusion, based on analysis of a small structural macroeconometric model, that the high average level of interest rates has been due to a combination of slow growth of (nominal) money supply and continuing price inflation, which together have kept real balances small in relation to prevailing levels of real economic activity.

TABLE I

ESTIMATION RESULTS FOR THE VECTOR AUTOREGRESSION

Equation	Standard Error	F-Statistics					
		F(M)	F(C)	F(D)	F(X)	F(P)	F(R)
M	.0039	6.84*	3.06**	2.75**	3.64*	1.33	1.68
C	.0024	1.33	9.87*	1.32	1.62	.45	1.76
D	8.8425	2.10***	1.21	2.19***	1.34	1.62	2.09***
X	.0067	2.87**	5.07*	1.45	1.37	4.07*	2.11***
P	.0034	1.05	1.31	.27	.97	1.63	1.19
R	.5896	2.30***	1.00	.95	.80	.17	1.61

*significant at 1% level.
**significant at 5% level.
***significant at 10% level.

Definitions of variable symbols:

M = growth rate of money (M1)
C = growth rate of total nonfinancial credit
D = change in federal budget deficit
X = growth rate of real GNP
P = rate of change of GNP deflator
R = change in 3-month Treasury bill rate

TABLE 11

ALTERNATIVE FORECASTS OF U.S. SHORT-TERM INTEREST RATES

	Actual					Forecasts Conditional on:				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
		—	M	C	D	X	P	M/P	X,M/P	M,C,D,X,P
1979:4	11.47%	10.29%	10.30%	10.94%	10.52%	10.27%	11.09%	9.64%	9.33%	9.64%
1980:1	12.04	11.18	13.32	12.64	12.76	12.28	13.21	11.96	12.22	11.40
1980:2	14.00	11.65	11.99	11.22	13.44	12.28	13.35	11.56	11.92	10.12
1980:3	8.13	10.93	11.03	12.16	14.63	12.43	13.47	11.19	11.23	8.59
1980:4	11.58	11.26	12.25	12.75	15.40	12.27	14.69	12.44	12.30	9.37
1981:1	14.72	11.30	10.17	12.24	14.29	11.98	14.49	11.23	11.62	7.82
1981:2	13.64	11.24	11.02	11.92	12.48	11.69	13.68	11.36	12.16	8.11
1981:3	14.70	11.57	10.98	11.48	12.35	12.71	13.39	12.13	13.98	7.89
1981:4	13.87	11.04	8.86	11.68	12.87	13.03	12.41	11.45	13.01	7.22
1982:1	12.41	10.72	8.03	10.21	12.28	12.73	11.20	11.14	10.98	7.54
1982:2	12.82	11.03	7.04	8.24	10.48	12.05	11.13	11.65	11.12	7.41
1982:3	11.91	10.77	5.70	7.92	10.02	12.18	10.81	11.57	10.47	8.06
1982:4	7.75	10.83	3.91	6.60	10.31	12.66	10.24	11.12	10.29	8.58
1983:1	7.81	10.94	2.50	4.71	10.92	11.99	10.13	11.71	9.96	10.05
1983:2	8.25	10.97	1.77	3.83	10.11	11.89	10.38	12.03	10.23	12.06
Mean	11.67%	11.05%	8.59%	9.87%	12.19%	12.16%	12.24%	11.48%	11.39%	8.92%
Mean Error	—	-.62	-3.08	-1.80	.52	.49	.57	-.19	-.28	-2.74
Root Mean Square Error	—	2.38	4.15	2.85	2.52	2.52	2.09	2.49	1.89	4.32

Notes: Error equals forecast minus actual.
See Table I for definitions of variable symbols.

TABLE III

SUMMARY OF FORECASTS FOR OTHER VARIABLES

	M	C	D	X	P
Actual					
1979:4-1980:3	5.45%	9.20%	$51.4b	-1.62%	8.76%
1980:4-1981:3	6.24	9.45	55.3	4.11	8.86
1981:4-1982:3	6.31	8.65	119.0	-2.66	5.47
1982:4-1983:2	9.68	7.50	195.8	2.63	3.14
Forecast					
1979:4-1980:3	6.73%	10.75%	$31.3b	.09%	9.71
1980:4-1981:3	7.43	10.18	57.3	.94	8.64
1981:4-1982:3	7.84	10.37	79.1	1.87	7.37
1982:4-1983:2	6.21	8.20	85.1	2.26	5.36

Note: See Table I for definitions of variable symbols.

Footnotes

1. The cut-off at 1976:2 represented the end of the sample used in the original presentation of the model in Friedman (1977).

2. The interest rate data are averages of daily observations for the first month of each quarter. The inflation data are contemporaneous with the interest rate data. Alternative ways of constructing the data — for example, aligning the interest rate and price change series differently, or using quarterly average interest rate observations — apparently make little difference for the results reported here.

3. The "Granger causality" from interest rates to output has been documented by Sims (1980b). "Granger causality" from credit to output is consistent with the findings of Friedman (1983).

4. The same story can be told in either real or nominal terms, of course, although the real version is presumably preferable unless the income elasticity of the demand for money is identical to the price elasticity. A forecast analogous to that reported in column (9), but conditional or nominal money and nominal income, results in mean error 1.19% and root-mean-square error 2.01%.

5. The root-mean-square error matches that of the forecast conditional on price inflation, but the mean error is smaller.

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