FEDERAL RESERVE BANK OF ST. LOUIS

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REVIEW

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Bank Financing of the Recovery

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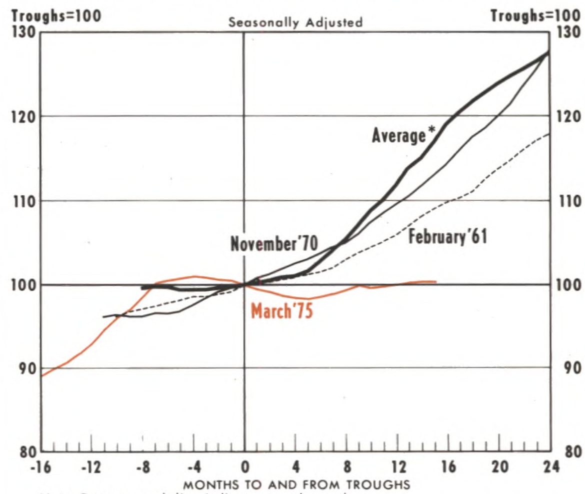
WHILE recovery periods display many common characteristics, each such period has its own unique features which distinguish it from other recoveries. A unique feature of the current recovery period is the lack of growth of bank loans. In previous recoveries, total loans of commercial banks have increased soon after recession troughs; in the current recovery period, total loans have remained essentially unchanged since the March 1975 trough in economic activity.

Even more uncharacteristic of previous recovery periods is the pattern of business loans at commercial banks. In contrast to the *increases* posted in previous recoveries, commercial bank business loans have *declined* in the current recovery. Since March of last year, business loans at commercial banks have declined at a 5 percent annual rate, compared to a 5.5 percent rate of increase for comparable phases of previous recoveries. In addition, the rate of decline in business lending by the larger commercial banks has been more rapid than for the rest of the banking system; since March of last year commercial and industrial loans of weekly reporting banks have declined at a 9.5 percent annual rate.

This pattern of bank lending raises some important questions for public policy. Have banks become more conservative in their lending practices than in the past? Is the relative lack of bank financing likely to hamper continued economic recovery? Have businesses developed alternative sources of credit? How have these developments influenced the ability of the U.S. Treasury to finance large deficits without causing substantial upward pressure on short-term interest rates?

Chart I

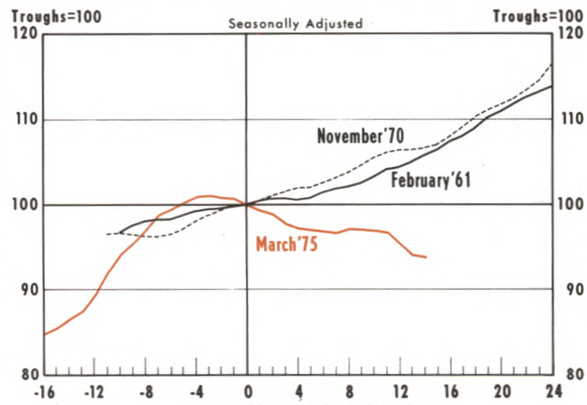
Total Loans by All Commercial Banks



Note: Date on each line indicates trough month.
*Average of 3 previous recession/recovery periods with troughs in October 1949, May 1954, and April 1958.

Chart II

Business Loans by All Commercial Banks



Note: Date on each line indicates trough month.

HAVE BANKS BECOME MORE CONSERVATIVE?

Table I

LOSS RATIOS OF ALL COMMERCIAL BANKS
(thousands of dollars)

	Net Total Losses[1]	Percent of Total Assets[2]	Net Loan Losses[3]	Percent of Total Assets[2]
1948	$ 46,450	.0304	$ 35,643	.0233
1949	56,837	.0374	53,333	.0350
1950	36,985	.0238	34,226	.0220
1951	51,620	.0309	36,258	.0217
1952	54,342	.0306	33,099	.0187
1953	91,822	.0492	55,574	.0298
1954	61,798	.0323	49,111	.0257
1955	113,617	.0566	48,623	.0242
1956	172,985	.0827	80,812	.0386
1957	138,996	.0643	67,113	.0310
1958	67,773	.0306	58,442	.0264
1959	250,001	.1053	48,525	.0204
1960	225,595	.0927	196,173	.0806
1961	188,208	.0734	175,656	.0685
1962	165,553	.0597	153,962	.0555
1963	237,676	.0803	226,578	.0766
1964	275,558	.0884	236,390	.0758
1965	327,031	.0948	305,428	.0885
1966	458,770	.1222	401,788	.1070
1967	455,948	.1132	432,514	.1073
1968	440,941	.0978	410,592	.0911
1969	499,212	.0988	488,750	.0967
1970	983,259	.1853	981,638	.1850
1971	1,088,661	.1889	1,087,200	.1886
1972	885,416	.1384	887,326	.1387
1973	1,162,566	.1576	1,159,187	.1571
1974	1,958,400	.2352	1,956,931	.2350
1975	3,244,828	.3556	3,242,830	.3554

[1]Losses on loans and securities less recoveries on loans and securities.
[2]Total assets for each year measured as of the end of the prior year. Assets in December 1968 and prior years include "other loans and discounts" at gross (before deduction of valuation reserves) value, as reported in 1969 and 1970. "Other loans and discounts" in 1948-1968 exclude Federal funds sold, now reported separately. Source: FDIC Annual Reports.
[3]Losses on loans less recoveries on loans.

Several events of the past two years would tend to make banks more conservative. Banks have sustained unusually large losses in the past two years, particularly on loans (see Table I for some historical comparisons). The Securities and Exchange Commission and the Federal bank regulatory agencies have been requiring banks to disclose more information on the risks they assume, and the press has published lists of "problem banks." In addition, bank regulators have been trying during recent years to get banks to increase their capital ratios, particularly the ratio of capital to riskier bank assets.[1]

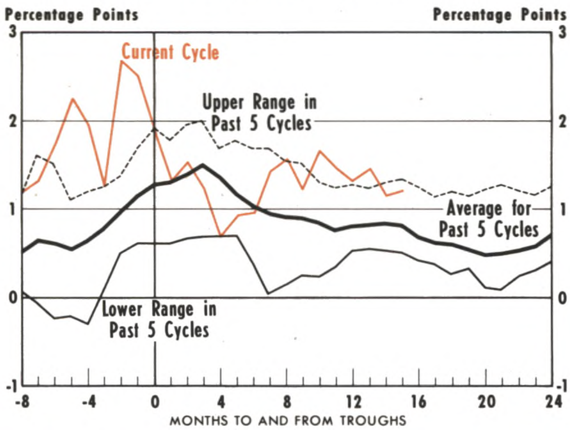
The "banks have become more conservative" explanation of recent bank lending behavior is supported by several empirical observations. For one, banks have not reduced their loans to businesses because of a lack of available reserves. Bank loans plus investments have risen at a 5.1 percent annual rate since March of last year, but almost all of this increase in earning assets has gone to investments, especially Federal Government debt. Investments as a percentage of the interest-earning assets of banks rose from 27 percent in the last quarter of 1974 (the low point for this ratio in recent years) to 32 percent in June of this year. This ratio rose to 34 percent in mid-1971 and declined steadily thereafter until early 1975.

As another possible indication of conservative behavior, banks have kept their announced prime lending rates high relative to the four- to six-month prime commercial paper rate — an alternative borrowing rate for larger firms. Since March of last year the differential between the prime rate and the commercial paper rate has averaged 1.4 percentage points, whereas that differential averaged 0.5 percentage point during 1971-74. Chart III compares the pattern of the differential between the prime rate and the commercial paper rate in the current recovery to the average differential and the range of that differential in comparable phases of four previous recoveries.[2] Since last fall, the interest rate differential has been above the average differential for comparable periods of prior recoveries. In addition, for most of the period since early this year the interest rate differential has been greater than that posted for comparable periods of each of the five prior recoveries. The relatively

[1]One of the major methods bank regulators have been using to induce banks to reduce their exposure to risk of failure is to deny applications by the most highly leveraged and poorly managed banking organizations to engage in new activities. For examples of such actions by the Federal Reserve Board, see discussions of cases in the following issues of the Federal Reserve *Bulletin*: June 1974, pp. 458-59; October 1974, pp. 731-32; November 1974, pp. 791-93; December 1974, pp. 864-65.

[2]This interest rate differential tends to have a cyclical pattern which, therefore, must be compared to its value in previous recession/recovery periods to determine whether it has been unusually large during recent months. See Richard T. Selden, *Trends and Cycles in the Commercial Paper Market* (New York: National Bureau of Economic Research, 1963), pp. 72-82.

Chart III
Differential Between the Commercial Bank Prime Lending Rate and the 4- to 6-Month Prime Commercial Paper Rate in Current and Past Cycles



high prime rate is an apparent indication of reluctance by banks to expand their lending to businesses.

WEAKNESSES OF THE CONSERVATIVE-BANKER EXPLANATION

Some Categories of Loans Increase

An indication that banks have not been unusually conservative in their lending practices in recent months is that, while business loans have declined, banks have increased their real estate and consumer loans. Mortgage debt held by all commercial banks rose 4.2 percent from the first quarter of 1975 to the first quarter of 1976. Consumer installment loans of all commercial banks began to increase after May of last year, rising at a 4 percent annual rate from May 1975 to April 1976.[3] The patterns of change in real estate loans and consumer installment loans have been somewhat different at the larger commercial banks. Real estate loans of weekly reporting large commercial banks remained essentially unchanged during the year ending in March of this year, but have increased at a 9.8 percent annual rate in the last three months. Their consumer installment loans began rising after June of last year, increasing 7.9 percent from June of last year to June of this year.

A large share of bank loan losses in the past two years has been in real estate loans. A survey conducted early this year indicates that the loans which banks expect to declare as losses this year are primarily real estate loans.[4] Also, loss ratios tend to be higher on consumer lending than on lending to business. Therefore, these increases in real estate and consumer loans indicate that risk reduction has not become a dominant objective of commercial bank lending policies.

Decline In Demand for Business Credit

Even though the commercial bank prime rate has been unusually high in relation to the commercial paper rate during the current recovery, there has not been a large-scale shift in credit demand by business firms from commercial banks to the commercial paper market. Commercial paper volume moved in its typical counter-cyclical pattern during the recent recession/recovery period, rising during the recession and declining for several months after the recession trough.[5] From March 1975 to May 1976, the volume of commercial paper declined at a 2 percent annual rate.

Since borrowing from commercial banks and borrowing in the commercial paper market are primary sources of short-term credit for many large businesses, the sum of these two sources can be used as a measure of the demand for short-term business credit. If the decline in business loans by banks during the current recovery was just due to banks keeping their interest rates on loans uncompetitive with the commercial paper rate, the sum of business loans plus commercial paper volume would have tended to follow the usual recovery pattern. During previous recovery periods the sum of commercial bank loans to business plus commercial paper volume has risen a few months after recession troughs, whereas in the current recovery this measure of credit demand has declined (see Chart IV).

The Changing Role of the Prime Rate

Several recent news stories mention that banks have been offering loans below the stated prime rate to a greater extent during recent months than in the past. In addition, banks have been relaxing other terms of lending, such as compensating balance requirements.[6] These stories about more bank loans at rates below

[3]Consumer installment loans outstanding tend to begin rising about two months after the rate of economic activity begins to rise. See Philip A. Klein, *The Cyclical Timing of Consumer Credit, 1920-67,* Occasional Paper 113, National Bureau of Economic Research, 1971, p. 28.

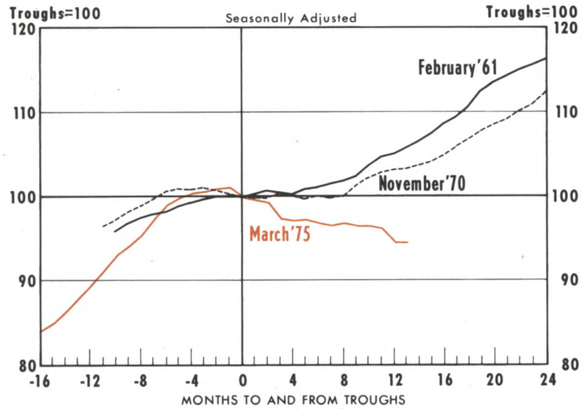
[4]*Wall Street Journal,* May 14, 1976, p. 10.

[5]Selden, *Trends and Cycles in the Commercial Paper Market,* pp. 72-74.

[6]*American Banker,* May 5, 1976, p. 1; *Business Week,* May 24, 1976, pp. 33-34.

Chart IV

Business Loans by All Commercial Banks Plus Commercial Paper Volume



Note: Date on each line indicates trough month.

the prime rate are confirmed by surveys of interest rates on short-term business loans at a sample of large commercial banks. Table II presents the percentage of loans made at and below the prime rate for selected survey periods.[7] The percentage of loans at interest rates below the prime rate increased in February and May of this year, although there was no marked rise in the percentage of loans made "at and below" the prime rate. The rise in the percentage of loans made at rates below prime was confined to loans of $1 million and over. These observations raise doubts about the reliability of the difference between the commercial bank prime lending rate and the commercial paper rate as an indicator of conservative lending policies by banks.

Incentives for maintaining the stated prime rate high relative to alternative interest rates and making loans at less than the prime rate, as in the current recovery period, may be the result of banks having made business loans at interest rates that float with the prime rate. This policy has become widespread throughout the banking industry in recent years.[8] By making loans with floating rates, banks have forgone the windfall gains they formerly received during periods of interest rate declines, but have reduced the risks of engaging in liability management during periods of widely fluctuating interest rates.

If interest rates on a bank's outstanding loans are not affected by prime rate changes, the bank's interest income on such loans will not be affected when the prime rate is adjusted. However, if banks make floating rate loans, a change in the prime rate does affect the interest income on outstanding loans as well as the volume of new loans attracted.

During the recent period of declining business demand for short-term credit, banks with floating interest rates on their outstanding loans have had incentives to keep their stated prime rates high and earn relatively high income on outstanding business loans until they are paid off. However, given the relatively large differential between the stated prime rate and other short-term interest rates, banks have had strong incentives to offer credit at less than the prime rate to firms which can also borrow in the commercial paper market, disregarding the conventional banking practice of using the prime rate as the minimum loan rate.[9] As noted above the increase in loans at interest rates below the prime rate since last year has been primarily loans of $1 million or more, which would be largely to firms that could also borrow in the commercial paper market.

EXPLANATIONS OF THE DECLINE IN BUSINESS LOANS

Discarding the argument that banks have become more conservative, two reasons appear to explain the lack of bank financing in the current recovery:

(a) Businesses continued to reduce their inventories by large amounts and for an unusually long period of time into the current recovery.

(b) The volume of funds that business firms generate internally has increased even more rapidly during recent quarters than during previous recovery periods, reducing the external financing requirements of businesses. Banks have responded to the decline in business credit demand by significantly expanding their holdings of investments and increasing their loans in sectors of the economy in which demand for bank financing has been rising (including real estate and consumer loans) with the pace of economic activity.

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[7]In the sample, banks report the dollar amount and interest rate of each business loan $1,000 and over made during the first seven business days of February, May, August and November of each year. The date each loan was made is not reported. The prime rate has changed during several of these survey periods in recent years, creating difficulty in determining which loans were made at the prevailing prime rate. Observations in Table II are from surveys conducted during periods when the prime rate did not change.

[8]Richard B. Miller, "Everybody's Floating the Loan Rate," *The Bankers Magazine* (Spring 1975), pp. 42-45.

[9]For an analysis of the role of the prime rate before floating rates became so common, see Donald Hodgman, *Commercial Bank Loan and Investment Policy* (Champaign, Illinois: University of Illinois, 1963).

Table II

PERCENTAGE OF BUSINESS LOANS AT AND BELOW THE PRIME RATE

Percentage Distribution of Dollar Amount by Size of Loan and Interest Rate

(thousands of dollars)

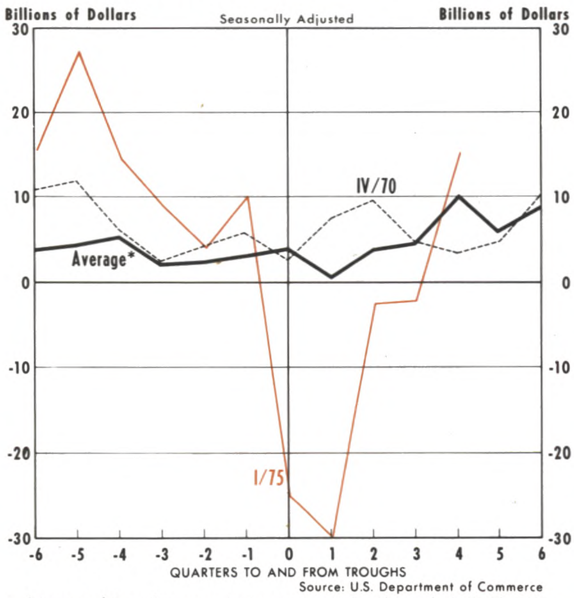
Month of Survey	Prime Rate		All Sizes	$1 - $10	$10 - $100	$100 - $500	$500 - $1,000	$1,000 and over
May 1976	6.75%	below 6.75	13.9%	2.2%	0.9%	1.5%	2.4%	18.7%
		at and below 6.75	46.8	3.7	5.7	20.2	36.2	56.6
Feb. 1976	6.75	below 6.75	8.7	1.8	0.5	1.1	1.8	12.0
		at and below 6.75	38.0	3.1	5.0	18.4	29.8	46.4
Aug. 1975	7.50	below 7.50	4.3	3.4	1.3	3.1	3.4	4.9
		at and below 7.50	39.3	5.5	6.7	21.9	32.1	46.7
May 1975	7.50	below 7.50	6.8	3.9	1.3	2.3	4.6	8.4
		at and below 7.50	46.1	5.4	6.4	22.0	35.9	55.6
Aug. 1974	12.00	below 12.00	5.2	49.4	30.0	11.8	5.9	2.6
		at and below 12.00	63.1	55.8	42.7	38.9	49.8	70.1

Reduction in Inventories

Changes in business inventories during the first four postwar business cycles were similar in amount and timing; the average changes in inventories during those recession/recovery periods are shown in Chart V. The 1970 recession was rather mild compared to other postwar recessions; firms were not induced to reduce inventories, but merely to reduce the rate of accumulation for one quarter. In contrast, inventory reductions beginning in late 1974 were unusually large and have continued for an unusually long period of time into the current recovery. Businesses finally began to increase their inventories in the first quarter of this year.

Chart V

Change in Business Inventories



Source: U.S. Department of Commerce

*Average of 4 previous recession/recovery periods with troughs in IV/49, II/54, II/58, and I/61.

The unusually rapid accumulation of inventories during 1973 and much of 1974 was partially a reaction to shortages of various materials and products caused by wage and price controls and the real and expected effects of the reduction in the supply of energy. Also rapid price increases in late 1973 through the first three quarters of 1974 induced speculation on the prospects of inventory profits. The depth of the recession in 1974-75 reduced the prospects of inventory profits and gave businesses incentives for the rapid liquidation of inventories beginning late that year as inventories became excessive in relation to sales.

Statistical studies of the determinants of bank loans indicate that changes in business inventories have been primary determinants of changes in bank loans to businesses.[10] Therefore, the large inventory reduc-

[10]Stephen M. Goldfeld, *Commercial Bank Behavior and Economic Activity* (Amsterdam: North Holland Publishing Co., 1966), pp. 82-86, 162; and Patric H. Hendershott, "Recent Development of the Financial Sector of Econometric Models," *Journal of Finance* (March 1968), pp. 57-58, 62-65.

Table III

SELECTED SERIES FROM THE FLOW OF FUNDS ACCOUNTS FOR NONFINANCIAL CORPORATE BUSINESS
(billions of dollars; seasonally adjusted annual rates)

	1973				1974				1975				1976[1]
	I	II	III	IV	I	II	III	IV	I	II	III	IV	I
Profits Before Tax	94.2	98.1	94.9	93.5	100.8	109.6	126.8	100.2	72.7	86.4	108.1	108.9	114.2
Gross Internal Funds	83.7	83.6	84.8	86.3	85.3	80.5	75.3	84.8	85.9	103.0	113.7	112.8	120.0
Fixed Investment	104.1	107.6	110.9	112.0	112.3	118.0	116.3	113.3	110.6	107.8	110.9	115.8	119.7
Net Funds Raised In Financial Markets	73.9	70.7	66.1	57.9	75.4	91.6	72.8	68.7	30.9	36.4	31.5	44.7	32.3
Net New Equity Issues	7.0	8.7	5.1	8.9	6.2	5.0	0	5.2	7.7	12.9	6.9	12.2	7.2
Corporate Bonds	9.2	11.9	12.5	10.3	18.8	20.7	18.0	27.9	41.9	33.7	17.0	26.7	19.7
Corporate Mortgages	15.1	18.4	17.7	13.3	12.6	17.4	7.3	6.3	6.6	9.2	11.1	13.6	12.0

[1]Data for I/76 are incomplete and preliminary.

tions during the current recovery period can be considered a major cause of the declines in bank loans to businesses.

Increase in Internally Generated Funds

Table III presents several series from the flow-of-funds accounts for the nonfinancial corporate sector in recent years. The series "Gross Internal Funds" measures retained earnings of nonfinancial corporations plus their capital consumption allowances, with some adjustments for foreign profits and changes in the value of inventories. The larger the increase in gross internal funds, the smaller the external financing requirements of firms tend to be, other things equal.

Gross internal funds increased 40 percent from the first quarter of 1975 to the first quarter of this year. This was a more rapid rate of increase than in the first year of each of the four previous recoveries. This relatively rapid expansion was due to a sharp acceleration in pre-tax corporate profits, which rose 57 percent from the first quarter of 1975 to the first quarter of 1976.

Lengthening the Maturities of Business Liabilites

From the fourth quarter of 1974 to the first quarter of 1976, net funds raised in financial markets by nonfinancial corporations increased $41.6 billion. Funds raised from long-term sources (issuing equities, bonds, and mortgages) increased $57.1 billion, and short-term liabilities that had been incurred in financial markets were reduced by $15.5 billion.[11] Since fixed investment by corporations during the current recovery has been about equal to their internally generated funds (see Table III), the increase in funds from long-term sources has not been used to finance increases in long-term assets; instead, such funds have been used to replace short-term debt in corporate balance sheets. This shift to long-term financing is largely a response to regular cyclical forces and the unusually large changes in business inventories discussed above.

As indicated in Chart VI the ratio of long-term funds raised by nonfinancial corporations to net total funds raised has increased during recession periods and remained relatively high for a few quarters after recession troughs. This pattern can be attributed to both a cyclical response in the allocation of business investment between inventories and fixed investment and to cyclical movements in the demand for financial credit and demand for equities.

Business firms tend to finance inventories from short-term borrowing and fixed investment from long-term borrowing, thereby attempting to match the length of time over which assets are held with the maturities of funds raised. Corporate fixed investment and inventory investment move pro-cyclically, with inventory investment more sensitive to reductions in aggregate demand. As discussed above, business firms do not begin rapid inventory accumulation until a few quarters after recession troughs. These cyclical patterns of fixed investment and inventory investment help explain the cyclical pattern of financing illustrated in Chart VI.

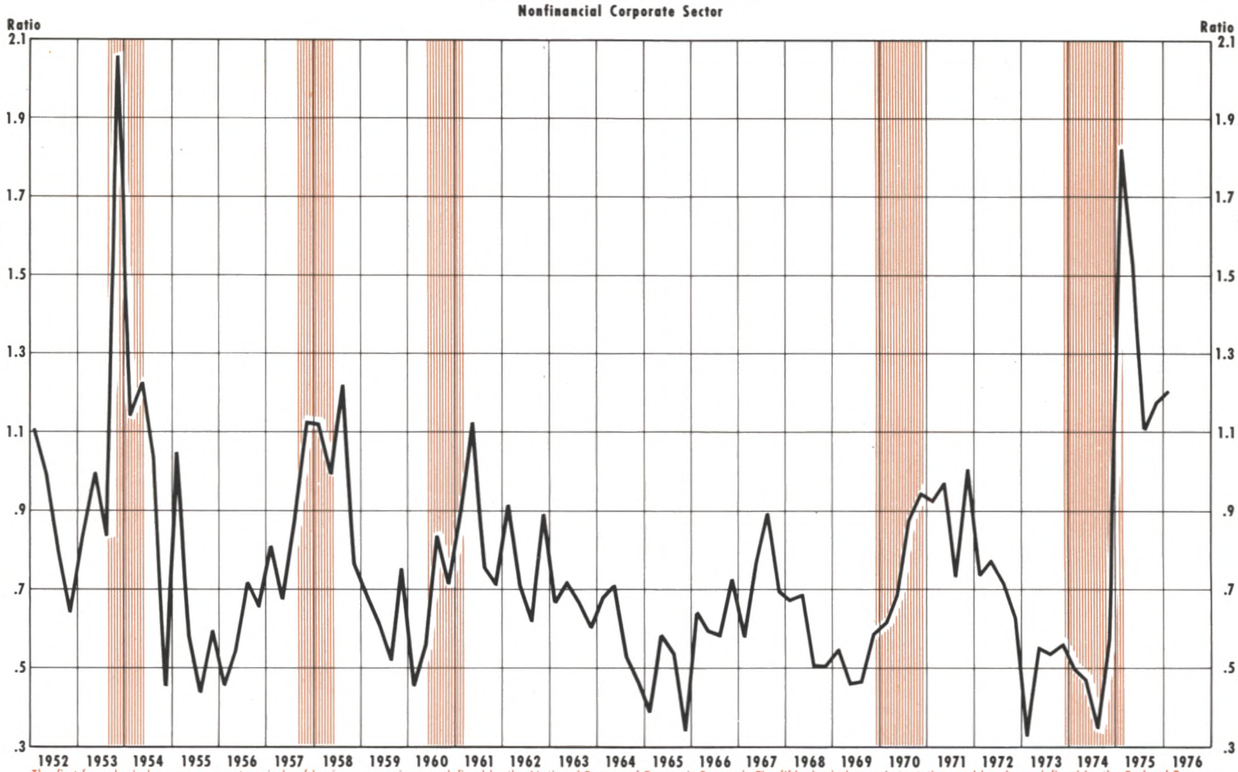
Total demand for credit in the economy tends to decline during recessions and rise as economic activity increases. Total net funds raised by nonfinancial corporations also move procyclically, but funds raised

[11]These data were calculated by accumulating seasonally unadjusted quarterly changes in funds raised. Note that data in Table III are at seasonally adjusted annual rates.

Chart VI

Ratio of Funds Raised from Long-Term Sources to Total Net Funds Raised*

Nonfinancial Corporate Sector



The first four shaded areas represent periods of business recessions as defined by the National Bureau of Economic Research. The fifth shaded area is tentative, and has been defined by the Federal Reserve Bank of St. Louis.

*Long-term sources of funds are equity issues, bonds, and mortgages.

Latest data plotted: 1st quarter

by nonfinancial corporations from issuing bonds and equity securities have different cyclical patterns.

The procyclical pattern of total credit demand tends to cause interest rates to move procyclically, including interest rates on long-term debt instruments. Business requirements for funds from long-term sources rise when economic activity is expanding and businesses are increasing their capital investments. Therefore, given the tendency for long-term interest rates to be lower during recessions than during the following periods of economic recovery, there is some incentive for businesses to do their long-term financing during recessions in anticipation of future increases in capital investment.

Changes in corporate debt over business cycles reflect such a financing strategy. Corporate bonds outstanding have increased more rapidly during the past five recessions than in periods just prior to those recessions, even though *total* net funds raised by nonfinancial corporations declined during those recession periods.[12] Although long-term credit demanded by corporations increases during recession periods, the *net* effect of corporate credit demand, reduction in demand for credit by other sectors, and possible shifts in supply of credit due to reduced inflationary anticipations create a tendency for long-term interest rates to decline during recessions. One study traces this cyclical pattern of corporate financing back to 1900.[13]

Typically, stock prices begin to rise a few months before recession troughs, as investors anticipate coming recoveries and corresponding rises in business profits. Rising stock prices, in turn, increase the

[12]These past five recessions include the most recent one ending around March 1975. The phase of the recent recession that was due to a decline in aggregate demand began in the fall of 1974, and that period is used as the cycle peak for purposes of examining the influences of declining aggregate demand on long-term interest rates and long-term borrowings by corporations. For an analysis of causes for the most recent recession, see Norman N. Bowsher, "Two Stages of the Current Recession," this *Review* (June 1975), pp. 2-8.

[13]W. Braddock Hickman, *The Volume of Corporate Bond Financing Since 1900* (New York: National Bureau of Economic Research, 1953), pp. 132-179.

attractiveness to businesses of raising funds by issuing equity securities. During postwar business cycles equity issues by nonfinancial corporations have increased substantially during trough quarters and the first few quarters of recovery.

Corporate financing patterns during the recent recession and current recovery appear to reflect the usual cyclical influences plus that of the unusually large swings in inventory investment and liquidation. There may have been a more permanent shift in business preferences for more long-term financing, but not enough time has elapsed since the recent recession to distinguish such an influence from the cyclical tendencies in corporate finance.

IMPLICATIONS FOR FINANCING FEDERAL BUDGET DEFICITS

Commercial banks increased their holdings of Federal Government debt at a 57 percent annual rate from January 1975 to March 1976, largely in response to the decline in demand for bank loans by business firms. This reduction in demand for short-term credit by businesses is one development which has made it possible for the Treasury to finance large budget deficits in 1975 and into 1976 without having put substantial upward pressure on short-term interest rates.

Business demand for short-term credit is likely to increase in the near future, as the incentives for inventory investment increase along with the general economic expansion. Corporate cash flow is likely to increase less rapidly in the future since corporate profits tend to rise less rapidly after the first year of an economic recovery. The shift in corporate financing to long-term sources during the recent recession and current recovery appears to be largely a cyclical phenomenon. As business demand for short-term credit increases, the Federal Government will not be able to continue financing large budget deficits without putting some upward pressures on short-term rates.

An Explanation of Movements In Short-Term Interest Rates

ALBERT E. BURGER

VIRTUALLY all central banks are concerned about movements in interest rates since, rightly or wrongly, the public usually regards the central bank as being responsible for such movements. An influential body of economic analysis also assigns considerable importance to the effects of movements in interest rates on economic activity. In addition, central banks have traditionally been concerned with the stability or viability of financial markets, where such stability and viability is usually viewed as being endangered by substantial fluctuations of interest rates. Consequently, in their policy deliberations the monetary authorities tend to give considerable weight to the possible impacts of their policy actions on interest rates.

It is important, therefore, to investigate the process by which interest rates are determined. This article is a modest step in that direction as it illustrates the manner in which a proposed explanation (hypothesis) of the movements in the short-term interest rate can be designed and tested. *The purpose is not to develop a forecasting equation for the short-term interest rate,* but to understand the process whereby interest rates are generated. The influence of key policy-determined variables, such as the growth rate of the monetary base and the money supply, are incorporated into the hypothesis.

A basic tenet of scientific investigation is that it is never proven that an hypothesis describes the one and only true world. Every hypothesis, if it is of any scientific value, must be formulated in such a manner that it can be falsified by some set of observations. The more easily it can be falsified, the better the design of the hypothesis. Therefore, the result of any such process should be considered only tentative and subject to further testing. If the logical consequences of an hypothesis are not in agreement with the data, then it is back to the drawing board. Such a situation could result for any number of reasons, all of which must be carefully studied. If the hypothesis is not rejected, we have not found the truth, but instead have taken just a very tentative step in our understanding of some economic process. Given this *caveat emptor*, we now proceed with the formal derivation and testing of an hypothesis designed to explain the month-to-month movements in the short-term interest rate.

The first step in the design and testing of the hypothesis is to present a model of the market for short-term credit with specified constraints on the parameters of the model. The next step is to specify the observable data used to represent such general terms as "the state of economic activity," the "growth rate of money," "growth of prices," etc. The conjunction of the model, the constraints, and the specification of the empirical counterpart of the terms appearing in the model represent the hypothesis.

A reduced-form expression for the short-term interest rate is constructed and, using the restrictions on the structural parameters, test statements are derived. These test statements are then confronted with empirical observations to determine whether they are in "good agreement" with historical observations. After testing the hypothesis, a dynamic simulation of the short-term interest rate is performed using the reduced-form model for the interest rate.

THE MODEL AND ITS EMPIRICAL SPECIFICATIONS

An algebraic formulation of the hypothesis is presented in Exhibit I. In the short-term credit market model, the demand for and supply of credit are divided into two parts — the private sector (equations 1 and 2) and the Government sector (equations 5 and 6). The private sector demand (D^p) and supply (S^p) of credit are influenced by such factors as the prevailing interest rate (i), the expected interest rate (i^e), the expected rate of change of prices ($\dot{P}^e$), and the growth rate of the monetary base ($\dot{B}$). The expected rate of change of prices is postulated to depend upon the prevailing long-run growth rate of money ($\dot{M}$), recent changes in prices ($\dot{P}$), and the

Exhibit I

ALGEBRAIC FORMULATION OF THE HYPOTHESIS

Market for Short-Term Credit

(1) private sector demand for credit:
$$D^p = a_0 + a_1 i + a_2 i^e + a_3 \dot{P}^e$$
(2) private sector supply of credit:
$$S^p = b_0 + b_1 i + b_2 i^e + b_3 \dot{P}^e + b_4 \dot{B}$$
(3) formation of interest rate expectations:
$$i^e = c_0 + c_1 i_{t-1} + c_2 i_{t-2}$$
(4) formation of price expectations:
$$\dot{P}^e = d_1 \dot{P} + d_2 \dot{M} + d_3 U + v_t$$
(5) Government demand for credit: $D^G = e_0 + e_1 U$

(6) Government supply of credit: $S^G = f_0 + f_1 U$

(7) total demand for credit: $D = D^p + D^G$

(8) total supply of credit: $S = S^p + S^G$

(9) equilibrium condition: $D = S$

where:

i = short-term interest rate

i^e = expected short-term interest rate

$\dot{B}$ = short-run rate of growth of the monetary base

$\dot{P}^e$ = expected rate of change of prices

$\dot{P}$ = lagged actual rate of change of prices

U = state of economic activity

$\dot{M}$ = lagged long-run growth rate of money

v_t = random variable

Constraints

(10) $a_1 < 0$	(21) $d_2 > 0$
(11) $a_2 > 0$	(22) $d_3 < 0$
(12) $a_3 > 0$	(23) $e_1 > 0$
(13) $b_1 > 0$	(24) $f_1 < 0$
(14) $b_2 < 0$	(25) $\lvert a_3 d_3 \rvert > \lvert f_1 - e_1 \rvert$
(15) $b_3 < 0$	(26) $d_2 > d_1$
(16) $b_4 > 0$	(27) $\lvert d_1 \rvert > \lvert d_3 \rvert$
(17) $c_1 > 0$	(28) $\lvert d_2 \rvert > \lvert d_3 \rvert$
(18) $c_1 + c_2 > 0$	(29) $1 - c_1 - c_2 > 0$
(19) $c_1 > c_2$	(30) $1 + c_2 > 0$
(20) $d_1 > 0$	(31) $1 + c_1 - c_2 > 0$

Reduced Form for Interest Rate

$$(32)\quad i_t = A_0 + A_1 i_{t-1} + A_2 i_{t-2} + A_3 \dot{P} + A_4 \dot{M} + A_5 U + A_6 \dot{B} + \varepsilon_t$$

Test Statements for the Hypothesis

(33) $A_1 > 0$	(38) $A_5 < 0$
(34) $A_1 + A_2 > 0$	(39) $A_6 < 0$
(35) $A_1 - A_2 > 0$	(40) $A_4 - A_3 > 0$
(36) $A_3 > 0$	(41) $A_3 + A_5 > 0$
(37) $A_4 > 0$	(42) $A_4 + A_5 > 0$

current state of economic activity (U). Equation (4) essentially states that expectations about future movements in prices depend not only upon the past rate of change of prices, but also upon information about the long-run growth rate of money and the current state of economic activity. Price expectations are also hypothesized to depend upon certain random shocks that are represented by the term v_t which appears in equation (4).

The expected interest rate (i^e) is stated to depend upon past values of the interest rate (equation 3). Current-month decisions to supply or demand credit are hypothesized to depend, among other things, upon the level of the short-term interest rate in the two previous months. The supply of credit is also stated to depend upon the growth of a liquidity variable, in this model represented by the growth of the monetary base.

The Government sector's demand for and supply of credit are specified as dependent upon the state of economic activity. Observation of the behavior of the Government sector suggests that its demand for credit also depends upon such things as its commitment to financing social programs, military developments in the world, and changes in tax laws. The hypothesis presented in this paper does not explicitly take these factors into account, but allows them to affect the intercept term that appears in the equation for the Government sector's demand for credit. Further development of the hypothesis might explicitly include these factors. However, primarily due to the difficulty of finding empirical counterparts to these concepts on a monthly basis, they were not explicitly taken into account.

Constraints on the Variables

The lower portion of Exhibit I presents a listing of the hypothesized constraints on the structural parameters of the model used to represent the short-term credit market. These constraints state that the private sector's demand for credit (D^p) depends positively upon the expected short-term interest rate (i^e) and the expected rate of change of prices ($\dot{P}^e$), and negatively upon the current short-term interest rate (i). The private sector's supply of credit (S^p) depends positively on the rate of growth of the monetary base ($\dot{B}$) and the current interest rate, and negatively on the expected rate of change of prices and the expected interest rate. The expected interest rate is postulated to depend positively upon past values of the interest rate. A series of past increases in the interest rate is hypothesized to generate expectations of still further upward movements in interest rates, thereby decreasing the amount of credit supplied at the current interest rate and increasing the quantity demanded at the current interest rate.

Price expectations are hypothesized to depend positively on recent changes in prices and the long-run growth rate of money, and negatively on the state of economic activity. For example, if prices have been rising rapidly in the current period, but the long-run trend growth of money has fallen and unemployment has risen, then the hypothesis implies that investors will not fully extrapolate into the future the current rapid growth of prices, but will modify their price expectations based on these latter two factors.

The Government sector's demand for credit is specified to depend positively, and the Government sector's supply of credit to depend negatively, upon the state of economic activity. For example, as the state of economic activity deteriorates, the expenditures of Government trust funds rise faster than their receipts and, hence, they reduce their purchases of Government securities.

As a further restriction upon the parameters of the model it is assumed that:

$$(25)\ |a_3 d_3| > |f_1 - e_1|$$

This assumption essentially states that the response of private demands for credit to changes in the state of economic activity are larger than the net Government reaction.

Furthermore, it is hypothesized that a one percentage point change in the long-run growth rate of money has a greater impact on the expected rate of inflation ($\dot{P}^e$) than does a one percentage point increase in the rate of change of prices ($\dot{P}$):

$$(26)\ d_2 > d_1$$

It is also hypothesized that a one percentage point change in the rate of change of prices has more of an effect on price expectations than does a one percentage point change in the state of economic activity (U):

$$(27)\ |d_1| > |d_3|$$

In addition, it is hypothesized that a one percentage point change in the long-run growth rate of money has more of an influence on the expected rate of inflation than does a one percentage point change in the state of economic activity:

$$(28)\ |d_2| > |d_3|$$

The specification of the signs and relative size of the coefficients on the structural parameters of the model is part of the hypothesis to be tested.

Stability Conditions

The equation for the expected interest rate may be rewritten as

$$i^e - c_1 i_{t-1} - c_2 i_{t-2} = c_0,$$

a second order difference equation. Hence, the necessary and sufficient conditions for the stability of the equilibrium value of i and the condition $i^e = i$ requires further restrictions on admissable values for c_1 and c_2:[1]

$$(29)\ 1 - c_1 - c_2 > 0$$

$$(30)\ 1 + c_2 > 0$$

$$(31)\ 1 + c_1 - c_2 > 0$$

Reduced Form for the Short-Term Interest Rate

Using the equilibrium condition that total demand for credit equals total supply (D = S) and substituting equations (3) and (4) into (1) and (2), the following reduced-form expression for the short-term interest rate is derived:

$$(32)\ i_t = A_o + A_1 i_{t-1} + A_2 i_{t-2} + A_3 \dot{P} + A_4 \dot{M} + A_5 U + A_6 \dot{B} + \varepsilon_t$$

where:
$$A_o = \frac{c_o(b_2 - a_2) + (b_o - a_o) + (f_o - e_o)}{a_1 - b_1}$$

$$A_1 = \frac{c_1 (b_2 - a_2)}{a_1 - b_1}$$

$$A_2 = \frac{c_2 (b_2 - a_2)}{a_1 - b_1}$$

$$A_3 = \frac{d_1 (b_3 - a_3)}{a_1 - b_1}$$

$$A_4 = \frac{d_2 (b_3 - a_3)}{a_1 - b_1}$$

$$A_5 = \frac{d_3 (b_3 - a_3)}{a_1 - b_1} + \frac{f_1 - e_1}{a_1 - b_1}$$

$$A_6 = \frac{b_4}{a_1 - b_1}$$

$$\varepsilon_t = \left[\frac{b_3 - a_3}{a_1 - b_1}\right] v_t$$

Specification of Test Statements

The constraints (10) - (31) that were placed on the parameters of the credit market model logically imply signs and ordering relationships for the co-

[1]For a discussion of necessary and sufficient conditions for stability of a second order difference equation, see Samuel Goldberg, *Introduction to Difference Equations* (New York: John Wiley & Sons, Inc., 1958), pp. 169-72.

efficients of the reduced-form equation for the short-term interest rate. From the statement of the reduced form in equation (32) and from the set of conditions (10) - (31), the test statements numbered (33) - (42) are derived (Exhibit I). These test statements are used to test the hypothesis. The derivation of these test statements is shown in the Appendix to this article.

ESTIMATION OF THE REDUCED-FORM EQUATION: 1963-72

The reduced-form equation (32) was estimated by ordinary least squares using monthly data. All data are seasonally adjusted, except the interest rate. The data that were used were those available at the end of May 1976.

The yield on prime four-to-six-month commercial paper is used as the measure of the short-term interest rate (i). It should be emphasized, however, that the purpose of this paper is not to build a model of the commercial paper market. The four-to-six-month commercial paper rate is taken as a proxy for the movement of all short-term interest rates. The unemployment rate is used as a proxy for the state of economic activity (U). The money stock is represented by the amount of demand deposits and currency. The long-run growth rate of money ($\dot{M}$) is represented by the annual rate of growth of money over the last 36 months. Prices are measured by the consumer price index. The rate of growth of prices ($\dot{P}$) is measured as the annual rate of growth of the consumer price index over the previous six months. The monetary base is represented by the series published by the Federal Reserve Bank of St. Louis. The variable $\dot{B}$ is measured as the annual rate of change of the monetary base over the prior three months.[2]

The growth rates of the consumer price index and the money stock are lagged one period, based on the presumption that these are the data that credit market participants would have available in each period. Since the unemployment rate is taken as a general proxy for the state of economic activity, it is not lagged.

Equation (32) was first estimated over the 120 monthly observations from January 1963 through December 1972. The results are as follows, where the numbers in parentheses are t-statistics:

$$(43)\quad \underset{}{i_t} = \underset{(4.60)}{.781} + \underset{(16.90)}{1.348}\, i_{t-1} - \underset{(-6.94)}{.500}\, i_{t-2} + \underset{(2.03)}{.060}\, \dot{P} + \underset{(2.28)}{.064}\, \dot{M} - \underset{(-2.96)}{.066}\, U - \underset{(-2.48)}{.029}\, \dot{B}$$

$R^2 = .98$ $\quad SE = .186 \quad$ $DW = 1.99$

The estimated values of the coefficients of the reduced-form equation are in agreement with the test statements (33) - (40) that are shown in Exhibit I.

$$A_1 = 1.348 > 0$$
$$A_1 + A_2 = .848 > 0$$
$$A_1 - A_2 = 1.348 + .500 > 0$$
$$A_3 = .060 > 0$$
$$A_4 = .064 > 0$$
$$A_5 = -.066 < 0$$
$$A_6 = -.029 < 0$$
$$A_4 - A_3 = .064 - .060 > 0$$

ESTIMATION OF THE REDUCED-FORM EQUATION OVER ALTERNATIVE PERIODS

To investigate whether the hypothesis remains in good agreement with observed data when the sample period is altered, the reduced-form equation for the short-term interest rate was estimated over moving ten-year periods beginning with 1961 and ending in 1975 (six, ten-year periods). This procedure gives an indication as to whether the results reported so far are peculiar to the sample period 1/63 - 12/72.

The results of estimating the reduced-form equation over alternative sample periods are given in Table I. Most of the results are in good agreement with the test statements (33) - (40). However, there are two cases where the test statements do not appear to be in agreement with the data. The coefficient on the growth of the base in the period 1/66 - 12/75 appears to violate test statement (39), where $A_6 < 0$. Even though the sign on the coefficient is negative, the t-statistic is very small, indicating that only at a very low level of probability can the hypothesis that $A_6 = 0$ be rejected. In the period 1/61 - 12/70 the estimated coefficient on prices exceeds that on money, hence, $A_4 - A_3 < 0$. This result suggests that the conjecture that the response of price expectations to the long-run growth of money exceeds the response to

[2] $\dot{P} = \dfrac{P_{t-1} - P_{t-7}}{P_{t-7}}(2)(100)$ = annual rate of change of consumer price index over the previous six months.

$\dot{M} = \dfrac{M_{t-1} - M_{t-37}}{M_{t-37}}(100) \div 3$ = annual rate of change of money over the previous 36 months.

$\dot{B} = \dfrac{B_t - B_{t-3}}{B_{t-3}}(4)(100)$ = annual rate of change of the monetary base over the previous three months.

Table I

ESTIMATED VALUES OF THE COEFFICIENTS OF THE REDUCED-FORM EQUATION*

Independent Variable	Estimated Coefficients 1/61-12/70	1/62-12/71	1/63-12/72	1/64-12/73	1/65-12/74	1/66-12/75
$\dot{P}$	0.068	0.056	0.060	0.062	0.125	0.089
	(2.74)	(2.20)	(2.03)	(1.65)	(4.09)	(2.82)
$\dot{M}$	0.047	0.064	0.064	0.126	0.134	0.170
	(1.46)	(2.42)	(2.28)	(3.19)	(3.12)	(3.13)
U	−0.067	−0.059	−0.066	−0.083	−0.106	−0.122
	(−2.83)	(−2.82)	(−2.96)	(−2.68)	(−2.68)	(−3.89)
$\dot{B}$	−0.025	−0.029	−0.029	−0.032	−0.035	−0.014
	(−2.62)	(−2.71)	(−2.48)	(−2.11)	(−1.86)	(−0.75)
i_{t-1}	1.235	1.375	1.348	1.302	1.261	1.262
	(13.74)	(17.60)	(16.90)	(15.98)	(15.79)	(15.24)
i_{t-2}	−0.378	−0.520	−.500	−0.484	−0.509	−0.479
	(−4.59)	(−7.31)	(−6.94)	(−6.61)	(−6.88)	(−6.11)
Constant	0.780	0.734	0.781	0.733	0.929	0.648
	(4.44)	(4.69)	(4.60)	(3.39)	(3.58)	(2.09)
R^2	0.992	0.989	0.984	0.976	0.973	0.958
SE	0.157	0.169	0.186	0.246	0.314	0.365
DW	1.965	1.956	1.994	1.843	1.875	1.897

*Numbers in parentheses are t-statistics.

the past rates of change of prices is not correct in the earlier periods.

Test statements (41), where $A_3+A_5>0$, and (42), where $A_4+A_5>0$, involve comparing the relative size of the coefficient on the unemployment rate (A_5) with the coefficient on prices (A_3) and the long-run growth rate of money (A_4). The unit of measurement of the unemployment rate differs from the units of measurement of prices and money, which are measured as annual rates of change. Therefore, beta coefficients are computed for A_3, A_4, and A_5, and are used to assess the test statements (41) and (42).[3]

The beta coefficients for each of the independent variables in the six sample periods are presented in Table II. For each of the sample periods, the beta coefficient for prices exceeds the beta coefficient for the unemployment rate. Hence, assumption (27), where $|d_1|>|d_3|$ (a one percentage point change in the past rate of change of prices has more effect on price expectations than does a one percentage point change in the unemployment rate), is judged to be in good agreement with the data.

Table II

BETA COEFFICIENTS AND STANDARD DEVIATIONS OF THE INDEPENDENT VARIABLES

Beta Coefficients

Sample Periods	$\dot{P}$	$\dot{M}$	U	$\dot{B}$
1/61 - 12/70	.073	.044	−.041	−.027
1/62 - 12/71	.062	.063	−.035	−.036
1/63 - 12/72	.067	.058	−.042	−.040
1/64 - 12/73	.074	.102	−.045	−.041
1/65 - 12/74	.180	.083	−.052	−.040
1/66 - 12/75	.136	.095	−.102	−.017

Standard Deviations

Sample Periods	$\dot{P}$	$\dot{M}$	U	$\dot{B}$
1/61 - 12/70	1.824%	1.606%	1.054%	1.859%
1/62 - 12/71	1.750	1.565	.925	1.925
1/63 - 12/72	1.632	1.317	.930	2.010
1/64 - 12/73	1.912	1.295	.872	2.057
1/65 - 12/74	2.735	1.180	.937	2.156
1/66 - 12/75	2.743	.996	1.490	2.204

The beta coefficient for the long-run growth rate of money exceeds the beta coefficient for the unemployment rate in every period except the last sample period 1/66 - 12/75. Hence, assumption (28), where $|d_2|>|d_3|$ (a one percentage point change in the long-run growth rate of money has a greater ef-

[3]The beta coefficient for an independent variable is defined as the coefficient for that variable multiplied by the standard deviation of the variable divided by the standard deviation of the dependent variable. See Arthur S. Goldberger, *Econometric Theory* (New York: John Wiley & Sons, Inc., 1964), pp. 197-98; and Dick A. Leabo, *Basic Statistics*, 4th ed. (Homewood, Illinois: Richard D. Irwin, Inc., 1972), pp. 473-74.

fect on price expectations than does a one percentage point change in the unemployment rate), is in agreement with the data in all sample periods except the one that extends into 1975. The results in this last period raise serious questions about the acceptance of proposition (28). However, this latter period appears to have special characteristics that were not associated with the majority of the years in the earlier sample periods. For example, as shown in Table II, the standard deviation of the unemployment rate rises to 1.490 in the 1966-75 period, compared to a standard deviation of between 0.872 and 0.937 in the four prior sample periods. These results indicate a need for careful further investigation of the difference between specific initial conditions in this latter period and the earlier periods.

EXAMINATION OF SELECTED PROPERTIES OF THE MODEL

In this section certain specific properties of the reduced-form model of interest rate determination are examined. The testing of the hypothesis of interest rate determination that was presented in the first section of this paper is, of course, prior to the examination of the specific properties of the reduced-form model.

First, the importance of the growth rates of prices, money, and base, and the level of the unemployment rate on the short-term interest rate is examined. The equilibrium short-term interest rate for each sample period is determined and then is decomposed to show the influence of each component.

Second, the dynamic properties of the model are examined. The model, as estimated over the period 1/63 - 12/72, is simulated over the period 1/63 - 5/76. In the simulation, the actual values of $\dot{P}$, $\dot{M}$, $\dot{B}$, and U are used, and the model generates lagged values of the interest rate.

Dynamic simulation of the reduced-form model, which is derived from the hypothesis about interest rate determination, provides another chance to confront the hypothesis with the actual behavior of the interest rate. If such a dynamic simulation fails to replicate the general pattern of movements in the short-term interest rate, this does not in itself falsify the hypothesis. However, such a result would tend to raise questions about the specification of the model and, hence, influence most economists' willingness to tentatively accept the hypothesis from which the reduced-form model has been derived.

The reduced-form model of interest rate determination is specified such that random shocks to price expectations influence the behavior of the short-term interest rate. It will be recalled that the reduced-form model for the interest rate (32) has a disturbance term (ε_t). In the first dynamic simulation this term is set equal to zero. In the next simulation, shocks are introduced in specific months to illustrate the effects of such shocks on the dynamic behavior of the model. This procedure does not prove that shocks took place in the months in which they are introduced. It only shows that an observed pattern of sharp fluctuations in the short-term interest rate, that appears to be unrelated to the basic underlying movements of money, prices, base, and economic activity, is consistent with the hypothesis.

Equilibrium Interest Rate

The reduced-form equation, as estimated over the sample period 1/63 - 12/72, may be written as follows:

$$i_t - 1.348\, i_{t-1} + .500\, i_{t-2} = \delta$$

Therefore, the equilibrium solution for the interest rate, i*, is given by:

$$i^* = \frac{\delta}{1 - 1.348 + .500}$$

As shown in the Appendix, the solution for this second order difference equation satisfies the conditions for a stable equilibrium value of the interest rate.[4]

To solve for the equilibrium value of the interest rate (i*), the values of $\dot{P}$, $\dot{M}$, $\dot{B}$, and U were set at their mean values for each sample period. As an example of the computation of the equilibrium interest rates, the following method was used for the 1/63 - 12/72 period. The numbers in parentheses are the estimated coefficients for that period, as shown in Table I, and these coefficients are multiplied by mean growth rates for the respective independent variables, as shown in Table III.

3.303 (.060)	=	.198
4.756 (.064)	=	.304
4.653 (−.066)	=	−.307
5.458 (−.029)	=	−.158
Constant	=	.781
		.818

$$\delta = .818$$

[4]A stable equilibrium is defined as one for which any displacement from equilibrium is followed by a sequence of values of the interest rate which again converge to an equilibrium. See Samuel Goldberg, *Introduction to Difference Equations*, pp. 169-70.

Table III

EQUILIBRIUM INTEREST RATES

Sample Periods	Equilibrium Interest Rate	Mean Values $\dot{P}$	$\dot{M}$	U	$\dot{B}$
1/61 - 12/70	5.07%	2.805%	3.906%	4.723%	4.561%
1/62 - 12/71	5.27	3.108	4.295	4.649	4.999
1/63 - 12/72	5.38	3.303	4.756	4.653	5.458
1/64 - 12/73	5.90	3.865	5.274	4.573	5.740
1/65 - 12/74	6.45	4.877	5.683	4.619	6.049
1/66 - 12/75	6.68*	5.530	5.927	5.017	6.210

Assuming the coefficient on the growth rate of the monetary base is not equal to zero. If the coefficient on the base is set equal to zero, then i = 7.08%.

$$i^* = \frac{.818}{1 - 1.348 + .500} = \frac{.818}{.152} = 5.38\%$$

This procedure was repeated using the estimated coefficients for each sample period and setting the values of $\dot{P}$, $\dot{M}$, $\dot{B}$, and U at their mean values. These results are shown in Table III.

The mean values of the independent variables were chosen so as to approximate a consistent set of values for these variables. For example, using past relationships, it would seem inappropriate to assume that an equilibrium growth rate of prices of, say, 9 percent would be consistent with a 2 percent equilibrium growth rate of money, or that an 8 percent equilibrium growth rate of base would be consistent with 2 percent money growth.

Relative Importance of $\dot{P}$, $\dot{M}$, $\dot{B}$, U on Interest Rates

Each of the estimated coefficients of the reduced-form equation was multiplied by the respective mean growth rate of that variable to which the coefficient is attached. For example, A_3 (the estimated coefficient of the growth rate of prices) was multiplied by the mean growth rate of prices.

If we let $\delta_1 = A_3 \cdot$ (mean growth rate of prices)
$\delta_2 = A_4 \cdot$ (mean growth rate of money)
$\delta_3 = A_5 \cdot$ (mean unemployment rate)
$\delta_4 = A_6 \cdot$ (mean growth rate of base)
$\delta_o = A_o$

then the equilibrium interest rate (i^*) can be expressed as:

$$i^* = \frac{\delta_o}{1 - A_1 - A_2} + \frac{\delta_1}{1 - A_1 - A_2} + \frac{\delta_2}{1 - A_1 - A_2} + \frac{\delta_3}{1 - A_1 - A_2} + \frac{\delta_4}{1 - A_1 - A_2}$$

The relative contribution of each factor to the equilibrium interest rate in each sample period is given in Table IV. For comparison purposes, the results in Table IV should be read from left to right across the Table. Each row in the Table shows the changing influence of each factor as all factors are assumed to vary in a consistent manner.

The results of this procedure indicate that the major factors accounting for the rise in the equilibrium interest rate from 5.07 percent in 1/61 - 12/70 to 6.68 percent in 1/66 - 12/75 were the accelerations in the mean growth rates of prices and the long-run growth rate of money. The mean value of the long-run growth rate of money rose from 3.9 percent in 1/61 - 12/70 to 5.9 percent in the last sample period. Associated with this increase in the mean growth rate of money was an increase in the mean growth rate of prices from 2.8 percent to 5.5 percent. Since in this model $\dot{P}$ and $\dot{M}$ are the major factors influencing the expected rate of change of prices, these results indicate that a rise in the expected rate of inflation is a major influence operating to raise the equilibrium interest rate.

These results also indicate that the liquidity effect of a rise in the growth rate of the monetary base has a small effect relative to the effects of the associated changes in other factors. As the average growth rate of the monetary base increased across the sample periods, the average growth rate of money also increased, and consequently, the average growth rate of prices increased. The combined effect of the accelerated growth rates of money and prices swamped the corresponding liquidity effect of the faster growth rate of the base on the short-term interest rate.

Dynamic Simulations

In this section the results of two dynamic simulations are reported. The simulations were performed using the reduced-form equation for the short-term interest rate as estimated over the period 1/63 - 12/72. Then, using these estimated coefficients and the actual values of $\dot{P}$, $\dot{M}$, U, and $\dot{B}$, and setting $\varepsilon_t = 0$, the monthly pattern of the short-term interest rate was simulated for the period 1/63 - 5/76. The period 1/63 - 12/72 was an in-sample simulation, and the period 1/73 - 5/76 was an out-of-sample simulation. Values of $\dot{P}$, $\dot{M}$, U, and $\dot{B}$ vary over the period and

Table IV

INDIVIDUAL CONTRIBUTIONS OF MAJOR FACTORS TO EQUILIBRIUM INTEREST RATE

	1/61-12/70	1/62-12/71	1/63-12/72	1/64-12/73	1/65-12/74	1/66-12/75
$\dot{P}$	1.34%	1.20%	1.30%	1.32%	2.46%	2.27%
$\dot{M}$	1.29	1.90	2.00	3.65	3.07	4.65
U	−2.21	−1.89	−2.02	−2.09	−1.98	−2.82
$\dot{B}$	−.80	−1.00	−1.04	−1.01	−.86	−.40
Constant	5.46	5.06	5.14	4.03	3.75	2.99
Total*	5.08	5.27	5.38	5.90	6.44	6.69

*Total figures may differ slightly from rates reported in Table III due to rounding.

lagged values of the interest rate are those generated by the model. The results of this simulation are shown in Chart I.

As can be seen from the chart, the simulated pattern of the commercial paper rate follows the general contours of the actual pattern of the commercial paper rate. This relation is quite close in the period 1963-72. During this period the mean error between the actual interest rate and the simulated interest rate was about 4 basis points, and the root mean squared error was about 45 basis points. These and other statistics for comparing the performance of the simulation are given in Table V.

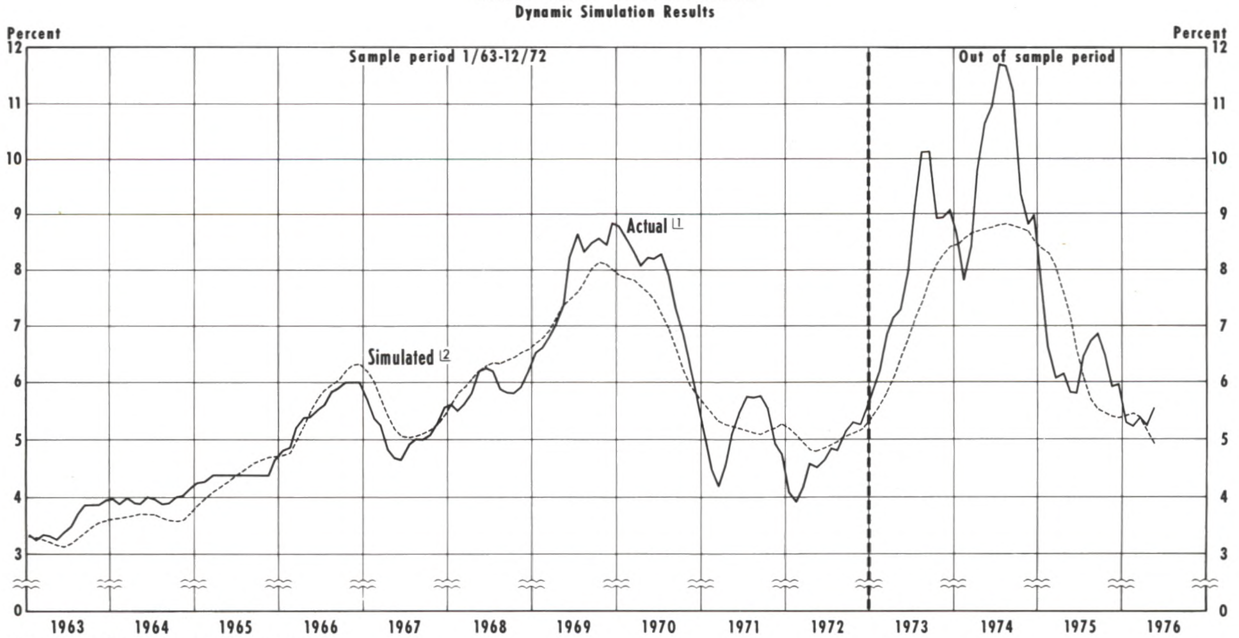
As the simulation is carried on from early 1973 through mid-1976, the statistics used to evaluate the performance of the simulation show a marked rise in the errors. As shown in Table V, the mean error for the period 1973-75 rises to 68 basis points, and the root mean squared error rises to 145 basis points.

Two points should be made about the simulation results from the 1973 through mid-1976 period. First, as the simulation is carried on from the start of 1973 through May 1976, the simulated values of the short-term interest rate continue to reproduce the general pattern of the short-term interest rate. The simulated rate rises sharply from early 1973 through late 1974 and then falls sharply into 1975. However, in contrast to the smooth pattern of the simulated interest rate, the actual interest rate displayed a series of very sharp fluctuations in this period. For example,

Chart I

Short-Term Interest Rate

Dynamic Simulation Results



[1] 4- to 6-month prime commercial paper rate.

[2] Simulated interest rate using coefficients estimated over 1/63 - 12/72, initial values set at actual interest rate for 11/62 and 12/62.

Latest data plotted: May

Table V

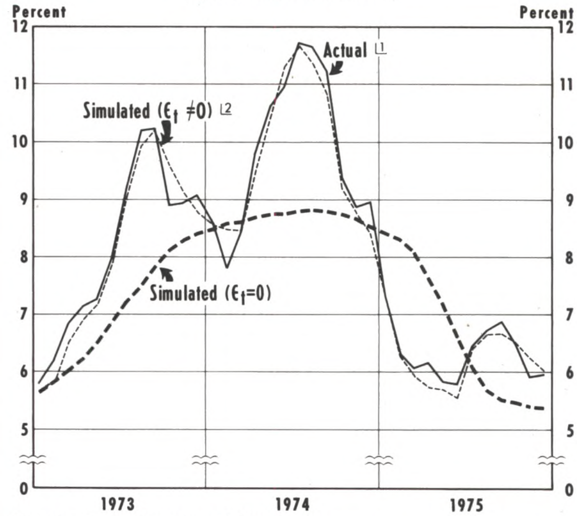
DIFFERENCE BETWEEN THE ACTUAL AND SIMULATED SHORT-TERM INTEREST RATE: SUMMARY STATISTICS

	1963-1972	1973-1975
Mean	.037%	.679%
Absolute Mean	.355	1.217
Mean Squared Error	.199	2.109
Root Mean Squared Error	.446	1.452

Chart II

Short-Term Interest Rate

Dynamic Simulation Results



[1] 4- to 6-month prime commercial paper rate.

[2] Simulated interest rate using coefficients estimated over 1/63 - 12/72, initial values set at actual interest rate for 11/72 and 12/72.

Latest data plotted: December

the actual interest rate (commercial paper rate) rose from about 6 percent in early 1973 to above 10 percent in September 1973, fell to about 8 percent in early 1974, then rose to about 12 percent in July 1974, and fell to about 6 percent in March 1975.

Second, the actual interest rate does not continue to diverge from the simulated value of the interest rate. For short periods the actual value moves sharply above the simulated rate, but then it rapidly converges back to the pattern of the simulated rate. By the end of 1975 and into 1976, the actual and simulated rates are again moving closely together.

Therefore, the question arises as to what accounts for these sharp short-run deviations of the actual interest rate from the simulated path of the interest rate. To begin, first note that in the initial simulation ε_t was set equal to zero. In other words, no random shocks to price expectations were introduced into the simulation. Given the dynamic characteristics of the reduced-form equation for the interest rate, adding shocks (setting $\varepsilon_t \neq 0$) will affect the simulated pattern of the interest rate. For example, if ε_t is set at a value greater than zero in one period and then allowed to return to zero in every following period, the effect on the simulated interest rate will appear, not only in the first period, but also in following periods. Eventually the simulated interest rate will converge back to the level determined by the growth rates of money, prices, base, and the level of the unemployment rate. However, in the interim, the simulated rate will have deviated sharply from that generated by setting $\varepsilon_t = 0$.

Consequently, a second simulation was performed to illustrate the behavior of the simulated interest rate when periodic shocks are introduced. The simulation was begun in 1/73 and the initial values for the interest rate were set at their actual values for November and December 1972. Then, shocks were introduced in selected months, and the system was allowed to adjust to the shocks. In many months ε_t was set equal to zero. Then periodically ε_t was set at a value greater or less than zero. The results of this simulation, one in which periodic shocks were introduced in selected months along with the changing growth rates of prices, money, base, and the unemployment rate, are shown in Chart II and Table VI. Chart II shows that by selectively introducing periodic shocks, a simulated pattern of the short-term interest rate can be generated that closely approximates the actual behavior of the short-term interest rate.

The exact causes of such shocks are not well understood and have not been the subject of much empirical investigation. One example of such a shock to price expectations would be the announcement of the oil embargo that occurred in 1973. This development quite likely affected price expectations, but was not incorporated in information about the past rate of change of prices, money, or the state of economic activity. This development probably had recurring effects on price expectations each time OPEC met to set the price of oil and each time the U.S. Government announced a new program to combat the "energy crisis."

As another example of how such shocks might originate, consider the case where the Federal Government announces that it expects to run a deficit over the next few years that, by past standards, is

Table VI

COMPARISON OF ACTUAL AND SIMULATED INTEREST RATES: $\varepsilon_t \neq 0$

Date	Actual Interest Rate	Simulated Interest Rate $\varepsilon_t \neq 0$	Shocks ε_t
1/73	5.78%	5.65%	0
2/73	6.22	5.83	0
3/73	6.85	6.51	.50
4/73	7.14	6.91	0
5/73	7.27	7.17	0
6/73	7.99	7.88	.50
7/73	9.18	9.00	.75
8/73	10.21	9.90	.50
9/73	10.23	10.19	0
10/73	8.92	9.58	−.50
11/73	8.94	9.10	0
12/73	9.08	8.76	0
1/74	8.66	8.55	0
2/74	7.83	8.49	0
3/74	8.42	8.48	0
4/74	9.79	9.53	1.00
5/74	10.62	10.95	1.00
6/74	10.96	11.31	0
7/74	11.72	11.65	.50
8/74	11.65	11.38	0
9/74	11.23	10.81	0
10/74	9.36	9.19	−1.00
11/74	8.81	8.76	.50
12/74	8.98	8.42	0
1/75	7.30	7.24	−1.00
2/75	6.33	6.27	−.50
3/75	6.06	5.91	0
4/75	6.15	5.73	0
5/75	5.82	5.69	0
6/75	5.79	5.54	0
7/75	6.44	6.42	1.00
8/75	6.70	6.65	0
9/75	6.86	6.66	0
10/75	6.48	6.51	0
11/75	5.91	6.25	0
12/75	5.97	6.01	0

very large. Consequently, there is a great amount of discussion in the financial press and among economic forecasters concerning the implications of this pattern of projected large deficits. Suppose further that the consensus opinion is that these deficits imply that the central bank will respond by sharply increasing its purchases of Government securities; hence, the growth of money will be much more rapid than was previously observed. This chain of events could conceivably lead to a substantial shock to price expectations. In other words, the future rate of inflation would now be expected to be greater than what individuals had expected given the past rate of change of prices and the long-run growth of money.

Suppose that after a period of time, even though there are large deficits, the money supply does not accelerate, and the Federal Reserve firmly announces that it does not intend to allow an acceleration in money growth. Consequently, this may result in a revision of price expectations in the downward direction ($\varepsilon_t < 0$) and, hence, a substantial fall in interest rates may occur.

These results contain the interesting implication that the basic mechanism generating interest rates may not have changed radically during the period 1973-75. Rather, a series of shocks occurred during this latter period which resulted in much greater variation in interest rates than can be accounted for by the changing growth rates of money, base, prices, and the level of the unemployment rate.

SUMMARY AND CONCLUSIONS

An hypothesis designed to explain the movements in the short-term interest rate has been presented in this article. The hypothesis was given explicit form in the mathematical representation of the short-term credit market presented in equations (1) - (9). Signs and relative sizes were attached to the parameters of the structural equations. From the structural equations a reduced-form expression for the interest rate was derived. Empirical counterparts to the terms appearing in the reduced-form equation were specified. All of these steps are integral parts of the hypothesis.

Other economists might favor a different specification of the short-term credit market. Also, they might contend that "the short-term interest rate" should be mapped into the empirical counterpart of the Treasury bill rate instead of the commercial paper rate, or that "prices" should be represented by the wholesale price index rather than the consumer price index, or that the "state of economic activity" is not well represented by the unemployment rate. These assertions can only be evaluated when they are given definite form by respecifying the hypothesis and deriving new test statements that can be confronted with empirical evidence.

No attempt was made to justify *a priori* the specification of the model, the assignment of signs to the parameters of the model, or the use of specific empirical counterparts to the theoretical terms that appear in the model. Instead, the hypothesis was formulated in such a manner that statements could be derived from the hypothesis that were capable of being falsified by observed data. The potential falsifiers of the hypothesis were the test statements (33)-(42). These test statements are derivable consequences of the hypothesis. Conceivably, some or all of the test statements (33) - (42) could have turned out to be not in agreement with the data. This could have resulted from any of the steps involved in constructing the hypothesis. Such results provide evidence against the hypothesis, hence, requiring careful analysis of the cause of the falsification and possible reformulation of one or more parts of the hypothesis.

The test statements were generally in good agreement with the observed data. These results were not specific only to the initial sample period that was chosen, but also held as the sample period was varied over fifteen years. This does not mean the hypothesis is a "true" representation of the determinants of the short-term interest rate. It only means that, subject to a continuation of more rigorous testing of the hypothesis, it might be tentatively considered as a representation of the process whereby the short-term interest rate is determined.

As was pointed out in the discussion of the test results, there were a few cases where some of the test statements did not agree with the data. These are important results and cast doubt on parts of the hypothesis. Hence, they require careful further investigation. Two of these results were peculiar to the sample period 1966-75. It was mentioned that the latter years of this period had special characteristics that were "different" from the earlier years of the sample period. This assertion was developed in more detail in latter sections of the paper.

After testing the hypothesis, the reduced-form model for the interest rate was used to examine certain selected properties of the proposed explanation of the movements in the interest rate. An equilibrium interest rate was derived for each of the sample periods. These results indicated a fairly substantial rise in the equilibrium interest rate as the sample period was changed. This rise was attributed primarily to the increased average long-run growth rate of money and the faster average growth of prices operating through their effects on price expectations.

Dynamic simulations of the interest rate were performed using the reduced-form model for the interest rate. The results of these simulations indicated the possibility of recurring shocks in the 1973-75 period. Consequently, an alternative simulation was performed where shocks were introduced in selected months. It was shown that such a procedure resulted in a pattern of the simulated interest rate which closely approximated the pattern of the actual interest rate. These results led to the conjecture that the underlying mechanism generating interest rates was unchanged in the last few years. In other words, the evolution of the short-term interest rate continued to depend upon the same basic factors — the influence of the growth rate of money, prices, the state of economic activity, and the growth of the base. Sharp divergences from this path were accounted for by periodic shocks.

At the start of this paper it was stated that it was not the purpose of this article to develop a pure forecasting model for the short-term interest rate. The simulation results reported in the paper, however, have some interesting implications for forecasting interest rates. They indicate that even if an individual were lucky enough to correctly predict the future growth rates of prices, money, monetary base, and the unemployment rate, this might only permit a forecast of the general contour of the future path of interest rates. In periods such as the last few years, periodic shocks may occur which, according to the model developed in this paper, would result in sharp upward or downward movements in interest rates. Without knowledge of the timing and magnitude of these shocks, which are usually assumed to be randomly distributed over a sufficiently long period, it would not be possible to closely forecast for an extended period the actual path of the short-term interest rate.

These results also point out difficulties that can result for a central bank if it tries to tightly control short-run movements in interest rates. Suppose there is a shock that raises price expectations and, consequently, interest rates. The dynamic properties of the reduced-form interest rate model derived from the hypothesis presented in this paper show that such shocks result in a sharp rise in the interest rate. However, in the absence of future shocks, the interest rate will not continue to rise indefinitely, but after a time will begin to fall and converge back toward the level determined by the growth rates of prices, money, base, and the state of economic activity. If, however, the central bank takes aggressive action to halt the rise in rates, then interest rates will not converge back to the level determined by the previous growth rates of prices, money, and base, but will converge to a new higher level. Also, such a process raises the possibility of further positive shocks to price expectations and substantial further upward pressures on interest rates.

APPENDIX I

DERIVATION OF TEST STATEMENTS

(33) $A_1 > 0$

$$A_1 = \frac{c_1 (b_2 - a_2)}{a_1 - b_1}$$

(17) $c_1 > 0$

(14) $b_2 < 0$

(11) $a_2 > 0$

Therefore: $c_1 (b_2 - a_2) < 0$

(10) $a_1 < 0$

(13) $b_1 > 0$

Therefore: $(a_1 - b_1) < 0$

Therefore: $A_1 > 0$

(34) $A_1 + A_2 > 0$

$$A_1 + A_2 = (c_1 + c_2) \left(\frac{b_2 - a_2}{a_1 - b_1}\right)$$

Since: $(a_1 - b_1) < 0$

Since: $(b_2 - a_2) < 0$

Therefore: $\dfrac{b_2 - a_2}{a_1 - b_1} > 0$

(18) $c_1 + c_2 > 0$

Therefore: $A_1 + A_2 > 0$

(35) $A_1 - A_2 > 0$

$$A_1 - A_2 = (c_1 - c_2) \left(\frac{b_2 - a_2}{a_1 - b_1}\right)$$

(19) $c_1 > c_2$

Therefore: $c_1 - c_2 > 0$

Since: $\left(\dfrac{b_2 - a_2}{a_1 - b_1}\right) > 0$

Therefore: $A_1 - A_2 > 0$

(36) $A_3 > 0$

$$A_3 = \frac{d_1 (b_3 - a_3)}{a_1 - b_1}$$

(20) $d_1 > 0$

(12) $a_3 > 0$

(15) $b_3 < 0$

Therefore: $d_1 (b_3 - a_3) < 0$

Since: $a_1 - b_1 < 0$

Therefore: $A_3 > 0$

(37) $A_4 > 0$

$$A_4 = \frac{d_2 (b_3 - a_3)}{a_1 - b_1}$$

(21) $d_2 > 0$

Therefore: $d_2 (b_3 - a_3) < 0$

Since: $a_1 - b_1 < 0$

Therefore: $A_4 > 0$

(38) $A_5 < 0$

$$A_5 = \frac{d_3 (b_3 - a_3) + (f_1 - e_1)}{a_1 - b_1}$$

(22) $d_3 < 0$

(25) $| a_3 d_3 | > | f_1 - e_1 |$

Therefore: $- a_3 d_3 + (f_1 - e_1) > 0$

Since: $d_3 b_3 > 0$

Therefore: $d_3 (b_3 - a_3) + (f_1 - e_1) > 0$

Since: $a_1 - b_1 < 0$

Therefore: $A_5 < 0$

(39) $A_6 < 0$

$$A_6 = \frac{b_4}{a_1 - b_1}$$

(16) $b_4 > 0$

Since: $a_1 - b_1 < 0$

Therefore: $A_6 < 0$

(40) $A_4 - A_3 > 0$

$$A_4 - A_3 = (d_2 - d_1)\left(\frac{b_3 - a_3}{a_1 - b_1}\right)$$

(20) $d_1 > 0$

(21) $d_2 > 0$

(26) $d_2 > d_1$

Therefore: $(d_2 - d_1) > 0$

Since: $\left(\frac{b_3 - a_3}{a_1 - b_1}\right) > 0$

Therefore: $A_4 - A_3 > 0$

(41) $A_3 + A_5 > 0$

$$A_3 + A_5 = (d_1 + d_3)\left(\frac{b_3 - a_3}{a_1 - b_1}\right) + \left(\frac{f_1 - e_1}{a_1 - b_1}\right)$$

(27) $| d_1 | > | d_3 |$

Therefore: $d_1 + d_3 > 0$

Since: $\left(\frac{b_3 - a_3}{a_1 - b_1}\right) > 0$

Since: $\left(\frac{f_1 - e_1}{a_1 - b_1}\right) > 0$

Therefore: $A_3 + A_5 > 0$

(42) $A_4 + A_5 > 0$

$$A_4 + A_5 = (d_2 + d_3)\left(\frac{b_3 - a_3}{a_1 - b_1}\right) + \left(\frac{f_1 - e_1}{a_1 - b_1}\right)$$

(28) $| d_2 | > | d_3 |$

Therefore: $(d_2 + d_3) > 0$

Therefore: $A_4 + A_5 > 0$

APPENDIX II

STABILITY CONDITIONS FOR EQUILIBRIUM INTEREST RATE

Given a difference equation of the form:

$$y_{k+2} + z_1 y_{k+1} + z_2 y_k = \delta$$

$$\delta = \text{constant}$$

the necessary and sufficient conditions for a stable equilibrium are given by:

$$1 + z_1 + z_2 > 0$$
$$1 - z_2 > 0$$
$$1 - z_1 + z_2 > 0$$

Rewriting the equation for the interest rate as:

$$i_t + z_1 i_{t-1} + z_2 i_{t-2} = \delta$$

where,

$$z_1 = - A_1$$
$$z_2 = - A_2$$

the stability conditions for 1/62 - 12/73 are given as:

$$1 + (-1.348) + .500 > 0$$
$$1 - .500 > 0$$
$$1 - (-1.348) + .500 > 0$$

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