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In This Issue . . .

This issue of *Review* contains four articles relating to monetary policy and banking.

In the first article, "Was the 1982 Velocity Decline Unusual?" John A. Tatom analyzes recent movements in velocity. Velocity, the ratio of the nation's GNP to its money stock, fell sharply in 1982. Since velocity is an indicator of the public's demand for money, many analysts have interpreted the decline as an unanticipated shift in the public's desired holdings of transaction balances. According to this view, the shift worsened economic performance and raised serious doubts about the future prospects of controlling both inflation and spending by controlling the monetary aggregates.

Tatom explains that velocity normally displays a cyclical pattern, rising faster than average during expansions and falling in recessions. He points to three reasons why velocity declines in recessions. First, money stock growth often accelerates after the economy enters a recession. Spending in the economy responds proportionately, but with a lag. As a result, velocity growth is temporarily depressed, then temporarily raised. The initial change, depressing velocity growth, tends to occur immediately; it is observed during the recession and reinforces the velocity decline associated with the slowing in money growth that preceded the recession.

Second, real income falls during a recession. Because the public's preference for money does not fall proportionately with its reduced demand for goods and services, M1 tends to rise relative to GNP.

Finally, during recessions, businesses often develop excess inventory. The temporary production adjustments to eliminate this excess initially push production down sharply relative to sales. During such a period of inventory adjustment, measured velocity falls sharply.

To assess whether recent velocity movements were unusually large, Tatom uses a model that describes velocity movements from 1948 to mid-1981 to compare velocity movements from mid-1981 through 1982 with actual developments. Tatom shows that the 1982 velocity decline was not unusual when compared with the estimates based on past velocity movements.

In the second article, "Changes in the Monetary Growth Rate and the Time Pattern of Interest Rates," W. W. Brown and G. J. Santoni re-examine the widely held view that permanent increases in the monetary growth rate cause market interest rates initially to decline, then ultimately to rise above their original levels. The path that interest rates follow when adjusting to a change in the monetary growth rate is important for two reasons. First, if changes in money growth change the *ex ante* real interest rate, even temporarily, the result will be sizable disturbances in general economic activity. Second, the timing of the adjustment in market interest rates reveals information about the lag in the response of economic activity to changes in monetary policy.

Brown and Santoni examine monthly data on interest rates and monetary growth over the period July 1914–February 1983 to determine whether changes in monetary growth induce changes in interest rates and, if so, what the direction, magnitude and timing of the effect are. When the data period is partitioned to control for the effects of the different monetary institutions (for example, the gold standard), they find that interest rates have responded to monetary impulses in the commonly believed manner only since 1971. Even in this case, however, the initial decline in short-term interest rates associated with an increase in the monetary growth rate is quite small; the subsequent rise is proportionate to the increase in money growth. Further, interest rates appear to adjust fully to a change in monetary growth within one year.

In "The Effect of State Banking Laws on Holding Company Banks," Donald M. Brown investigates the effect of state banking laws on the financial and market characteristics of banks owned by bank holding companies.

Brown applies a statistical approach known as probit analysis to a sample of banks from six unit-banking states. In those states that permit multi-bank holding companies, he finds that the financial and market characteristics of one-bank and multi-bank holding company subsidiaries differ significantly from one another, as well as from independent banks. Such characteristics associated with one-bank holding company subsidiaries also differ from those of independent banks in states that prohibit multi-bank holding companies. Furthermore, one-bank holding companies in this group of states share financial characteristics of both the one-bank and multi-bank holding company subsidiaries in the other group of states. This suggests that, if it were legal in those states to form multi-bank holding companies, some of the holding companies would choose to own several banks. Finally, Brown finds that banks are more likely to be owned by bank holding companies in states that permit multi-bank holding companies than in those that do not.

Brown concludes that studies which attempt to examine the effects of holding company ownership on bank financial ratios and market characteristics should control both for differences among state banking laws and for differences between one-bank and multi-bank holding companies.

In the last article in this issue, "Inflation: Assessing Its Recent Behavior and Future Prospects," R. W. Hafer examines the effect of monetary and nonmonetary factors in explaining the recent decline in inflation. Hafer finds that the decline in the average rate of money growth during the past few years accounts for the downward trend in inflation. Moreover, he finds that the drop in the inflation rate below that implied by the rate of money growth is explained, to a large degree, by the downward movement in the relative price of energy.

When the influence of the declining relative price of energy abates, however, Hafer argues that "inflation will tend to move back in line with the average growth of money." Using estimates obtained from the I/1960–I/1983 sample period, and assuming that the average rate of money growth continues to grow at 7.5 percent (the trend growth in I/1983), the author simulates the inflation rate for the period 1983–85 for different assumptions about energy price changes. If relative energy prices remain unchanged, inflation was simulated to be about 6.5 percent in 1983 and above 7 percent in 1984 and 1985. If relative energy prices decline throughout 1983 then stop declining, inflation was simulated to be about 6 percent in 1983 and about 7 percent for 1984 and 1985. Hafer concludes that the popular notion that inflation finally has been tamed is likely to be invalid unless the average growth of money is significantly reduced.

Was the 1982 Velocity Decline Unusual?

JOHN A. TATOM

THE nation's GNP growth in 1982 was so weak relative to the pace of monetary expansion that the velocity of money — the ratio of GNP to M1 — fell significantly. This decline contrasts sharply with the steadily rising trend in velocity over the past 35 years.

The Council of Economic Advisers (CEA) refers to 1982 velocity behavior as "historically atypical" and "not fully understood." In explaining the large velocity "shift," the CEA attributes a major role to changes in asset demands of individuals and businesses, arising from new financial opportunities or changes in asset preferences. The CEA phrases the importance of unusual shifts in velocity growth succinctly:

> The presumption, on the basis of past experience, is that most velocity changes are temporary. Thus, increasing the rate of monetary growth in response to temporary declines in velocity runs the risk of providing excessive liquidity and increasing inflation, while a failure to recognize a continuing shift in liquidity preference or velocity runs the risk of providing inadequate liquidity and reducing real GNP.[1]

Had velocity growth not shifted last year, nominal GNP growth would have been substantially higher, and the recession presumably would have not been as lengthy or as severe.

Some observers, interpreting this development as the breakdown of monetarist theory, have suggested that "If velocity has become impossible to predict, it could be 20 years before monetarism becomes the linchpin of policy again."[2] Before concluding that the link between monetary growth and spending has been broken or addressing the implications of such a breakdown for monetary policy, it is useful to place last year's velocity developments in historical perspective and to examine the extent of any deviation in the historical relationship between velocity and the factors that influence it.

THE RECENT BEHAVIOR OF VELOCITY IN HISTORICAL PERSPECTIVE

On an annual basis, the velocity of M1 grew steadily from 1959 to 1981, averaging a 3.2 percent rate of increase. In 1982, M1 velocity *fell* at a 2.3 percent rate. Since the standard deviation for velocity growth from 1959–81 was only 1.20 percent, the recent decline, as the CEA has indicated, appears substantial. Indeed, *any* decline would appear unusual based on the record of systematic increases in velocity since 1959.

Declines in velocity are not unprecedented, however. For example, on an annual basis, M1 velocity fell at a 1.5 percent rate from 1953 to 1954.[3] Moreover, there have been years in the postwar period when velocity growth was virtually nil, such as 1952 (0.2 percent) and 1958 (0.1 percent).[4]

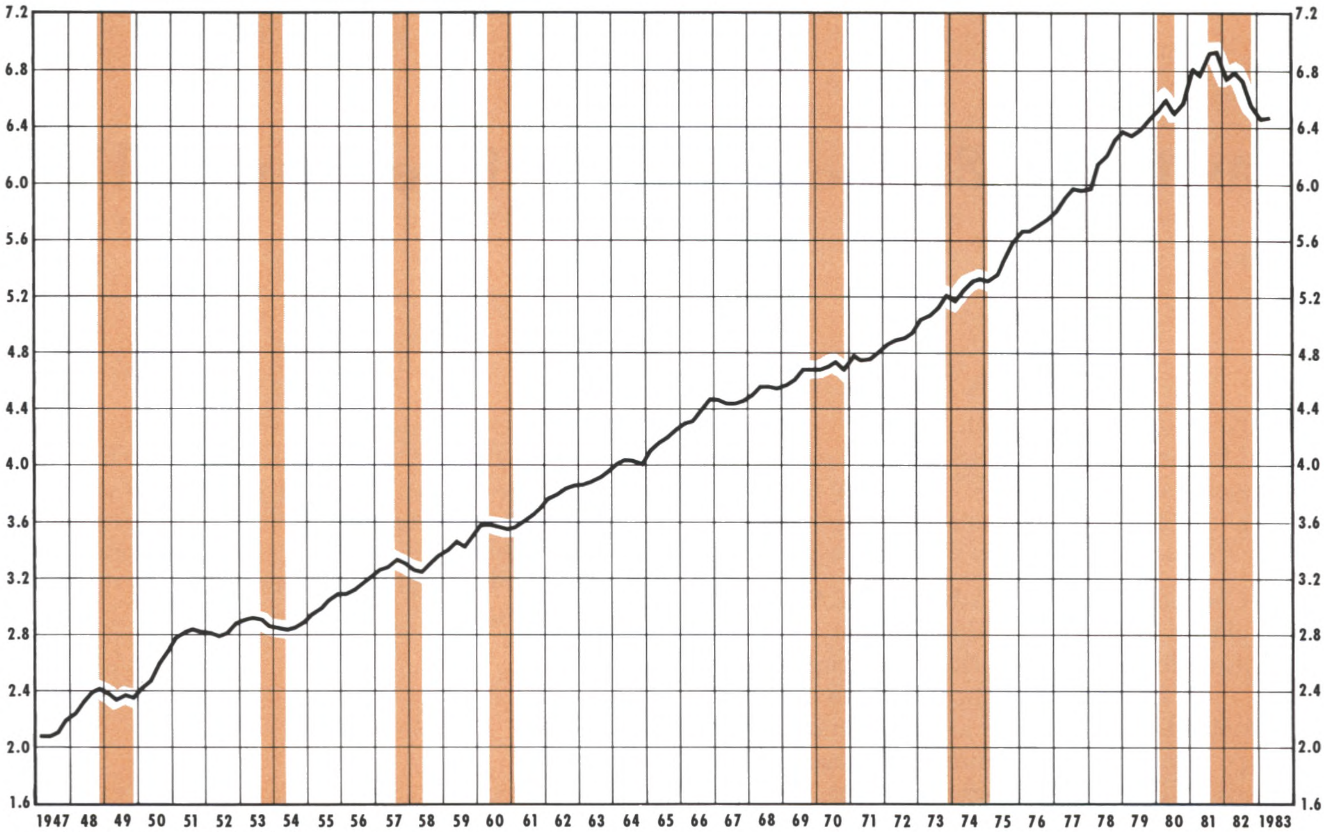
[1] *Economic Report of the President* (Government Printing Office, 1983), pp. 21–22.

[2] See "The Failure of Monetarism," *Business Week*, April 4, 1983, pp. 64–67. In the same article, Robert J. Gordon remarks that "monetarism has been decimated by the collapse of velocity in 1982."

[3] The current measure of M1 begins in 1959. The old measure used before 1980 is used here for the period 1947 to 1959. In 1959, the two measures were nearly identical so that an historical series is obtained by splicing the two series.

[4] L. R. Klein and R. F. Kosobud, "Some Econometrics of Growth: Great Ratios in Economics," *The Quarterly Journal of Economics* (May 1961), pp. 173–98, argue that, adjusted for its trend rate of growth, velocity is one of the "great" ratios that might be viewed as a fundamental parameter for economic theory. They reach this conclusion, notwithstanding their evidence indicating periodic sharp velocity declines relative to trend.

Chart 1
Velocity (GNP/M1)



Shaded areas represent periods of business recessions.

The Quarterly Record

Additional insight into the 1982 velocity decline can be obtained using quarterly data. Velocity fell at an 11.2 percent annual rate in the first quarter of 1982, rose at a 3.3 percent rate in the second quarter, fell at a 3.4 percent rate in the third quarter, then fell at a 9.9 percent rate in the last quarter of 1982. Chart 1 shows quarterly levels of velocity since 1947; periods of recession are shaded. Note that there are numerous quarters in which velocity fell, especially during recessions.

From the first quarter of 1947 to the third quarter of 1981, velocity declined in 32 of the 138 quarters, or about one-fourth of the time. Moreover, velocity typically fell in periods of economic decline. There are 25 quarters that span the peak-to-trough periods; velocity declined in 64 percent of them. Nonetheless, the magnitude of the velocity declines in the first and fourth quarters of 1982 far exceed the largest one-quarter decreases in velocity of about 6 percent observed in I/1948, II/1948, IV/1953 and I/1958. One would have to look back to 1945 or earlier recessions to find more rapid decreases in velocity.

Table 1 shows velocity's growth rate from peak to trough in eight postwar recessions. While a decline in velocity in such periods is not unusual, the size of the peak-to-trough decline in the recent recession is the largest recorded. The velocity decline was fairly small in the four previous recessions. Indeed, in the 1970 recession, velocity was flat, and in the 1973–75 recession it rose. Yet, except for the 1973–75 recession, when the unemployment rate rose 3.5 percentage points from peak to trough, the four previous recessions were not as severe as the recent experience when unemployment rose 3.3 percentage points from peak to trough.[5] The recent experience compares more

[5]The data in table 1 suggest that velocity movements in the 1973–75 recession, when velocity actually increased, were more anomalous than recent velocity movements. The 1973–75 change is consistent with a one-time downshift in the demand for money occurring during that recession. See R. W. Hafer and Scott E. Hein, "The Shift in Money Demand: What Really Happened?" this *Review* (February 1982), pp. 11–16.

closely to that in the first three postwar recessions, when the unemployment rate rose about 3.2 percentage points from peak to trough.[6]

EXPLANATIONS OF RECENT VELOCITY MOVEMENTS

The recent behavior of velocity is broadly consistent with the velocity declines that occurred in most previous recessions. Nonetheless, analysts have advanced a variety of hypotheses to account for the 1982 velocity experience. Two of these explanations are conventional: they are that (1) declining inflation, or (2) declining interest rates, have reduced the cost of holding money and, consequently, the demand for money relative to goods and services has increased.[7]

A second group of hypotheses includes those that usually are not incorporated in conventional analyses. Principal among these is that recent financial innovations have lowered the cost of holding money, thereby increasing its demand and reducing velocity. Another hypothesis in this vein is that international asset preferences have changed so that foreigners' demand for the U.S. money stock is greater. According to this view, the international strength of the dollar accounts for the decline in velocity.[8] All four explanations suffer from a lack of historical perspective that blunts their intuitive appeal.

Table 1

Growth Rates of Velocity in the Last Eight Recessions

Peak – Trough	Velocity growth rate[1]	Increase in the unemployment rate[2]
IV/1948 – IV/1949	−2.8%	3.2%
II/1953 – II/1954	−2.7	3.2
III/1957 – II/1958	−3.2	3.2
II/1960 – I/1961	−1.4	1.6
IV/1969 – IV/1970	0.0	2.2
IV/1973 – I/1975	1.5	3.5
I/1980 – III/1980	−0.8	1.4
III/1981 – IV/1982	−4.3	3.3

[1]Compounded annual rate of change in GNP/M1, where the old (pre-1980) measure of M1 is used prior to 1959.

[2]Percentage-point change in the quarterly average of unemployment as a percent of the civilian labor force.

Declining Inflation

Inflation has declined steadily since the first quarter of 1981, but velocity declines did not become a source of concern until a year later. As measured by the rate of increase in the GNP deflator, inflation peaked at 10.4 percent in the year ending in the first quarter of 1981. This rate declined to 7.1 percent over the following year, then to 4.7 percent in the year ending in the first quarter of 1983. The decline in velocity is concentrated heavily in only two quarters of 1982, long after the decline in inflation began. Moreover, in the first three quarters of 1981, when the inflation was slowing sharply, velocity rose at a 7.1 percent rate. Of course, it is conceivable that changes in expected inflation lagged far behind actual inflation developments, but lacking evidence of such a delayed and discontinuous adjustment process, such a notion can be disregarded.

[6]Declining velocity in recessions is not a postwar phenomenon. Using Robert Gordon's estimates of quarterly GNP and Milton Friedman and Anna Schwartz' data on M1, a measure of M1 velocity can be constructed since mid-1914. In the seven recessions from 1919–45, velocity fell in all and, with one exception, at a faster pace than in the 1981–82 recession. The periods are (growth rates in parentheses): III/1918–I/1919 (−28.8 percent), I/1920–III/1921 (−6.6 percent), II/1923–III/1924 (−6.7 percent), III/1926–IV/1927 (−2.2 percent), II/1929–I/1933 (−12.8 percent), II/1937–II/1938 (−5.8 percent), and I/1945–IV/1945 (−22.5 percent). See Robert J. Gordon, "Price Inertia and Policy Ineffectiveness in the United States, 1890–1980," *Journal of Political Economy* (December 1982), pp. 1087–117; and Milton Friedman and Anna Jacobson Schwartz, *A Monetary History of the United States, 1867–1960* (Princeton University Press, 1963).

[7]See Bluford H. Putnam, "This Money Bulge Isn't Inflationary," *Wall Street Journal*, April 27, 1983, for a discussion of these explanations and others. Also, see John P. Judd, "The Recent Decline in Velocity: Instability in Money Demand or Inflation?" Federal Reserve Bank of San Francisco *Economic Review* (Spring 1983, forthcoming). Judd claims that declining interest rates explain the pattern of money growth since the end of 1981 and that the demand for money contained in the San Francisco money market model was stable. Velocity fell because of this predictable strength in money demand. Judd does *not* argue that the sensitivity of money demand to changes in interest rates and inflation has changed. An example of the latter argument is contained in Flint Brayton, Terry Farr and Richard Porter, "Alternative Money Demand Specifications and Recent Growth in M1" (Board of Governors of the Federal Reserve System, May 23, 1983; processed).

[8]Putnam, "This Money Bulge," provides this explanation along with the declining inflation and financial innovation explanation. Also, see Vincent Salvo, "Is U.S. Money Growth A Foreign Affair?" *International Finance*, (Chase Manhattan Bank, April 25, 1983), pp. 1, 7, 8.

Declining Interest Rates

Explanations that focus on declining interest rates also do not match up well with the recent pattern of velocity declines. In the first quarter of 1982, corporate Aaa bond yields averaged 15.01 percent and had risen from 14.62 percent one quarter earlier or 14.92 percent two quarters earlier. During the remaining quarters of 1982, the bond yield declined to 14.51 percent, 13.75 percent and 11.88 percent.[9] The pattern in the second half of 1982 is consistent with a decline in velocity. What remains unexplained, however, is the largest decline in velocity, which occurred in the first quarter.

Financial Innovations

Financial innovations are a widely discussed explanation of velocity shifts. This argument is by far the most puzzling, because there were no major innovations over the period in which velocity behavior appeared aberrant to most observers. Analysts generally refer to the introduction of super-NOW accounts or money market deposit accounts in connection with this hypothesis. Unfortunately, the former were not allowed until January 1983 and the latter were authorized in mid-December 1982, three weeks before the *end* of the period of declining velocity discussed above.[10]

Foreign Demand for the Dollar

The international currency preferences explanation also does not match the recent velocity pattern. The effective exchange rate has been rising steadily since the third quarter of 1980, except for a decline in the fourth quarter of 1981. The rates of increase in the exchange value of the dollar from III/1980 to III/1981 and from IV/1981 to IV/1982 are 28.8 percent and 16 percent, respectively. In the first period, velocity *rose* 5.6 percent despite the strong appreciation of the dollar. Only in the latter period, when the rate of appreciation *slowed*, did velocity growth slow.

An earlier example further illustrates the difficulty with this explanation. In the second quarter of 1981, just before the recent recession, the exchange value of the dollar was virtually the same as in the third quarter of 1977. Over the four-year period, the exchange rate first fell rapidly (12 percent rate from III/1977 to IV/1978), then declined more slowly (1.6 percent rate from IV/1978 to III/1980), and finally surged upward (28.5 percent rate from III/1980 to II/1981). Over the same periods, velocity grew at 4.5, 1.6, and 5.6 percent rates, respectively. Thus, velocity growth was strongest during the period of rapid appreciation. Moreover, it was only slightly slower — and well above trend growth — during the period of rapid decline in the value of the dollar.

The conceptual difficulty with this explanation is that the movements in the exchange value of the dollar *reflect* inflation and monetary growth developments. At least for the United States, the major provider of the world money supply, these factors are included in conventional analyses of GNP growth and velocity. It is not likely that the exchange rate could exert a major impact of its own.[11]

WHY DOES VELOCITY FALL IN RECESSIONS?

Declining Real Income

The principal reason that velocity declines in a recession is because of a temporary decline in real income. Velocity can be viewed as real income (x) per

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[9]The use of short-term rates does not alter the disparate pattern. In the first quarter of 1982, 3-month Treasury bill yields averaged 12.81 percent, *higher* than the 11.75 percent yield a quarter earlier, although somewhat below the 15.05 percent average yield two quarters earlier. This rate also declined over the subsequent three quarters.

[10]The only example of a major financial innovation in recent years that fits the hypothesis is the introduction of nationwide NOW accounts in January 1981. There was a sharp surge in the share of total checkable deposits held as NOW balances or other checkable deposits from January to April. Earlier analyses have failed to reveal any unusual velocity developments in 1981 due to this shift. See John A. Tatom, "Recent Financial Innovations: Have They Distorted the Meaning of M1?" this *Review* (April 1982), pp. 23–35; Scott E. Hein, "Short-Run Money Growth Volatility: Evidence of Misbehaving Money Demand?" this *Review* (June/July 1982), pp. 27–36; Bryon Higgins and John Faust, "NOWs and Super-NOWs: Implications for Defining and Measuring Money," Federal Reserve Bank of Kansas City *Economic Review* (January 1983), pp. 3–18. On the absence of effects from the late 1982 and early 1983 innovations, see John A. Tatom, "Money Market Deposit Accounts, Super-NOWs and Monetary Policy," this *Review* (March 1983), pp. 5–16.

[11]The currency preferences argument also appears to confuse money and other financial assets. While the foreign demand for U.S. financial assets has risen dramatically, especially in 1980 and 1981, foreign ownership of money has not. Estimates based on individual, partnership and corporate deposits show essentially no change in the less than 2.5 percent of gross demand deposits due to foreign holders for December data from 1978 through 1982. Similarly, bank demand liabilities to foreigners, including all foreign banks or excluding foreign financial institutions, have shown no tendency to increase since 1979. *Federal Reserve Bulletin* (May 1983), p. A25 and p. A59.

unit of real money balances (m). An income elasticity of demand for money less than one will yield procyclical velocity; for example, a 1 percent decline in real income will induce a smaller reduction in the demand for real money balances. As a result, velocity, x/m, will fall during a recession, other things held constant.[12]

Lagged Adjustment of GNP to Monetary Growth

Velocity also typically falls in recessions due to the link between nominal GNP growth and money growth. The growth rate of nominal GNP is determined primarily by the growth rate of the money supply. There are lags, however, in the response of nominal GNP to changes in money growth. When money growth slows, GNP growth initially slows by less; thus, velocity growth rises. Within a few quarters, however, the effect of the slowing in money growth is reflected in further reductions in GNP growth so that, while GNP growth continues to slow and money growth does not, velocity growth falls.

Furthermore, the monetary theory of the business cycle indicates that, after some time (about two quarters), a substantial decline in the money growth will cause a recession. The periods of falling velocity growth associated with a slowing in money growth coincide with the period of recession induced by a slowing in money.[13]

The pattern of money growth over the last two years bears out this type of movement. Table 2 shows the growth rates of M1 and velocity for the period from III/1980 to IV/1982. During quarters in which money growth accelerated, such as III/1980, II/1981, I/1982 and IV/1982, velocity growth was negative. Moreover, these periods followed unusually slow money growth, such as in the second half of 1981 and in II/1982. In periods when velocity growth slowed, including III/1980, II/1981, IV/1981, I/1982, III/1982 and IV/1982, the slowing was due in part to the contemporaneous acceleration in money growth and in part to the adverse reactions of GNP growth to past slowings in money growth.

Table 2

Recent Growth Rates of the Money Stock (M1) and Its Velocity

Quarter	Money	Velocity
1980/III	16.9%	−6.2%
IV	9.8	5.2
1981/I	5.0	14.8
II	9.2	−2.5
III	3.1	9.8
IV	3.3	0.4
1982/I	11.0	−11.2
II	3.3	3.3
III	6.3	−3.4
IV	13.7	−9.9

The Course of Inventory Adjustment

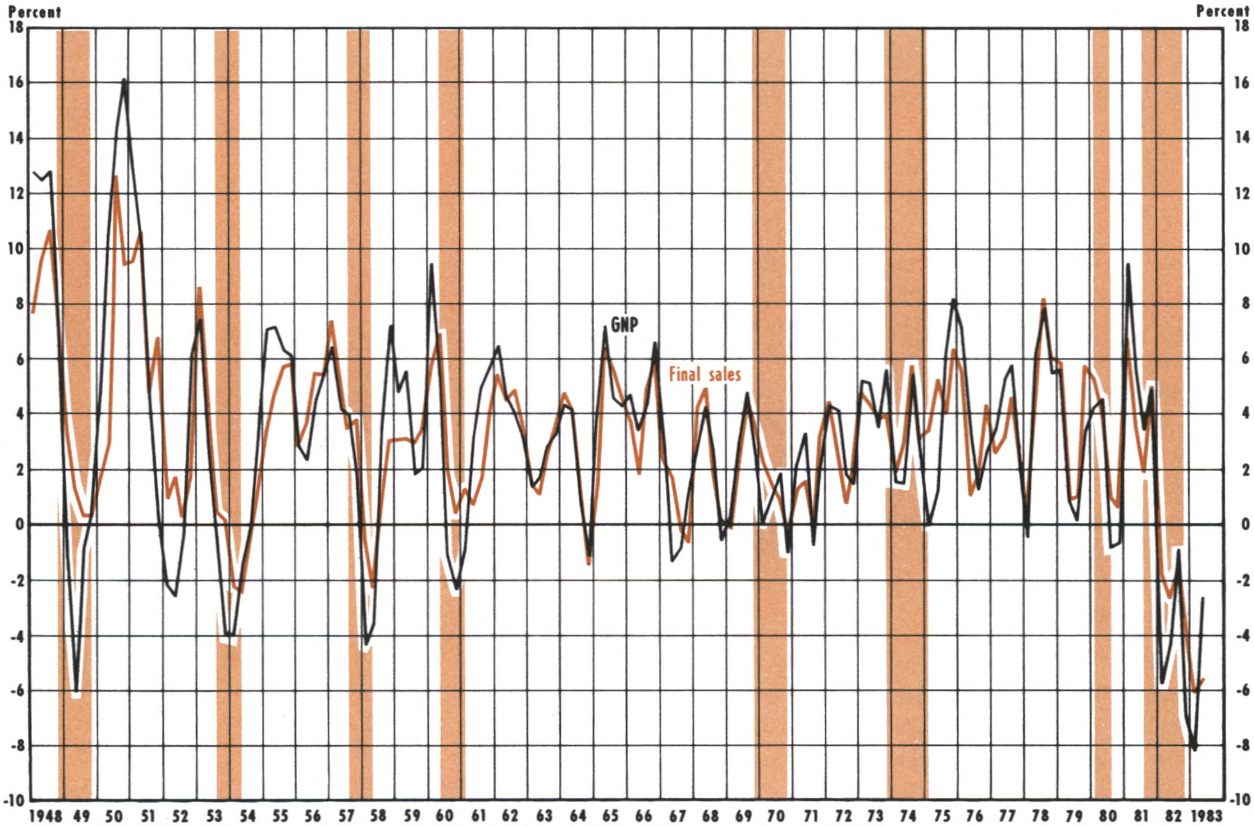
When sales growth slows in the late stage of a cyclical expansion or the early stage of a recession, firms may either fail to anticipate the decline, anticipate that the decline is more temporary than is the case, or simply choose to adjust production growth more slowly. In each event, firms would fail to reduce production as much as sales fell, thus accumulating undesired inventories. Since inventory investment, whether desired or not, is included in spending on final goods and services, GNP can be temporarily strong compared with desired spending, or GNP velocity can be raised relative to final sales (GNP less inventory investment) velocity.

Similarly, when sales expand in the late stages of a recession or early stages of recovery, firms may not anticipate the expansion, anticipate that it is only tem-

[12]Milton Friedman, "The Quantity Theory of Money — A Restatement," in Milton Friedman, ed., *Studies in the Quantity Theory of Money* (University of Chicago Press, 1956), pp. 18–19, explains that the demand for money, in principle, depends on "expected income" or "permanent income." In recessions, measured income or GNP declines relative to permanent income. As a result, money holdings rise relative to measured income or GNP, but not relative to permanent income. Such a movement in money holdings relative to spending also is expected based on a "precautionary motive" for holding money. As "The Failure of Monetarism" notes, "In a weak economy, fear of losing one's job is a strong incentive for keeping a larger amount of money in a checking account in order to get at it quickly" (p. 64).

[13]The theory that velocity declines relative to trend during a recession because of the same slowing in money growth that causes the recession was developed and subjected to one of its first tests by Clark Warburton, "The Theory of Turning Points in Business Fluctuations," *Quarterly Journal of Economics* (November 1950), pp. 529–49. See also Milton Friedman, "A Theoretical Framework for Monetary Analysis," in Robert J. Gordon, ed., *Milton Friedman's Monetary Framework* (University of Chicago Press, 1974), pp. 1–62. Friedman provides a theory of nominal income in which velocity is procyclical due to deviations of monetary growth from the expected growth of nominal income (see especially pp. 38–48). He also indicates that this result is reinforced by deviations in money supply growth from growth in the demand for money (pp. 51–53).

Chart 2
Growth Rates of GNP Velocity and Final Sales Velocity [1]



[1] GNP velocity is GNP/M1. Final sales velocity is final sales/M1. The growth rates are annualized two-quarter changes in the logarithm.
Shaded areas represent periods of business recessions.

porary, or simply engage in production smoothing; thus, they initially will meet the sales increase out of inventory rather than stepped-up production. In this case, GNP will not keep pace with final sales, so that velocity measured relative to GNP will fall compared with velocity measured relative to final sales.

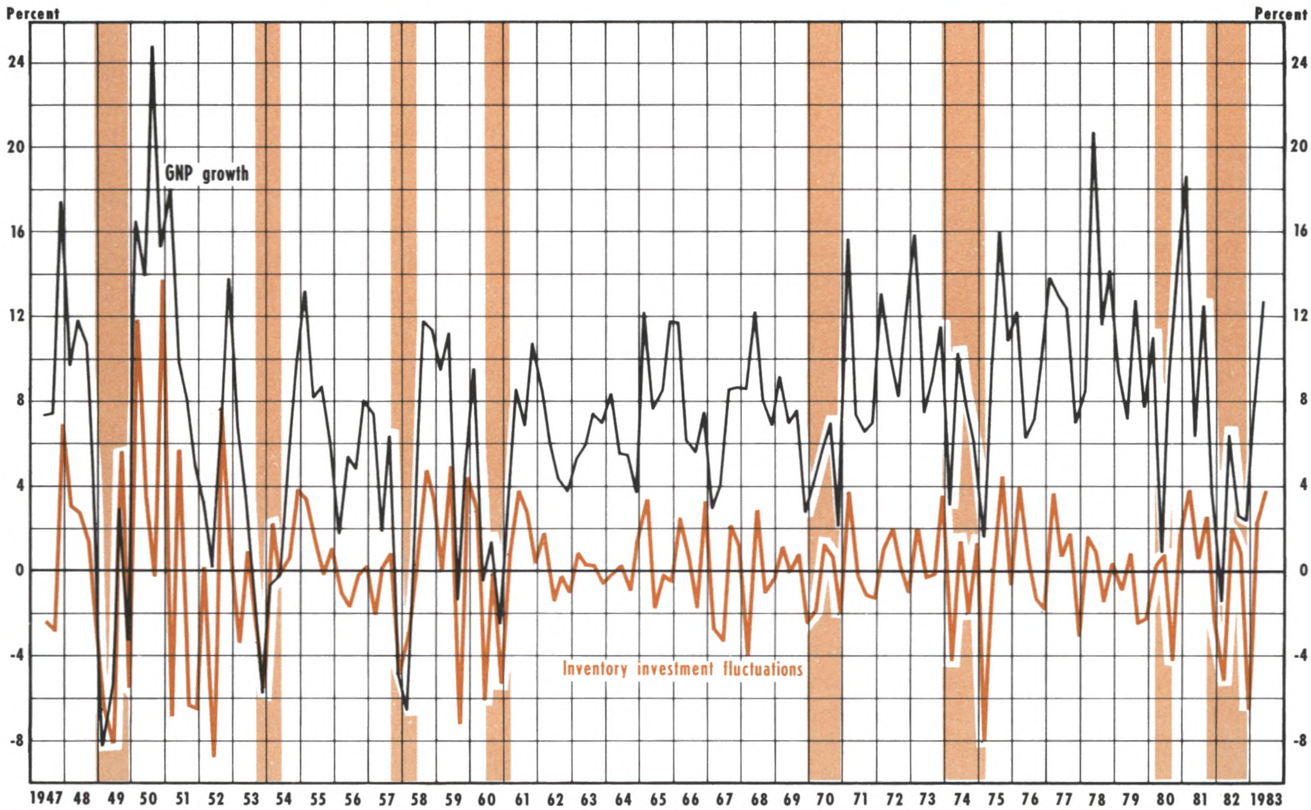
Chart 2 shows the growth rates of GNP velocity and final sales velocity since 1948. Two-quarter periods are used to smooth the data somewhat. The average growth rates of the two series from I/1948 to II/1983 are nearly identical (3.17 percent for GNP and 3.18 percent for final sales). The two measures of velocity growth are fairly similar except around the end of the shaded recession periods and the beginning of the recoveries. At these times, much wider swings occurred in GNP velocity due to inventory adjustments.[14]

Table 3
Recent Developments in Real Inventory Investment, Output and Sales

Quarter	Real inventory investment	Real GNP growth rate	Real final sales growth rate
1981/IV	$ 6.0	−4.9%	−2.3%
1982/I	−10.2	−5.5	−1.3
II	−3.4	0.9	−0.9
III	−1.3	−1.0	−1.5
IV	−22.7	−1.3	4.5

[14]For a discussion of the importance of inventory movements before, during and after recessions, see John A. Tatom, "Inventory Investment in the Recent Recession and Recovery," this *Review* (April 1977), pp. 2–9. Also, Frank DeLeeuw, "Inventory Investment and Economic Instability," *Survey of Current Business* (December 1982), pp. 23–31, provides evidence of this greater volatility of production and demonstrates that the source of this "instability" is producers' lagged responses to changes in demand, especially in the adjustment of goods in process and material inventories.

Chart 3
Contribution of Inventory Investment Fluctuations to GNP Growth [1]



[1] GNP growth and inventory investment fluctuations are annualized quarterly changes in the logarithm.
Shaded areas represent periods of business recessions.

The recent divergence in the two measures of velocity growth is large, because of the sharp swings in inventory investment in the first and fourth quarters of 1982. Table 3 shows real inventory investment from the preceding peak to the end of 1982, as well as real final sales and real GNP growth. The pace of inventory reductions in both the first and fourth quarters of 1982 (−\$10.2 billion and −\$22.7 billion (1972 prices), respectively) are among the largest on record, with the latter exceeding the previous record of −\$14.3 billion in early 1975. In both of these quarters, real final sales growth accelerated. Each of these sales accelerations was associated with a sharp acceleration to double-digit money growth (see table 2). In each case, the improvement in real sales was met out of inventory, indicating either that producers failed to anticipate the improvement, or that they were willing to treat it as an opportunity to eliminate undesired inventory, allowing production growth to rise more smoothly.

As noted above, GNP growth is more volatile than that of real final sales due to relatively large swings in inventory investment. On average, these swings should cancel out so that GNP growth matches final sales growth. One way to assess the contribution of inventory swings to GNP growth is to decompose GNP into the product of two components: S and $(1+I/S)$, where S is final sales and I is the change in business inventories. The growth rate of nominal production ($400\ \Delta\ln$ GNP) can be broken down into a component that arises from the growth of sales and a second component, the production growth which meets changes in the ratio of inventory investment to final sales [$400\ \Delta\ln\ (1+I/S)$]. Chart 3 shows this second component along with total GNP growth from 1947 to the second quarter of 1983.

On average, the growth rate of production matches that of final sales; the contribution of inventory swings [$400\ \Delta\ln(1+I/S)$] is essentially zero (−0.01 percent), though it ranges widely from about −8.8 percent to 13.5 percent in some quarters. The most pronounced effects are in recessions, when large negative effects are registered, and in the initial stages of recovery, when some of the large positive contributions of the end of inventory depletions are evident. Not surprisingly, the negative effects of inventory depletion in the first and fourth quarters of 1982 are among the largest negative effects shown in chart 3.

WAS VELOCITY GROWTH IN 1982 REALLY AN ABERRATION?

Weak or negative velocity growth is common during recessions because of (1) the influence of the transitory reduction in GNP with its smaller attendant reduction in the demand for money, (2) the pattern of money growth that usually gives rise to the recession, and (3) inventory adjustments that typically depress production relative to sales before or during the initial stage of a recovery.

To assess the cyclical nature of velocity, one must account for the strong trend in its growth rate, as well as several transitory or, perhaps, permanent effects arising from monetary and fiscal policy changes and other shocks. The direct cyclical component of velocity is captured by relating the level of velocity to the GNP gap, the percentage by which the nation's potential output exceeds its actual real GNP.[15] An increase in the GNP gap reflects a decline in real income relative to potential output. Its effect on velocity indicates the operation of the income elasticity of money demand and captures, in part, the transitory effect of cyclical inventory movements on observed GNP.

It is well-known that current GNP growth depends on past as well as current monetary policy actions. Because the demand for goods and services responds with a lag, current GNP or velocity measures are subject to temporary movements arising from changes in money growth. Fiscal policy also can influence GNP; a fiscal measure, specifically the growth rate of high-employment federal expenditures, is included in the velocity equations below.[16]

There are other factors that influence velocity, especially the opportunity cost of holding money instead of other assets. An increase in the cost of holding money reduces the demand for it and raises velocity, other things being equal. A major component of the cost of holding transaction balances is the rate of depreciation of the value of money, or the general rate of increase of prices. In addition, other assets can be held instead of money so that the real rate of return on alternative investments influences the decision to hold money. Given the expected inflation rate, movements in nominal interest rates reflect movements in real rates of return.

Velocity, then, is hypothesized to be a function of (1) current and past levels of the money stock (M) and high-employment expenditures (E); (2) inflation expectations, which, if expectations are unbiased, can be measured by changes in the rate of increase of the GNP deflator (P); (3) the rate of interest, in this instance, measured by the Aaa bond yield (r); and (4) slack, measured by the GNP gap. Two other factors that affect GNP at least temporarily — strikes that temporarily affect production and spending (S), measured by days lost due to strikes relative to the size of the civilian labor force, and movements in the relative price of energy (p^e), measured by the producer price of fuel and related products and power deflated by the business sector implicit price deflator — are included.

Estimating Velocity Growth

To find the historical relationship of velocity growth to these factors, differences in logarithms are used to measure growth rates, in which case the variable is expressed with a dot above it.[17] An estimate for veloc-

[15]The GNP gap (G) is measured here by the difference in the logarithm of each series. This Bank's potential output series is used to measure the gap. It is explained in John A. Tatom, "Potential Output and the Recent Productivity Decline," this *Review* (January 1982), pp. 3–16. Changes in the GNP gap are highly correlated with other cyclical measures such as changes in measures of the capacity utilization rate or unemployment rate, so that they can often be used interchangeably. For example, the simple correlation coefficient between quarterly changes in the unemployment rate and the GNP gap is 0.70 over the period III/1948–III/1981.

[16]The inclusion of lagged effects of monetary and fiscal policy is based on the Andersen-Jordan equation for GNP growth. See Keith M. Carlson, "A Monetary Analysis of the Administration's Budget and Economic Projections," this *Review* (May 1982), p. 14; and John A. Tatom, "Energy Prices and Short-Run Economic Performance," this *Review* (January 1981), pp. 3–17. The latter suggests the inclusion of some other factors that are discussed below. Lagged adjustment to money supply changes has also been emphasized recently by Jack Carr and Michael R. Darby, "The Role of Money Supply Shocks in the Short-Run Demand for Money," *Journal of Monetary Economics* (September 1981), pp. 183–99. An earlier formulation and test of this hypothesis may be found in Leonall C. Andersen, "Observed Income Velocity of Money: A Misunderstood Issue in Monetary Policy," this *Review* (August 1975), pp. 8–19. The results here have the same properties and policy implications as the Andersen-Jordan equation.

[17]Arithmetically, velocity growth in a quarter is the sum of the rates of increase of prices and real output, less the growth rate of money during the quarter. Thus, the strong significance of these factors on the right-hand-side of equation 4 is not surprising. The use of accelerations in money and prices reduces biases arising from the arithmetic relationship. The fact that the coefficients on contemporaneous money, gap and inflation are significantly different from unity reinforces the explanatory power of the equation. The simple correlation coefficients between $\Delta\dot{M}$, ΔG and $\Delta\dot{P}$ are ($\Delta\dot{M}$, ΔG) -0.08, ($\Delta\dot{M}$, $\Delta\dot{P}$) -0.03, and (ΔG, $\Delta\dot{P}$) -0.06. Biases arising from the arithmetic relationship do not appear to be a substantial problem for the interpretation or quality of the regression reported in table 4.

Table 4

A Model of GNP Velocity Growth: III/1948–III/1981

$$\dot{V}_t = \underset{(9.49)}{3.825} - \underset{(-11.10)}{0.801}\,\Delta\dot{M}_t - \underset{(-6.44)}{0.555}\,\Delta\dot{M}_{t-1} - \underset{(-3.80)}{0.371}\,\Delta\dot{M}_{t-2}$$

$$- \underset{(-2.79)}{0.248}\,\Delta\dot{M}_{t-3} - \underset{(-2.22)}{0.188}\,\Delta\dot{M}_{t-4} + \underset{(2.74)}{0.032}\,\dot{E}_t$$

$$- \underset{(-0.41)}{0.005}\,\dot{E}_{t-1} - \underset{(-2.46)}{0.029}\,\dot{E}_{t-2} - \underset{(-3.85)}{0.004}\,\dot{E}_{t-3} - \underset{(-15.88)}{0.855}\,\Delta G$$

$$+ \underset{(1.16)}{0.015}\,\dot{r}_t + \underset{(6.96)}{0.443}\,\Delta\dot{P}_t - \underset{(-4.13)}{0.248}\,\Delta S_t - \underset{(-2.08)}{0.040}\,\dot{p}^e_t$$

$$- \underset{(-1.39)}{0.030}\,\dot{p}^e_{t-1} + \underset{(3.40)}{0.077}\,\dot{p}^e_{t-2}$$

$\bar{R}^2 = 0.80$ SE = 1.94 DW = 2.01 $\hat{\rho} = 0.45$ ($t = 5.81$)

ity growth from III/1948 to III/1981 is given in table 4.[18] The coefficients on the monetary growth terms indicate the cumulative sum of the effects of a rise in $\dot{M}$ on velocity growth.[19] Thus, an acceleration in money growth in period t by 1 percent initially reduces velocity growth in period t by 0.8 percent; subsequently, velocity growth is depressed by less: 0.6 percent one quarter later, 0.4 percent two quarters later, then 0.2 percent, 0.2 percent and, five quarters later, not at all. If velocity had been growing at 3.8 percent, assuming all other influences remain the same, such a sustained increase in money growth would yield a series of velocity growth rates that fell and then rose: 3.0 percent, initially, then 3.2 percent, 3.4 percent, 3.5 percent, and 3.5 percent, before returning to 3.8 percent five quarters later. There is no permanent effect of money growth on velocity growth, only transitory effects that disappear after five quarters.

The effect of the GNP gap on velocity is highly significant: each 1 percent increase in the gap reduces velocity by almost 0.9 percent. An increase in high-employment federal expenditures initially raises velocity, then reduces it. Energy price increases initially reduce velocity, then raise it, other factors remaining the same.[20] An increase in inflation significantly and permanently raises the level of velocity. The interest rate is not significant at conventional levels, but is included since it has the expected sign and a t-statistic that is greater than one.[21] Finally, strikes temporarily reduce velocity.[22]

Velocity Growth in the Recent Recession

When velocity growth is simulated for the 1981–82 recession, the equation tracks the actual developments quite well (see table 5). Despite the sharp reductions in velocity in the first and fourth quarters of 1982, unusual errors do not result. While undue attention to every wiggle in velocity growth is clearly to be avoided, it is worth noting that the record movements in inventories during these two quarters and their

[18]Long lag searches (up to 20 quarters for money and federal expenditure growth) were conducted for a sample period I/1955–III/1981, because data limitations are too great for the period beginning in III/1948. The optimal lag structure, chosen by F-tests of sequential addition of individual lags and groups of lags, was the same as that used here.

[19]Suppose that $\dot{V}_t = \beta_0\dot{M}_t + \beta_1\dot{M}_{t-1} + \ldots + \beta_n\dot{M}_{t-n}$; then $\dot{V}_t = \beta_0\Delta\dot{M}_t + (\beta_0+\beta_1)\Delta\dot{M}_{t-1} + \ldots + (\sum_{i=0}^{n-1}\beta_i)\Delta\dot{M}_{t-n-1} + (\sum_{i=0}^{n}\beta_i)\dot{M}_{t-n}$. If the permanent effect of a rise in $\dot{M}$ on $\dot{V}$ is zero, the last term vanishes. In the equation in table 4, the absence of a permanent effect can be tested by adding the money growth rate lagged five quarters to the equation. When this is done, its coefficient (−0.103) is not significantly different from zero (t = −0.78). Consequently, this permanent effect is constrained to zero in table 4 and for the examination of the recent experience. The coefficients on the $\Delta\dot{M}$ terms are estimated to lie along a second-degree polynomial without endpoint constraints. The F-statistic for the polynomial restriction is $F_{2,116} = 2.47$, so that the polynomial restrictions cannot be rejected.

[20]The sum of the federal expenditure effects on velocity is −0.047 and it is not significantly different from zero (t = 1.68). The sum of the energy price effects, 0.007, is also insignificant (t = 0.24). High-employment expenditures and energy prices have no permanent effect on velocity.

[21]When a short-term interest rate, the 4- to 6-month commercial paper rate, is used instead of the Aaa bond yield, its insignificant (t = 0.78) coefficient is 0.003. Otherwise, the equation estimates are virtually identical. Allowing the interest elasticity of velocity to be a positive function of the interest rate, by using Δr rather than Δln r, resulted in a higher standard error of estimate for both long- and short-term rates. For both rates, moreover, the coefficient reverses sign and the t-statistic falls below one-half. The small t-statistic reported for r in table 4 does not result from collinearity with changes in the inflation rate; the correlation coefficient of these two variables is virtually zero (−0.007).

[22]The model shown in table 4 can also be used successfully for final sales velocity growth, except that strikes, interest rates, and contemporary energy price changes do not affect it significantly. The model has the same properties; money growth, high-employment expenditure growth, and changes in the relative price of energy do not have significant permanent impacts on final sales velocity. The adjusted $\bar{R}^2$ of the final sales velocity growth rate is 0.46 over the period used in table 4. This equation is stable across the IV/1973 and III/1981 breakpoints at a 95 percent confidence level.

The gap coefficient in the final sales equation is much smaller (−0.44), indicating that the cyclical component of GNP velocity is capturing some of the inventory adjustment. A decomposition shows that money growth accounts for most of the sharp negative swings of GNP velocity growth, however.

Table 5

Simulating GNP Velocity Growth in the Recent Recession[1]

One-quarter period ending	Actual velocity growth	Simulated velocity growth	Error
1981/IV	0.43%	0.88	−0.45
1982/I	−11.86	−9.57	−2.29
II	3.24	0.79	2.25
III	−3.43	0.29	−3.71
IV	−10.43	−7.83	−2.60
III/1981–IV/1982	−4.41	−3.09	−1.32
		Root-mean-squared error 2.53	

[1]Growth rates are expressed as 400 times the change in the logarithm of velocity.

Table 6

Factors Accounting for Velocity Growth: III/1981–IV/1982[1]

Direct Contribution of:	
Constant	3.9%
Cycle	−4.9
Variations in money growth	−0.7
Inflation changes	−0.5
Interest rate changes	−0.3
High-employment federal expenditure growth	−0.3
Energy price shocks	−0.1
Strike activity	0.0
Unexplained residual	−1.3
TOTAL	−4.3%

[1]Based on table 4 coefficients and actual changes in the factors influencing velocity. The results are converted to compounded annual rates. Total does not add due to rounding.

impact on production and velocity are captured surprisingly well. The mean error for the recession period (1.32 percent) and the root-mean-squared error (2.53 percent) are not at odds with the quality of the errors characterizing the prior behavior of velocity growth, indicated by the equation's standard error of 1.94 percent.[23]

When the equation in table 4 is re-estimated for the longer period to IV/1982, the F-statistic that is used to test for a structural change between the earlier period and the latest five recession quarters is $F_{5,123} = 1.55$, which is not significant at a 95 percent confidence level. This F-test and the evidence in table 5 indicate that the historically weak performance of velocity in the recent recession is not unusual; that is, it has resulted from the normal working of factors that tend to depress GNP velocity in recessions, not from a major breakdown of past relationships.[24]

The coefficients in the velocity growth equation can be used to decompose the simulated growth rates into the direct contribution of each variable during the recent recession.[25] The results for the recent recession period appear in table 6. The primary factor accounting for the decline was the normal cyclical response to the transitory decline in income associated with the recession; this effect, measured by the change in the GNP gap and indicated in the table as the "cycle" influence, was −4.9 percent. The second major factor was the transitory effect arising from variations in money growth before and during the recession. Since the primary determinant of the decline in real output or the size of the GNP gap is the pattern of past monetary growth, the lion's share of the recent behavior of velocity is directly or indirectly attributable to the volatile path of monetary growth.

Other factors played minor roles. In particular, declining inflation and declining interest rates each con-

[23]The equation in table 4 can be used to generate simulations for velocity growth in earlier recessions (see table 1) on a comparable basis. When this is done, the direction of the velocity movement in each of the seven previous recessions is accurately simulated; the mean absolute error for these seven recessions is 1.07 percent.

[24]The equation in table 4 is stable according to a Chow test. Also, when the sample period is broken at the fourth quarter of 1973, the F-statistic is $F_{15,103} = 1.45$, which is not significant at a 5 percent significance level.

[25]The major controversy addressed here is the velocity decline in the recent recession, especially in 1982. In the first quarter of 1983, velocity fell at a 5.75 percent compounded annual rate. The decline, while substantially smaller in size than those in the first and fourth quarters of 1982, is noteworthy for its size in the absence of a major swing in the contribution of inventory liquidations. Indeed, while real inventory investment remained negative, \$−15.4 billion (1972 prices), the contribution of inventory investment to GNP growth was positive, +2.3 percentage points, since the pace of liquidation slowed. More important, when the velocity model is used to make a one-quarter-ahead forecast from IV/1982, the predicted velocity growth rate is −0.9 percent. Thus, the error in I/1983 is significantly larger (2.5 times larger) than the standard error of the estimating equation. None of the F-test results or conclusions about the five-quarter simulation experiment in table 5 are altered if the first quarter of the recovery is included, however.

tributed 0.5 percentage points or less to the decline. Nonetheless, these other factors amplified the decline somewhat.[26]

CONCLUSION

The velocity of money fell sharply in the recent recession, suggesting to some observers at least that the relationship of the money stock to total spending had broken down. Indeed, many observers went on to posit new hypotheses concerning the reasons for the velocity decline such as financial innovations, foreigners' attractions to dollar assets, or unusually strong reactions to the slowing of the U.S. inflation rate or interest rates. Upon closer scrutiny, however, the timing and magnitude of these developments do not match up well with velocity developments in the recent past.

The velocity decline does appear, superficially, to represent a major break from past experience and, therefore, to be a source of concern for policymakers. After all, in 1982 velocity fell at a 2.3 percent rate (year over year) after rising at a 3.2 percent average rate over the previous 22 years, suggesting a shortfall of 5.5 percentage points. On a quarter-to-quarter basis, the decline in velocity during the recent recession was even larger.

It is not unusual, however, for velocity to decline in a recession. It is, in fact, quite typical. Short-term movements in velocity reflect diverse reactions of the economy to monetary policy actions. In a recession, all of these reactions generally contribute to a temporary decline in velocity. Given the length and severity of the recent recession, where the severity is measured by the unemployment rate or the gap between the nation's potential and actual real GNP, it is not surprising that velocity registered the largest decline in post-World War II recessions.

A detailed development of the standard hypotheses concerning velocity behavior, including the transitory influences of monetary growth, fiscal policy, and energy price shocks on observed spending and velocity, suggests an empirical formulation that accounts well for velocity behavior in the post-World War II era. More important, simulations of this historical experience for the recent recession indicate that there were no significant breakdowns in the relationship of the factors accounting for velocity behavior.

In a previous study of velocity movements, Andersen concluded that "the use of observed changes in velocity growth, by themselves, in conducting monetary policy is often misleading and potentially dangerous."[27] This conclusion is perhaps most important surrounding recessions and the early stages of recovery when velocity movements are so strongly influenced by the temporary effects of past monetary actions.

Monetary growth tends to be most variable around a period of recession, especially when a sizable decline initially sets off the recession itself. Such a variation in money growth creates temporary movements in velocity; not only is the supply of money in flux, but real output is as well, as the demand for money adjusts to the money supply variation. Variations in real output and velocity are further enlarged temporarily by inventory adjustments.

In the recent recession, these processes were magnified by the degree and extent of monetary stringency during some periods prior to the recession. As a result, the normal cyclical movement of money demand was large, and swings in inventory investment further distorted, temporarily, the movements of velocity. Other factors, including the temporary decline in inflation and movements in interest rates, federal expenditures and energy prices all worked in the same direction, reducing velocity in the recent recession. Thus, the extent of the decline in velocity in the recent recession was not unusual, nor did it represent an atypical shift with important, but unknown, implications for policymaking.

[26]Interestingly, compared with the previous seven postwar recessions, the cyclical component was not unusually large in the recent recession. The cyclical contribution (compounded annual rate from cycle peak to trough) in the seven recessions from 1948–49 to 1980 is estimated to be −5.4 percent, −5.2 percent, −5.1 percent, −2.9 percent, −3.0 percent, −4.7 percent and −5.0 percent, respectively. Four of the previous seven effects exceed the recent cyclical effect.

[27]Andersen, "Observed Income Velocity of Money," p. 19.

Monetary Growth and the Timing of Interest Rate Movements

W. W. BROWN and G. J. SANTONI

IT IS widely believed that market interest rates follow a particular time path in response to changes in the rate of monetary growth. This time path is important because interest rates are thought to be one of the conduits of monetary policy.

In particular, an unanticipated but permanent increase in the monetary growth rate will presumably lower market interest rates, temporarily resulting in a reshuffling of resources among competing uses. As a consequence, an economy characterized by slack will be pushed to a permanently higher level of aggregate demand, employment, output and, eventually, higher market interest rates as a result of the monetary stimulus.

The length of the time path followed by interest rates reveals information concerning the lag in monetary policy's effect. Curiosity about this provided the initial motivation for earlier empirical investigations.[1] This paper discusses the theoretical argument and examines some evidence regarding the response of interest rates to changes in monetary growth.

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[1]William E. Gibson, "Interest Rates and Monetary Policy," *Journal of Political Economy* (May/June 1970), pp. 431–55; Burton Zwick, "The Adjustment of the Economy to Monetary Changes," *Journal of Political Economy* (January/February 1971), pp. 77–96. Phillip Cagan, *Changes in the Cyclical Behavior of Interest Rates* (National Bureau of Economic Research, Occasional Paper 100, 1966); William E. Gibson and George E. Kaufman, "The Sensitivity of Interest Rates to Changes in Money and Income," *Journal of Political Economy* (May/June 1968), pp. 472–78; Phillip Cagan and Arthur Gandolfi, "The Lag in Monetary Policy as Implied by the Time Pattern of Monetary Effects on Interest Rates," *The American Economic Review, Papers and Proceedings* (May 1969), pp. 277–84; Phillip Cagan, *The Channels of Monetary Effects on Interest Rates* (National Bureau of Economic Research, 1972); Michael Melvin, "The Vanishing Liquidity Effect of Money on Interest: Analysis and Implications for Policy," *Economic Inquiry* (April 1983), pp. 188–202.

THE THEORY

Equation 1 breaks the nominal interest rate, i, into its two components: the *ex ante* real interest rate, r, and the expected rate of inflation, $\dot{P}_e$.

$$(1)\ i = r + \dot{P}_e$$

The waxing and waning of the effects of a change in monetary growth on each of these components generates the time path followed by the nominal rate. An unanticipated change in monetary growth initially affects the *ex ante* real rate of interest; this is called the "liquidity effect."[2] The permanent change in monetary growth, once it is known, affects the expected rate of inflation and is called the "Fisher effect."

The Liquidity Effect

The theoretical argument concerning the liquidity effect typically runs as follows: an unanticipated increase in the monetary growth rate results initially in an excess supply in the money market at the existing nominal rate of interest. Part of this excess shows up as an increase in the demand for securities. The prices of securities are bid up, and nominal yields decline until the market clears.[3]

[2]Traditionally, the term "liquidity effect" was used to describe the impact of an unanticipated change in the stock of money on interest rates. More recently, however, the term has been applied to the *initial* effect on interest rates of an unanticipated change in the stock of money induced by an unanticipated change in the monetary growth rate. We have adopted the more recent usage of the term in this paper. Milton Friedman, "Factors Affecting the Level of Interest Rates," *Money Supply, Money Demand, and Macroeconomic Models*, J. T. Boorman and T. M. Havrilesky, eds. (Allyn and Bacon, Inc., 1972), pp. 205–06.

[3]See, for example, Cagan, *The Channels of Monetary Effects*. Note, particularly, that "the first round effects of money creation are ignored . . . ." (p. 85)

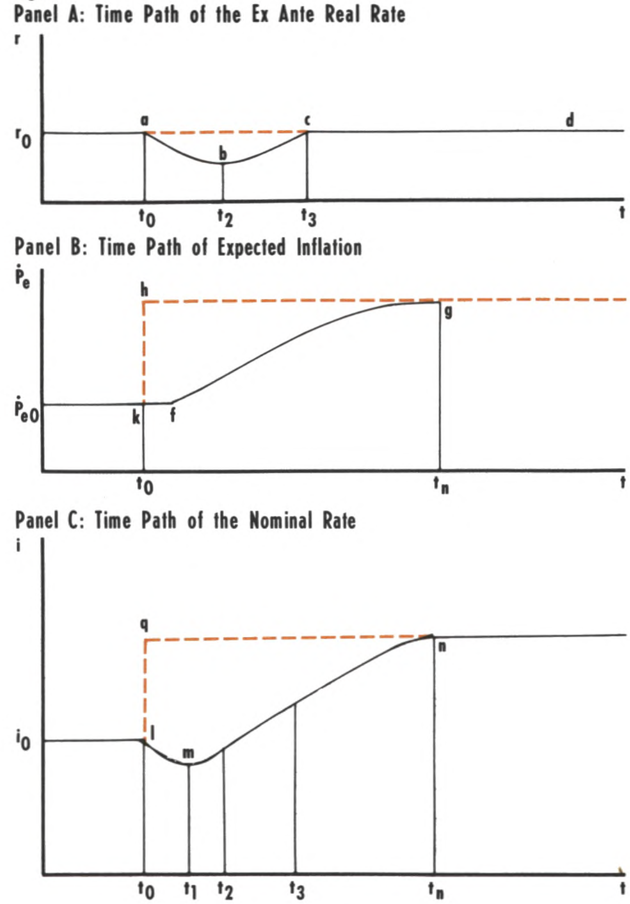
Coincident with the downward movement of nominal yields in the loanable funds market is a reduction in the *ex ante* real rate of interest in the goods market. The result is that investment demand is stimulated and saving out of current income is reduced. The contention is that real investment and consumption rise, stimulating economic activity. The excess demand for real present resources that follows from this decline in the *ex ante* real rate is made up by "the flow of funds supplied out of the discrepancy between actual and desired money balances. . . ."[4]

After a sufficient time, the excess supply in the money market is eliminated by an expansion in nominal income. This expansion raises the demand for money, reverses the liquidity effect and returns the *ex ante* real interest rate to its original level.

The Fisher Effect

A permanent increase in the monetary growth rate will result in a permanently higher rate of inflation, ceteris paribus. Since lending contracts typically specify fixed nominal payment streams, a higher nominal rate will be required to compensate lenders for the increased rate of depreciation expected to occur in the real value of their receipts. If credit market participants acquire information regarding the permanently higher rate of inflation with a lag, the convergence of the nominal rate upon a higher level will occur gradually with a corresponding lag.

Figure 1



An Illustration of the Time Path

Figure 1 depicts hypothesized time paths of the *ex ante* real rate of interest, r (panel A), the expected rate of inflation, $\dot{P}_e$ (panel B), and the nominal rate of interest, i (panel C), that result from an unanticipated and permanent increase in the monetary growth rate beginning at time t_0.

Assuming that the expected rate of inflation and the price level do not immediately adjust to the change in monetary growth, the *ex ante* real rate of interest moves along a path like abc and remains below its initial level until time t_3. The liquidity effect is illustrated by the movement from a to b; the expansion effect is shown by the movement from b to c.

Panel B of figure 1 illustrates the time path of the expected rate of inflation. Given the lag in the acquisition of information concerning the permanently higher rate of monetary growth, the expected rate of inflation is presumed to adjust along a path like kfg. This is the Fisher effect.

Panel C presents the time path of the nominal interest rate. It is derived by adding the time path of the expected rate of inflation to the time path of the *ex ante* real rate of interest as suggested by equation 1 to obtain the path lmn. Note that the nominal rate reaches a minimum in period t_1, which is both higher and occurs earlier than the minimum of the *ex ante* real rate.

The path of the nominal rate depends on how swiftly the expected rate of inflation responds.[5] It is possible

[4]*Ibid.*, p. 87.

[5]We assume that nominal rates adjust perfectly to changes in expected inflation as suggested by Fisher's theory. For further discussion of this issue, see John A. Carlson, "Short-Term Interest Rates as Predictors of Inflation: Comment," *American Economic Review* (June 1977), pp. 469–75; Jan Walter Elliot, "Measuring the Expected Real Rate of Interest: An Exploration of Macroeconomic Alternatives," *American Economic Review* (June 1977), pp. 429–44; Eugene F. Fama, "Short-Term Interest Rates as Predictors of Inflation," *American Economic Review* (June 1975), pp. 269–82.

that the nominal rate will fail to decline in response to an increase in the monetary growth rate even though the *ex ante* real rate does. In the extreme, if expectations and the price level were to adjust perfectly and instantaneously to the permanent increase in monetary growth at t_0, there would be no liquidity effect. An excess supply of money, which is a precondition for the operation of a liquidity effect, would not exist. The expected rate of inflation and the nominal rate would move along the paths khg and lqn, respectively.

AN ECONOMIC CONSTRAINT ON THE TIME PATH

Theory provides little guidance in identifying the actual time paths that are followed by the nominal and *ex ante* real interest rates. This can only be resolved empirically. The time paths that interest rates follow when adjusting to a change in monetary growth will be constrained, however, by the wealth-maximizing behavior of individuals. The time paths must be such that they cannot be predicted (*ex ante*) by market participants.

Efficient Markets and the Response of the Nominal Rate

On an intuitive level, a systematic and predictable relationship between the nominal interest rate and changes in the monetary growth rate that are *known* to be permanent (like that shown by the path lmn in panel C of figure 1) may imply that profitable trading opportunities are left unexploited by financial market participants.[6] If transaction costs are low relative to the predicted change in the value of the security traded, selling, and selling short at t_0, will result in trading profits. Naturally, such trading would tend to eliminate the lag in the adjustment of nominal interest rates, causing the time path to move toward one like lqn.[7]

The acquisition of new information, of course, is costly and these costs may increase with the rate of acquisition. Under these circumstances, interest rates will adjust to changes in monetary growth with a lag. The length of the lag will depend upon the relative costs and benefits of acquiring information more rapidly.

Efficient Markets and the Path of the Real Rate

Since the *ex ante* real rate of interest reflects the value of present consumption (short-lived, nondurable goods) relative to future consumption (long-lived, durable goods), the liquidity effect implies a specific time path of the relative prices of long- in terms of short-lived goods. In particular, the time path of the *ex ante* real rate in panel A of figure 1 suggests that the prices of more durable goods (long-lived assets) rise relative to less durable goods (short-lived assets) from t_0 to t_2, then fall to their "normal" levels from t_2 to t_3.[8]

Our previous comments regarding the limits to profitable bond trading apply as well to the predictability of this U-shaped pattern in the prices of long- and short-lived assets. That is, predictable U-shaped swings in the relative prices of various assets (as implied by the time pattern of the real rate shown in panel A of figure 1) may indicate that profitable trading is possible in

[6]This point was discussed by Fisher in 1896. "If gold appreciates in such a way or in such a sense that he (the ordinary man) expects a shrinking margin of profit, he will be cautious about borrowing unless interest falls; and this very unwillingness to borrow, lessening the demand in the 'money market' will bring interest down." Further, "every chance for gain is eagerly watched. An active and intelligent speculation is constantly going on, which . . . performs a well-known and provident social function for society. Is it reasonable to believe that foresight, which is the general rule, has an exception when applied to falling or rising prices?" Irving Fisher, "Appreciation and Interest," *Publications of the American Economic Association* (August 1906), pp. 36–37.

[7]Eugene F. Fama, "Efficient Capital Markets: A Review of Theory and Empirical Work," *The Journal of Finance*, Papers and Proceedings (May 1970), pp. 383–417; and Frederic S. Mishkin, *A Rational Expectations Approach to Macroeconometrics* (National Bureau of Economic Research, 1983).

[8]As an example, see Milton Friedman's discussion. He reasons that "from a longer-term view, the new balance sheet (of the public) is out of equilibrium, with cash being temporarily high relative to other assets. Holders of cash will seek to purchase assets to achieve a desired structure. This will bid up the price of assets . . . . These effects can be described as operating on 'interest rates,' if a more cosmopolitan interpretation of 'interest rates' is adopted than the usual one which refers to a small range of marketable securities.

"The key feature of this process is that it tends to raise the prices of sources of both producer and consumer services relative to the prices of the services themselves . . . . It therefore encourages the production of such sources (this is the stimulus to 'investment' . . .) and, at the same time, the direct acquisition of services rather than of the source (this is the stimulus to 'consumption' relative to 'savings'). But these reactions in their turn tend to raise the prices of services relative to the prices of sources, this is, to *undo the initial effects* [our emphasis] on interest rates.

"Of course, all these forces operate *simultaneously* [our emphasis] and there are ebbs and flows and not merely movement in one direction." Milton Friedman, "The Lag in Effect of Monetary Policy," in Milton Friedman, ed., *The Optimum Quantity of Money and Other Essays* (Aldine Publishing Co., 1970), pp. 255–56.

these markets. As in financial markets, however, such trading will tend to limit these changes in relative prices to magnitudes that essentially reflect the cost of transacting.[9] In short, the time paths of both real and nominal interest rates will be constrained by the existence of efficient financial and capital markets.[10]

SEARCHING FOR A VALID TEST PERIOD

The conditions that must exist to generate a time path of interest rates like that shown in panel C of figure 1 are not trivial. Since the time path presumably is generated by a monetary policy shock, the institutional environment must be one that allows these shocks to occur. In particular, the operation of a Fisher effect will be especially sensitive to the implications the existing monetary institutions have for the expected duration of changes in the monetary growth rate and the possibility that these changes can be induced by the fiat of the monetary authority. In short, the institutions must be such that exogenously determined changes in the monetary growth rate are possible. In addition, since the liquidity effect depends upon monetary changes being unanticipated, it will operate only during periods in which the monetary authority can cause unpredictable changes in money growth.[11] A precondition of this is that changes in money growth are unrelated to prior movements in other economic variables, particularly, interest rates.

Unfortunately, data concerning anticipated and unanticipated money growth are not directly observable, and we know of no satisfactory method of empirically separating actual money growth into these two components. In addition, it is not generally possible to directly observe the *ex ante* real interest rate. For these reasons, the liquidity effect tends to be confounded by the Fisher effect in empirical tests. However, since one of our main purposes is to discover the lag in the effect of monetary policy as implied by the time path of nominal interest rates, this is not particularly troublesome.

In the following, we examine various historical periods during which different monetary institutions prevailed. Our purpose is to discover a period that will yield a valid test of the hypothesis concerning the time path.

The Gold Standard Period: 1900–29[12]

The Gold Standard Act became law in March of 1900 and remained in force until January of 1934 when it was superseded by the Gold Reserve Act. During this period, the price of gold was fixed at $20.67 per ounce and, equally important, gold circulated as a medium of exchange. Maintenance of this type of gold standard imposes binding constraints on the monetary authorities that prevent them from generating significant and long-lived changes in money growth (in the absence of new gold discoveries or improvements in mining technology). "The stock of money must be whatever is necessary to balance international payments."[13] Hence, any change in the growth rate of money that, if maintained, would cause the future supply of money to deviate from that necessary to maintain the balance of payments and the fixed exchange rate between the dollar and gold must eventually be offset by a change in the opposite direction.

During this period, individuals holding monetary assets, in large part, were insulated from changes in the real value of their assets. Under the gold standard, any unanticipated change in the general level of prices produced by temporary changes in the quantity of money "was likely to reverse or 'correct' itself, i.e.,

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[9]See Frank H. Knight, "Unemployment: And Mr. Keyne's Revolution in Economic Theory," *Canadian Journal of Economics and Political Science* (1937), pp. 112–13; Frank H. Knight, "Capital, Time and the Interest Rate," *Economica* (August 1934), pp. 257–86; Lloyd W. Mints, *Monetary Policy for a Competitive Society* (McGraw-Hill, 1950), pp. 58–70; Gustav Cassel, "The Rate of Interest, the Bank Rate, and the Stabilization of Prices," in *Readings in Monetary Theory* (The Blakiston Company, 1951), pp. 319–33; and Frank H. Knight, *The Ethics of Competition* (Books for Libraries Press, 1969), pp. 273–74.

[10]If the changes in *relative* prices that are described in footnote 8 always follow the same time sequence, it is possible that profitable trades are left unexploited. On the other hand, if "all these forces operate simultaneously," the possibility of wealth increasing exchange is eliminated but so is the time path of the *ex ante* real rate. As it stands, the argument appears to be ambiguous concerning the time path followed by the *ex ante* real interest rate.

[11]Frederic S. Mishkin, "Monetary Policy and Long-Term Interest Rates: An Efficient Markets Approach," *Journal of Monetary Economics* (January 1981), pp. 29–55; Frederic S. Mishkin, "Monetary Policy and Short-term Interest Rates: An Efficient Markets-Rational Expectations Approach," *The Journal of Finance* (March 1982), pp. 63–72; David A. Pierce, "Relationships — and the Lack Thereof — Between Economic Time Series, with Special Reference to Money and Interest Rates," *Journal of the American Statistical Association* (March 1977), pp. 11–22.

[12]To avoid the confounding effects of the depression years, we have omitted them from our analysis.

[13]Milton Friedman and Anna Schwartz, *A Monetary History of the United States 1867–1960* (Princeton University Press, 1963), p. 191.

'average out' over time."[14] Friedman and Schwartz note that ". . . the gold standard ruled supreme when the act (the Federal Reserve Act) was passed, and its continued supremacy was taken for granted. . . ."[15]

Consequently, since changes in monetary growth were arguably viewed as temporary during this period, we would not expect to observe the Fisher effect.

While the gold standard prevented significant and long-lived changes in money growth, it did not prevent the occurrence of short-term swings in the growth rate. The coefficient of variation in the annual growth rate of money is 87 percent during the 1914–29 period. In contrast, during the 1970–82 period, which has been characterized as a period of highly volatile money growth, the coefficient of variation is 20 percent.

Since the liquidity effect is a short-term phenomenon predicated on unanticipated changes in the monetary growth rate (whether permanent or temporary), this period would seem to be particularly appropriate in testing for its presence because the Fisher effect is arguably zero. Temporary changes in the growth rate of money did not induce confounding impacts on the nominal rate. Roughly, movements in nominal rates should mirror movements in real rates during the gold standard.[16] If money is exogenous with respect to interest rates and if not all of the changes in monetary growth that occurred were anticipated, then the estimated relationship for this period should depict a time path of interest rates similar to that shown in panel A of figure 1.

The End of the Gold Standard Act Through the Korean War: 1934–53

From mid-1934 through March of 1953, little variation occurred in short-term interest rates. For example, table 1 lists the level of the commercial paper rate and the number of months during which the rate remained constant at a particular level. The table indicates that the recorded commercial paper rate changed only four times during the period running from June 1934 through June 1938 and that, during this time, it remained constant at .75 percent for a period of 26 months. In fact, month-to-month changes in the recorded commercial paper rate were zero in all but 46 of the entire 225 months. In contrast, for the period 1954–82, the rate *failed* to change in only 25 out of 348 months.

Since there was little month-to-month variation in either the commercial paper rate or other interest rates during the 1934–53 period, and since there is reason to believe that money was endogenous to interest rates during this period, we have treated it separately in the empirical tests.[17]

The Korean War to the Present: 1954–82

Since the end of the Korean War, month-to-month variation in nominal interest rates has been considerable. The Gold Reserve Act, however, continued to tie the dollar, albeit loosely, to gold until August 15, 1971. Consequently, we have split the 1954–82 period at this point. During the latter period, the behavior of the monetary authority has been free of the formal constraints imposed by gold. If a relationship similar to that shown in panel C of figure 1 exists between money and interest rates, it should show up during this period.

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[14]Benjamin Klein, "Our New Monetary Standard: The Measurement and Effects of Price Uncertainty," *Economic Inquiry* (December 1975), p. 471; see, as well, I. B. Ibrahim and Raburn M. Williams, "The Fisher Relationship Under Different Monetary Standards," *Journal of Money, Credit and Banking* (August 1978), pp. 363–70. In addition, the major discoveries of gold had occurred prior to 1900 and the cyanide process was successfully applied to gold mining in the 1890s.

[15]Friedman and Schwartz, *A Monetary History*, p. 191.

[16]One might question whether changes in the nominal rate tracked changes in the real rate of interest during this period. To check this, we regressed annual changes in the yield of high grade corporate bonds (Standard and Poor's) on annual changes in the ratio of the Consumer Price Index divided by an index of stock prices (Standard and Poor's) for the period 1907–29. Given Klein's evidence, changes in the bond yield during this period should reflect changes in the real interest rate. The CPI, of course, is heavily weighted in the favor of present consumption goods and thus represents the average price of current consumption. The stock price index is an index of the prices of capital goods. Changes in the ratio of these two prices will track changes in the real rate of interest and be reflected by changes in the bond yield during the gold standard period. The results are given below (t-values in parentheses):

$$\Delta i = .05 + \underset{(5.97)}{16.01}\Delta(\text{CPI/STDP})$$

$$R^2 = .59 \quad DW = 1.81$$

The results are consistent with the claim that changes in bond yields reflected changes in the real rate of interest during this period.

Interestingly, the relationship breaks down completely for the more recent period, 1954–82. The results for this period are:

$$\Delta i = .38 + \underset{(.98)}{.54}\Delta(\text{CPI/STDP})$$

$$R^2 = .15 \quad RHO = \underset{(1.84)}{.33} \quad DW = 1.62$$

For further evidence, see Robert J. Shiller and Jeremy J. Siegel, "The Gibson Paradox and Historical Movements in Real Interest Rates," *Journal of Political Economy* (October 1977), p. 905.

[17]Friedman and Schwartz, *A Monetary History*, p. 562.

EMPIRICAL ESTIMATION

Using monthly nominal interest rates and money supply data, we have run regressions for each of the subperiods 1914–29, 1934–53, 1954–70 and 1971–82. In each case, the money supply is defined as M1 balances.[18] The interest rate is defined as the commercial paper rate (4–6 month maturity prior to November 1979 and 120-day maturity after). In each period, the monthly change in the interest rate is regressed on monthly changes in the rate of monetary growth in the contemporaneous month and 38 past (lagged) monthly changes.[19] This specification initially was identified as the unrestricted model. In order to determine whether the estimated coefficients are sensitive to the lag length and to identify statistically redundant lags, the structure was shortened to 24, 18, 12, 6, 3, 1 and zero months. At each stage, an F-test was applied to determine whether the omitted lags were significant.[20]

July 1914 – December 1929

Table 2 presents the results for the 1914–29 period. The test for lag length revealed a lag structure of three months. All of the estimated coefficients are negative, and three are significantly different from zero. The sum over the coefficients is significantly negative as well. These results suggest that a one percentage-point (100 basis-point) increase in the monetary growth rate would have produced a decline of about one basis point in the commercial paper rate during this period.[21] Empirically, the estimated effect is surely miniscule and, as indicated by the F-statistic (2.08), we cannot reject the hypothesis that the relationship arose randomly. The constant term in the regression is statistically insignificant, which is consistent with the efficient market hypothesis that interest rate changes have no trend.

Table 1

The Unusual Behavior of the Commercial Paper Rate: June 1934 – February 1953

Period	Number of Months	Level of Rate
6/34–1/35	8	.88%
2/35–3/37	26	.75
4/37–2/38	11	1.00
3/38–6/38	4	.88
7/38–12/38	6	Variation
1/39–8/39	8	.56
9/39–11/39	3	.69
12/39–5/41	18	.56
6/41	1	.54
7/41–11/41	5	.50
12/41–1/42	2	Variation
2/42–5/42	4	.63
6/42	1	.67
7/42–3/44	21	.69
4/44	1	.72
5/44–6/46	26	.75
7/46	1	.77
8/46–11/46	4	Variation
12/46–8/47	9	1.00
9/47–1/48	5	Variation
2/48–7/48	6	1.38
8/48–9/48	2	Variation
10/48–7/49	10	1.56
8/49	1	1.43
9/49–11/49	3	1.38
12/49	1	1.33
1/50–7/50	7	1.31
8/50–4/52	21	Variation
5/52–2/53	10	2.31

SOURCE: Board of Governors of the Federal Reserve System, Banking and Monetary Statistics, 1914–41, pp. 449–51 and 1941–70, pp. 674–76.

Further, the results for this period are consistent with a long-run Fisher effect of zero. This result was expected, given the constraints implied by the gold standard.

Applying a Granger "causality" test, we examined the data to determine whether changes in the interest rate are endogenous to changes in monetary growth,

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[18] M1 balances were employed since broader monetary aggregates are more likely to be endogenous with respect to interest rates. While the United States was on a gold standard prior to 1914, monthly M1 data are not available before June 1914.

[19] This lag length was selected as a point of departure and is based upon earlier work concerning the time path. See Cagan and Gandolfi, "The Lag in Monetary Policy."

[20] This test is sensitive to the initial lag length specified in the unrestricted model. As a consequence, it is possible that the test will reject some variables that are, in fact, significant if too long a lag is specified. To control for this, we ran the tests with the lag length in the unrestricted model initially set at 38. We then reduced the number of lags in the unrestricted model to 24 and ran the test again. This was continued until we exhausted all of the possibilities.

[21] For further discussion regarding this process, see Cagan and Gandolfi, "The Lag in Monetary Policy," p. 280.

Table 2

The Relationship Between Changes in Money Growth and Changes in Interest Rates: July 1914 – December 1929

Estimated Equation

$$\Delta i_t = \text{Constant} + \sum_{k=0}^{3} a_k \Delta \dot{M}_{t-k}$$

Coefficient	Estimate[1]	t-ratio
Constant	−.840	0.29
a_0	−.102	1.24
a_1	−.269	1.93*
a_2	−.379	2.59*
a_3	−.169	1.72*
Σa_t	−.9	2.17*
Rho	0.43	5.43*
$\bar{R}^2$ = .19	DW = 1.92	F = 2.08

[1]Adjusted for first-order autocorrelation.

*Significantly different from zero at the 95 percent confidence level.

Note: Units of the coefficients are in basis points per 1 percentage-point change in the monthly annualized rate of change in the money stock.

Table 3

Causality Tests

Period	Lags	F-statistic $\Delta i = f(\Delta \dot{M})$	F-statistic $\Delta \dot{M} = \phi(\Delta i)$
7/1914–12/1929	3	0.93	1.21
	6	1.46	0.83
	9	1.69	2.09*
	12	1.50	2.43*
	18	1.41	1.62
1/1934–12/1953	3	0.26	0.00
	6	0.44	0.59
	9	0.48	0.58
	12	0.00	0.57
	18	0.40	0.47
1/1954–12/1970	3	0.71	3.28*
	6	1.21	5.01*
	9	1.58	3.34*
	12	1.62	2.99*
	18	1.37	2.50*
	24	1.25	2.44*
	38	1.24	1.63*
1/1971–2/1983	3	14.97*	19.50*
	6	14.32*	9.73*
	9	9.74*	5.22*
	12	8.84*	4.31*
	18	6.15*	2.79*

*Significantly different from zero at the 95 percent confidence level.

while changes in monetary growth are exogenous to changes in the interest rate. Lag lengths of 3, 6, 9, 12 and 18 months were used in the test. Our results, presented in table 3, reject the hypothesis that changes in the monetary growth rate caused changes in the interest rate during this period.

On the whole, the results from the gold standard period are disappointing. We had hoped that they would provide some insight regarding the timing and magnitude of the liquidity effect. The table 2 results, however, are far from statistically impressive. They indicate a negligible, at best, liquidity effect. This, of course, is consistent with our expectations, given efficient markets, but the interest rate does not return to its original level as predicted and the causality tests suggest that the changes in monetary growth that occurred during the period did not "cause" changes in the interest rate.

January 1934 – December 1953

Table 4 presents our results for the commercial paper rate during the 1934–53 period. As expected, due to the lack of variation in market rates, no relationship appears to exist between changes in the monetary growth rate and interest rates. None of the lags were significant in the F-tests. As a consequence, table 4 only reports the regression for the change in monetary growth contemporaneous to the change in the interest rate. Even in this case, we cannot reject the hypothesis that the constant and the coefficient of the change in monetary growth are zero.

The results of the Granger tests indicate that the money and interest rate series were independent during the period. This held for each lag length used in the test (see table 3).

January 1954 – December 1970

Our results for the January 1954 – December 1970 period are presented in table 5. The lag structure indicated by the F-test contains 24 months and, as in earlier periods, the constant is insignificant. These results generally are not consistent with the appear-

Table 4

The Relationship Between Changes in Money Growth and Changes in Interest Rates: January 1934 – December 1953

Estimated Equation

$$\Delta i_t = \text{Constant} + a_t \Delta \dot{M}_t$$

Coefficient	Estimate[1]	t-ratio
Constant	.38	.70
a_0	.000015	.0014
Rho	.42	7.17*
$\bar{R}^2$ = .18	DW = 2.00	F = 0.00

[1]Adjusted for first-order autocorrelation.

*Significantly different from zero at the 95 percent confidence level.

Note: Units of the coefficients are in basis points per 1 percentage-point change in the monthly annualized rate of change in the money stock.

Table 5

The Relationship Between Changes in Money Growth and Changes in Interest Rates: January 1954 – December 1970

Estimated Equation

$$\Delta i_t = \text{Constant} + \sum_{k=0}^{24} a_k \Delta \dot{M}_{t-k}$$

Coefficient	Estimate[1]	t-ratio
Constant	1.43	0.67
a_0	−0.30	0.84
a_1	−0.72	1.26
a_2	−0.80	1.10
a_3	−0.43	0.55
a_4	0.13	0.15
a_5	0.39	0.45
a_6	1.92	2.19*
a_7	3.02	3.39*
a_8	2.99	3.28*
a_9	2.67	2.86*
a_{10}	2.93	3.05*
a_{11}	2.98	3.03*
a_{12}	2.10	2.13*
a_{13}	1.99	2.05*
a_{14}	1.89	1.98*
a_{15}	2.14	2.31*
a_{16}	2.39	2.62*
a_{17}	2.10	2.35*
a_{18}	2.20	2.50*
a_{19}	2.20	2.52*
a_{20}	1.54	1.81*
a_{21}	1.28	1.59
a_{22}	0.78	1.05
a_{23}	0.85	1.41
a_{24}	−0.24	0.61
Σa_k	36.00	2.52*
Rho	0.45	7.20*
$\bar{R}^2$ = .31	DW = 1.92	F = 1.87

[1]Corrected for first-order autocorrelation.

*Significantly different from zero at the 95 percent confidence level.

Note: Units of the coefficients are in basis points per 1 percentage-point change in the monthly annualized rate of change in the money stock.

ance of either a contemporaneous or lagged liquidity effect in nominal interest rates. While the first four coefficients are negative, they are statistically indistinguishable from zero.

With the exception of lag 24, the remaining coefficients are all positive and 15 are significant. Their sum (36.00 basis points) differs significantly from zero, which is consistent with the Fisher effect. The upward adjustment of the interest rate, however, is less than that implied by the Fisher effect.[22]

The results of the Granger test suggest that changes in the interest rate are exogenous to changes in the monetary growth rate, while changes in the monetary growth rate are endogenous to changes in the interest rate (see table 3). This result held up for each of the lag lengths employed. It appears that the causality relationship is one-way, running from interest rates to money. The theoretical arguments that underpin the hypothesis regarding the time path, however, are based on the assumption that money causes interest rates.

[22]We have little faith in the results obtained during this period. Unlike the other periods we consider, the F-test for lag length is particularly sensitive to the initial lag specification. Beginning with a lag length of one month and adding lags, the test reveals a lag of three months. On the other hand, beginning with 38 months and dropping lags, the test reveals a length of 24 months. This ambiguity did not surface in any of the other periods we examined.

Table 6

The Relationship Between Changes in Money Growth and Changes in Interest Rates: January 1971 – February 1983

Estimated Equation

$$\Delta i_t = \text{Constant} + \sum_{k=0}^{12} a_k \Delta \dot{M}_{t-k}$$

Coefficient	Estimate[1]	t-ratio
Constant	−0.66	0.07
a_0	−2.64	2.48*
a_1	7.58	5.21*
a_2	9.87	5.34*
a_3	11.07	5.15*
a_4	11.58	4.74*
a_5	11.00	4.18*
a_6	13.40	4.96*
a_7	9.33	3.46*
a_8	7.60	2.97*
a_9	6.43	2.85*
a_{10}	4.66	2.39*
a_{11}	5.15	3.38*
a_{12}	3.30	3.10*
Σa_k	98.33	4.63*
Rho	0.37	4.81*
$\bar{R}^2$ = .50	DW = 1.95	F = 10.97

[1]Adjusted for first-order autocorrelation.

*Significantly different from zero at the 95 percent confidence level.

Note: Units of the coefficients are in basis points per 1 percentage-point change in the monthly annualized rate of change in the money stock.

These results, with respect to both the incomplete adjustment of the nominal rate and the endogeny of money with respect to interest rates, can be explained by the operation of the Gold Reserve Act. Other explanations are no doubt possible. In any case, they reveal little about the lag in the effect of an exogenously determined monetary policy. In this sense, the results obtained for this period, as for the earlier periods, are disappointing.

January 1971 – February 1983

Our results for the most recent period in which the dollar has been legally free from gold are summarized in table 6. The F-test indicated a lag structure of 12 months. As before, the constant term is not significantly different from zero. More important, the results are consistent with the existence of a contemporaneous liquidity effect. The coefficient of the contemporaneous change in the monetary growth rate is negative and significant. As expected, the liquidity effect is quite small numerically (2.65 basis points) and short-lived.[23]

The remaining coefficients are all positive and significant. The sum over the coefficients (98.33 basis points) is significantly different from zero and statistically indistinguishable from 100 (t = .08) as predicted by the Fisher effect. Further, the bulk of the adjustment in the interest rate (61.86 basis points) takes place within six months.

Chart 1 illustrates the time path of the interest rate that is implied by these results. A comparison of chart 1 with figure 1 (panel C) indicates the results obtained for the more recent period conform roughly to those implied by rapidly changing inflation expectations.[24]

The Granger test for this period indicates bi-directional causality. On the whole, the results of the Granger test suggest that the January 1971–February 1983 period is the only one of those considered that is a candidate for a valid test of the hypothesis regarding the time path. It is only during this period that we cannot reject the hypothesis that changes in the monetary growth rate caused changes in the interest rate.[25]

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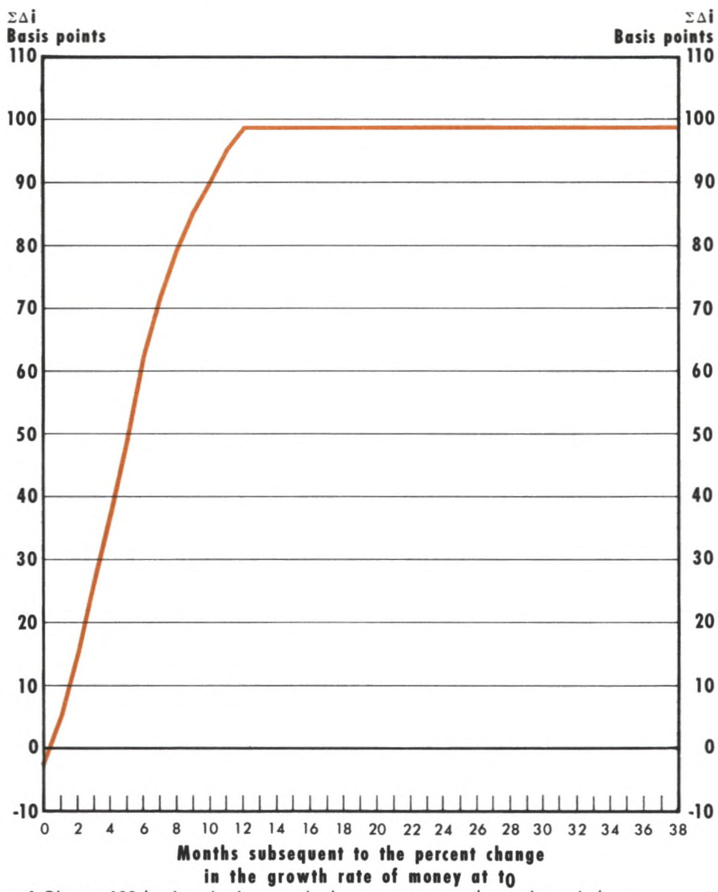
[23]In an effort to highlight the liquidity effect that apparently occurs in the month contemporaneous to the change in monetary growth, we regressed Wednesday-to-Wednesday changes in the 3-month Treasury bill rate on the weekly change in the growth rate of the finally revised seasonally adjusted stock of M1. The contemporaneous and three lags of the monetary variable were included as independent variables. The data periods were 12/28/77–9/26/79 and 10/3/79–10/6/82. The period was split in this fashion to control for the Fed's announced policy shift in October 1979 and its subsequent reversal in October 1982. The results were disappointing in that a significant relationship failed to emerge in either subperiod.

[24]Earlier work on this question concluded that the lag was considerably longer than 12 months. See, for example, Cagan and Gandolfi, "The Lag in Monetary Policy," pp. 277–84.

[25]All of the tests were run again with the corporate Aaa bond rate identified as the dependent variable. Three important differences between these results and those for the commercial paper rate were noted. First, during the gold standard period, the lag was 38 months. A statistically significant but very small liquidity effect (.76 basis points) emerged. The Fisher effect again was zero. The results of the Granger test indicate one-way causality running from money to Aaa bond rates. Second, during the January 1954 – December 1970 period, the lag was zero months. Neither liquid-

Chart 1

Time Path of the Interest Rate [1]



[1] Given a 100 basis-point increase in the monetary growth rate in period zero.

SUMMARY AND CONCLUSION

A widely held view is that changes in the monetary growth rate operate on the nominal interest rate through systematically lagged liquidity and Fisher effects. In particular, increases in monetary growth are thought to produce initial declines and subsequent increases in the nominal and real rates of interest.

Our results suggest that only the data from the period since 1971 represent a fruitful basis for testing this hypothesis. Before then, the money and interest rate data were either independent series or money was endogenous with respect to interest rates. When these subperiods are excluded from the sample, the short-term nominal interest rate is observed to adjust completely to a change in the monetary growth rate with a lag of 12 months.

The monthly data for the most recent period reveal a statistically significant but economically anemic liquidity effect that dissipates rapidly. This was to be expected, given efficient financial and capital markets. On the other hand, the results concerning the Fisher effect are fairly strong. They suggest that an increase (decrease) in the monetary growth rate that persists for more than one month will result in an increase (decrease) in interest rates, other things constant. As a change in the monetary growth rate comes to be regarded as permanent, short-term rates will fully adjust within 12 months. The direction and magnitude of the change in short-term rates will mirror the change in monetary growth.

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ity or Fisher effects were apparent in the data. The Granger test indicates that money and Aaa bond rates were independent series. Third, during the January 1971 – February 1983 period, the lag is 12 months (consistent with that of the commercial paper rate). However, the data reject the appearance of a liquidity effect in nominal interest rates. None of the estimated coefficients are negative. Eleven coefficients are significantly positive but they sum to less than 100 basis points. The Granger test indicates bidirectional causality.

The Effect of State Banking Laws on Holding Company Banks

DONALD M. BROWN

BANK holding companies are subject to a variety of state banking laws that govern the extent of branch banking and the number of banks that can be owned. In response to different legal environments, significant differences may result between the reported operating results of independent banks and holding company banks; as one consequence, bank financial ratios may be affected significantly by state banking laws.[1] These financial ratios include measures of bank profitability, efficiency and portfolio composition. Variables representing the characteristics of a bank's market also may be affected by state banking laws. These market variables include measures of market structure, size and growth.

This article has two purposes. The first is to determine whether bank financial ratios and market variables are related to bank holding company ownership or state laws limiting the number of banks owned by any one holding company. The second is to determine whether there are significant economic incentives favoring the formation of multi-bank holding companies over one-bank holding companies.

WHY DO BANK HOLDING COMPANIES EXIST?

Bank holding companies have specific advantages over independent banks. They generally avoid being taxed on internal dividend payments, they can engage in a wider range of non-banking activities, they are less hampered by geographical restrictions, and they can raise funds by selling the commercial paper of the parent corporation; they also can circumvent state branching restrictions. These advantages are more important to some bank holding companies than to others; likewise, they are more fully realized by owning some banks rather than others. The economic value of these advantages is reflected in the prices that holding companies offer for different banks.

If the costs associated with holding company ownership were low relative to the potential gains, all banks would be owned by holding companies. This, of course, is not the case. Bank holding companies incur a variety of costs: regulatory, administrative, even the one-time cost of getting permission to acquire banks. A bank will remain independent until the discounted present value of the advantages of holding company ownership outweigh the discounted present value of the costs.

Regardless of the number of banks they own, all holding companies are subject to the same federal regulations. Consequently, any gain realized by multi-bank holding companies must be associated with ownership of the banks themselves; it is not related to the profits associated with the permissible range of non-bank activities.

THE EFFECT OF REGULATION ON BANK HOLDING COMPANIES

Federal Regulatory Constraints

Federal regulatory policy may prevent multi-bank holding companies from owning certain banks. The

[1]Bank financial ratios have been examined extensively by economists. A lengthy bibliography of this literature, including citations through part of 1978, may be found in Ronald L. Schillereff, *Multibank Holding Company Performance* (UMI Research Press, 1982).

As used herein, "state banking laws" refer specifically to state laws governing branch banking and bank holding companies.

Table 1

The Distribution of States Among Categories of State Banking Laws[1]

	OBHC States (holding companies may own only a single bank)	**MBHC States** (holding companies may own more than one bank)
Unit Banking (banks may have only a single full-service office)	3	7
Limited Branching (banks may branch within a defined area — usually a county)	5	11
Statewide Branching (banks may branch throughout the state)	0	24

[1]State banking laws effective April 1, 1983.

SOURCE: Board of Governors of the Federal Reserve System.

Board of Governors of the Federal Reserve System is likely to prevent an acquisition by a multi-bank holding company if that company already has a large market share or if the acquisition would substantially increase concentration in a banking market. The Board also may prevent acquisitions or holding company formations for reasons other than competition. For example, it may rule unfavorably if the holding company is thought to be financially weak. Consequently, some banks may be either independent or owned by one-bank holding companies solely because of actual or anticipated regulatory denials.

The Adaptation of Bank Holding Companies to State Banking Laws

State banking laws also may affect bank ownership. Table 1 categorizes states according to their restrictions on branching and bank holding companies and shows the distribution of the 50 states among these categories. If the legal constraints imposed by state laws are binding, banks and bank holding companies will attempt to circumvent them.[2] Multi-bank holding companies represent one way to circumvent the state branching restrictions described in table 1.

In unit-banking and limited-branching states that permit multi-bank holding companies, bank holding companies are not constrained to own only one bank; each one-bank holding company does so by choice. Because both one-bank and multi-bank holding companies exist simultaneously in these states, their owners must face different incentives. Consequently, they may own different types of banks or manage their banks in ways that produce different operating results and portfolio compositions.

Any prohibition of branching is more effective if multi-bank holding companies also are prohibited.[3] Even though some holding companies in states prohibiting both types of organizations might wish to own only one bank, others would choose to own more banks in the absence of the constraint. The constrained and unconstrained one-bank holding companies in these states may have different financial and market characteristics.

In states that allow statewide branching, both branch banks and multi-bank holding companies

[2]We cannot know the effect of a constraint with certainty until it is removed; however, the existence of unit banks and one-bank holding companies in states that allow both statewide branching and multi-bank holding companies is strong circumstantial evidence that state banking laws are not binding on all organizations.

[3]Table 1 offers some circumstantial evidence. None of the 24 states that allow statewide branching prohibit multi-bank holding companies. Apparently, once banks are allowed to branch throughout a state, preventing holding companies from owning more than a single bank is not an effective constraint.

potentially can achieve the same geographic scope.[4] Consequently, multi-bank holding companies and one-bank holding companies that own branch banks may not display significant differences in terms of their financial and market characteristics. On the other hand, there may be significant differences between a one-bank holding company that owns a branch bank and another in the same state that owns a unit bank.

Distortions of Reported Financial Results

Differences in reported financial characteristics do not necessarily reflect actual operating differences. Comparisons of the financial ratios of unit and branch banks, whether located in the same or different states, are distorted by financial reporting conventions. Because the financial results of a bank's branches are aggregated for reporting purposes, differences between the reported financial characteristics of branch and unit banks may be due partly to lumping different-sized branches in different locations into a single reporting entity. The problem exists if the state allows limited or statewide branching. It is compounded in branching states that allow multi-bank holding companies because a multi-bank holding company (subject to regulatory approval) may choose either to charter a subsidiary bank separately or make it the branch of another subsidiary bank. Thus, the reported financial characteristics will depend upon the permissible legal forms.

Is There an Economic Incentive for Multi-Bank Holding Companies?

Although it might be argued that the existence of multi-bank holding companies is prima facie evidence that some companies have an economic incentive to own more than one bank, multi-bank holding companies could arise by chance. Assume, for example, that owning two or more banks conferred no net gain to a bank holding company. It should then make no difference whether a bank is owned by a one-bank or multi-bank holding company. Even if banks with certain observable characteristics typically are owned by bank holding companies, any specific holding company could hold either one or several of these banks. In this example, whether a bank is owned by a holding company depends upon the bank's own observed financial and market characteristics alone.

Assume, now, that some bank holding companies derive some net advantage from owning several banks. These advantages may arise from the nature of either the bank or the bank holding company; they are distinct, however, from the advantages realized by one-bank holding companies. Under this assumption, multi-bank holding companies would own some banks that would not be owned by one-bank holding companies. Therefore, a bank's chance of being owned by a holding company would depend on state laws regarding multi-bank holding companies, as well as its individual financial and market characteristics.

We cannot say a priori that there are economic incentives for some bank holding companies to own several banks. The issue must be decided on the basis of empirical evidence. Although a variety of empirical tests could be chosen, the tests used in this article focus on the relationship between bank holding company ownership and a bank's financial and market characteristics in unit-banking states.[5]

EMPIRICAL TESTS OF THREE PROPOSITIONS ABOUT HOLDING COMPANY BANKS IN UNIT-BANKING STATES

Three testable propositions regarding certain bank characteristics in unit-banking states can be derived

[4]Federal law effectively prevents interstate branching and interstate banking expansion by holding companies. States can extend a statutory invitation to out-of-state bank holding companies, but only a handful actually have done so. Alaska allows out-of-state companies to buy Alaskan banks that have operated for at least three years. Maine, Massachusetts and New York permit holding companies from states that reciprocate; the Massachusetts law limits reciprocity to only New England states. Washington allows out-of-state holding companies to purchase banks in the state that are in financial difficulty. Finally, Delaware and South Dakota allow out-of-state holding companies to own special-purpose banks, which are operated under rules that prevent them from actively soliciting deposits from the public. (Information on these state laws was provided by the staff of the Board of Governors of the Federal Reserve System.)

[5]Since this study is confined to a sample of banks from unit-banking states, it does not provide direct evidence on whether multi-bank holding companies circumvent state branching restrictions. A worthwhile direction for future research would be to expand the sample to include banks from states that allow limited and statewide branch banking. Empirical tests on the expanded sample could determine whether the incentives of multi-bank holding companies are reduced or eliminated in states having less stringent restrictions on branching.

This study also does not explore the nature of the economic incentive to own several banks. The evidence presented in the next section indicates that, whether the incentive arises from cost advantages, control over price or some other source, it is apparently quite strong. Another worthwhile direction for future research would be to investigate its source.

from the preceding discussion:

1. The financial and market characteristics of banks owned by multi-bank holding companies will differ from those of other banks.
2. The financial and market characteristics of banks owned by one-bank holding companies will differ from those of other banks; they will depend on state laws regarding multi-bank holding companies.
3. A bank is more likely to be owned by a holding company if the state permits multi-bank holding companies.

Methodology and Sample Characteristics

These propositions are tested by probit analysis to estimate the effect of certain independent variables on the likelihood that a bank is owned by a bank holding company.[6] The following are the dependent variables in three probit regression models, each of which represents a choice between alternative forms of ownership:

Y_1 = 1, if a bank is owned by a multi-bank holding company,
= 0, otherwise;

Y_2 = 1, if a bank is owned by a one-bank holding company,
= 0, otherwise;

Y_3 = 1, if a bank is owned by either a one-bank or multi-bank holding company,
= 0, otherwise.

The sample on which the probit models are estimated consists of all insured commercial banks in six western and midwestern unit-banking states. The sample is divided into two subsamples of three states. States in one subsample permit multi-bank holding companies; states in the other prohibit them.[7] Any holding company that owns two or more banks in any state is defined as a multi-bank holding company; the others are one-bank holding companies.

Four probit regression equations are estimated for each of the years 1978 and 1981. The Y_1 model is estimated on the subsample permitting multi-bank holding companies; the Y_2 model is estimated separately on each subsample; and the Y_3 model is estimated on the full sample.

Independent Variables

Table 2 defines the independent variables used in the probit models and reports their summary statistics for both 1978 and 1981.[8] The same financial variables have been used in many empirical studies that have investigated differences between independent and holding company banks. These variables were constructed from financial data in annual bank call reports and income statements for the years ending December 31, 1978, and December 31, 1981. The variables measuring market characteristics were computed by aggregating bank financial data across banking markets, which were defined as either Standard Metropolitan Statistical Areas (SMSAs) or counties (in the case of counties not part of SMSAs).

A comparison of the variables' means in 1978 and 1981 shows that the ratios of operating expense and net federal funds sold to total assets (ROE and RNFFS) were markedly higher in 1981, and the ratio of total loans to total assets (RTL) was lower in 1981. These differences may be explained by the economic conditions prevailing in 1981, when interest rates reached historically high levels and loan demand (partly reflective of interest rates) was low. Increases in the means of dummy variables SMSA and MBHC between 1978 and 1981 indicate increases in the proportion of sample banks located in SMSAs and states that allow multi-bank holding companies.

[6]Probit analysis is a non-linear estimation technique frequently used when a model's dependent variable represents the choice between two alternatives. For explanations of the probit model, see Robert S. Pindyck and Daniel L. Rubinfeld, *Econometric Models and Economic Forecasts*, 2nd ed. (McGraw-Hill Book Company, 1981), pp. 280–87; and George G. Judge and others, *The Theory and Practice of Econometrics* (John Wiley and Sons, 1980), pp. 591–92.

[7]In the six states used in this study, Colorado, Missouri and Wyoming permit multi-bank holding companies; Kansas, Nebraska and Oklahoma prohibit them.

[8]Some independent variables were considered for inclusion in the models but were dropped because they were highly correlated with other independent variables. In each subsample and in the full sample, most simple correlations between included independent variables were less than 0.20 in absolute value in both 1978 and 1981. The simple correlations exceeding 0.40 are reported below:

1978 Correlations	OBHC Subsample	MBHC Subsample	Full Sample
ROE, RNI	0.41	−0.41	—
CR, SMSA	−0.42	−0.61	−0.50
CR, DCRMBHC	—	—	0.41
MBHC, DCRMBHC	—	—	0.55

1981 Correlations	OBHC Subsample	MBHC Subsample	Full Sample
ROE, RNI	−0.48	—	—
CR, SMSA	−0.43	−0.63	−0.51
CR, DCRMBHC	—	—	0.41
MBHC, DCRMBHC	—	—	0.56
REQ, RNFFS	—	0.42	—

Table 2
Definitions and Summary Statistics of Independent Variables

Variable	Definition	1978 Mean	1978 Standard deviation	1981 Mean	1981 Standard deviation
RNI	net after tax income/total assets	0.010	0.007	0.013	0.009
ROE	operating expense/total assets	0.063	0.022	0.100	0.021
REQ	equity capital plus reserves/total assets	0.092	0.037	0.092	0.038
RTL	total loans, gross/total assets	0.551	0.116	0.518	0.122
RNFFS	federal funds sold less federal funds purchased/total assets	0.038	0.065	0.061	0.082
TA	total assets/1,000,000	0.032	0.111	0.043	0.158
SMSA	=1, if bank is located in an SMSA =0, otherwise	0.293	0.455	0.303	0.460
MBHC	=1, if state where bank is located allows MBHCs =0, otherwise	0.416	0.493	0.427	0.495
CR[1]	market Herfindahl index	0.257	0.155	0.254	0.150
MKGR	five-year growth of total market assets	0.656	0.203	0.778	0.254
DCR[2]	=1, if CR > .25 =0, otherwise				
DCRTA	DCR × TA	0.009	0.022	0.011	0.029
DCRSMSA	DCR × SMSA	0.013	0.113	0.013	0.114
DCRMBHC	DCR × MBHC	0.178	0.383	0.187	0.390

[1]The index is calculated on the basis of shares of total assets:

$$CR = \sum_{i=1}^{n} (TA_i/\sum^{n} TA),$$

where TA_i is the total assets of the ith banking organization in the market. Note that $0<CR\leq 1$.

[2]The variable DCR was not included in the probit models because it is highly correlated with CR. It does enter in the three interaction variables.

A positive (negative) sign on an independent variable's coefficient indicates that higher values of the variable increase (decrease) the likelihood that a bank is owned by the specified type of bank holding company. The coefficient of TA is expected to be positive in the Y_1 model. This expectation is based not on theory, but on previous empirical study.[9] It assumes that as a bank's size increases, ceteris paribus, the likelihood that the bank is owned by a multi-bank holding company also increases.

No predictions can be made as to the signs of other coefficients in the Y_1 and Y_2 models. Although many empirical studies have investigated the relationship between holding company ownership and bank financial ratios, they have potentially important weaknesses, including a nearly universal failure to control for the potential effects of diverse state banking laws. Moreover, they frequently have produced conflicting results.

The variables MBHC and DCRMBHC are included in only the Y_3 model.[10] As the following section explains, the estimated coefficient of MBHC is predicted

[9]Multi-bank holding companies tend to own larger banks. Many of these organizations own lead banks that are among a state's largest banks. Subsidiary banks other than lead banks often are larger than the average bank in their markets and seldom are among the very small banks.

[10]In the subsample on which the Y_1 and first Y_2 models were estimated, MBHC took on the value of 1 for all observations, while DCRMBHC took on the value of 1 or zero. In the subsample on which the second Y_2 model was estimated, both variables took on the value of zero for all observations.

to be positive, and the estimated coefficient of DCRMBHC is predicted to be negative.

The Criteria for Accepting or Rejecting the Propositions

The first proposition is "accepted" (in the statistical sense) if the likelihood ratio of the Y_1 estimation is statistically significant in both 1978 and 1981. This would indicate that, in unit-banking states that permit multi-bank holding companies, banks owned by multi-bank holding companies differ from other banks on the basis of their financial and market characteristics.

For the first proposition to be accepted, neither the sizes, statistical significance, nor the signs of the estimated coefficients need to be invariant over the two years. Coefficients may differ between 1978 and 1981 because changing economic conditions affected multi-bank holding company subsidiaries and other banks differently; because the modest increase in the total number of banks and/or the proportionately large increase in multi-bank holding company subsidiaries occurring in the subsample between 1978 and 1981 (see tables 3a and 3b) altered the compositions of the two groups of banks; because the financial and market characteristics of the two groups of banks are following different long-term trends; or for a combination of these reasons. None of these possibilities would obviate the conclusion that banks owned by multi-bank holding companies differ from other banks.

The second proposition is accepted if, in both 1978 and 1981, the likelihood ratios of the two Y_2 estimations are statistically significant *and* if the signs or statistical significance of the coefficients differ between the two estimations. The former would show that one-bank holding company banks differ from other banks in their financial and market characteristics, regardless of whether multi-bank holding companies are permitted. The latter would show that the financial and market characteristics of one-bank holding company banks depend on whether a state allows or prohibits multi-bank holding companies. Differences in financial and market characteristics between one-bank holding company banks in the two subsamples would be the result of differences between constrained and unconstrained holding companies in the states that prohibit multi-bank holding companies. Like the first proposition, the second proposition is not refuted by different coefficient estimates in the 1978 and 1981 estimations.

The coefficients in the Y_1 and Y_2 estimations can be compared in the same manner. If, in states that allow multi-bank holding companies, the signs or statistical significance of the coefficients differ between the Y_1 and Y_2 estimations, then banks owned by the two types of holding companies have different financial and market characteristics.

The third proposition depends on the coefficient of MBHC in the Y_3 estimation. It is accepted if the estimated coefficient is positive and significantly greater than zero in both 1978 and 1981. A positive sign would indicate that, given its financial and market characteristics, a bank is more likely to be owned by a bank holding company (*either* a one-bank or multi-bank holding company) if it is located in the unit-banking states that permit multi-bank holding companies.

The interaction variable DCRMBHC is included in the Y_3 model to account for the possible effect of federal regulation on the likelihood of holding company ownership. The Board of Governors is more likely to prevent acquisitions by multi-bank holding companies in highly concentrated markets (DCR = 1) than in less concentrated markets (DCR = 0); therefore, the coefficient of DCRMBHC is predicted to be negative in both 1978 and 1981.

Empirical Results

Y_1 Estimations — The results of the Y_1 estimations are reported in column 1 of tables 3a and 3b. Both likelihood ratios are highly significant, indicating that banks owned by multi-bank holding companies differ from other banks in terms of the independent variables included in the Y_1 model. Moreover, most estimated coefficients also are statistically significant, which indicates that the corresponding independent variables are different for multi-bank holding company subsidiaries than for other banks.

Several coefficients had the same sign and were statistically significant in both years. The estimated coefficients of TA are positive and statistically significant, as predicted. The results also show that, even after controlling for the influence of bank size (TA), banks owned by multi-bank holding companies are located more often in metropolitan areas and less concentrated banking markets. The positive coefficients on the interaction variable DCRTA imply that, ceteris paribus, a larger bank in a highly concentrated market is more likely to be owned by a multi-bank holding company than a smaller bank in the same market.

Other coefficients differed between the two years. In 1978, banks owned by multi-bank holding com-

Table 3a

Coefficient Estimate Results of Probit Analysis (1978) (t-statistics in parentheses)

Independent Variables	(1) MBHC Subsample[1] Y_1	(2) MBHC Subsample[1] Y_2	(3) OBHC Subsample[2] Y_2	(4) Full Sample Y_3
Financial variables				
RNI	−12.39	47.75**	30.57**	9.87*
	(−1.45)	(4.11)	(4.85)	(2.48)
ROE	−2.56	16.79**	−3.33	−1.22
	(−0.52)	(3.01)	(−1.50)	(−0.82)
REQ	0.24	−6.06**	−14.21**	−2.41**
	(0.23)	(−2.88)	(−7.28)	(−3.16)
RTL	2.01**	−0.44	1.82**	1.92**
	(4.30)	(−0.87)	(5.48)	(7.63)
RNFFS	−2.05*	1.62	−1.43*	−0.97*
	(−2.53)	(1.94)	(−2.26)	(−2.06)
TA	7.49**	−0.99	3.11**	6.49**
	(4.68)	(−1.02)	(3.17)	(6.14)
Market variables				
SMSA	0.44**	0.12	−0.26*	0.09
	(3.26)	(0.85)	(−2.49)	(1.18)
MBHC				0.46**
				(6.61)
CR	−1.17**	0.98**	0.16	0.16
	(−2.72)	(2.93)	(0.59)	(0.76)
MKGR	0.20	0.05	−1.38**	−0.31*
	(1.17)	(0.26)	(−5.64)	(−2.41)
DCRTA	7.18*	−2.77	−0.87	4.32*
	(2.22)	(−0.86)	(−0.52)	(2.10)
DCRSMSA	0.59	−0.36	0.13	0.29
	(1.40)	(−0.68)	(0.42)	(1.13)
DCRMBHC				−0.35**
				(−3.55)
Constant	−1.60**	−2.09**	0.61	−1.26**
	(−3.58)	(−4.54)	(1.74)	(−5.75)
Likelihood ratio test	221.07**	45.77**	187.29**	348.92**
N[3]	1,101	1,101	1,546	2,647
Y=1[4]	369	181	529	1,100

*Significant at 5 percent confidence level.

**Significant at 1 percent confidence level.

[1]States that permit multi-bank holding companies.

[2]States that prohibit multi-bank holding companies.

[3]Number of observations.

[4]Number of observations on the dependent variables (Y_1, Y_2 or Y_3) at 1. Other observations at zero. The numbers do not add across because there are 21 subsidiary banks of multi-bank holding companies in the one-bank holding company subsample.

Table 3b

Coefficient Estimate Results of Probit Analysis (1981) (t-statistics in parentheses)

Independent Variables	(1) MBHC Subsample[1] Y_1	(2) MBHC Subsample[1] Y_2	(3) OBHC Subsample[2] Y_2	(4) Full Sample Y_3
Financial variables				
RNI	−7.00	38.38**	55.24**	21.47**
	(−1.76)	(5.72)	(8.71)	(6.38)
ROE	0.42	2.70	6.17	3.08*
	(0.26)	(1.48)	(1.89)	(2.31)
REQ	−2.38*	−9.30**	−24.90**	−8.26**
	(−2.40)	(−4.96)	(−12.08)	(−9.55)
RTL	0.69	0.57	1.03**	1.32**
	(1.83)	(1.42)	(3.08)	(5.64)
RNFFS	0.84	−0.13	−2.02**	−0.39
	(1.56)	(−0.22)	(−3.85)	(−1.08)
TA	8.31**	−4.77**	1.34*	3.78**
	(5.76)	(−3.11)	(2.00)	(4.62)
Market variables				
SMSA	0.42**	0.08	−0.22*	0.12
	(3.57)	(0.65)	(−2.18)	(1.59)
MBHC				0.40**
				(5.58)
CR	−1.20**	0.69*	0.72**	0.20
	(−2.93)	(1.99)	(2.59)	(0.93)
MKGR	0.20	0.17	−0.86**	−0.31**
	(1.17)	(0.94)	(−6.44)	(−3.11)
DCRTA	5.43*	−0.76	−1.16	4.83**
	(2.13)	(−0.30)	(−0.93)	(2.82)
DCRSMSA	0.25	−0.23	−0.05	0.07
	(0.58)	(−0.47)	(−0.16)	(0.28)
DCRMBHC				−0.35**
				(−3.61)
Constant	−0.85**	−1.10**	0.97*	−0.43*
	(−2.76)	(−3.32)	(2.30)	(−2.02)
Likelihood ratio test	217.52**	91.54**	328.62**	397.70**
N[3]	1,174	1,174	1,575	2,749
Y = 1[4]	448	275	811	1,561

*Significant at 5 percent confidence level.

**Significant at 1 percent confidence level.

[1]States that permit multi-bank holding companies.

[2]States that prohibit multi-bank holding companies.

[3]Number of observations.

[4]Number of observations on the dependent variables (Y_1, Y_2 or Y_3) at 1. Other observations at zero. The numbers do not add across because there are 27 subsidiary banks of multi-bank holding companies in the one-bank holding company subsample.

panies devoted a larger share of their portfolios to loans and sold fewer net federal funds as a proportion of total assets, while their ratios of equity to total assets did not vary significantly from other banks. On the other hand, in 1981, these banks had significantly lower ratios of equity to total assets, while the share of their portfolios devoted to loans and net federal funds sold did not vary significantly from other banks.

Y_2 Estimations — The Y_2 estimations are reported in columns 2 and 3 of tables 3a and 3b. The highly significant likelihood ratios indicate that, regardless of state policy toward multi-bank holding companies, banks owned by one-bank holding companies differ from other banks.

In 1978, the estimated coefficients of the financial variables had uniformly opposite signs and statistical significance in columns 1 and 2 (see table 3a). The differences between the columns were fewer in 1981. Banks owned by one-bank holding companies earned a higher return on total assets than other banks in 1981, whereas the return of banks owned by multi-bank holding companies did not vary significantly from other banks; furthermore, multi-bank holding company subsidiaries tended to be larger than other banks, and one-bank subsidiaries tended to be smaller (see table 3b). The findings indicate that one-bank and multi-bank holding companies had different financial ratios in the states that permit multi-bank holding companies.

The estimated coefficients of the market variables are similar in both 1978 and 1981. In column 2 of the tables, the estimated coefficients of market concentration (CR) are positive and significant, whereas in column 1 the coefficients of CR are negative and significant. This difference implies that banks owned by one-bank holding companies tend to be located in more concentrated markets, while banks owned by multi-bank holding companies tend to be located in less concentrated markets. The estimated coefficients of the other market variables in column 2 are not statistically significant.

A comparison of column 3 with columns 1 and 2 in the tables shows that banks owned by one-bank holding companies in unit-banking states that *prohibit* multi-bank holding companies exhibit similarities to both types of holding companies in the other subsample of states. In column 3, the estimated coefficients of all financial variables, except ROE, are statistically significant at the 5 percent confidence level or better. In 1978, they took the sign of the estimated coefficient from column 1 or 2 that had the t-statistic of larger absolute value. In 1981, this was the case for the estimated coefficients of RNI and TA; estimated coefficients of other financial variables were either statistically insignificant in columns 1 and 2 (ROE, RTL, RNFFS) or they had the same sign (REQ). Apparently, some holding company banks in the states that prohibit multi-bank holding companies have similar financial characteristics to one-bank holding company subsidiaries in those states that permit multi-bank holding companies; others have similar financial characteristics to multi-bank holding company subsidiaries. This interpretation is consistent with the characterization, in the preceding section, of one-bank holding companies in this subsample as either constrained or unconstrained organizations.

The estimated coefficients of the market variables do not exhibit the same pattern. In column 3, only the negative estimated coefficients of the dummy variable representing metropolitan markets (SMSA) and the market growth variable (MKGR) were statistically significant in both 1978 and 1981. The latter was not significant in either of the other estimations, and the former was significant but positive in the Y_1 estimations. In 1981, the estimated coefficient of CR in column 3 was statistically significant, taking the positive sign of the coefficient estimate in column 2.

Y_3 Estimations — The Y_3 estimations are reported in column 4 of tables 3a and 3b. The high likelihood ratios indicate that holding company banks, as a group, can be distinguished from independent banks on the basis of the independent variables. The positive and highly significant estimate of the MBHC coefficient in both 1978 and 1981 strongly supports the third proposition. The negative and highly significant estimate of the DCRMBHC coefficient in both 1978 and 1981 confirms the prediction that, ceteris paribus, banks in highly concentrated markets are less likely to be owned by a holding company if the state permits multi-bank holding companies.

CONCLUSIONS

One-bank and multi-bank holding company subsidiaries in unit-banking states have different financial and market characteristics than other banks. Moreover, the characteristics of the one-bank holding company banks depend on state laws regarding multi-bank holding companies. In addition, a bank is more likely to be owned by a holding company in unit-banking states that permit multi-bank holding companies than in unit-banking states that prohibit them.

These results clearly imply that empirical studies that examine the effects of holding company ownership on bank financial ratios should control for differences among state banking laws, as well as for differences between one-bank and multi-bank holding companies. Though this may not appear to be a startling conclusion, recent studies have failed to control for one or both of these differences.[11] Future studies will have to do so if they are to correctly assess the factors that cause financial and market characteristics to differ among banks.

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[11]Johnson and Meinster, Jackson, and Mayne fail to control for differences in state laws, while Fraas fails to account for differences between one-bank and multi-bank holding companies; Rose and Scott, and Graddy and Kyle, fail on both counts. Only Mingo accounted for both, by limiting his sample to nine unit-banking states that permit multi-bank holding companies and excluding subsidiary banks that were owned by one-bank holding companies. By limiting his sample in this way, the author also avoided the aggregation problem with comparing the financial results of unit and branch banks. See Rodney D. Johnson and David R. Meinster, "The Performance of Bank Holding Company Acquisitions: A Multivariate Analysis," *Journal of Business* (April 1975), pp. 204–12; William Jackson, "Multibank Holding Companies and Bank Behavior" (Working Paper 75-1, Federal Reserve Bank of Richmond, July 1975); Lucille S. Mayne, "A Comparative Study of Bank Holding Company Affiliates and Independent Banks, 1969–1972," *Journal of Finance* (March 1977), pp. 147–58; Arthur G. Fraas, *The Performance of Individual Bank Holding Companies,* Staff Economic Studies 84 (Board of Governors of the Federal Reserve System, 1974); Peter S. Rose and William L. Scott, "The Performance of Banks Acquired by Holding Companies," *Review of Business and Economic Research* (Spring 1979), pp. 18–37; Duane B. Graddy and Reuben Kyle, III, "Affiliated Bank Performance and the Simultaneity of Financial Decision-Making," *Journal of Finance* (September 1980), pp. 951–57; and John J. Mingo, "Managerial Motives, Market Structures and the Performance of Holding Company Banks," *Economic Inquiry* (September 1976), pp. 411–24.

Inflation: Assessing Its Recent Behavior and Future Prospects

R. W. HAFER

THE inflation rate in the United States has gone through a remarkable decline during the past three years. In the first quarter of 1980, the inflation rate, measured by movements in the GNP deflator, stood at 10.01 percent. In the first quarter of 1983, it was down to 5.64 percent. This dramatic change has been attributed to a variety of things. Monetary policy typically is one reason given for the drop in inflation. Improving productivity and lower wage demands also have received some credit. Declines in oil prices precipitated by concessions among OPEC oil producers is mentioned as well.[1]

In general, popular discussion of the inflation problem suggests that inflation finally has been tamed.[2] As one analyst noted recently, "It now looks as if we can have our cake and eat it too — get a solid economic recovery, while inflation continues to decline."[3] The purpose of this paper is twofold. First, it provides evidence about the relative importance of monetary and nonmonetary factors in explaining the behavior of inflation during the past few years. Specifically, it assesses the impact of energy price developments in conjunction with monetary growth changes on the measured inflation rate. Second, it provides some simulation results for inflation through 1985. If the future resembles the past — that is, *if the empirical relationship between money growth and inflation remains intact* — recent celebrations of the permanent demise of inflation are premature.

THE MONEY GROWTH-INFLATION LINK

Economists define inflation as a persistent rise in the general level of prices for goods and services. Inflation is primarily a monetary phenomenon; that is, the primary factors influencing future inflation are the current and past behavior of the money stock. This view is based on empirical evidence amassed over a variety of periods and across diverse economies. As one example, Friedman and Schwartz conclude, after examining the link between money growth and inflation in the United States and the United Kingdom from 1867 to 1975, that "except only for the United States interwar period, the ultimate effect of monetary change is absorbed by prices."[4]

While this monetarist approach to explaining inflation focuses attention primarily on the growth of the money supply, it does not ignore the effect of nonmonetary factors in the short run. While nonmonetary

[1]See, for example, Bluford Putnam, "This Money Bulge Isn't Inflationary," *Wall Street Journal,* April 27, 1983; Peter Grier, "Why Continued Success is Likely in Effort to Tame Inflation," *Christian Science Monitor,* February 28, 1983; Harry B. Ellis, "Drop in Oil Prices, Interest Rates, and Inflation Could Mean Stronger Recovery," *Christian Science Monitor,* February 28, 1983; and Jonathan Fuerbringer, "Consumer Prices Up Slight 0.2%," *New York Times,* February 26, 1983.

[2]See "Brokerage Says Inflation May be Under Control for Years," *Christian Science Monitor,* May 19, 1983; and Linda Stern, "Economists Optimistic on Inflation Outlook," *New York Journal of Commerce,* February 28, 1983. For another viewpoint, see Alfred L. Malabre, Jr., "Though Consensus Sees Mild Inflation Ahead, Some Signs Suggest a Returning Price Spiral," *Wall Street Journal,* May 3, 1983; Caroline Atkinson, "Inflation Still Alive and Influencing Policy," *Washington Post,* February 24, 1983; and "Index Forewarns Inflation Resumption," *New York Journal of Commerce,* May 18, 1983.

[3]David Jones, chief economist of Aubrey Lanston & Co., quoted in Grier, "Why Continued Success is Likely in Effort to Tame Inflation."

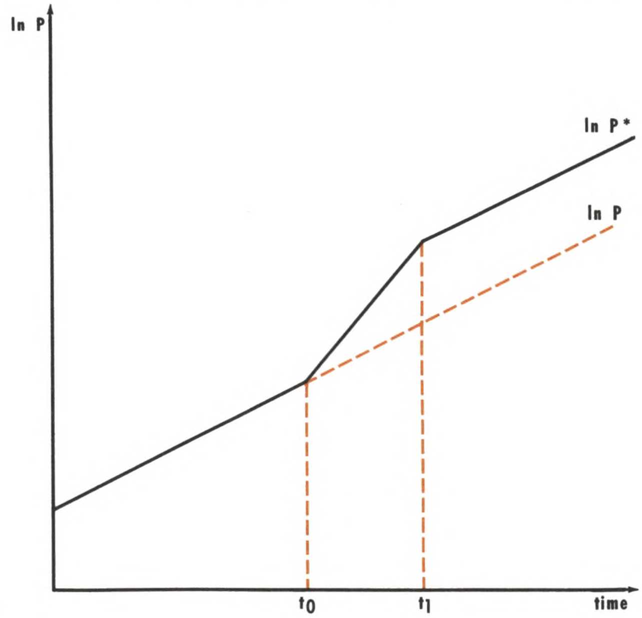
[4]Milton Friedman and Anna J. Schwartz, *Monetary Trends in the United States and the United Kingdom: Their Relation to Income, Prices, and Interest Rates, 1867–1975* (University of Chicago Press, 1982), p. 627.

forces, such as wage and price controls, wage increases above productivity changes or OPEC oil price changes do not have a *lasting* influence on the rate of inflation, they can produce *temporary* effects on the measured inflation rate. Consequently, inflation often deviates temporarily from the rate determined solely by the growth of money.

To see how this can occur, consider the price behavior shown in figure 1. The line labeled lnP represents how the log of the price level would behave, over time, if monetary pressures alone affected prices, and if the trend rate of money growth were constant. Because the price level is shown in terms of its logarithm, the change over time (that is, $\ln P_t - \ln P_{t-1}$) represents the growth rate of the price level — the inflation rate.

Suppose at time t_0 an increase in the price of oil occurs, as it did in late 1973 and again in 1979. One effect of the oil price increase is to reduce the aggregate supply of goods through the economic obsolescence of some existing capital equipment.[5] If aggregate demand remains unchanged, the result is an increase in the level of prices (the jump from lnP to lnP*) over and above what would result from trend money growth alone. The period of adjustment to the new, higher price level (lnP*) is depicted in figure 1 by the time span t_0 to t_1. During this period the rate of change of prices — that is, the slope of the line lnP* relative to the line lnP — is greater than that explained by money growth alone. This represents the fact that, from t_0 to t_1, the measured rate of inflation is higher than that attributed solely to monetary factors, represented by the line lnP. Once the adjustment period ends, however, the rate of inflation returns to the monetary rate, represented by the common slope of the lines lnP* and lnP. Thus, while nonmonetary factors can influence the measured inflation rate for relatively brief periods, monetary factors determine the long-term path of inflation.[6]

Figure 1
The Effect of Nonmonetary Factors on the Measured Rate of Inflation



To illustrate the persistent relationship between money growth and inflation, chart 1 plots the three-year average rate of money growth (M1) and the annual rate of inflation for the past two decades. The three-year average of M1 growth is used because studies indicate that changes in money growth affect prices with a lag.[7] Although the inflation rate seldom equals the long-run average rate of money growth exactly, it moves around the average money growth, as if the average growth of money sets the norm for the inflation rate. This observed tendency provides the basis for monetary policy actions intended to reduce inflation.[8]

Chart 1 reveals that, while inflation may wander from the rate dictated by average money growth, such departures are short-lived. These deviations reflect the previously discussed transitory influence of nonmonetary factors that impinge on the price level. For example, the measured rate of inflation was below the

[5]A discussion of this effect is presented in Denis S. Karnosky, "The Link Between Money and Prices — 1971–76," this *Review* (June 1976), pp. 17–23; and John A. Tatom, "Energy Prices and Short-Run Economic Performance," this *Review* (January 1981), pp. 3–17. A broader analysis can be found in Robert H. Rasche and John A. Tatom, "Energy Price Shocks, Aggregate Supply and Monetary Policy: The Theory and International Evidence," *Carnegie-Rochester Conference Series*, Vol. 14 (1981).

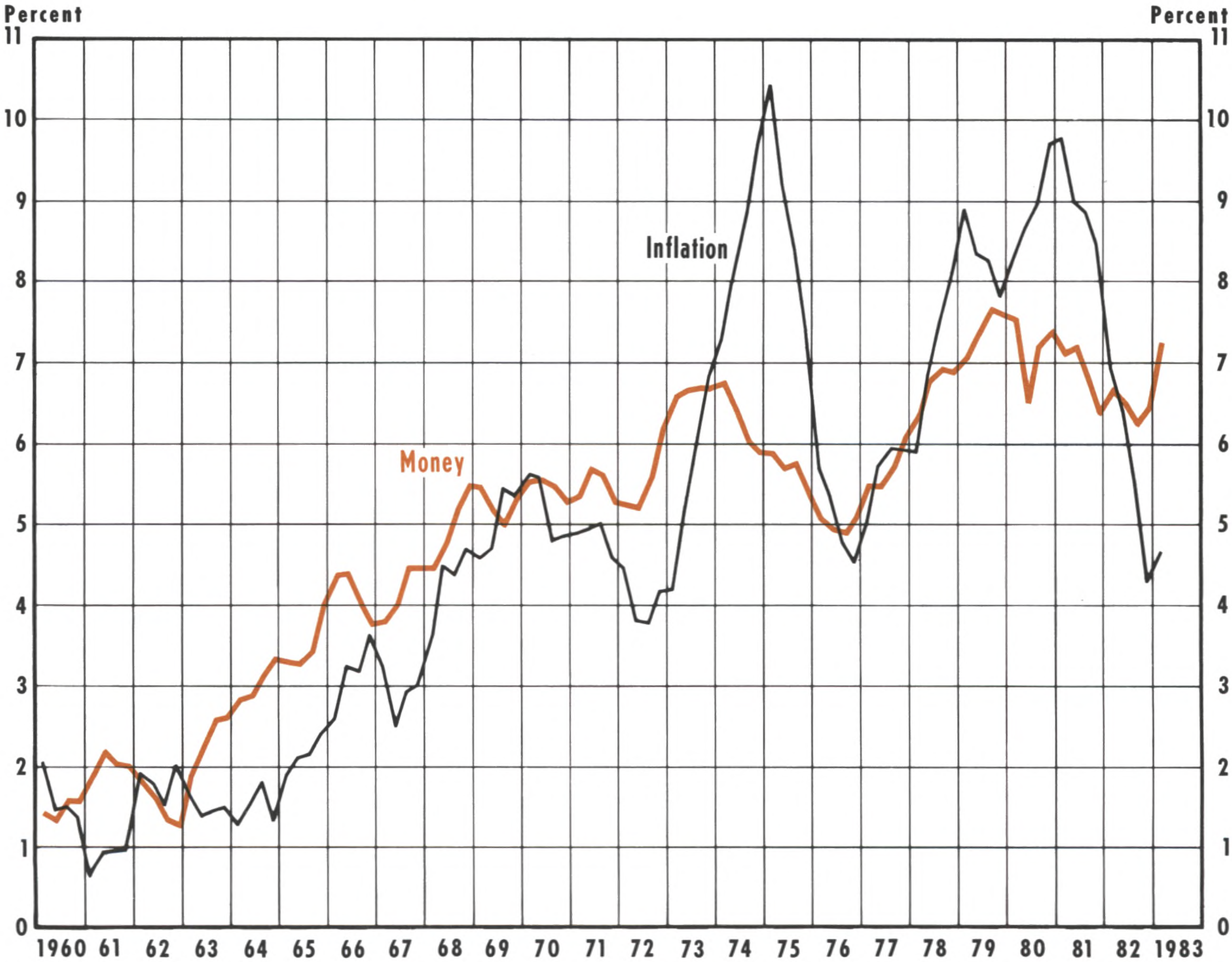
[6]Empirical evidence for this argument is presented in Robert J. Gordon, "World Inflation and Monetary Accommodation in Eight Countries," *Brookings Papers on Economic Activity* (2:1977), pp. 409–68; and James R. Barth and James T. Bennett, "Cost-push versus Demand-pull Inflation: Some Empirical Evidence," *Journal of Money, Credit and Banking* (August 1975), pp. 391–97. For a general discussion, see Dallas S. Batten, "Inflation: The Cost-Push Myth," this *Review* (June/July 1981), pp. 20–26.

[7]See, for example, Keith M. Carlson, "The Lag From Money to Prices," this *Review* (October 1980), pp. 3–10; and Albert E. Burger, "Is Inflation All Due to Money?" this *Review* (December 1978), pp. 8–12.

[8]See, "Announcement," *Federal Reserve Bulletin* (October 1979), p. 830. Specifically, "appropriate constraint on the supply of money and credit is an essential part of any program to achieve the needed reduction in inflationary momentum and inflationary expectations."

Chart 1

Trend Money Growth and Inflation [1]



[1] Trend money growth is measured as a 13-quarter moving average of money growth. Inflation is a 4-quarter growth rate of the GNP deflator.

average money growth rate during the early 1970s, reflecting the Nixon administration's imposition of wage and price controls. The removal of these controls, along with the dramatic increase in OPEC oil prices in late 1973, account for the sharp increase in the inflation rate above average money growth. Oil price shocks again explain much of the similar behavior of inflation in the 1978–80 period.[9]

[9]See Karnosky, "The Link Between Money and Prices;" Tatom, "Energy Prices and Short-Run Economic Performance;" and Rasche and Tatom, "Energy Price Shocks, Aggregate Supply and Monetary Policy."

Some Evidence

The relationship portrayed in chart 1 suggests that short-term movements in inflation can be explained by accounting for the influence of money growth and a few

For a more general discussion of relative price shocks and their effects on measured rates of inflation, see Alan S. Blinder, "The Consumer Price Index and the Measurement of Recent Inflation," *Brookings Papers on Economic Activity* (2:1980), pp. 539–65; Stanley Fischer, "Relative Price Shocks, Relative Price Variability, and Inflation," *Brookings Papers on Economic Activity* (2:1981), pp. 381–431; and Lawrence S. Davidson, "Inflation Misinformation and Monetary Policy," this *Review* (June/July 1982), pp. 15–26.

specific nonmonetary factors that have influenced the measured rate of inflation. One relationship that has been used to successfully explain inflation uses a distributed lag of money growth to capture the "underlying" monetary influence on inflation, and changes in the relative price of energy as one measure of short-run influences that produce deviations of inflation from its trend.[10] Estimated for the sample period I/1960 to IV/1979, the results are (t-statistics in parentheses):[11]

$$(1)\ \dot{P}_t = \underset{(-2.13)}{-0.838} + \underset{(12.36)}{1.100} \sum_{i=0}^{12} \dot{M}_{t-i} + \underset{(0.51)}{0.008}\ \dot{EP}_{t-1}$$

$$+ \underset{(2.55)}{0.051}\ \dot{EP}_{t-2} \underset{(-0.54)}{-0.011}\ \dot{EP}_{t-3} + \underset{(3.10)}{0.052}\ \dot{EP}_{t-4}$$

$$\bar{R}^2 = 0.815 \qquad SE = 1.164 \qquad DW = 1.85$$

where $\dot{P}$ = rate of change of prices, measured as the first difference in the natural logarithm of the GNP deflator,

$\dot{M}$ = rate of change in the money stock, measured as the first difference in the natural logarithm of M1, and

$\dot{EP}$ = rate of change in the relative price of energy.[12]

Summarizing the results, the $\bar{R}^2$ indicates that the estimated relationship captures over 80 percent of the variation in inflation, with slightly over a 1 percent average prediction error (SE = 1.16). The estimated coefficient on the money term (1.100) reveals that a 1 percentage-point increase in the long-run average growth of money will lead to an increase in inflation of about 1 percentage point.[13] Changes in relative energy prices generally have a significant influence on the measured inflation rate. Consequently, omitting their influence would give a misleading signal of the effect of a change in average money growth on the rate of inflation.[14]

The results presented in equation 1 conform to the explanation presented earlier. That is, there is a one-to-one correspondence between money growth and inflation over the long run, and nonmonetary factors may account for significant departures from that rate over shorter time periods.

EXAMINING THE RECENT DROP IN INFLATION

Between the first quarter of 1980 and the first quarter of 1983, the rate of inflation has fallen over 4 percentage points. How much of this decline is due to the monetary policies of the past few years? How much is due to favorable changes in the relative price of energy?

To answer these questions, equation 1 was used to produce out-of-sample forecasts of the inflation rate from I/1980 to I/1983. Two forecasting experiments were conducted using the estimates reported in equation 1: First, one set of inflation rate forecasts was generated using the actual pattern of money growth and relative energy price changes that occurred during this period. The second set of inflation forecasts was obtained by assuming that energy prices had remained unchanged and that changes in money growth alone were responsible for the reduction in inflation. These two sets of inflation forecasts are reported in table 1. The actual rate of inflation during this period also is presented for purposes of comparison.

The quarter-to-quarter variability in the actual inflation rate is evident in table 1. For example, the average inflation rate across the 13-quarter period was 7.35 percent with a standard deviation of 2.51 percent. The resulting coefficient of variation (standard deviation/mean) is 0.34 percent. In contrast, the inflation rate forecasts generated using only money growth show little variation over the period: their standard deviation is only 0.36 percent and, given an average value of 6.63 percent, their coefficient of variation is only 0.05 percent. What these statistics suggest is that quarter-to-quarter inflation forecasts that are based on trend money alone fail to capture much of the sizable short-run variation in recent inflation.

[10]See Tatom, "Energy Prices and Short-Run Economic Performance." The equation estimated here is slightly modified.

[11]The equation is estimated using a contemporaneous and 12 lagged terms of money growth. An Almon polynominal estimation procedure is employed where the degree of the polynominal is set at four. No endpoint constraints are used. The estimated equation also includes two dummy variables to capture the effects of the wage and price control imposition and removal during the early 1970s. Thus, the dummy variable (D1) has a unity value during the control period of III/1971–I/1973 and zero otherwise. The second dummy variable (D2) is used to capture the phasing out of controls, taking on a unity value for the period I/1973–I/1975 and zero elsewhere. The estimated coefficients (and their t-statistics) are: D1 = −1.83 (−3.65) and D2 = 0.72 (1.24).

[12]The relative price of energy is defined as the ratio of the fuels and related products and power component of the producer price index to the business sector deflator.

[13]The estimated value of 1.10 is not statistically different from unity at the 5 percent level of significance (t = 1.12).

[14]Adding the relative energy price terms significantly increases the explanatory power of the estimated equation at the 5 percent level. Using a standard F-test, the calculated F-statistic is 5.80.

Table 1

Inflation Forecasts: I/1980–I/1983

Period	(1) Actual	(2) Money only	(3) Money & Energy	Errors (1) – (2)	Errors (1) – (3)
I/1980	10.01%	7.50%	10.17%	2.51	−0.16
II	9.66	6.46	9.39	3.19	0.26
III	9.14	6.82	10.64	2.32	−1.50
IV	9.97	6.90	9.26	3.08	0.71
I/1981	10.34	6.67	8.27	3.67	2.07
II	6.60	6.81	7.98	−0.21	−1.38
III	8.58	6.52	8.31	2.06	0.28
IV	8.40	6.23	6.72	2.18	1.69
I/1982	4.21	6.46	7.11	−2.25	−2.91
II	4.49	6.42	6.90	−1.93	−2.41
III	4.88	6.25	5.39	−1.37	−0.51
IV	3.65	6.26	4.85	−2.61	−1.20
I/1983	5.64	6.87	7.58	−1.22	−1.93
		Summary statistics:	Mean error	0.72	−0.54
			Mean absolute error	2.21	1.31
			RMSE	2.37	1.56

The forecast results using money and energy price effects (column 3, table 1) do better in modeling recent short-term movements in inflation. This result is made more explicit by comparing the forecast errors from the two experiments in the last two columns of table 1. The forecast errors derived from the "money only" model display a number of large mistakes. For example, six of the errors are two or more standard deviations away from what equation 1 normally would predict. In contrast, only two such errors are found in the money-plus-energy equation's forecast.

The summary statistics reported in table 1 provide additional evidence indicating that the forecast errors are reduced considerably when energy price changes are included along with the monetary factors. Although each model has a relatively small mean error, the mean absolute error and root-mean-squared error (RMSE) for the money-plus-energy price model is noticeably lower than that for money alone.[15]

The forecast results suggest that energy price developments have contributed significantly to the recent decline in inflation. The overall conclusion derived from these empirical results is that, while the downward path of money growth during the past few years accounts for the basic downward trend of inflation, declining energy prices are the primary reason why the actual rate of inflation in 1982 was less than the rate determined by money growth alone.[16]

IS INFLATION REALLY DEAD?

The average rate of money growth can be viewed as a measure of the underlying rate of inflation. Although recent energy price reductions have caused measured inflation to fall below average money growth, past

[15]The root-mean-squared error is defined as

$$\text{RMSE} = \sqrt{\frac{\sum_{t=1}^{N} (\dot{P}_t^A - \dot{P}_t^E)^2}{N}}$$

where $\dot{P}^A$ is the actual rate of inflation, $\dot{P}^E$ is the forecasted rate, and N is the number of periods being forecast. The RMSE for the full model is well within two standard errors of the equation, in contrast with that from the forecasts based only on money growth.

[16]This is not to say, however, that money growth played a minor role in forecasting recent inflation. To see this, we omitted money growth and used only energy price changes to forecast inflation. The result is a dramatic failure to accurately predict inflation: the mean forecast error across the I/1980–I/1983 period using only changes in the relative energy price is −6.93 percent, and the RMSE is 7.09 percent. These statistics are dramatically larger than those reported in table 1 for either model.

Table 2
Inflation Simulation Results: 1983–85

	Simulated inflation	
Year	Money only	Money and relative price of energy[1]
1983[2]	6.59%	6.19%
1984	7.25	6.76
1985	7.17	7.17

[1]See footnote 19 in the text for assumptions about declines in relative price of energy during 1983.

[2]Simulated values for last three quarters only.

experience suggests that once these nonmonetary influences have dissipated, inflation will tend toward the average growth of money. Thus, if there were no further relative price shocks in the near future and if money growth were to remain at its present trend rate, what would the underlying inflation rate be over the next few years?

Simulated inflation rates for the 1983–85 period given the above scenario are presented in the first column of table 2.[17] These suggest that, if the average rate of money growth remains at 7.5 percent, its trend rate in I/1983, future inflation rates likely will be higher than the current rate. For instance, the simulated rate of inflation for 1983 is over 6.5 percent, and rates for 1984 and 1985 exceed 7 percent.

What if the downward drift in relative energy prices continues throughout 1983?[18] To see what effect these further reductions in relative energy prices would have on inflation through 1985, simulations were produced assuming that relative energy prices will decline throughout 1983, but remain constant from 1984 onward.[19] These simulations are reported in the second column of table 2.

The simulations using both money and relative energy prices are lower than the "money only" results for 1983 and 1984; by 1985, however, the effects on the inflation rate of the lower relative energy prices in 1982 and 1983 have fully dissipated. At that time, the rate of inflation is simulated to return back to the average rate of money growth.

CONCLUSION

Evidence presented in this article indicates that recent declines in inflation are due both to a drop in the average rate of money growth and to reductions in the relative price of energy. Once the favorable effects of these relative energy price declines abate and assuming no changes in the historical money growth-inflation link, inflation will tend to move back in line with the average growth of money. Thus, even if relative energy prices decline over the rest of 1983, unless the average rate of M1 growth declines, it is premature to conclude that "runaway inflation is now safely behind us."[20]

[17]The simulations were calculated by re-estimating equation 1 for the period I/1960–I/1983. The results are (t-statistics in parentheses):

$$(1') \quad \dot{P}_t = \underset{(-1.85)}{-0.702} + \underset{(13.48)}{1.065} \sum_{i=0}^{12} \dot{M}_{t-i} + \underset{(0.23)}{0.003}\, \dot{EP}_{t-1}$$
$$+ \underset{(3.59)}{0.055}\, \dot{EP}_{t-2} + \underset{(0.09)}{0.001}\, \dot{EP}_{t-3} + \underset{(2.79)}{0.038}\, \dot{EP}_{t-4}$$
$$- \underset{(-3.42)}{1.716}\, D1 + \underset{(1.59)}{0.782}\, D2$$
$$\bar{R}^2 = 0.827 \qquad SE = 1.182 \qquad DW = 1.83$$

Adding the extra observations produces some minor changes in the estimated coefficients. Even so, the basic outcome reported in equation 1 is duplicated in equation 1′.

[18]For an analysis suggesting that this may occur, see Mack Ott and John A. Tatom, "Are There Adverse Inflation Effects Associated with Natural Gas Decontrol?" *Contemporary Policy Issues* (October 1981), pp. 27–46.

[19]The assumptions used are that the relative price of energy will decline during 1983 at rates of 22.4 percent, 20.0 percent and 6.0 percent in each of the final two quarters. I would like to thank Jack Tatom for these figures.

[20]This statement is from Martin Feldstein, quoted in Stern, "Economists Optimistic on Inflation Outlook."

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