Review

June/July 1982 Vol. 64, No. 6

- 3 The Discount Rate and Market Interest Rates: What's the Connection?
- 15 Inflation Misinformation and Monetary Policy
- 27 Short-Run Money Growth Volatility: Evidence of Misbehaving Money Demand?

igitized for FRASER

ederal Reserve Bank of St. Louis

The Review is published 10 times per year by the Research Department of the Federal Reserve Bank of St. Louis. Single-copy subscriptions are available to the public free of charge. Mail requests for subscriptions, back issues, or address changes to: Research Department, Federal Reserve Bank of St. Louis, P.O. Box 442, St. Louis, Missouri 63166.

Articles herein may be reprinted provided the source is credited. Please provide the Bank's Research Department with a copy of reprinted material.

The Discount Rate and Market Interest Rates: What's the Connection?

DANIEL L. THORNTON

DISCOUNT rate changes invariably send newspaper reporters to the phone to call their favorite economist to ask the inevitable question: What will this do to market interest rates? The impact of discount rate changes on market interest rates apparently is the source of much public confusion and misunderstanding.

This confusion arises from a variety of factors. First, the discount rate is an administered rate set by the Federal Reserve. Second, high interest rates often occur when the discount rate is high, while low interest rates often occur when the discount rate is low. Finally, discount rate changes often are associated with changes in other interest rates in the same direction. These factors have led to a misunderstanding about the pre-eminence of the discount rate in credit markets.¹

The idea of the pre-eminence of the discount rate stems, in part, from a failure to understand the mechanism through which changes in the discount rate are transmitted to market interest rates. The purpose of this article is to analyze the theoretical basis of the link between the discount rate and market interest rates, and to review the recently observed relationship between these rates in light of the theoretical discussion.

THE THEORETICAL CONNECTION BETWEEN THE DISCOUNT RATE AND MARKET INTEREST RATES

The discount rate is the interest rate at which Federal Reserve banks lend reserves to depository institutions, primarily to enable these institutions to meet their reserve requirements.² The relationship between the discount rate and market interest rates can be illustrated using a simple, static model of interest rates called the *loanable funds theory*. According to the loanable funds theory, interest rates are determined by the intersection of the demand for and supply of credit, as illustrated in figure 1. The demand for credit consists of investment demand, government demand (deficits) and changes in the demand for money.³ The supply of credit is composed of public and private savings and changes in the supply of money. Changes in the discount rate affect market interest rates only to the extent that they alter the demand for or the supply of credit.

The Discount Rate and the Supply of Credit

Changes in the discount rate directly affect the supply of credit through their impact on the money supply. To illustrate this, consider the simple model of the money supply given by:

(1) $M^{S} = m \cdot B$.

The supply of nominal money (M^S) is determined by the product of the monetary base (B) and the money multiplier (m). The monetary base consists of the total reserves of depository institutions plus currency held by the nonbank public. The money multiplier summarizes the effect of all other factors on the money supply and, for the purpose of our analysis, is

¹For a recent statement on the importance of the discount rate, see Saul H. Hymans, et al., "The U.S. Outlook for 1982," *Economic Outlook USA* (Winter 1982), p. 3. For a statement about the discount rate as a pivotal rate in the market, see George McKenney, *The Federal Reserve Discount Window* (Rutgers University Press, 1960), p. 6.

²As a result of the Monetary Control Act of 1980, enacted on March 31, 1980, all depository institutions will have the same reserve

requirements. The uniform reserve requirements will be phased in over a number of years. For more details, see "The Federal Reserve Requirements" (Board of Governors of the Federal Reserve System, 1981). The Monetary Control Act also has given thrift institutions access to the discount window through "extended credit borrowing." For more details, see "The Federal Reserve Discount Window" (Board of Governors of the Federal Reserve System, 1980).

³The supply curve is sloped positively on the assumption that higher interest rates encourage more savings and because the money supply may be positively related to the interest rate (see footnote 4 below). The demand for loanable funds is downward sloping due to the downward sloping marginal efficiency of investment and the inverse relationship between the demand for money and interest rates.

assumed to be constant and independent of market interest rates. $\!\!\!^4$

Total reserves supplied by the Federal Reserve can be broken down into those supplied at the discount window, called borrowed reserves (BR), and those supplied through open market operations, called nonborrowed reserves (NBR). The monetary base, therefore, can be written as the sum of BR, NBR and currency held by the nonbank public (C). Thus, equation 1 can be rewritten as:

(2) $M^S = m \cdot (BR + NBR + C)$.

Changes in the discount rate affect market interest rates through their impact on borrowing from the Federal Reserve. For example, an *increase* in the discount rate will *reduce* the level of borrowing, ceteris paribus, reducing both the monetary base and the money supply. As a result, the supply-ofcredit schedule in figure 1 will shift to the left and market interest rates will rise. Reducing the discount rate will have the opposite effect.

Discount Rate Changes and Depository Institution Borrowing

The crucial link between the discount rate and market interest rates is the connection between the discount rate and borrowing from the Federal Reserve. When the discount mechanism originally was formulated, it was assumed that banks would be reluctant to be in debt to the Federal Reserve and would endeavor to repay their indebtedness as soon as possible.⁵ It was thought that the Federal Reserve could control the level of bank borrowing by reinforcing banks' reluctance to borrow, through the administration of the discount window, and by altering the discount rate.⁶ Given the nonpecuniary costs associated with discount window administration, an increase in the discount rate would reduce the level of borrowing; reductions in the discount rate would have the opposite effect.

Later, it was recognized that the relationship between the discount rate and borrowing at the discount window was not quite so simple. Borrowing from the Federal Reserve is only one of several methods depository institutions use to adjust their reserve positions. They can borrow from the Federal Reserve, buy federal funds in the federal funds market, or sell earning assets, such as short-term Treasury securities.⁷ It is not simply the level of the discount rate that influences a depository institution's decision to borrow, but the level of the discount rate *relative* to rates on alternative adjustment assets. A financial institution confronted with a reserve deficiency will adjust its reserve position in the least costly manner. Thus, the important variable in the decision to borrow is the so-called least-cost spread between the rate on the next best reserve adjustment asset and the discount rate.

In the aggregate, borrowing is usually represented by an equation like (3) below, in which (i_d) denotes the discount rate and (i_a) denotes the interest rate on next best reserve adjustment asset.⁸

(3) BR = $a_0 + a_1 (i_a - i_d), a_0 \ge 0, a_1 > 0$

In this equation, ao denotes a "frictional" level of

⁴It is sometimes argued that the money supply is positively related to interest rates due to changes in the public's desire to hold various assets in response to interest rate changes. For an analysis of the monetary base approach to the money supply process, see Jerry L. Jordan, "Elements of the Money Stock Determination," this *Review* (October 1969), pp. 10-19.

⁵Winfield Riefler noted that "the reluctance of member banks to borrow is not based solely upon the philosophy of reserve banks, however. Indeed, that philosophy merely expresses the desire of the great majority of the member banks themselves to remain out of debt . . . and a feeling on their part that borrowing for profit is unsound. . . . Long before the establishment of the reserve system, it was one of the fundamental traditions of sound banking practice in this country, that a bank's operations should be confined to the resources which it derives from its stockholders and depositors and interbank borrowing was at all times limited." Winfield Riefler, *Money Rates and Money Markets in the United States* (Harper and Bros., 1930), p. 29.

⁶It is still thought that depository institutions are reluctant to borrow from the Federal Reserve; however, it has been a longstanding question whether the reluctance is inherent or induced. The use of nonprice rationing at the discount window began as early as 1918. See Clay Andersen, A Half-Century of Federal Reserve Policymaking: 1914-1964 (Federal Reserve Bank of Philadelphia, 1965).

⁷Prior to September 1968, depository institutions could adjust their reserve position by reducing the level of their deposits and, hence, required reserves. In September 1968, the Federal Reserve introduced lagged reserve accounting, in which required reserves in the current week are based on deposit levels of two weeks previous.

At the same time, the Federal Reserve changed Regulation D to permit a reserve deficiency carryover equal to 2 percent of required reserves. Depository institutions can also adjust their reserve position by carrying over the deficiency into the next reserve week. Carryovers in excess of 2 percent of required reserves are charged a rate 2 percentage points above the lowest discount rate in effect on the first day of the calendar month in which the deficiency occurs. It should be noted that only borrowing from the Federal Reserve adds reserves to the system as a whole.

⁸The borrowing equation usually includes variables to measure the degree of reserve pressure of depository institutions, such as the level of or the change in nonborrowed reserves. Because they have no significance for our purpose, they were ignored here.

Figure 1 Credit Market Equilibrium



borrowing (i.e., borrowing that occurs even if the discount rate is not the least costly alternative).⁹

Given equations 2 and 3, the connection between the discount rate and market interest rates is apparent. Increases in the discount rate reduce the least-cost spread, which reduces borrowing and The extent of the increase in the market interest rate is determined by the sensitivity of borrowing to the least-cost spread (a1) and by the interest sensitivity of the demand for credit. The more borrowing is interest-sensitive to the least-cost spread (i.e., the larger a1), the greater will be the shift in the supply of credit for any change in the discount rate. The larger the shift in the supply of credit, the greater the change in the market interest rate, for any given credit demand curve. Also, the less interest-sensitive the demand for credit (i.e., the steeper the demand curve), the greater the change in the market interest rate for any given shift in the supply schedule resulting from a change in the discount rate.

The Discount Rate, Interest Rates and Monetary Policy

Unfortunately, the above analysis is overly simple in that it ignores the role of monetary policy in influencing the link between the discount rate and market interest rates. Specifically, the relationship between the discount rate and market interest rates depends on other monetary policy actions and, in particular, on the operating procedure of the Federal Reserve. For example, if the Federal Reserve were to pursue a policy of controlling the level of interest rates, changes in the discount rate would have no independent impact on market rates. The reason for this is straightforward. Under an interest rate targeting procedure, the Trading Desk of the Federal Reserve Bank of New York would offset any movement in market rates by changing the level of nonborrowed reserves through open market operations; that is, the leftward shift in the credit supply schedule due to an increase in the discount rate would be offset by a rightward shift resulting from Federal Reserve open market operations. The impact of the change in the discount rate on the market rate would be nil.¹⁰

A similar result would hold if the Federal Reserve chose to control the level or growth of the money

For a discussion of the various theories of depository institutions' borrowing, see Riefler, *Money Rates and Money Markets in the United States*; Lauchlin Currie, *The Supply and Control of Money* (Harvard University Press, 1934); Robert Turner, *Member-Bank Borrowing* (Ohio State University Press, 1938); Murray E. Polakoff "Reluctance Elasticity, Least-Cost, and Member Bank Borrowing: A Suggested Integration," *Journal of Finance* (March 1960), pp. 1-18; Murray Polakoff and William Silber, "Reluctance and Member-Bank Borrowing: Additional Evidence," *Journal of Finance* (March 1967), pp. 88-92; and Stephen Goldfeld and Edward Kane, "The Determinants of Member Bank Borrowing: An Econometric Study," *Journal of Finance* (September 1966), pp. 499-514.

⁹The fact that there is usually some level of borrowing even when the discount rate is above most other short-term market interest rates is usually construed as prima facie evidence of the inadequacy of the alternative mechanisms in providing the reserve adjustment needs of *all* depository institutions. At the other extreme, borrowing takes the form of a subsidy if the discount rate is substantially below market rates. See R. Alton Gilbert, "Benefits of Borrowing from the Federal Reserve when the Discount Rate is Below Market Interest Rates," this *Review* (March 1979), pp. 25-32.

¹⁰It should be noted that the Federal Reserve cannot "peg" interest rates in an inflationary environment without continually accelerating the growth rate of money. See Milton Friedman, "The Role of Monetary Policy," *American Economic Review* (March 1968), pp. 1-17.

supply, and if it effected its control through monetary base (or total reserve) targeting. In this instance, an increase in the discount rate would lower the level of borrowing and, hence, the monetary base. If this change caused the base to deviate from its desired path, given a money growth objective, the Federal Reserve would increase nonborrowed reserves via open-market operations in order to return the monetary base to its desired path. Changes in the discount rate would have no independent effect on either the money supply or market interest rates.

The effect of a discount rate change on market rates could be significant when the Federal Reserve targets on nonborrowed reserves as it currently does. In this instance, changes in the discount rate alter aggregate borrowing, the monetary base and the money supply as before. The movement in the base would not necessarily be offset through open market operations. As long as nonborrowed reserves are on path, the Federal Reserve might choose not to offset changes in borrowings associated with changes in the discount rate.¹¹ Under the present system of lagged reserve accounting (LRA), however, the effect of a discount rate change on aggregate borrowing, the monetary base and the money supply will be much smaller.

The Role of Lagged Reserve Accounting

The present system of lagged reserve accounting, which was introduced in September 1968, has made depository institutions' demand for reserves less responsive to interest rate changes.¹² Thus, any change in the supply of reserves, either through changes in NBR or the discount rate, produces a larger change in the rates on reserve adjustment assets, such as federal funds and Treasury bills.

In order to see this point, consider the following simple model of the market for reserves. Reserves are supplied by the Federal Reserve either through open market operations or at the discount window. NBR are determined solely by Federal Reserve actions and are independent of market interest rates. In contrast, BR are related to interest rates via equation 3. Depository institutions' demand for reserves is composed of their demand for required reserves (as determined by their deposit levels) and their demand for excess reserves. Under a system of contemporaneous reserve accounting (CRA), both required reserves and excess reserves are assumed to be negatively related to the rate on reserve adjustment assets.¹³ This equilibrium is illustrated in figure 2a by the intersection of R_e and R^c_d.

Under a system of LRA, current required reserves are determined by depository institutions' deposits of the prior two weeks. The demand for *current required reserves* is completely insensitive to the interest rates on reserve adjustment assets. The interest responsiveness of the demand for reserves is determined solely by the demand for excess reserves. Thus, demand for reserves under LRA is less interest-sensitive (steeper), as illustrated by R¹_d in figure 2b.¹⁴

The impact of a change in the discount rate under CRA and LRA is illustrated in figure 2. An increase in the discount rate reduces the amount of reserves supplied at each market rate, shifting the reserve supply curve to R'_s . Given that the demand for

¹¹The reader might legitimately inquire as to why the Federal Reserve would not offset all changes in aggregate borrowing if it did not desire a change in the money supply. Unfortunately, there is no simple answer to this question. Recently the Federal Reserve has attempted to offset changes in borrowing *only* if they are viewed to be permanent in some sense. See David E. Lindsey, "Nonborrowed Reserve Targeting and Monetary Control" in *Improving Money Stock Control: Problems*, *Solutions and Consequences*, conference cosponsored by the Federal Reserve Bank of St. Louis and the Center for the Study of American Business, Washington University, October 30-31, 1981 (forthcoming).

It should be noted, however, that if the Federal Reserve were to offset all changes in borrowings that move them off their nonborrowed reserve path, they would essentially be targeting on total reserves or the base.

¹²Since this article was completed, the Federal Reserve Board adopted a resolution to return to contemporaneous reserve accounting.

¹³Under CRA, depository institutions must weigh the marginal costs of having to adjust their reserve position either at the discount window or in the market with the marginal gain from making additional loans and investment and, thereby, creating additional deposits. Thus, when either the discount rate or the rates on alternative adjustment assets increase relative to depository institutions' lending rates, they respond by curtailing their lending and investment activities, which reduces their deposit liabilities and their demand for required reserves. Thus, the demand for required reserves would be interestsensitive under CRA. Under LRA, the demand for required reserves is determined by deposit levels two weeks previous and, hence, is independent of current interest rates.

Excess reserves are thought to be held as a source of liquidity for the depository institution. As such, the opportunity cost of holding excess reserves is income forgone by not investing them in some income-generating asset, like federal funds. Thus, the demand for excess reserves is thought to be responsive to changes in market interest rates. The demand for excess reserves, however, is generally not thought to be responsive to interest rates.

¹⁴The equilibrium market rate is shown the same for both CRA and LRA for ease of illustration. This accommodation to convenience does not affect the conclusions.



reserves is less interest-sensitive under LRA, interest rates must rise by more in order to restore market equilibrium. Thus, a change in the discount rate will result in a larger change in the interest rates on reserve adjustment assets, and a smaller change in aggregate borrowing, the monetary base and the money supply.

The Effect on Other Market Rates

A change in the discount rate has its initial effect on the market interest rate of reserve adjustment assets. The extent to which a change in the market rates of these assets spills over to other market interest rates depends on the substitutability of assets in the portfolios of financial intermediaries and the public. To illustrate this point, assume for simplicity that depository institutions use only one asset as an alternative to borrowing from the Federal Reserve, and that this asset is not held in the portfolios of the rest of the private sector of the economy (e.g., federal funds). Thus, there are no close substitutes for this asset in the portfolios of nondepository institutions. In this case, the initial impact of a change in the discount rate would be reflected primarily in the market rate of this asset. The effect on other market interest rates would materialize only as depository institutions modified their lending and investment activities in light of the higher marginal cost of reserve adjustment funds.

The Discount Rate and the Demand for Credit

The discount rate also affects market interest rates via the demand for credit through the so-called announcement effect. According to this view, the business and financial communities regard discount rate changes as *signals* of the future direction of monetary policy. Discount rate changes are thus said to alter expectations about the future of business profits and the direction of interest rates.

Unfortunately, the impact of the announcement effect depends on the exact nature of these expectation effects.¹⁵ To illustrate this, consider the following: If the Federal Reserve increased the discount rate, individuals might interpret this action as an indication that a slower rate of monetary growth, a lower rate of inflation and, hence, lower interest rates will soon follow. If this were the case, they might

¹⁵Warren Smith has argued that the exact impact of the announcement effect depends on the market perception of the efficacy of monetary policy, the elasticity of interest rate expectations and the distributions of these expectations among borrowers and lenders in the market. See Warren Smith, "Instruments of General Monetary Control," National Banking Review (September 1963), pp. 47-76; "The Discount Rate as a Credit Control Weapon," Journal of Political Economy (April 1958), pp. 171-77; and "On the Effectiveness of Monetary Policy," American Economic Review (September 1956), pp. 588-606.





reduce their current demand for credit in anticipation of lower future interest rates. The demand for credit would shift to the left and, ceteris paribus, current interest rates would fall. The combined effects of a discount rate increase on the supply of and the demand for credit in this instance, under nonborrowed reserve targeting, are illustrated in figure 3a. An increase in the discount rate shifts both the supply-of-credit and the demand-for-credit schedules to the left. Market interest rates would rise or fall depending on whether the shift in the demand curve is small or large, relative to the shift in the supply curve.

Conversely, individuals might interpret the discount rate increase as an indication that market interest rates will temporarily rise. In this case, the current demand for credit would increase. Under these circumstances, an increase in the discount rate would shift the supply of credit to the left and the demand for credit to the right as illustrated in figure 3b. Market interest rates would then have risen in response to a discount rate change.¹⁶



h

Supply of credit

Demand for credit

Quantity of credit

Furthermore, it has been noted that changes in the discount rate are sometimes merely *technical adjustments*, designed to bring the discount rate in line with changes in market interest rates. Thus, if discount rate changes are commonly interpreted as signals of policy change, they may be misinterpreted. It has even been suggested that, given the Federal Reserve Banks' tendency to make these technical adjustments, a failure to change the discount rate when market rates are changing could be construed as a change in Federal Reserve policy.¹⁷

¹⁶Warren Smith has commented that, rather than changing the demand for credit in the short run, a discount rate increase may merely induce market participants to shift to different term assets in response to expectations of higher or lower future interest rates. If this were the case, the yield curve would shift with changes in the discount rate. See Smith, "The Discount Rate as a Credit Control Weapon."

¹⁷For a recent interpretation of discount rate changes as technical adjustments, see Hymans, et. al., "The U.S. Economic Outlook for 1982." For an interesting look at various interpretations of a discount rate change, see Charles Walker, "Discount Policy in Light of Recent Experience," *Journal of Finance* (May 1957), pp. 223-37; Milton Friedman, A Program for Monetary Stability (Fordham University Press, 1959); and Ralph A. Young, "Tools and Processes of Monetary Policy," in Neil H. Jacoby, ed., United States Monetary Policy (Fredrick A. Proeger, 1964), pp. 24-72.

The Discount Rate and the Level of Market Interest Rates

Up to this point, the discussion has been solely in terms of the effect of *changes* in the discount rate on market interest rates. Nothing has been said about the relationship between the *level* of the discount rate and the *level* of market interest rates. Thus, one additional point must be made before proceeding to the empirical analysis. The point is that there are numerous factors that affect the supply of and the demand for credit besides the discount rate. Thus, there is no one level of market interest rates that necessarily corresponds to any given level of the discount rate. It would not be surprising, then, to find that other factors dominate movements in market interest rates in the longer run. This is especially true when one recognizes that the discount rate is an administered rate that is changed infrequently.

THE DISCOUNT RATE AND MARKET INTEREST RATES: THE RECENT EXPERIENCE

Now consider the empirical evidence on the relationship between the discount rate and market interest rates. The data analyzed is from January 1978 to April 1982, a period chosen because it is timely and because it is characterized by markedly different Federal Reserve operating procedures. Until October 6, 1979, the Federal Reserve followed a procedure of federal funds rate targeting; that is, it conducted open market operations in such a way as to keep the federal funds rate in a narrow range established by the Federal Open Market Committee (FOMC). Also, the Federal Reserve followed a policy of changing the discount rate frequently to maintain a fairly constant federal funds rate/ discount rate differential.

Since October 1979, the Federal Reserve has pursued a policy of controlling the monetary aggregates through a nonborrowed reserve targeting procedure.¹⁸ Thus, the announced federal funds rate range has been much wider since October 6, and the federal funds rate has exhibited more dayto-day variability. Moreover, the average daily spread between this rate and the discount rate has been much wider.¹⁹

Establishing the precise relationship between the discount rate and market interest rates is extremely difficult. Ideally, sets of equations representing the demand for credit, the supply of credit and a market-clearing condition should be specified. In this way, one could not only estimate the extent of the impact of a discount rate change on various market interest rates, but also identify the most significant source of the change (i.e., its effect through the supply of or the demand for credit).²⁰ In practice, however, this is difficult. As a result, the impact of a discount rate change on warket interest rates is usually estimated with a reduced-form model, which

A significant discount rate effect would be clear evidence of an announcement effect, since the impact of a discount rate change on the money supply would be incorporated in the base. Unfortunately, an insignificant discount rate will not necessarily imply the absence of an announcement effect; this result could also be obtained if the money supply is relatively interest-inelastic. Thus, one would have to show both that the money supply schedule is interest-elastic and an insignificant discount rate in such a reduced-form equation to argue convincingly that there is no announcement effect. Regretably, practical problems make this virtually impossible.

It is possible to show that the discount rate is insignificant in a reduced-form equation, *employing seasonally adjusted data*, for the 10/1979 - 10/1981 period. The money supply equation exhibits some interest elasticity, however, only if *seasonally unadjusted data* is used. Because personal income (the only available monthly income series) is available only on a seasonally adjusted basis, it is impossible to estimate the reduced-form equation using seasonally unadjusted data. Thus, the insignificant discount rate variable in the seasonally adjusted, and an announcement effect.

¹⁸For a discussion of the Federal Reserve's operating procedure since October 6, 1979, see Stephen Axilrod and David E. Lindsey, "Federal Reserve System Implementation of Monetary Policy: Analytical Foundations of the New Approach," *American Economic Review* (May 1981), pp. 246-52; R. Alton Gilbert and Michael E. Trebing, "The FOMC in 1980: A Year of Reserve Targeting," this *Review* (August/September 1981), pp. 2-22; Richard W. Lang, "The FOMC in 1979: Introducing Reserve Targeting," this *Review* (March 1980), pp. 2-25; and Lindsey, "Nonborrowed Reserve Targeting and Monetary Control."

¹⁹For a discussion of the relationship between the federal funds rate and the FOMC's announced federal funds rate range, see Lang, "The FOMC in 1979: Introducing Reserve Targeting"; and Gilbert and Trebing, "The FOMC in 1980: A Year of Reserve Targeting."

²⁰One possible way to identify a separate announcement effect is to specify a general model of the supply of and the demand for money. This could be done by simply including the discount rate as a separate variable in the demand for money and supply of money functions, and testing to see whether it has a significant effect on either or both. However, the correspondence between the discount rate and market interest rates, due to the fact that discount rate changes tend to follow market interest rate changes, biases this test toward the rejection of the announcement effect unless one has precise knowledge of the Federal Reserve's discount rate reaction function. This problem could be overcome by simply estimating a reduced-form, equilibrium money stock equation. This equation would have the money stock a function of the exogenous variables of the system: aggregate income, the monetary base and the discount rate.

does not permit one to differentiate between supplyside and demand-side effects.²¹

The Discount Rate and Market Rates

To determine the effect of discount rate changes on market interest rates, the following equation was estimated using both the federal funds and the 3-month Treasury bills to represent alternative adjustment assets:

(4)
$$\triangle i_{at} = \delta_0 + \sum_{j=1}^{10} \delta_j \triangle i_{at-j} + \delta_2 \ \triangle DR_t + \epsilon_t$$

10

This equation was estimated using daily data for the period from January 10, 1978, to April 13, 1982, and for subperiods of federal funds rate targeting and NBR targeting.²² The 10-day distributed lag of the market rate was included to capture the effect of other factors on the market rate before the discount rate change.

Table 1 presents estimates of equation $4.^{23}$ The change in the discount rate, denoted by $\triangle DR$, equals the change only on the day that it became effective. The $\triangle DR$ variable was partitioned into technical changes— $\triangle DRT$ —and nontechnical changes— $\triangle DRNT$ —to test whether there is a different effect if discount rate changes are made solely for technical reasons (i.e., to keep the discount rate in line with market interest rates [see insert, page 12]).²⁴

²²The data were partitioned on September 19, 1979, the effective date of the last discount rate change prior to the implementation of the new operating procedures on October 6, 1979.

Federal Reserve Bank of St. Louis

Also, a discount rate surcharge variable, \triangle SC, was included in some of the regressions in the NBR targeting period to capture any effect of the Federal Reserve's surcharge on large, frequent borrowers.²⁵

The results for the entire period indicate that a discount rate change has a significant positive effect on both the federal funds and the Treasury bill rates. When the equation is estimated for subperiods of federal funds rate and NBR targeting, however, the results change. The coefficient on ΔDR is not significantly different from zero for the Treasury bill rate during the period of federal funds rate targeting. In contrast, the coefficient on ΔDR is significant for both market rates during the period of NBR targeting. Furthermore, the coefficient estimates on ΔDR are larger during the latter period.

The preceding section noted that discount rate changes would not affect market interest rates if the Federal Reserve targeted on them, but would affect market rates under NBR targeting. The results for the Treasury bill rate equation correspond with this analysis, but the results from the federal funds rate equation do not. If depository institutions primarily rely on the federal funds market to adjust their reserve positions, however, it is conceivable that most of the impact of a discount rate change could be absorbed by the federal funds rate with virtually no spillover to other market rates. This even seems likely when one recognizes that the Federal Reserve has never followed a policy of rigidly pegging the level of the federal funds rate.

In addition, discount rate changes generally were made in order to keep the rate spread between the discount rate and the federal funds rate in a fairly narrow band during the funds rate targeting period.²⁶ Thus, during this period, discount rate changes may have been anticipated and fully reflected in market rates before the discount rate change. The Federal Reserve allowed the spread between the discount and the federal funds rates to be much larger and variable during the NBR target-

²¹Among the studies that have attempted to test for an announcement effect using a reduced-form model are: H. Kent Baker and James M. Meyer, "Impact of Discount Rate Changes on Treasury Bills," Journal of Economics and Business (Fall 1980), pp. 43-48; Douglas R. Mudd, "Did Discount Rate Changes Affect the Foreign Exchange Value of the Dollar During 1978?" this Review (April 1979), pp. 20-26; Rodger Waud, "Public Interpretation of Federal Reserve Discount Rate Changes: Evidence on the 'Announcement Effect,'" Econometrica (March 1970), pp. 231-50; and Raymond Lombra and Raymond Torto, "Discount Rate Changes and Announcement Effects," Quarterly Journal of Economics (February 1977), pp. 171-76.

²³The equations were estimated with ordinary least squares (OLS) and with a maximum likelihood procedure that adjusts for first-order autocorrelation. OLS results are reported if the estimate of the coefficient of autocorrelation was not significantly different from zero. The results, however, were essentially invariant to the estimation technique.

²⁴Discount rate changes were made for purely technical reasons on May 11 and July 3, 1978, and on May 30, June 13, July 28, 1980, and December 4, 1981.

²⁵The Federal Reserve first introduced a surcharge of 3 percent to the basic discount rate for large and frequent borrowers on March 17, 1980. The effective surcharges and dates are: 3 percent on March 17, 1980, removed May 7, 1980; 2 percent on November 17, 1980; 3 percent on December 5, 1980; 4 percent on May 5, 1981; 3 percent on September 22, 1981; 2 percent on October 13, 1981, removed November 17, 1981.

²⁶The average spread between the discount and the federal funds rates between discount rate changes ranged from 50 to 100 basis points.

Table 1

Estimates of Equation 4

Period	Constant	△DR			∆sc	Sum of lags	ρ	R ² /SEE
			Fed	eral Funds R	ate			
1/10/78-	.007*	.487				536	26	.117
4/13/82	(.476)	(2.831)					(8.84)	.648
	.003*		.736	134*		253	41	.121
	(.185)		(3.678)	(.462)			(14.76)	.646
1/10/78-	.023	.312				-1.462	61	.323
9/19/79	(2.892)	(2.247)					(16.00)	.252
	.023		.431	583*		1.378	68	.332
	(2.963)		(3.023)	(1.564)			(19.28)	.250
9/20/79-	.006*	.553				326	19	.110
4/13/82	(.217)	(2.300)					(4.92)	.803
	.001*		.884	092*		283	32	.11,4
	(0.057)		(3.006)	(.239)			(8.58)	.800
	.001*	.414*			.423	453	14	.119
	(.105)	(1.679)			(2.823)		(3.59)	.792
	.007*		.687	038*	.375	426	22	.120
	(.237)		(2.206)	(.098)	(2.501)		(5.73)	.797
			Tre	asury Bill Ra	te			
1/10/78-	.002*	.357				.261	N.A.	.046
4/13/82	(.307)	(5.655)						.230
	.000*		.473	.104*		.308	08	.051
	(.028)		(6.234)	(.942)			(2.64)	.228
1/10/78-	.010	.028*				226	N.A.	.067
9/19/79	(2.103)	(.454)						.095
	.010		.054*	167*		384	N.A.	.068
	(2.13)		(.839)	(.970)				.095
9/20/79-	.002*	.434				.286	N.A.	.050
4/13/82	(.181)	(4.979)						.286
	002*		.613	.110*		.349	12	.059
	(.157)		(5.687)	(.778)			(3.07)	.282
	.003*	.396			.094*	.124	.13	.053
	(.199)	(4.546)			(1.762)		(3.33)	.283
	.001*		.573	.139*	.064*	.262	N.A.	.059
	(.067)		(5.056)	(.967)	(1.153)			.285

*Indicates the coefficient is not significant at the .05 level.

N.A. indicates the equation was estimated with ordinary least squares.

ing period. Hence, discount rate changes may not have been anticipated as well during this period, resulting in a more significant announcement effect on the demand side.

Furthermore, the absolute value of discount rate changes were larger in the latter period. The nine discount rate changes in the early period averaged 50 basis points, while each of the 11 changes in the latter period were 100 basis points in absolute value. Thus, one could argue that only larger discount rate changes have a significant effect on market interest rates.

To further investigate the relationship between discount rate changes and market interest rates, the equations were re-estimated using both $\triangle DRNT$ and $\triangle DRT$, which reflect nontechnical and technical

Reasons for Changes in the Discount Rate

Date	Change	Reason
May 11, 1978	61/2 to 7%	Action taken to bring discount rate in closer alignment with short-term interest rates.
July 3, 1978	7 to 71/4%	Essentially the same as above.
August 21, 1978	7¼ to 7¾%	Action taken in view of recent disorderly conditions in foreign exchange markets, as well as the continuation of serious domestic inflation.
September 22, 1978	7¾ to 8%	Action taken to bring discount rate in closer alignment with short-term interest rates, and as a further step to strengthen the dollar.
October 16, 1978	8 to 81⁄2%	Action taken to bring the discount rate in closer alignment with short-term interest rates, and in recognition of the continued high inflation rate and of the current international financial condition.
November 1, 1978	8½ to 9½%	Action taken to strengthen the dollar and to counter continuing domestic inflationary pressures.
July 20, 1979	9½ to 10%	Action taken in view of the recent rapid expansion of the monetary aggregates, to strengthen the dollar on foreign exchange markets and to bring the discount rate into alignment with short-term interest rates.
August 17, 1979	10 to 101/2%	Action taken in view of the continuing strong inflationary forces and the relatively rapid expansion in the monetary aggregates.
September 19, 1979	10½ to 11%	Action taken to bring the discount rate into alignment with short-term interest rates, and to discourage excessive borrowing from the discount window.
October 9, 1979	11 to 12%	Action taken to bring discount rate into closer alignment with short-term rates, and to discourage excessive borrowing.
February 15, 1980	12 to 13%	Concern about the increased price of imported oil adding to inflationary pressures underscored the need to raise the discount rate and maintain firm control over the growth of money and credit.
May 30, 1980	13 to 12%	Action taken entirely in recognition of recent substantial declines in short-term market interest rates to levels below the discount rate.
June 13, 1980	12 to 11%	Essentially the same as above.
July 28, 1980	11 to 10%	Essentially the same as above.
September 26, 1980	10 to 11%	Action taken as part of a continuing policy to discourage excessive growth in the monetary aggregates.
November 17, 1980	11 to 12%	Action taken in view of the current level of short-term interest rates and the recent rapid growth in the monetary aggregates and bank credit.
December 5, 1980	12 to 13%	Action taken in light of the level of market rates and consistent with the existing policy to restrain excessive growth in money and credit.
May 5, 1981	13 to 14%	Action taken in light of the current levels in short-term market interest rates and the need to maintain restraint in the monetary and credit aggregates.
November 2, 1981	14 to 13%	Action taken against the background of recent declines in short-term interest rates and the reduced level of adjustment borrowing at the discount window. It is consistent with a pattern of continued restraint on the growth of money and credit.
December 4, 1981	13 to 12%	Action taken to bring the discount rate into better alignment with short-term interest rates that were prevailing recently in the market.

Source: Federal Reserve Bulletins released the month of or one month after the announced change in the discount rate.

changes in the discount rate, respectively. Discount rate changes that are made purely for technical reasons might have less of an impact on market rates in that either (1) the Federal Reserve offsets their effect on the supply of credit through open market operations because they were not intended as a change in policy, or (2) the announcement effect was weaker because market participants do not view such changes as indications of a change in Federal Reserve policy.²⁷ If either of these is true, the coefficient on $\triangle DRNT$ will be larger than the coefficient on $\triangle DR$, and the coefficient in $\triangle DRT$ will not be statistically significant. Table 1 shows that these

²⁷Under LRA a change in the discount rate produces a much smaller change in aggregate borrowing than under contemporaneous reserve accounting. Thus, the level of open market operations required to offset the effect of this change on money is much smaller.

results were obtained in every instance. Thus, it appears that only discount rate changes that are made for nontechnical reasons have a significant impact on market interest rates. The coefficient on Δ DRNT in the Treasury bill rate equation, however, was not significant during the early period. Discount rate changes appear to have had no impact on the 3-month Treasury bill rate under interest rate targeting, regardless of the reason for the change.²⁸

The Effects of the Surcharge

The effects of the discount rate surcharge on market interest rates during the NBR targeting period are mixed. When the discount rate surcharge variable is added to the federal funds rate equation, the coefficients on the discount rate variables become smaller. Furthermore, the coefficients on the surcharge variables are statistically significant. These results indicate a significant positive surcharge effect on the federal funds rate. In addition, they indicate that the estimates of the discount rate effect alone are unduly large when the surcharge variable is ignored. This is likely because of the interaction of discount rate and surcharge effects.²⁹

When the surcharge variable is included in the Treasury bill rate equation, the coefficients on the discount rate variables are essentially unaffected. The coefficients on the \triangle SC variable are insignificant and small. Thus, it appears that the surcharge has no appreciable impact on the Treasury bill rate.

The Levels of the Discount Rate and Market Rates

The fact that discount rate changes have a significant immediate effect on market interest rates does not mean that there is a significant relationship between the *level* of the discount rates and the *level* of market rates. One would anticipate that any effect of a discount rate change on market interest rates would be reflected in market rates rather quickly, so that movement in these rates between discount rate changes would be dominated by other factors.³⁰ This is borne out in a casual observation of the relationship between the discount rate and market rates over this period as shown in chart 1.

It is clear from this chart that market interest rates varied from levels substantially above the discount rate to levels substantially below it over this period. This merely reflects the previously noted fact that there is no level of market interest rates that necessarily corresponds to a given level of the discount rate.

Furthermore, there were at least three occasions when discount rate changes were closely followed by movements in the 3-month Treasury bill rate in the opposite direction (June 13, 1980, December 5, 1980, and May 5, 1981). In the last instance, the federal funds rate and the Treasury bill rates moved in opposite directions. The federal funds rate rose from early May to mid-July 1981, then declined. In contrast, the bill rate fell from early May to early July, then rose until late August. Thus, it is difficult to find any consistent longer-term relationship between the level of the discount rate and the level of market interest rates.

CONCLUSIONS

Market interest rates are influenced by numerous factors that affect the supply of and demand for credit. *One* of these factors is the discount rate. The impact of the discount rate on market rates varies with the Federal Reserve's operating procedures. If the Federal Reserve is controlling interest rates, the monetary base or total reserves, changes in the discount rate have no effect on interest rates independent of the general tenor of monetary policy; the Federal Reserve simply would offset the effect of discount rate changes through open market operations. If the Federal Reserve is targeting on nonborrowed reserves, changes in the discount rate are more likely to have an impact on market rates, especially under lagged reserve accounting.

²⁸The results presented in this section appear to be robust. They are essentially unchanged if the equation is estimated in level form, although the \overline{R}^2 s are much larger. Also, essentially the same results are obtained by a statistical comparison of the one-day percentage changes in the market rates on the day the discount rate change became effective with the 10-day and 20-day growth rates prior to the discount rate change.

²⁹It is important to include the surcharge variable in the latter period because some of the changes in the discount rate and the surcharge overlap. The overlapping dates are: November 17, 1980, December 5, 1980, and May 5, 1981. Failure to include the surcharge could result in a spurious estimate of the discount rate effect.

³⁰In an effort to uncover a possible lagged response of the federal funds rate to discount rate changes, equation 4 was estimated with a 20-day distributed lag of the △DR variable. None of the lagged variables, however, was significant except for the seventh day. It is interesting to note that, since most of the discount rate changes became effective on a Monday, the seventh-day lag would be Wednesday, the close of the "reserve week." This result, however, is perhaps too tentative to assign any significance to it.



Data indicate that *changes* in the discount rate have produced a significant, albeit varied, immediate impact on both the federal funds rate and the 3-month Treasury bill rate since January 1978. The effect of a discount rate change on the federal funds rate was significant for periods of both federal funds rate targeting and nonborrowed reserve targeting. Discount rate changes significantly affected the Treasury bill rate, however, only in the period of nonborrowed reserve targeting. Furthermore, changes in the discount rate that were made for purely technical reasons had no effect on either market interest rate, while changes in the Federal

Reserve's surcharge on large, frequent borrowers during the nonborrowed reserve targeting period had a significant effect only on the federal funds rate.

There is virtually no evidence, however, that discount rate changes have had a significant, independent effect on market rates in the longer run. Therefore, while changes in the discount rate do produce changes in market interest rates in the short run, they do not appear to be the most significant factor affecting the level of market interest rates in the longer run.

Inflation Misinformation and Monetary Policy

LAWRENCE S. DAVIDSON

Consumer prices, held back by the recession and another drop in gasoline and car prices, rose only two-tenths of one percent in February from January's level, continuing the sharp decline in the inflation rate... It shows a steady decline in inflation over the past several months.¹

THE above excerpt is a perfect example of misinformation, a problem that stems from confusing the measurement of price change with the measurement and causes of inflation. The failure to distinguish the symptoms — like changing gasoline prices — from the causes of inflation can lead to serious policy errors.

This article presents evidence to support the hypothesis which states that efforts to counteract short-term price changes generally are unnecessary and counterproductive.² We begin by analyzing the behavior of the individual components of the personal consumption expenditures index to determine the "causes" of observed quarterly changes in the average price level. We then analyze the performance of a variable series constructed to approximate the cyclical or nontrend movements in the measured inflation rate. An analysis of this series reveals why the public should be reluctant to pressure policymakers into reacting quickly to even large short-run changes in the measured inflation rate. Finally we present data which suggest that monetary policies to combat short-run changes in the inflation rate raise the risk of increasing the underlying or long-term trend of inflation.

Two Views of Inflation: Arithmetic vs. Monetary

The measurement of inflation necessarily begins with a price index. The most widely known and used index is the consumer price index (CPI), an index of the average price of a fixed basket of goods and services chosen by a typical urban family. The fixedweight personal consumption expenditures price index (PCEI), though similar in most respects to the CPI, is preferable to it in one particular aspect — its treatment of the weight of housing costs.³ The important points for our discussion are:

- (1) The PCEI is a weighted average of individual goods prices,
- (2) The value of the PCEI in any given month can be greatly influenced by changes in the price of individual commodities.

The measured inflation rate is a simple mathematical transformation of the above price index. For example, instead of saying that the value of the PCEI rose from 100 to 104, the inflation rate expresses this

Lawrence S. Davidson, an associate professor of business economics and public policy at Indiana University, is a visiting scholar at the Federal Reserve Bank of St. Louis.

¹New York Times, March 24, 1982.

²This does not imply, however, that such price changes do not impose costs on certain groups. Policymakers may wish to enact legislation to address these problems. It is argued here only that such increases do not warrant macroeconomic remedial policy. Alan Blinder comes to the same conclusion: "From the macro perspective, the volatility of the CPI often distracts attention from the economy's underlying or 'baseline' rate of inflation. I speculate that extreme swings in the CPI inflation rate occasionally contribute to extreme swings in national economic policy." Alan Blinder, "The Consumer Price Index and the Measurement of Recent Inflation," *Brookings Papers on Economic Activity* (February 1980), p. 564.

³For more on this problem, see Blinder, "The Consumer Price Index and the Measurement of Recent Inflation," pp. 539-65.

price rise as a percentage change. In the above example, we would say that the inflation rate was 4 percent, or $(\frac{104 - 100}{100}) \times 100$ percent.

Calculating the inflation rate in this way leads one to the valid conclusion that a large increase in the price of one good (e.g., food) can cause a large change in the value of the PCEI and, therefore, in the measured inflation rate. It is incorrect, however, to say that food prices cause inflation.

This is because the arithmetic view tells only part of the story. Individual prices rise and fall, often in seemingly random and unpredictable ways. Economists call these *relative* price changes (since individual prices are changing relative to one another). Monetary and fiscal policy are not designed to be effective in changing relative prices. These and other macro stabilization policies are better suited to affect the joint movement of *all* prices, or inflation.

To understand inflation, we must first distinguish between inflation and relative price changes. Relative prices are determined by the supply and demand conditions in the markets for individual goods. For example, suppose that there were a change in people's tastes that caused them to spend more of their income on recreation and less on durable goods, while other saving and spending plans remained the same. This change in relative demand should raise the relative price of recreational goods and services while lowering that of durables. Since total spending remains unchanged, the total demand for all goods and services is unchanged; only the allocation of demand across markets has been altered. Therefore, the overall price level is the same; only relative prices have changed.

If individuals temporarily reduced saving so they could continue purchasing the same amount of durable goods while purchasing more recreational services, then the total dollar demand and the price level would be higher.⁴ Individuals would be acting as if they were given more income, causing them to spend more. Once they replenish their savings, however, total demand and the price level will return to their original lower levels. Thus, a permanent change in relative demand does not cause sustained inflation, though it does cause permanent changes in relative prices and may cause a temporary change in the price level.

Relative price changes also occur when there are changes in supply conditions.⁵ These include relative changes in labor productivity, wages or other costs associated with the production process. Such changes in a given individual market can cause the cost-per-unit to rise, which in turn causes its relative price to rise. With a given income, people who continue to buy the higher-priced item will be forced to spend less on other goods, which puts downward pressure on these prices. This "cost-push" example has the same outcome as the relative demand example: relative prices are permanently changed, the price level may change temporarily, but inflation is unaffected.

In the case of increases in the price of inputs like oil, which are used to produce many goods, the increases in the price level may be more pervasive and sustained. If increases in the price of oil are "pushed through," causing the retail price of most goods to rise, individuals whose income has not similarly risen are able to buy fewer goods and services at the higher prices. Both the quantity demanded and supplied are, therefore, lowered. This lower rate of output is permanent unless incomes rise. A tax rebate accompanied by an increase in the growth rate of money could temporarily raise incomes enough to restore demand to the earlier rate of production, but will lead to another increase in the price level as individuals attempt to buy more of all goods.

The point of these examples is that a variety of factors affecting the cost and relative demand structures in individual markets can cause relative prices to change. The constraint that binds the price changes in all the markets is total spending, or income. Without a commensurate increase in spending, none of these factors can cause *all* prices to rise, that is, none can lead to a permanent rise in the price index.

The Relationship Between Inflation and Individual Price Changes

A rise in the measured inflation rate always hides a great deal of information. The increase may result

⁴If all individuals reduced their savings, there would be less loanable funds available for business investment. Therefore, the increase in consumer spending facilitated by the temporary reduction in saving would be offset by a decline in business spending on investment goods. Although the consumer price index is temporarily increased, an investment deflator would be lower. A combined measure of overall consumer and business prices would be unaffected by this change in saving.

⁵For a more detailed explanation of cost-push inflation, see Dallas S. Batten, "Inflation: The Cost-Push Myth," this *Review* (June/July 1981), pp. 20-26.

Table 1

Means and Standard Deviations of Percentage Changes in the PCEI and Its 18 Major Components¹

		II/1959 - IV/1967		I/1968 - I/1981	
Category	Weight	Mean	Standard deviation	Mean	Standard deviation
Motor vehicles	.052	1.13%	3.85%	5.06%	4.83%
Furniture	.045	0.30	1.16	3.69	2.56
Other durables	.017	1.27	1.69	5.01	3.36
Food	.261	1.82	2.37	6.96	4.58
Clothing	.082	1.66	1.55	3.81	2.26
Gas & oil	.031	1.62	4.81	10.58	17.29
Fuel oil & coal	.012	1.01	4.33	14.72	20.05
Other nondurables	.081	1.78	1.29	5.71	3.31
Housing services	.137	1.53	0.45	5.54	1.84
Housing operations	.060	1.73	1.69	6.57	3.24
Transportation services	.037	2.32	1.97	7.33	4.82
Personal care services	.019	2.76	1.76	7.15	3.02
Medical services	.058	3.76	1.88	7.64	4.09
Personal business services	.054	3.39	3.44	7.11	3.23
Education & research	.013	2.87	1.66	7.50	2.67
Recreation services	.022	3.53	1.90	5.11	1.88
Religious & welfare	.015	1.61	3.09	7.31	3.66
Net foreign travel	.003	1.62	5.29	7.67	14.96
PCEI	1.000	1.85	0.98	6.34	2.39

from all prices rising together, or merely one price rising by itself. Furthermore, this change may prove to be either temporary or permanent. Policymakers concerned with the causes of and cure for inflation would find this hidden information highly relevant.

Consider the behavior of the individual prices of goods and services included in the PCEI over the past 23 years. Table 1 lists various information about the 18 major categories that make up this index. Because inflation generally has been higher since 1968, the table can be conveniently divided into two periods: a nine-year period before 1968 and a 14year period afterward. The table shows the mean and the standard deviation for the PCEI and each of its 18 components over both periods. This PCEI is a fixedweight version, which retains the weights from the first quarter of 1959.⁶ The weights are the percentages of total expenditure allocated to each component.

The measured average yearly inflation rate more than tripled from 1.85 percent in the initial period to 6.34 percent in the latter. The standard deviation, a measure of dispersion around the average, more than doubled. In the 1968-81 period, the annualized quarterly inflation rate averaged 6.34 percent per year, but the average deviation in any particular quarter was about 2.4 percent. This implies that the inflation rate was between 1.5 percent and 11.1 percent, 95 percent of the time. During this period

⁶A fixed-weight index is used because variable-weight indices, when used to compare quarter-to-quarter changes, mix together

price and quantity change. The fixed-weight index is a measure of pure quarter-to-quarter price change. Once fixed, no set of weights perfectly captures the buying patterns of the average household over a long period of time. We arbitrarily chose to use weights from the beginning of the sample period. Using weights from the end of the period would not measurably alter the results here. This is because the weights have not changed enough on individual price components to change the behavior of the overall measured inflation rate.

(1968-81), selected categories averaged between:⁷

Housing services:	1.9% to 9.1%
Motor vehicles:	-4.0% to 14.6%
Fuel oil and coal:	-24.6% to $54.02%$

Fuel oil and coal prices, the fastest-growing consumer prices, averaged over 14 percent per year, followed closely by gas and oil at about 10.6 percent per year. Furniture (3.7 percent) and clothing (3.8 percent) were the most slowly growing consumer prices.

The evidence from table 1 suggests that the measured inflation of the recent past is not the result of all prices rising at the same rate each quarter. These figures, however, say very little about the role of particular relative prices as causes of *sustained* price change. For example, fuel oil and coal prices rose, on average, faster than any of the other prices. But these increases were anything but gradual or persistent. Of the 88 quarters from II/1959 to I/1981, the inflation rate of fuel oil and coal exceeded the rate of the PCEI only 45 times. That means during 43 of the quarters, fuel oil and coal prices rose more slowly than overall inflation. In 22 of these quarters, the absolute price of fuel oil and coal *fell* (a negative inflation rate for this category). During these 88 quarters, there was not a single episode when the inflation rate on fuel oil and coal increased for more than four consecutive quarters. This pattern (though not necessarily the magnitude) of volatility is typical of most price components. Chart 1, which presents the growth rates of the PCEI and two of its components, reveals the oscillatory behavior of the PCEI. Note that there has been only one episode since 1959 when the overall PCEI inflation rate climbed consecutively for more than three quarters. More will be said about that episode below.

It is cumbersome to discuss each individual price change and its implications for the measured overall inflation rate. Therefore, we introduce a summary measure of nonproportional or relative price changes (RELP). The RELP series is constructed as follows: For each quarter, subtract the rate of change of the overall PCEI (which is, by definition, the average inflation rate of all components) from each of the 18 component inflation rates. Then multiply the absolute value of each of these 18 deviations for this quarter by its weight and add them.⁸ This gives the value of RELP for each quarter.

If all prices grow at the same rate, RELP will equal zero. If, however, a few prices rise significantly faster during the quarter than the rest, the value of RELP will rise. If these prices then decelerate (and/ or if the others accelerate), so that all prices are again rising more equally, RELP will fall.

As chart 2 shows, the RELP measure has a number of interesting features:

- (1) The greatest increases in RELP came in 1972 and 1973 during food-price shocks, during wage and price decontrol and after oil prices quadrupled.
- (2) While the value of RELP fell from the end of 1973 until 1978, it generally averaged a higher value than before 1973.
- (3) While RELP showed no obvious trend before 1970, its average value has been rising since then (from about 1.62 before 1971 to 3.46 thereafter).⁹

In summary, inflation has been anything but a smooth, upward transition in all prices. It is typified by a few prices racing ahead of the others, then falling back relatively quickly. In one episode, RELP accelerated for seven consecutive quarters, but this was an unusual period, typified by a series of food supply shortfalls, wage and price decontrol and, finally, the oil crisis.

One implication of this evidence is that individual price changes have a significant — albeit temporary

⁷These confidence intervals assume that quarterly inflation rate changes are normally distributed. A normal distribution roughly means that quarterly inflation rate values fall equally above and below the mean and that most of the values are close to the mean. The standard deviation of a random variable measures how much these quarterly inflation rate changes differ from the mean value on the average. The 95 percent confidence interval contains any observations of the quarterly inflation rate that are within two standard deviations of the mean. Since the mean and standard deviation are respectively 6.34 percent and 2.39 percent, there is a 95 percent probability that the quarterly inflation rate is between 1.5 percent (= 6.34 percent - 2 (2.39 percent)) and 111 percent (= 6.34 percent + 2 (2.39 percent)). Similar confidence intervals can be constructed for any of the inflation rate series.

⁸The same category weights used to construct the overall PCEI are used here.

⁹While we have noted how RELP arithmetically "causes" price change, others have argued that increases in the inflation rate have *caused* higher levels of relative price change. One can see from chart 2 that there is a correlation between the average percentage change in the PCEI and the average value of RELP. The implication of this finding is that higher average inflation rates, which raise the value of RELP, increasingly confuse economic agents and raise the likelihood of reduced output and higher unemployment rates. See, for example, Mario I. Blejer and Leonardo Leiderman, "On the Real Effects of Inflation and Relative-Price Variability: Some Empirical Evidence," *Review of Economics and Statistics* (November 1980), pp. 539-44; and Milton Friedman, "Nobel Lecture: Inflation and Unemployment," *Journal of Political Economy* (June 1977), pp. 451-72.



Chart 1 Growth Rates of the PCEI and Two Components

Digitized for FRASER http://fraser.stlouisfed.org/ Federal Reserve Bank of St. Louis



Relative Price Change and the Average Inflation Rate

— impact upon overall changes in the measured inflation rate. This finding has important policy content. Macroeconomic policies, which are designed to affect incomes or spending, are not efficient devices for combating the frequent and quickly reversible relative price changes. Therefore, policy aimed exclusively at stabilizing all changes in the inflation rate will be unproductive. It may even be counterproductive if the relative price changes are both highly unpredictable and transient.

Nonmonetary Price Change

Monetarists have argued that the dominant determinant of sustained spending change is money growth. Therefore, they say, it is primarily sustained money growth that produces inflation (a sustained increase in the prices of all goods and services).

Past studies have found that the underlying inflation rate is significantly related to past growth rates

FEDERAL RESERVE BANK OF ST. LOUIS

of the money supply.¹⁰ Carlson finds that, since the 1970s, about 12 quarters of past monetary growth translate into an equal *sustained* change in the inflation rate. Thus, we assume that a simple 12-quarter moving average of money growth rates approximates the monetary influence on sustained inflation.¹¹ For example, if this moving average rate equals 4 percent, then we assume that money is responsible for an underlying inflation rate of 4 percent in a given quarter. If the inflation rate actually is 6 percent in that quarter, then the residual 2 percent can be attributed to nonmonetary causes of price change.

Monetarists also believe that there are numerous sources of price change, yet only changes in money growth can permanently alter the rate of inflation. Therefore, we expect that nonmonetary factors will sometimes affect short-term measured inflation rates. If these nonmonetary sources of measured inflation arise unexpectedly over time, and if they only temporarily affect the inflation rate, then the only lasting, predictable and controllable source of inflation would be monetary growth.

One way to determine if the monetary explanation of inflation is valid is to examine the impact of nonmonetary influences on price changes to see if they have any long-run influences on inflation. To do this, we define nonmonetary price change as the measured inflation rate of a given quarter, minus the 12-quarter moving average of money growth rates. We then examine the behavior of this series (referred to as PDEV) and the changes in it (henceforth called Δ). The monetarist view of inflation would be supported by a variety of evidence about PDEV and Δ :

(1) If changes in nonmonetary inflation, \triangle , are temporary, then positive values of \triangle soon would be followed by negative ones. Accordingly, PDEV would rise and then fall toward its original value.

(2) If the increases in \triangle are totally reversible, then over the sample period the sum of the negative \triangle s would be exactly equal to the sum of the positive

ones. Therefore, the average value of Δ would be zero.

It is important to note that this discussion does not imply that the average value of PDEV is zero. The average value of PDEV need not equal zero for two reasons. First, the theory discussed here suggests that monetary growth affects the average of all prices. This does not mean that money growth is the source of all changes in *consumer* goods prices as measured by the PCEI. Second, there are factors that affect the rate of inflation for some time without being a constant source of its variability. For example, the trend rate of growth of labor force productivity may keep the inflation rate above or below any given sustained monetary growth rate for some period of time.¹²

(3) Even if \triangle were transient and totally reversible, there could be room for policy action if it were predictable. This would give policymakers time to formulate a policy. According to the monetarist view, negative \triangle s will follow positive ones. This relationship, however, should not allow for reliable predictions of \triangle over time.

Chart 3 presents PDEV and its change, \triangle . From 1959 to 1981, PDEV and \triangle averaged -0.09 and 0.01, respectively. Prior to 1973, PDEV was generally negative; thereafter it was positive. The overall and subperiod averages are shown in table 2.

Judging from the average value of PDEV in the two subperiods, money growth does not fully explain the average inflation rate in either period. In the earlier period, inflation was 0.87 percent below the 3.56 percent growth rate of money. From 1973 to 1981, however, inflation was 1.21 percent above the 6.42 growth rate of money.¹³

¹⁰Keith M. Carlson, "The Lag from Money to Prices," this *Review* (October 1980), pp. 3-10; and Denis S. Karnosky, "The Link Between Money and Prices: 1970-76," this *Review* (June 1976), pp. 17-23.

¹¹These studies of money and prices use econometric methods and employ distributed lag functions. Furthermore, these relationships have been found using the overall gross national product deflator. Therefore, this 12-quarter moving average is only a rough approximation of the influence of money on the trend rate of inflation. However, this moving average as well as longer moving averages and econometric proxies behave quite similarly and therefore the qualitative findings here would not be seriously changed by using these other measures. See footnotes 13 and 16 for more details on one econometric variant.

¹²One measure of labor productivity is output per hour of all persons in the private business sector. After increasing at a 2.9 percent annual rate from 1961 to 1971, it rose at only a 1.2 percent annual rate from 1971 to 1980.

¹³As a check on these results, an alternative proxy for PDEV was developed. In this case, the monetary contribution to inflation is estimated from an econometric price equation. This equation relates the percentage change in the PCEI to a 12-quarter Almon lag on growth rates of M1, contemporaneous and two lag values of relative energy prices, and two dummy variables for the control and decontrol phases of the Nixon wage-price controls. PDEV is calculated by subtracting from the actual rate of change of the deflator its predicted value based only on the monetary part of the estimated equation.

The average value of PDEV from 1959 to 1981 is .097, very close to the .090 value of the variant reported in the text. The values of PDEV over the early and later subperiods are -.54 and .50, respectively. This version of PDEV suggests a smaller, but still evident, contribution of nonmonetary factors to the measured inflation rate over the two subperiods.



In contrast, the small average values of \triangle in both periods reveal that the average *change in PDEV* was nearly zero. This suggests that, although factors other than money help to determine the average level of the inflation rate, short-run *changes* in these nonmonetary factors tend to offset one another over time.

Out of 88 quarters, PDEV fell (\triangle was negative) 45 times. Further, there were 56 times when a rise in PDEV was followed by a fall, or vice versa. Using a statistical test designed to measure the regularity of these changes, we find no significant relationship between \triangle values over time.¹⁴ This means that changes in the rate of nonmonetary price change are

not correlated with past changes. Thus, persistent nonmonetary effects on changes in the inflation rate are not evident, and past values of \triangle are not reliable predictors of future ones.

This simple test says nothing about the size of changes in PDEV, especially over specific episodes within the sample period. We can use a standard statistical procedure to indicate whether any given PDEV or Δ is worth worrying about (large enough to be considered a statistically important deviation from zero). For example, in chart 3, note that PDEV is less than zero during most quarters prior to 1973. Is this evidence that nonmonetary factors were holding inflation substantially below the rate dictated by money?

To answer this question, we analyze what might be called "large" values of PDEV. Values of PDEV

¹⁴See Edward J. Kane, *Economic Statistics and Econometrics* (Harper & Row, 1968), especially pages 364-65, for a description of this runs test.

Table 2 Nonmonetary Price Change						
PDEV	-0.87%	1.21%	-0.09%			
\triangle	-0.06%	0.15%	0.01%			

or \triangle in chart 3 that fall outside the shaded area are evidence that nonmonetary factors caused *large* price changes.¹⁵ A number (say three or four) of consecutive quarters of large and rising values of PDEV or rising \triangle s would be considered evidence of the persistent effect of nonmonetary factors on price change.

Chart 3 reveals that the only run of large PDEV values occurred over the four-quarter period from I/ 1974 to IV/1974.¹⁶ Here, nonmonetary factors contributed to inflation rising significantly faster than money for one year. Another episode, from II/1972 to IV/1972, which lies near the rejection region, comprises three quarters when inflation grew slower than money. These episodes deserve additional consideration since it could be argued that systematic nonmonetary factors caused sustained inflation above and below the money growth rate.

What happened during 1974 had its beginning in IV/1973 when the prices of fuel oil and coal rose at an annualized rate of 63 percent, and gas and oil prices

increased by 33 percent. In I/1974 both energy groups again had large annualized rate increases of 91 percent and 63 percent, respectively. These increases, though very large, accounted for only about half of the increase in the measured inflation rate of the first quarter in 1974. In fact 17 of the 18 component prices accelerated — an historical rarity.

By II/1974 the inflation rate of energy items, though still high, was falling dramatically. Judging from food and energy prices alone, the overall inflation rate could have fallen as low as 7.4 percent (from 12.4 percent in I/1974) had it not been for an increase in the relative price of motor vehicles and nondurables (other than food and energy). The overall inflation rate stayed at 9.6 percent in III/1974 and inched up to 9.7 percent in IV/1974 despite the fact that energy prices had leveled off. In the last quarter, the problem appears to be the 12 percent increase in food prices. Given the large weight on food prices, measured inflation could have been down to about 8 percent or less had it not been for this single event.

To summarize, this historical period found nonmonetary sources of inflation persistently greater than zero. It followed, however, on the heels of an unprecedented jump in the rate of increase of energy prices. It appears that within six months the peak nonmonetary effect had been reached.¹⁷ Further, it appears that events beyond the second quarter of 1974 were separate but adjacent periods of equally bad luck. In the first quarter of 1974, most prices responded to the oil crisis. If the subsequent increases in motor vehicles, nondurables and food prices at various times in the next nine months were related to earlier energy price increases, then we do have a single episode. Even in this interpretation, the bulk of the effect of PDEV occurred within six months, and traces of it were scarce within 12.18

The other interesting episode occurred in 1972 when inflation was below the trend growth of money. This episode shows that the more stringent

¹⁵Our sample yields only one estimate of the true mean of PDEV. The shaded area in chart 3 is called a confidence interval. This shows by how much the mean could vary in repeated samples without refuting that the population mean is zero. Thus, if we took another independent sample and found a non-zero value for the mean that was inside the confidence interval, it would not refute the hypothesis that the population mean is zero. The area outside the confidence interval is called the rejection region. If a sample mean lies in this zone, it rejects the hypothesis that the mean value of nonmonetary inflation is zero. By choosing a level of confidence higher than 95 percent, say 99 percent, the area in chart 3 would be wider and there would be no runs of PDEV values in the rejection area. Lowering the confidence level to 90 percent does not change the results, though there are two episodes that nearly fall into the rejection region: I/1980-IV/ 1980 and II/1972-IV/1972. The former period witnessed severe oil price shocks while the latter, which is discussed more in the text, occurred during wage and price controls.

¹⁶The econometric variant of PDEV discussed in footnote 13 yields the same general conclusion: the largest values of PDEV occur during 1974. Using this variant of PDEV, however, there is no series of consecutive values of PDEV in the rejection area. This is even stronger evidence than that presented in the text for the transitory nature of changes in nonmonetary inflation.

¹⁷Using very different methods, John A. Tatom, "Energy Prices and Short-Run Economic Performance," this *Review* (January 1981), pp. 3-17, also found a very short peak in the inflation rate attributable to energy prices. His econometric model of the price level used the GNP implicit price deflator and found it to peak within four quarters after the rise in energy prices.

¹⁸The Labor Department attributed the large increases in food prices over the last half of 1974 to poor weather and crop failures. See Toshika Nakayama, Lloyd E. Wigren and Paul Monsen, "Price Changes in 1974 — An Analysis," *Monthly Labor Review* (February 1975), especially page 15.



Chart 4 Deviations from Trend of Inflation and Money Growth

phases of the Nixon wage-price controls effectively kept measured inflation from catching up to trendmoney growth (which accelerated from about 5 percent at the end of 1971 to 6.5 percent by the last quarter of 1972). It is interesting that when the less restrictive Phase III of the controls began in January 1973, PDEV quickly turned positive as prices began to make up for lost ground.

Money Growth and Inflation Misinformation

The previous sections suggest that the main cause of sustained increases in measured inflation is not

changes in relative prices. The data presented in this section show that the trend growth rate of money rose from about 2 percent in the early 1960s to 7 percent in the early 1980s. This section suggests that this rising trend stems from an information problem. We already have shown that the measured inflation rate often accelerates when relative prices change. If policymakers misread such temporary increases as permanent changes in the inflation rate, they may employ a contractionary monetary policy. We show below that tight money periods have usually followed large increases in the measured inflation rate but have been followed by periods of monetary expansion. At the end of each cycle, the trend growth rate of both money and prices has been higher.



Chart 4 plots the deviations from trend for both the annualized quarterly rates of growth of the CPI and M1.¹⁹ The shaded vertical bars represent episodes of large price increases, lasting two or more quarters, in which the measured inflation rate grew faster than its trend. In each case, we find these above-trend price increases accompanied by large reductions in the growth rate of money and/or below-trend monetary growth.²⁰ These reductions, however, were generally of short duration. Chart 5 presents the 12-quarter moving average of the annualized percentage change in M1. The shaded vertical bars refer to the same periods of large price increase as those in chart 4. Chart 5 shows that the contractions in money fol-

¹⁹Above we argued that the PCEI is a better measure of price change, and therefore the CPI is not used throughout this article. In this section, however, it is important to use the CPI because it is announced more regularly (monthly instead of quarterly) and probably is used more widely. The results in chart 4 are not greatly altered when the PCEI is used instead of CPI, since the two generally move together. One important exception occurred during the first two quarters of 1979. The rate of change of the CPI increased in both quarters; the rate of change of the PCEI fell. Therefore, if the PCEI were used in the analysis in the text, there would be one less historical episode when measured inflation rose in two or more consecutive quarters.

²⁰The theme of this article is that all short-term changes in published indices of prices do not demand policy responses. The evidence, however, suggests that monetary growth has fallen after large short-term measured price increases. This does not imply that monetary policy is solely determined by price changes or that it always responds to them. The behavior of money is determined by several factors, and to argue that all monetary changes are attributable to price change would be incorrect. The evidence does suggest, however, that large shortterm increases in measured inflation above its 12-quarter trend have been associated with subsequent large short-term decreases in the rate of growth of money below its 12-quarter trend. Stanley Fischer, "Relative Shocks, Relative Price Variability, and Inflation," Brookings Papers on Economic Activity (February 1981), pp. 381-431, in an econometric investigation, also finds evidence that monetary contractions trail inflation surges following relative price shocks. See especially page 408.

lowing these large price increases generally had only temporary effects on the trend growth rate of money and therefore on a variety of measures of inflation.

These abrupt contractions in monetary growth generally have been offset by subsequent monetary expansions. Furthermore, these variations in monetary growth have had severe side effects. Poole finds that monetary decelerations generated recessionary conditions in the United States.²¹ Batten and Hafer come to the same conclusion in their analysis of the impact of short-run money growth in the United States, Britain, West Germany and Italy.²²

SUMMARY AND CONCLUSIONS

This article provides evidence of an information problem inherent in policies that respond to observed changes in the measured inflation rate. The evidence is not inconsistent with the theory that short-run bouts of tight money follow short periods of rising inflation, help to quickly generate recessionary conditions, lead to subsequent longer periods of expansionary monetary policy and result in a rising *trend* growth rate of the money supply. The information problem that sets off these cycles is the misinterpretation of increases in measured price change as sustained inflation. We have provided evidence that nonmonetary sources of measured inflation are frequent, highly variable and quickly self-reversible. Therefore, employing policy to offset these individual shocks is difficult to accomplish or to justify.

This analysis has broad implications for policymakers. First, short-term changes in measured inflation do not call for an activist monetary policy. Second, a policy of steadily declining monetary growth will contribute to more economic stability, while it reduces the underlying rate of inflation. Finally, there is a need to distinguish the nature of the causes of individual bouts of price change as the first step in policy formulation. A sustained increase in the rate of change of all prices, once uncovered, is important information which policymakers can use to guide monetary and fiscal policies. Of course, the evidence reported here suggests that policymakers could ignore short-run measurements of inflation altogether by simply concentrating on the appropriate long-term monetary target.



²¹William Poole, "The Relationship of Monetary Decelerations To Business Cycle Peaks: Another Look at the Evidence," *Journal of Finance* (June 1975), pp. 697-712.

²²Dallas S. Batten and R. W. Hafer, "Short-Run Money Growth Fluctuations and Real Economic Activity: Some Implications for Monetary Targeting, this *Review* (May 1982), pp. 15-20.

Short-Run Money Growth Volatility: Evidence of Misbehaving Money Demand?

SCOTT E. HEIN

THE last two years have been anything but tranquil for the U.S. economy. Interest rates, for example, have been high and volatile. Twice during this period they rose to record levels: the prime rate hit 20 percent in April 1980, then rose to 21.5 percent in January 1981. Two recessions have occurred during this brief period, one of which apparently still lingers. Significant financial changes have taken place with an influx of deposits into money market mutual funds and an outflow from small time and savings deposits. The nationwide legalization of NOW accounts in early 1981 also resulted in a sizable reallocation of funds. Amid all of these developments, money growth also has been quite volatile.

Should the volatility of short-run money growth be a matter of concern? There appear to be two distinct schools of thought with regard to this question. One school argues that such volatility is not really a problem. It holds that "the need for precise short-run money supply control is technically questionable."¹ The other school argues that such volatility damages the economy. For example, Milton Friedman, in evaluating monetary policy over the last couple of years has written that "the yo-yo swings in monetary growth affected the economy directly, as well as through interest rates. Each surge in monetary growth was followed after some months by an acceleration in spendable income, output and employment; and each decline in monetary growth, by a retardation."²

Somewhat surprisingly, the two schools do not disagree about theoretical issues. Both schools agree that, in theory, the desirability of stabilizing shortrun money growth depends on the stability of the public's demand for money. Achieving stable money growth benefits the economy only if the public's demand for money does not change unexpectedly.

The issue that separates the two schools of thought is chiefly an empirical one: has money demand been reasonably stable? Those who argue that the volatility of short-run money growth in the past has not been a problem hold that money demand has been subjected to a series of unpredictable shifts. According to this reasoning, holding the rate of money growth in a tight band would have imposed significant costs on the economy. Suppose, for example, the public wants to hold larger money balances. If such a preference is thwarted by an adherence to pre-established monetary targets, the economy would be subjected to unnecessary restraint. Individuals seeking to build their money balances will reduce their demand for goods and services and financial assets, resulting in an economic slowdown.

The other school argues that money demand has been basically stable. In this view, as Friedman contends, rapid money growth overstimulates the economy, ultimately causing inflation, while sluggish money growth imposes undue restraint.

¹Stephen H. Axilrod and David E. Lindsey, "Federal Reserve System Implementation of Monetary Policy: Analytical Foundations of the New Approach," *American Economic Review Papers and Proceedings* (May 1981), p. 252. Also, see George W. McKinney, Jr., "The Name of the Game," *Economic View from One Wall Street* (February 26, 1982).

²Milton Friedman, "The Yo-Yo Economy," *Newsweek* (February 15, 1982). Also, see Milton Friedman, "The Federal Reserve and Monetary Instability," *Wall Street Journal*, February 1, 1982.

This article examines the evidence to determine whether money demand behavior over the last two years has been erratic enough to justify the observed volatility in money growth.

MONEY GROWTH AND THE DEMAND FOR MONEY

Chart 1 provides evidence on short-run (quarterly) money growth volatility. The chart plots, for each quarter since II/1962, quarterly money growth (at an annual rate) less the average of money growth over the prior 12 quarters. Thus, for example, the -2.0 percent reading for III/1962 shows that money grew 2 percentage points less in that quarter than its average growth rate in the previous three years.

The volatility shown in this chart has two different dimensions. One dimension is simply the *magnitude* of the deviation from trend. For example, in the third quarter of 1980, money grew at a rate 8 percentage points above trend, the largest positive deviation in the last 20 years. In the second quarter of 1980, money grew at a rate over 10 percentage points below trend, the largest negative deviation in the last 20 years. Thus, according to such a measure, money growth has been quite volatile over the last two years.

The second dimension is the *frequency* with which deviations of money growth relative to trend change signs. The chart shows that money growth relative to trend frequently has changed sign from positive to negative, and vice versa, over the last two years. This fluctuation stands in sharp contrast to the historical norm whereby money growth usually is above or below trend for several quarters in a row. Thus, the increased frequency of change of quarterly money growth relative to trend also supports the view that money growth over the last two years has been volatile.

The increased volatility in money growth alone does not demonstrate that the demand for money was unstable. Such a conclusion implicitly holds that the growth of the nominal money stock is completely demand-determined, ignoring completely the actions taken by monetary authorities. Since monetary authorities can change bank reserves, reserve requirements or the discount rate, it is entirely possible that changes in nominal money growth reflect their actions, instead of shifts in the public's desired money holdings. In other words, monetary authorities "can 'create' a product without necessarily being limited by the demand for it."³ Thus, one should not necessarily interpret changes in money growth as shifts in money demand.

A CONVENTIONAL MONEY DEMAND EQUATION AND THE EVIDENCE OF SHIFTS

One can analyze money demand on a more sophisticated basis by using econometric techniques. This article provides no new analysis on this topic; instead it describes how such evidence can be evaluated.

Economic theory holds that nominal money balances *relative to* the general price level (generally called "real" money balances) are the relevant guantity measure for demand analysis (just as standard demand theory explains the demand for physical goods and services, not the dollar value of those goods and services). Thus, when one focuses on real money, one recognizes that the usefulness of money clearly depends on the price of goods and services. For example, if the quantity of money that people hold remains unchanged while the average price of goods and services fall, a given stock of money will have greater value; that is, it will permit the purchase of more goods and services. Thus, the economically meaningful measure is the money stock relative to the average price of goods and services.⁴

Analysts commonly hypothesize that real money balances move opposite to a change in market interest rates and in tandem with a change in real income. A change in market interest rates negatively affects the demand for real balances, because it represents the opportunity cost of holding money. If market interest rates rise, individuals forgo more interest income by holding money and thus are expected to desire less money balances. As real income rises, however, individuals will want larger real money balances to purchase more goods and services. Thus, a change in real income is expected to have a similar effect on desired real money balances.

³Stephen H. Axilrod, "Monetary Policy, Money Supply, and the Federal Reserve's Operating Procedures," *Federal Reserve Bulletin* (January 1982), p. 13.

⁴For a discussion of the interpretation of changes in real balances, see A. B. Balbach and Denis S. Karnosky, "Real Money Balances: A Good Forecasting Device and a Good Policy Target?" this *Review* (September 1975), pp. 11-15.





A Typical Empirical Money Demand Equation

To empirically investigate the demand for money, the relationship between real money balances $(M/P)_t$ and current interest rates (i_t), real income (y_t), and lagged real balances $(M/P)_{t-1}$, is estimated using multiple regression analysis. The equation to be estimated is typically written as:

(1)
$$(M/P)_t = \beta_0 + \beta_1 i_t + \beta_2 y_t + \beta_3 (M/P)_{t-1} + \epsilon_t$$

The coefficients β_0 , β_1 , β_2 and β_3 show how desired real money balances respond to changes in the respective independent variables. The residual, ϵ_t , is assumed to be a *random variable* that fluctuates about zero. It represents the *unexplained* variation of actual real money balances from that predicted by the combination of the estimated regression coefficients and the values of the independent variables.

Last period's real balances are usually included in empirical estimations of money demand to capture an assumed adjustment process. Because of relevant transaction costs of adjusting real money balances, it is usually presumed that actual balances only slowly adjust to desired levels. The lagged value of real balances is included to capture such an adjustment process. By including lagged real money balances in the equation, we are assuming actual real balances only partially adjust to current changes in interest rates or real income.

A common procedure used in evaluating the behavior of money demand is to consider how well

an empirical relationship such as equation 1 simulates or predicts actual real money balances beyond the estimation period.⁵ Chart 2 plots the level of real money balances simulated with equation 1 and the actual real money balances for the out-of-sample interval I/1980-I/1982.⁶ Table 1 summarizes these results using a variety of statistical measures.⁷

⁶Estimating equation 1 in natural log (1n) form yields the following coefficient estimates and summary statistics for the I/ 1960-IV/1979 sample period (absolute value of t-statistics in parentheses):

 $\begin{array}{ll} (1') & \ln \left(M/P \right)_t = & 0.34 + 0.07 \ln y_t - 0.01 \ln \mathrm{RCP}_t \\ & (1.41) & (3.94) & (3.27) \\ & + & 0.85 \ln \left(M/P \right)_{t\text{-}1} - & 0.02 \, \mathrm{D1} \\ & (13.69) & (3.89) \end{array}$

$$\overline{\mathbf{R}}^2 = 0.94$$

where M is M1, P is the GNP deflator, y_t is real GNP, and RCP is the commercial paper rate.⁵ The estimated coefficient on $\ln y_t$ (0.07) indicates that a 1 percent increase in real income this quarter is usually associated with a 0.07 percent increase in real money balances. In a similar vein, the interest rate coefficient suggests that a 1 percent increase in interest rates (for example, from 10.0 percent to 10.1 percent) will lead to a 0.01 percent decline in real balances. Finally, the coefficient on lagged real balances (0.85) indicates that real balances will adjust to desired levels at a rate of 15 percent (1.00-0.85) per quarter. Thus, the long-run response to changes in interest rates and real income is much higher than the short-run response. In the out-of-sample simulations reported below, these coefficients along with actual values of the right-hand side variables are used to project the dependent variable.

This relationship is similar to that in R. W. Hafer and Scott E. Hein, "The Shift in Money Demand: What Really Happened?" this *Review* (February 1982), pp. 11-16. However, the passbook rate variable is excluded since its coefficient was insignificant. The equation was estimated using the Hatanaka two-step procedure to correct for first-order serial correlation in the residuals. D1 is a dummy variable that takes on a value of 1 after I/1974, capturing a one-time shift in the demand for money. The standard error of the estimated regression is 0.0045 and the estimate of the serial correlation coefficient is 0.35.

THE SECOND QUARTER OF 1980

Much hoopla has been made of the difference between the simulated real balances in the second quarter of 1980 and the actual balances at that time. Real money balances in that period turned out to be almost \$7 billion below what equation 1' predicted. Such a finding has been interpreted as evidence that money demand shifted downward significantly in II/1980.

Simulation Errors and Shifts

Equating a "shift" with a simulation error, however, is clearly inappropriate. Deviations of real balances from predicted or simulated values do not provide evidence of a behavioral shift in the relationship. Recall that when the equation is estimated, it is assumed that actual real money balances will fluctuate *randomly* around its predicted or simulated level. By assumption, the actual and simulated real money balances will usually deviate from each other by some unknown random value. Thus, we should expect similar fluctuations to occur out-ofsample. When considering only one simulation error, it is impossible to ascertain whether one is observing a shift (as represented by a change in one of the coefficients), or simply a large random fluctuation.8

When the deviations are consistently one-sided, however, one can conclude that a "shift" in the behavioral relationship has occurred (i.e., one of the coefficients, β_0 , β_1 , β_2 or β_3 , has changed). Chart 2, however, shows no evidence of consistent one-sided errors. Thus, there is little evidence from these simulations to indicate a "shift" in the behavioral relationship.

Moreover, recognize that if policymakers incorrectly equate prediction errors with shifts in money demand, then they will view any observed behavior in real money balances as *correct*. Thus, in either the case of rapid or slow money growth, no corrective action would be called for. However, if these disturbances are not true shifts in money demand, policymakers will actually allow money growth to fluctuate more than necessary.

⁵This procedure apparently dates back to Stephen M. Goldfeld, "The Case of the Missing Money," *Brookings Papers on Economic Activity* (3:1976), pp. 683-730. One crucial difference between Goldfeld's evidence and more recent interpretations is that Goldfeld provided evidence of sustained one-sided simulation error. Logically, Goldfeld's findings suggest a shift. More recent discussions incorrectly deduce a shift from a single period's simulation error. This point is subsequently more fully developed. For a more recent application, see Brian Motley, "Innovation and Money Demand," Federal Reserve Bank of San Francisco Weekly Letter (January 1, 1982).

⁷The equation simulates the natural log of real M1 balances. Table 1 presents the antilog of these simulated values, that is, levels of real money balances. Such a transformation, being nonlinear, will not yield optimal predictions. However, it does yield a better "feel" for the size of errors.

These simulations are static (when actual values of the lagged dependent variable are used) rather than dynamic (when predicted values of the lagged dependent variable are used). See Scott E. Hein, "Dynamic Forecasting and the Demand for

Money," this *Review* (June/July 1980), pp. 13-23, where it is argued that static forecast errors provide a better foundation from which to judge shifts in the demand for money.

⁸This is true regardless of the size of the error, because there is always a positive probability of drawing from the extreme tails of a normal probability distribution.



Actual and Simulated Real M1

Other Evidence of a Money Demand Shift

Few who argue that a shift occurred in II/1980 base their case on the one simulation error of chart 2, however. Two auxiliary arguments also are used to support the notion that there was a downshift in money demand. One argument is that a downshift occurred "in response to the very high and record levels of short-term interest rates reached in early spring."⁹ This argument holds that a sharp rise in interest rates, especially one that pushes rates beyond previous peaks, causes firms and individuals to institute new cash management techniques.¹⁰ These techniques, once in place, lead to *permanent decreases* in desired real money balances relative to a given level of real income and interest rates. In other words, money demand shifts downward following a sharp rise in interest rates. Such an argument has been used to explain the abnormal behavior of money demand since 1974 and is used now to bolster the evidence of another downshift.

Chart 2 proves false this explanation of the II/1980 decline in real balances. Were there actually a decline in the demand for real cash balances caused by individuals and firms instituting new cash management techniques in response to high interest rates, one should observe a level of real money balances that is *consistently* below simulated levels following the "downshift."

⁹Axilrod and Lindsey, "Federal Reserve System Implementation of Monetary Policy," p. 251.

¹⁰One of the earliest espousals of this hypothesis can be found in Richard D. Porter, Thomas D. Simpson, and Eileen Mauskopf, "Financial Innovation and the Monetary Aggregates," *Brook-*

ings Papers on Economic Activity (1:1979), pp. 213-29.

Table 1

Out-of-Sample Simulations of a Money Demand Equation (billions of dollars, seasonally adjusted)

Date	Actual (M _t /P _t)	Simulated (M _t /P _t)	Error ¹				
I/1980	\$230.1	\$230.1	0.0				
II/1980	223.0	229.8	-6.8				
III/1980	225.8	221.9	3.9				
IV/1980	226.2	226.0	0.2				
I/1981	223.5	226.4	-2.9				
II/1981	225.2	222.7	2.5				
III/1981	220.1	225.5	-5.4				
IV/1981	218.3	219.5	-1.2				
I/1982	221.9	218.2	3.7				
	Summary Statistics						
Mean er	0.6717						
Mean at	Mean absolute error:						
Root-me	3.6635						
Theil's i	0.0164						
Fraction of error due to							
(A)	0.03						
(B)		0.03					
(C)	:	0.94					
¹ Actual less simulated							

If this shift were permanent, as this argument suggests, the prediction error should remain negative for all quarters after II/1980. Chart 2 shows, however, that the equation does *not* consistently overpredict real balances after II/1980. Actual real balances in III/1980, instead, were slightly higher than the relationship would suggest. Further, real balances were slightly higher, on average, than the equation implies for the full III/1980-I/1982 period. Thus, one cannot empirically support the argument that a persistent, sizable downshift in money demand was precipitated by record interest rates in II/1980.

The second argument in support of a money demand downshift in II/1980 contends that the imposition of credit controls in March 1980 was responsible for a decrease in desired real balances. Such an argument contradicts economic theory, however. With credit controls explicitly limiting the extension of bank credit, individuals and business firms would desire larger money balances for anticipated transactions or precautionary purposes. Thus, theory suggests an increase in money demand during this period, not a decrease.

Thus, both auxiliary arguments in favor of a behavioral shift in money demand in II/1980 lack either logical foundation or supportive empirical evidence. Moreover, if there was a behavioral shift in money demand, the excess supply (supply exceeding demand) of money must have been offset by an increase in demand elsewhere. In other words, if economic participants actually wanted less money balances, they must have desired more of something else in exchange. There is little evidence, however, of increased demand for labor, goods and services, or financial assets in the economy.

Further, the generally declining interest rates in this period do not necessarily suggest a behavioral downshift in money demand as many insist. Declining interest rates do suggest an excess supply of credit, which can come about either because of an increase in credit supply or a decrease in credit demand. Only an increase in the supply of credit (as individuals become more willing to give up money today in exchange for a promise of money in the future) would be consistent with the notion of a downshift in money demand in II/1980, since there is no evidence of an increased demand elsewhere which would be required to offset the decreased demand for *both* credit and money. Yet, there appears little evidence of an increased supply of credit in this period. Chart 3 shows that the total funds raised by nonfinancial sectors *declined* markedly in II/1980. Thus, the fall in rates in the second quarter of 1980 is better explained by weakening credit demands associated with the recession, rather than the increased supply of credit.

If No Shift, Then What?

If money demand did not shift in II/1980, why were real money balances low relative to predicted levels? Perhaps the irregular behavior occurred on the "supply side." Robert Weintraub has suggested, for example, that slow money growth resulted from an unexpected decline in the money multiplier (the ratio of M1 balances to the monetary base), in response to a sizable shift in the desired currency holdings, as consumers became wary about the acceptability of credit cards during the control peChart 3



Credit Market Funds Raised by Nonfinancial Sectors

riod.¹¹ Such a change would drive up the currencydeposit ratio and reduce the money multiplier.

If the money multiplier declines, banks have to reduce the amount of deposits they create for a given amount of source base (or bank reserves). According to Weintraub's hypothesis, M1 balances declined because monetary authorities did not anticipate the *increased* demand for currency and offset it by increasing the base. Therefore, the observed decline in real money balances was due, not to a reduction in the *demand* for real balances, but to this unanticipated change in the supply of money caused by an increased demand for currency as a result of the credit controls. Although individuals wanted to hold as much, if not more, M1 balances following the imposition of the credit controls, the banking system precluded these demands from being satisfied. Once credit controls were removed, the Weintraub hypothesis suggests, the multiplier would come back within its historical ranges (see chart 4). Thus, real money balances could be expected to return to more historical levels as well. This is indeed what happened: actual real balances rose to about \$226 billion in III/1980 (see chart 2).

Therefore, one can interpret the behavior of real balances in II/1980 as evidence of a supply-side limitation, not a decrease in the demand for money. In this light, the large simulation error is merely evidence of temporary disequilibrium. Real money balances deviated from predicted levels, not because individuals desired less money, but because monetary authorities did not anticipate the effect of

¹¹Robert Weintraub, *The Impact of the Federal Reserve System's Monetary Policies on the Nation's Economy* (Second Report), Staff Report of the Subcommittee on Domestic Monetary Policy, House Committee on Banking, Finance and Urban Affairs, 96 Cong. 2 Sess. (Government Printing Office, 1980), p. 17.



M1 Multiplier and Ratio of Currency to Total Checkable Deposits

credit controls on the way people decided to hold their money.

John Judd and John Scadding also argue that "the rapid monetary deceleration in the second quarter of 1980 (as well as the rapid growth in the first and third quarters) was caused, not by a money-*demand* shift, but by a money-*supply* 'shock'."¹² While disagreeing with Weintraub about the mechanics of the supply shock (Judd and Scadding trace the supply shock to the contraction in bank loans that followed the Special Credit Control Program of 1980), Judd and Scadding, like Weintraub, recognize that "changes in the *supply* of money can dominate shortrun movements in the monetary aggregates."¹³ The important point here is not to differentiate between the Weintraub and Judd-Scadding hypotheses, but to recognize that both views explain the contraction in money growth by supply-side occurrences. Thus, deviations of actual real balances from those simulated by a money demand equation may be evidence of supply shocks, rather than demand shifts as many suggest.

¹²John P. Judd and John L. Scadding, "Liability Management, Bank Loans, and Deposit 'Market' Disequilibrium," Federal Reserve Bank of San Francisco, *Economic Review* (Summer 1981), p. 21.

¹³Ibid., p. 22.

THE NATIONWIDE "NOW" EXPERIENCE IN 1981: ANOTHER SHIFT?

The simulated values of real money balances also allow an evaluation of the impact of the nationwide legalization of NOW accounts on the demand for money. It has been argued that the introduction of NOW accounts might result in an increased demand for M1 balances, supposedly because of the explicit interest paid on such balances.¹⁴

The Federal Open Market Committee (FOMC) apparently believed such a result likely. In the first place, the FOMC increased the targeted growth ranges for M1 balances in 1981. In addition, the staff of the Federal Reserve Board of Governors developed a "shift-adjusted" M1 measure that would subtract the "artificially induced" demand resulting from the nationwide introduction of NOW accounts. This adjustment was determined, in large part, by surveying new NOW account depositors about the original source of the funds they deposited into these accounts. Asking such a question, however, provides little, if any, information about desired money holdings.¹⁵ An analysis of a conventional money demand relationship should be a better vehicle to address this issue.

If the nationwide legalization of NOW accounts had actually resulted in an increased desire to hold M1 balances, the conventional money demand relationship should have *consistently underpredicted* real balances after the nationwide introduction of these accounts. In other words, actual (real) M1 balances should have been consistently above the level simulated by the equation, as individuals held larger-than-expected balances. In chart 2, where observed (not shift-adjusted) real money balances are shown, however, no consistent underprediction occurred during the last five quarters. In fact, the equation slightly *overpredicts* real money balances. Thus, it does not appear that the nationwide legalization of NOW accounts increased desired M1 balances in any important way.¹⁶

CONCLUSION

Many analysts of monetary policy have used the recent financial innovations and the volatility of money growth as ammunition against pre-established monetary growth targets. These innovations supposedly have caused unpredictable swings in money demand. The behavior of actual money growth has been taken as evidence of such swings.

This article offers a counter argument. To begin with, swings in money growth are reliable indicators of money demand only to the extent that the supply of money has not itself been shocked. In the face of such shocks, large fluctuations in money growth cannot be interpreted as evidence of money demand shifts. The second quarter of 1980 was an episode of unusual money growth caused, not by shifting money demand, but rather by supply-side occurrences. M1 balances fell because the banking system was unable to support the public's desired deposit levels. The lesson learned from this episode is that

¹⁴Much of the discussion about the impact of NOW accounts has centered on the minimum balance requirements of such accounts. Since minimum balance requirements are higher on NOW accounts than on conventional demand deposits, it has been argued that M1 will grow. David E. Lindsey, "Nonborrowed Reserve Targeting and Monetary Control," paper presented at Economic Policy Conference on "Improving Money Stock Control: Problems, Solutions, and Consequences," has correctly pointed out, however, that the issue is one of money demand. No adjustment need be made if the demand for M1 remains unchanged.

¹⁵See John A. Tatom, "Recent Financial Innovations: Have They Distorted the Meaning of M1?" this *Review* (April 1982), pp. 23-35. Some have argued that the shift adjustment was developed to capture the *sources* of NOW inflows rather than the *uses*. Such an adjustment should *not* have been incorporated in the targeting of the money aggregates then!

¹⁶While no apparent irregularities exist when M1 is used, this is not the case when the shift-adjusted measure is employed. Many have recognized this fact. See, for example, Motley, "Innovation and Money Demand;" and John Wenninger, Lawrence Radecki and Elizabeth Hammond, "Recent Instability in the Demand for Money," Federal Reserve Bank of New York Quarterly Review (Summer 1981), pp. 1-9, where many explanations of such anomalous behavior are provided. The point of the present article, however, is that such explanations are not required. A puzzle exists only when the questionable shift-adjusted measure is used. Just because individuals are moving funds from savings to NOW accounts does not indicate, as the shift-adjustment procedure suggests, that more M1 balances are desired. There are always people moving funds from savings accounts to demand deposits. Such movement of funds, however, have never before been taken to suggest that the demand deposit measure should be adjusted. Why should such movements of funds now provide any more useful information? While it is clearly possible that the introduction of explicit interest payments on checkable deposits did result in an increased demand for M1 balances, surveying individuals to find out where funds for new NOW accounts came from is not going to be useful in addressing such an issue. Examining a money demand equation, which is a useful procedure, shows no evidence of an increased demand.

one-time deviations of real money balances from predicted levels do not necessarily indicate a shift in money demand. Such a deviation could just as well denote a temporary money market disequilibrium, caused by the growth of the money supply or a random fluctuation.

One precondition for a "shift" in money demand is a set of consistent, one-sided prediction errors, derived from an estimated money demand relationship. A conventional money demand equation, however, shows evidence of neither sustained periods of overprediction (a downshift) nor sustained periods of underprediction (an upshift) in the underlying empirical relationship. Thus, while significant financial innovations have occurred in the last two years, there is little evidence that these innovations resulted in money demand shifts. The M1 measure continues to have significant economic and policy content.