Recent Instability in M1's Velocity

The behavior of M1's velocity during the 1980s has been remarkably different from the 1970s. After increasing about 3.5 percent per year during the 1970s, M1's velocity has shown virtually no growth during the 1980s (chart). And its volatility has increased remarkably. Velocity growth in the 1980s (measured from the fourth quarter of one year to the fourth quarter of the next) has already ranged from −5.6 percent to +5.3 percent. Over the entire decade of the 1970s, the range was from −0.1 percent to +6.0 percent.[1] Since the predictability of M1's velocity is a key element in implementing a monetary targeting strategy, such dramatic changes in the behavior of velocity raise questions about what the underlying causes might be.[2]

This article explores some of the reasons for the changed behavior of M1's velocity. The introduction of NOW accounts nationwide in 1981 is one factor. Another is the sharp decline in interest rates that has accompanied the reduction of inflation. In addition, swings in inventories and the deteriorating trade balance appear to be important. While the unusual behavior of velocity can be traced to several factors, these factors themselves, however, are not very predictable. Hence, movements in velocity measured in terms of GNP will probably continue to be difficult to anticipate.

The first section of this article presents a brief review of recent movements in money, income, interest rates, and velocity. The second section analyzes the recent behavior of velocity using a conventional money demand equation. The final section presents an alternative analysis using the money-income reduced form equation.[3]

Review of recent velocity movements

The declines in M1's velocity in three of the last four years are certainly related to movements in interest rates (Table 1, column 3).[4] In each year that velocity declined the Federal funds rate fell, with the largest decline in velocity occurring in the year with the largest percentage drop in the funds rate (1982-II to 1983-II, shown in Table 1, columns 2 and 3). In contrast, over the period from 1983-II to 1984-II the funds rate rose and velocity increased as well. Clearly, fluctuations in interest rates explain a large part of the movements in velocity. These movements reflect the public's changing demand for money as the level of interest rates and the opportunity cost of holding M1 balances change.

However, too much weight might be assigned to changes in interest rates if GNP is not a good proxy for

[1]Velocity is the ratio of GNP to M1. The behavior of velocity during the 1960s was quite similar to the 1970s. It grew about 3 percent per year, and stayed in a range of −0.2 to 5.9 percent.

[2]For more background on the 1982-83 decline in velocity, see "Monetary Targeting and Velocity", Conference Proceedings, Federal Reserve Bank of San Francisco (December 1983).

[3]Economists tend to look at the relationship between money and GNP, *i.e.*, velocity, from two different perspectives, the demand for money and the reduced form equation. In the demand for money, the public's holdings of M1 balances are related to current and lagged values of interest rates and GNP. The interest rate variable measures the cost of holding funds in M1 as opposed to investing them, while GNP measures the need for money for transactions purposes. In the reduced form equation, the growth of M1 is viewed as the primary determinant of aggregate demand. Hence, the growth of nominal GNP is related to current and lagged values of M1. Both of these approaches are useful in analyzing unusual movements in velocity.

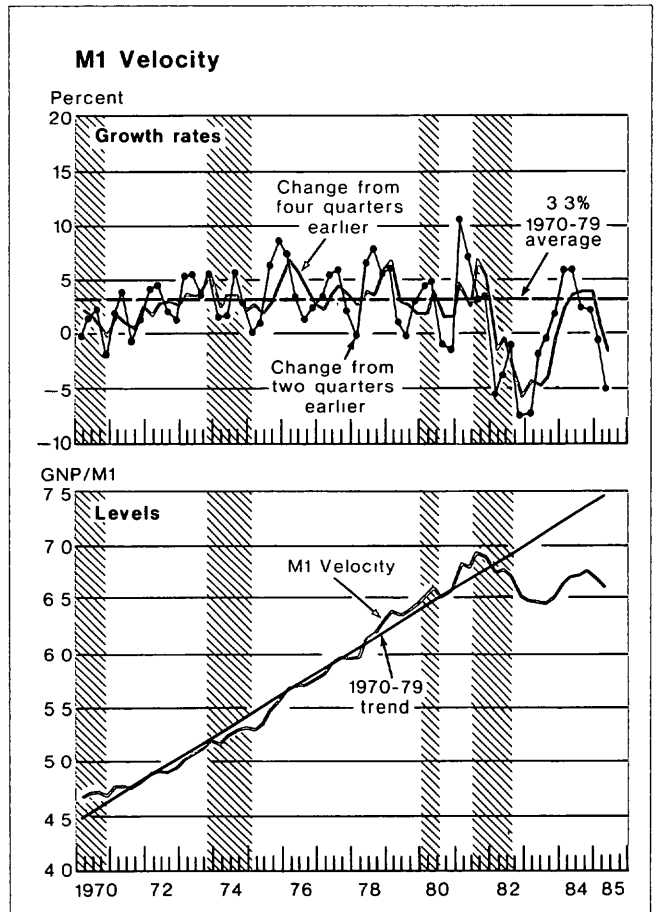
[4]The one-year periods run from the second quarter of one year to the second quarter of the next so that the first half of 1985 could be included.

the volume of transactions that is important for money demand. That is, in each of the three periods when velocity declined during the 1980s, GNP growth slowed because of a decumulation in inventories or a reduction of net exports or both These two components of GNP may not generate demand for money to nearly the same extent as the other components of GNP. Hence GNP growth during the periods when velocity declined could have been understating the increase in the quantity of transactions balances demanded

Velocity should measure the number of times per year a dollar of M1 is used for transactions purposes. GNP, however, is a measure of total production which can differ from total transactions for many reasons. For example, if consumers increase their transactions balances to purchase more goods, but firms choose to liquidate inventories rather than increase production, GNP is unchanged while M1 grows, and velocity declines Likewise, if consumers increase their money balances to purchase more goods, but buy imports made attractive by a strong dollar, the money supply increases while GNP is constant, and velocity declines Also, U.S. exports may affect the demand for money balances in foreign countries more than in the United States Very little demand for M1 may be generated domestically by exports if inter-business transactions at the various stages of the production process result in relatively small balances in the checking accounts of business firms, compared with the balances consumers would keep to purchase the final product. Hence, if U.S. exports decline because of weak foreign demand, GNP falls while M1 demand remains relatively unaffected, and velocity weakens. In general, it might be better to look at gross domestic final demand (GNP less inventory investment and net exports) when assessing the transactions demand for M1.[5]

Inventories and net exports appear related to the recent declines in velocity measured in terms of GNP (Table 1, column 7). Over the past year, for example, gross domestic final demand has been running about two percentage points above GNP, and in the first half of 1985 when the decline in velocity was particularly sharp, the divergence was 3.2 percentage points. In the two earlier periods when velocity was declining, GNP growth was also weaker than gross domestic final demand. Since the transactions demand for M1 was stronger than GNP, velocity growth (measured in terms of GNP) appeared unusually weak. If no allowance was made for the effects of inventories and net exports, then too much weight might be given to interest rates in explaining movements in velocity.

Changes in net exports and inventories have also been an important source of quarter-to-quarter volatility in velocity. Table 2 presents the ten largest deviations in M1's velocity (measured in terms of GNP) from its trend growth rate over the past ten years in descending order. The third column shows the reduction of the deviations when velocity is computed with net exports and inventories excluded from GNP. In every case, the deviation of velocity from trend becomes smaller, with an average reduction of four percentage points.



Shaded areas represent periods of recession, as defined by the National Bureau of Economic Research

Sources U S Department of Commerce and Board of Governors of the Federal Reserve System

[5]As long as the empirical analysis is done in a long-run context, the distinction between GNP and gross domestic final demand would not be all that important Their long-run average growth rates have been about the same However, during the 1980s net exports and inventories have had much larger effects than in the past and, therefore, the distinction between GNP and gross domestic final demand has become more important for understanding the demand for M1 For example, the mean absolute difference between the growth rates of GNP and gross domestic final demand has been 2 7 percentage points in the 1980s compared with 2 1 percentage points in the 1970s and 1 8 percentage points in the 1960s

Analysis using a demand for money equation

An econometric model of the demand for M1 can also illustrate the effects of inventories and net exports. In the conventional transactions approach, real GNP and short-term nominal interest rates, currently and in past quarters, determine the volume of real M1 balances.[6] In this article, the difference between real GNP and real gross domestic final demand (that is, the impact of net exports and inventories on GNP growth) is an additional explanatory variable used to capture the effect noted in the previous section.

A few calculations will show the contribution of this variable in the money demand equation. Ignoring time lags and the impact of the interest rate variable, assume an income elasticity of 0.5. That would yield a relationship: $m = 0.5y$, where m is the growth rate of real M1 and y is real GNP's growth rate. If GNP increases 10 percent, real M1 increases 5 percent. Including the difference between real income and gross domestic final demand (yf) would result in the following equation, assuming the elasticities of y and yf are both 0.5.

$$m = 0.5y - 0.5(y - yf)$$

In this case, a 10 percent increase in GNP due to a 10 percent increase in gross domestic final demand causes m to increase 5 percent as in the previous example. However, if yf increases 10 percent but y does not increase because inventories are run down, m will still increase 5 percent. In other words, the transactions demand for m will increase when the volume of transactions increases, even if GNP (the level of gross domestic production) does not increase because of inventory rundowns or increased imports.

The empirical results show that inventory investment and net exports are statistically important in a money demand equation (Table 3). The estimated coefficient for this variable is highly significant (at the 98.6 to 99.9 percent levels) in the three sample periods, thus improving the explanatory power of the equation about 20 percent. Moreover, the coefficient on the current quarter's GNP becomes more significant with the addition of this variable.

To show the importance of this additional variable for tracking the growth of M1 during the past few years, the regression equation was simulated after estimating the coefficients with and without the additional variable (Table 4). The simulation results are reported using coefficient estimates obtained from the 1971-80 and 1975-84 sample periods. The earlier sample period allows for an 18 quarter simulation period beyond the last year used for estimation. Alternatively, the 1975-84 sample period includes several quarters important for obtaining good coefficient estimates. Movements in M1, GNP, interest rates, inventories, and net exports were

[6] In the past, the most conventional specification related the log level of real M1 balances to the log levels of a short-term interest rate, real GNP, and lagged real M1 balances. For example, see Stephen M. Goldfeld, "The Demand for Money Revisited", *Brookings Papers on Economic Activity III* (1973), pages 577-638, and "The Case of the Missing Money", *Brookings Papers on Economic Activity III* (1976), pages 683-739. More recent research, however, suggests changes in logs, rather than log levels, would be a better way to specify the equation. See, for further detail, James S. Fackler and W. Douglas McMillin, "Specification and Stability of the Goldfeld Money Demand Function", *Journal of Macroeconomics* (Fall 1983), pages 437-459. In such equations, the coefficient on lagged money balances is quite small, suggesting that the lag from income and interest rates to money demand is short. To avoid constraining both GNP and the interest rate to the same implicit lag structure by using a lagged dependent variable, in this article the current and lagged values were incorporated directly in the regression. It appears to be an important distinction to make because the interest rate is insignificant in the current quarter, but significant lagged one quarter. GNP, on the other hand, is significant in the current quarter, but insignificant lagged one quarter.

Table 1

Recent Velocity Movements

In percent

Time period	Change in the level of Federal funds rate (1)	Percentage change in the level of Federal funds rate (2)	Velocity growth (3)	M1 growth (4)	Nominal GNP growth (5)	Gross domestic final demand growth (6)	Difference (7)=(6)−(5)
1984-II to 1985-II	−2.6	−25	−1.4	+7.3	+5.8	+7.6	+1.8
1983-II to 1984-II	+1.8	+20	+3.7	+7.5	+11.6	+10.9	−0.7
1982-II to 1983-II	−5.7	−39	−4.6	+11.9	+6.7	+8.4	+1.7
1981-II to 1982-II	−3.3	−18	−0.2	+5.1	+4.9	+5.7	+0.8

quite sharp in the 1980s Moreover, financial innovation and deregulation have affected the demand for M1 since the mid-1970s, suggesting that earlier data might bias coefficient estimates

In the 1971-80 sample period, including the difference between GNP and gross domestic final demand in the equation causes the average absolute forecast error of the one-quarter growth rate of M1 to fall 1.4 percentage points, or almost one-third. This, of course, still leaves an average quarterly miss of three percentage points In the second sample period, ending the estimation period in 1984 leaves only two quarters to test the model's ability to track actual money growth beyond the estimation period

However, these two quarters are of particular interest because of the extremely sharp decline in velocity Therefore, the objective of this exercise is to see whether an equation estimated through the early 1980s, when velocity growth slowed and its variability increased, could track this most recent acceleration in M1 growth The equation predicts 9 percent growth for the first half of 1985, while the actual growth is 10 4 percent. This relatively accurate forecast results from the larger estimated interest rate elasticity (in absolute value) in the later time period that occurs when earlier data are excluded and from the additional variable to control for the effects of inventories and net exports [7]

Table 2

Ten Largest Deviations in Velocity (Quarterly growth rates, from 1975 to 1985)

In percentage points at annual rates

Date	Deviation in velocity growth from 1975 to 1985 average: Using GNP	Using GNP less inventories and net exports	Difference in absolute value
1981-I	16 0	8 3	7 7
1982-IV	−13 7	−8 6	5 1
1982-I	−10 8	−6 1	4 7
1978-II	10 3	7 4	2 9
1980-III	−8 3	−6 5	1 8
1985-II	−7 6	−3 6	4 0
1981-III	7 5	4 7	2 8
1985-I	−7 0	−5 8	1 2
1975-III	6 8	3 1	3 7
1984-I	5 8	0 8	5 0
Mean absolute average	9 4	5 5	3 9

Analysis using a reduced form equation

Another way to analyze velocity movements is by using a reduced form equation relating the current quarter's GNP growth rate to current and past M1 growth [8] In this section, the analysis with the reduced form equation shows that much of the apparent instability in velocity, particularly in 1982 and 1985, stems from inventories and net exports as well as from the introduction of nationwide NOW accounts in 1981.

The reduced form equation says that GNP growth equals average velocity growth plus a weighted average of M1 growth in the current and four past periods. In other words, recent M1 growth is the primary determinant of current nominal aggregate demand. The basic form of this equation is shown as equation 1 in the right side of Table 5. To further refine this relationship, an article in an earlier *Quarterly Review* showed that M1 growth coming from other checkable deposits (OCD) tends to have only a little more than half of the impact on GNP that M1 growth coming from currency and demand deposits (MA) has.[9] This result appears in equation 2. The third equation in Table 5 is the same as the second equation except that gross domestic final demand (YF) replaces GNP (Y) as the dependent variable

In the context of the reduced form equation, the logic for subtracting inventories and net exports from GNP is different from that for money demand In this case, stronger M1 growth creates greater demand for goods and services, but if imports or inventories satisfy some of that demand, GNP growth does not pick up as much

[7]Other analysts have noted that the interest elasticity in the conventional money demand equation increases in absolute value when the sample period excludes earlier data In part, this could be due to the nationwide introduction of NOW accounts in 1981 NOW accounts earn explicit interest and consumers with NOW accounts could be more sensitive to changes in market rates than those with demand deposits Moreover, with the introduction of money market funds and MMDAs, it has become easier for consumers to shift their liquid assets into and out of M1 when market rates change For more detail, see Howard Roth, "Effects of Financial Deregulation on Monetary Policy", *Economic Review,* Federal Reserve Bank of Kansas City (March 1985), and M A Akhtar, "Financial Innovations and Their Implications for Monetary Policy An International Perspective", Bank for International Settlements, *Economic Papers No 9* (December 1983)

[8]Over the years, many objections have been raised to the reduced form approach In particular, M1, like GNP, is an endogenous variable and the correlation observed in the reduced form equation results from both variables responding in a systematic way to other factors in the economy Even if M1 is not exogenously determined, however, this relationship can be useful if M1 responds sooner to these other factors and hence is a good leading indicator of GNP For more detail, see John Wenninger, "The M1-GNP Relationship A Component Approach", this *Quarterly Review* (Autumn 1984)

[9]Wenninger, *op cit*

Table 3

Estimation Results for the Demand for Money

Sample period	Dependent variable	Coefficient estimates						Summary statistics		
		Constant	r	r(−1)	y	y(−1)	NE+II	ρ	$\bar{R}^2$	SE
1960-84	m	−0 0013	0 0065	−0 039	0 32	0 094	•	0 28	0 41	0 0070
		(1 0)	(1 1)	(6 3)	(4 1)	(1 2)				
1960-84	m	−0 0024	0 0063	−0 031	0 49	0 036	−0 49	0 29	0 48	0 0065
		(1 9)	(1 1)	(5 3)	(5 8)	(0 5)	(4 1)			
1971-80	m	−0 0043	0 014	−0 027	0 48	−0 013	•	0 10	0 51	0 0070
		(2 7)	(1 6)	(3 2)	(4 3)	(0 1)				
1971-80	m	−0 0056	0 011	−0 021	0 63	−0 009	−0 55	0 06	0 58	0 0065
		(3 8)	(1 3)	(2 6)	(5 3)	(0 1)	(2 5)			
1975-84	m	−0 0001	0 0055	−0 061	0 24	0 095	•	0 32	0 50	0 0081
		(0 0)	(0 5)	(5 8)	(1 8)	(0 7)				
1975-84	m	−0 0014	0 0038	−0 045	0 46	−0 005	−0 69	0 38	0 61	0 0069
		(0 6)	(0 4)	(4 7)	(3 6)	(0 0)	(3 9)			

Definition of variables·
m = Δln (M1/GNP deflator) r = Δln (3-month Treasury bill rate) y = Δln (real GNP)
NE+II = Δ(ln [real GNP] − ln [gross domestic final sales/GNP deflator])
•Not included

Table 4

Simulation Results for the Demand for Money

In percent at annual rates

Date	Actual M1 growth	Predicted M1 growth using equation estimated 1971-80		Predicted M1 growth using equation estimated 1975-84	
		Without net exports plus inventory investment	With net exports plus inventory investment	Without net exports plus inventory investment	With net exports plus inventory investment
1981-I	3 3	6 6	5 1	0 7	−0 2
1981-II	8 8	−2 2	−0 2	5 5	6 1
1981-III	3 1	14 0	12 3	12 4	11 5
1981-IV	5 1	−3 8	−2 4	−0 2	0 6
1982-I	8 9	6 9	7 8	8 1	9 7
1982-II	2 9	7 3	4 9	2 3	0 3
1982-III	5 9	0 6	4 0	3 5	6 9
1982-IV	16 3	10 2	10 4	12 9	12 6
1983-I	11 3	19 0	13 9	16 1	10 1
1983-II	12 2	9 7	13 5	6 0	11 3
1983-III	10 2	11 5	10 6	12 4	10 7
1983-IV	6 3	9 9	10 1	9 6	10 2
1984-I	6 2	10 1	8 0	10 4	7 7
1984-II	6 5	3 1	7 2	3 0	8 1
1984-III	4 5	4 2	2 2	4 9	2 6
1984-IV	3 2	3 6	3 6	3 3	3 7
1985-I	10 6	6 7	6 3	10 5	9 0
1985-II	10 2	7 7	9 8	5 7	9 1
Average absolute error		4 5	3 1	3 0	2 3

as would be expected Slow GNP growth relative to M1 growth reduces velocity from what it would have been if domestic production had risen Likewise, the demand for exports can weaken significantly for reasons unrelated to M1 growth, for example, sluggish growth in the economies of our trading partners Reduced demand for exports weakens GNP but leaves M1 growth unchanged, causing velocity growth to slow

The left side of Table 5 shows the simulation errors from each of these three equations Average errors appear in the upper half of the table and average absolute errors in the lower half The average error (a measure of bias) for the entire period falls from −2 8 percentage points to −1 1 percentage points when OCD and MA are allowed to have different impacts on GNP growth It declines further, to just −0 4 percentage point, when YF replaces Y as the dependent variable The reduction of the average error for the entire period stems mostly from better performance in 1982 and in the first half of 1985

Another striking improvement is the decline in the average absolute error (lower half of Table 5) The average absolute error declines from 5 3 to 4 4 percentage points when OCD and MA are allowed to have different-sized impacts, and declines further to 2 7 percent when gross domestic final demand is used as the dependent variable The reduction of the error for the period as a whole is found in mostly 1981, 1982, and the first half of 1985

The questions remain whether GNP growth in individual quarters has been particularly difficult for these equations to track and whether the distinction between GNP and gross domestic final demand would have made any difference in those quarters [10] Table 6 shows

[10]One way of exploring this question is to include a zero-one dummy variable for each quarter since 1979 Those dummy variables that are statistically significant—the estimated coefficient before the dummy variable is significantly different from zero using a t-test—occur in quarters where the equation had significant forecast errors For more on this approach, see R W Hafer, "Monetary Stabilization Policy Evidence from Money Demand Forecasts", Federal Reserve Bank of St Louis *Review* (May 1985)

Table 5

Reduced Form Results

In percentage points at annual rates

In-sample average errors	Y on M (1)	Y on MA, OCD (2)	YF on MA, OCD
1980	−0 1	0 0	0 1
1981	1 5	4 1	2 7
1982	−7 6	−4 2	−1 8
1983	−3 6	−1 9	−3 4
1984	0 6	2 0	1 6
1985 (first half)	−6 3	−5 8	−2 6
1980-85	−2 8	−1 1	−0 4
In-sample average absolute errors			
1980	2 4	2 5	2 7
1981	6 8	6 2	3 3
1982	7 6	4 2	1 8
1983	3 6	2 6	3 5
1984	2 3	2 9	2 1
1985 (first half)	6 3	5 8	2 6
1980-85	5 3	4 4	2 7

Equations	$\bar{R}^2$
(1) Y = 3 4 + 0 97M (6 2)	0 23
(2) Y = 2 9 + 1 17MA + 0 65 OCD (6 7) (3 4)	0 27
(3) YF = 3 4 + 1 08MA + 0 66OCD (7 1) (3 9)	0 30

Sample periods 1949-II to 1985-II

Y = quarterly growth rate of GNP

M = quarterly growth rate of M1

OCD = quarterly M1 growth due to the other checkable deposit components of M1

MA = quarterly M1 growth due to M1 less OCD

YF = quarterly growth rate of GNP less inventories and net exports

The equations are estimated with polynominal distributed lags covering the current quarter and four lags

the results by year for GNP and gross domestic final demand.[11]

In terms of GNP, four quarters out of 22 in the simulation period show statistically significant errors ranging from 10.7 to 13.5 percentage points: 1981-I, 1982-I, 1982-IV, and 1985-II. In all four cases, however, the errors become smaller (roughly half as large) in absolute value and turn statistically insignificant when gross domestic demand rather than GNP is used as the dependent variable. But the error in the first quarter of 1983 becomes larger in absolute value and turns significant when gross domestic final demand is used. In that quarter, when net exports and inventories were adding five percentage points to GNP growth, its growth was still considerably weaker than would have been expected from the very rapid pace of M1 growth. Hence, it appears that some "outliers" will still occur from time to time, even though the distinction between gross domestic final demand and GNP can reduce many of the large errors in the reduced form equation.

[11]The distinction between OCD and MA could not be made in this exercise. Nationwide NOWs were introduced in 1981. With a dummy variable for each quarter in the post-1979 period, it is not possible for the regression to assign separate weights to OCD and MA.

Conclusions

While it is not possible to account precisely for every quarterly movement in velocity, several factors have played important roles in recent years. From the point of view of money demand, these factors include the declines in interest rates, an increased responsiveness in the public's demand for M1 when interest rates change, and the consideration that GNP is not a good proxy for the total volume of transactions when net exports or inventories are strongly affecting its growth rate. From the perspective of the reduced form equation, the errors in predicting GNP with M1 are lowered when M1 growth is split into its interest bearing and non-interest bearing components, and when the distinction between GNP and gross domestic final demand is made.

However, it is very difficult to predict swings in inventories, net exports, interest rates, and the split in M1 growth among its components. Moreover, there has not been enough experience with M1 in this more deregulated environment to estimate very precisely the interest elasticity of the demand for M1. Hence, even though some of the reasons for the instability of velocity in the 1980s (measured in terms of GNP) can be identified *ex post*, velocity is not likely to be more predictable as a result.

Table 6

Significant Errors in Reduced Form Equations

In percentage points at annual rates

Quarter	1980		1981		1982		1983		1984		1985	
	Y	YF	Y	YF	Y	YF	Y	YF	Y	YF	Y	YF
I	1.8	1.0	10.7	3.1	−11.8	−5.9	−9.4	−12.5	4.6	−0.9	−6.5	−4.4
	(0.4)	(0.2)	(2.3)*	(0.7)	(2.5)*	(1.4)	(1.9)	(2.9)*	(1.0)	(0.2)	(1.4)	(1.0)
II	−1.3	−5.0	−6.1	−4.5	−3.8	−5.9	−6.0	−4.7	0.7	4.2	−10.0	−4.3
	(0.2)	(1.1)	(1.3)	(1.1)	(0.8)	(1.4)	(1.2)	(1.1)	(0.1)	(1.0)	(2.1)*	(1.0)
III	−3.8	−0.5	5.3	2.0	−6.8	−2.2	−5.9	−6.3	−3.2	−2.3		
	(0.8)	(0.1)	(1.1)	(0.5)	(1.5)	(0.5)	(1.2)	(1.5)	(0.6)	(0.5)		
IV	−1.0	1.0	−5.7	−4.1	−13.5	−5.9	−1.3	−2.3	−0.2	−0.6		
	(0.2)	(1.2)	(1.2)	(1.0)	(2.8)*	(1.3)	(0.3)	(0.5)	(0.0)	(0.1)		
Average error	−1.1	−0.9	1.1	−0.9	−9.0	−5.0	−5.7	−6.5	0.5	0.1	−8.3	−4.3
Average absolute error	2.0	1.9	7.0	3.4	9.0	5.0	5.7	6.5	2.2	2.0	8.3	4.3

Equations

$Y = 2.9 + 1.19\,M + \underset{(6.7)}{\text{dummy variable for each post-1979 quarter}}$

$YF = 3.2 + 1.12\,M + \underset{(6.7)}{\text{dummy variable for each post-1979 quarter}}$

*Significant at 95 percent level, see notes in Table 5 for explanation of variables.

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