The Credibility of the Federal Reserve's Monetary Targets

by

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Abstract

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This paper examines the credibility of the Federal Reserve's monetary targets using survey data on money growth forecasts to measure market expectations. The paper provides two main results. First, there is strong evidence that the monetary targets were credible over the 1978 to 1993 sample period, although credibility fell in the post-1985 period. Second, both the federal government deficit and Federal Reserve reputation of controlling money growth within the target ranges have a significant impact on credibility.

Introduction

In response to congressional pressure, the Federal Reserve adopted annual monetary growth targets and began announcing them to the public in 1975. Many economists view the establishment of monetary targets as a positive development for two reasons. First, money growth targets allow central banks to signal their intentions to get tough on inflation. If they do this in a credible manner, then the social costs of pursuing anti-inflationary policies can, presumably, be reduced.[1] Second, credible monetary targets cause the money supply to follow a mean-reverting process. To the extent that there is a strong relationship between the money supply and the aggregate price level, the targets cause the latter to also be mean-reverting, thus reducing long-term price level uncertainty in the economy. Lower uncertainty about future prices, in turn, raises the allocative efficiency of capital markets and leads to increased economic growth.[2]

The 20 year history of monetary targeting in the United States provides economists with considerable data that can be examined to shed light on many important policy questions. This paper focuses on two. First, to what extent has the public viewed the monetary targets as credible? That is, has the Federal Reserve been able to influence expectations in the economy by setting monetary targets? Second, what factors cause the credibility of the monetary targets to rise and fall?

Up to this point, no consensus has emerged in the literature about these questions. For example, Frankel and Hardouvelis (1985), and Hardouvelis and Barnhart (1989) have argued that the Federal Reserve's credibility as an inflation fighter rose when they placed greater weight on monetary targets following the change in operating procedures in late 1979. In addition, Friedman (1988) surmises that the credibility of the monetary targets fell after 1982:

> In the eyes of many economists, the Federal Reserve has been steering without a rudder since it effectively abandoned its commitment to monetary growth targets in 1982 (p.52) ...after mid-1982 there was no reason for anyone to find the Federal Reserve's commitment to its stated money growth targets credible (p. 65).

In contrast, Eichenbaum (1992) argues that the Federal Reserve has had much more difficulty establishing credibility:

> ...the issue of monetary targeting in the United States just isn't interesting from a positive point of view. We Never had it. What the Fed targeted in 1979 was high nominal interest rates, not low growth rates of M1. Surely no one believed otherwise — now or then. (p. 232)

These disparate views about the Federal Reserve's ability to set credible monetary targets suggest the need for additional empirical work.

This paper examines the credibility of the Federal Reserve's monetary targets. To do this, the paper uses survey data on money growth forecasts collected on a quarterly basis since 1978 by the *Washington Bond & Money Market Report*. This data provides us with a unique opportunity to examine whether the monetary targets have influenced money growth expectations and, if they have, how the influence has changed over time. Moreover, we can use the data to explore whether credibility has responded to: i) the nature of the monetary regime employed by the Federal Reserve, ii) the Federal Reserve's reputation in hitting the targets, and iii) the stance of fiscal policy.

The paper is outlined as follows. The next section discusses previous work that has attempted to measure credibility. Section two presents the Federal Reserve's annual and near-term monetary targets and separates the deviations from the annual targets into desired and undesired components. The third section discusses the survey data used in the study. The fourth section constructs the empirical model. The main empirical results are presented in sections five and six. The final section concludes the paper and discusses the policy implications.

1. Previous Work

One approach that has been employed to investigate the existence of credibility is to examine inflation-unemployment trade-offs or term structure equations across different monetary regimes. If a new anti-inflationary regime is credible, then a Phillips curve, estimated over some previous regime, should over-predict the rate of inflation during the period when the anti-inflation regime in place. Similarly, a credible anti-inflationary regime should, everything else held constant, cause expected inflation and long-term interest rates to fall. Using these approaches, Blanchard (1984) found evidence that the policy regime put in place by the Federal Reserve in 1979 attained some credibility.

Blackburn and Christensen (1989) point out that both of these approaches have drawbacks. First, the Phillips curve approach focuses on variables that adjust sluggishly to changes in the environment and thus are "not well suited for testing the forward-looking aspects of rational forecasting that are endemic to the credibility hypothesis." Second, term structure models do not provide precise results because it is difficult to disentangle the impact on long-term rates of, on the one hand, lower inflationary expectations and, on the other, the effect of tight money and higher current short-term rates. Third, both the Phillips curve and term structure approaches might produce misleading results if the prediction errors from these models are not due solely to the missing "credibility variable".

One way to overcome these problems is to construct more direct tests of the credibility hypothesis using survey data to measure market expectations. This is the approach used by Frankel and Hardouvelis (1985) and Hardouvelis and Barnhart (1989) to investigate the Federal Reserve's credibility as an inflation fighter during the late 1970s and early 1980s. In particular, they

use the change in the weekly money stock forecasted by approximately 45 fed watchers whose forecasts are collected each Tuesday by Money Market Services Incorporated. These forecasts are used to gauge the reaction of commodity prices to unexpected changes in the M1 money supply. These researchers argue that the Federal Reserve's credibility as an inflation fighter is measured by the response of commodity prices to unexpected increases in the money supply. If the response is negative (i.e., unexpected increases in the money supply lead investors to believe that future money growth and thus inflation will be lower and they respond to this expectation by shifting out of commodities and into money), the Federal Reserve has credibility.

Frankel and Hardouvelis use this approach to show that the Federal Reserve did not have credibility as an inflation fighter prior to October 1979, but that they did following the Volker-announced regime shift. Hardouvelis and Barnhart use a Kalman Filter model to show that credibility rose slowly following the October 1979 regime shift and that credibility varies with the rate of inflation.

One potential problem with using commodity prices reactions to unanticipated money growth to measure credibility is that the relationship between money and inflation may not be stable.[3] That is, the correlation between commodity prices and unexpected money might weaken not because the Federal Reserve has lost credibility, but because market participants believe that money growth no longer has a strong impact on inflation. In fact, it has been noted by many researchers (see Friedman 1988) that the correlation between money growth and inflation has deteriorated significantly in the post-1982 period. This potential problem is magnified when the analysis focuses on long periods of time as we do in this study. We can avoid this problem by focusing directly on money growth expectations rather than inflation expectations.

2. Monetary Targets

A. The Targets

Table 1 presents the upper and lower ranges of the annual M1 and M2 money growth targets set by the Federal Reserve since 1975. As the Table indicates, the Federal Reserve has used two different approaches to monetary targeting since 1975. Prior to 1979, the Federal Reserve announced annual target ranges for monetary growth on a quarterly basis using the previous quarter as the base period.[4] Each quarter the ranges were moved forward one quarter, thus causing the level of the aggregate implied by the new target to often differ greatly from the level implied by the original target.

The built-in base drift generated by a shifting base period prompted much criticism of the Federal Reserve. Following passage of the Full Employment and Balanced Growth Act of 1978 (the Humphrey-Hawkins Act), a new procedure for setting the monetary targets was established that was intended to restrict base drift. Beginning in 1979, the Federal Reserve established targets for the current calendar year during the February meeting of the Federal Open Market Committee (FMOC). The FMOC subsequently reviewed these targets at its July meeting and set preliminary targets for the following year. In all but three cases (at the February 1983, July 1983, and July 1985 meetings), the fourth quarter from the previous year was maintained as the base period throughout the year.[5]

Table 1 shows that the FMOC formally altered M1 or M2 targets at the July meeting on only three occasions under the new regime: 1983 (M1), 1985 (M1) and 1993 (M2). The Table also chronicles several cases when the FMOC explicitly stated that actual money growth would deviate from the target levels although the targets were not formally altered. For example, the FMOC stated at its February 1985 meeting that "growth in the monetary aggregates in the upper

part of their ranges for 1985 may be appropriate...".

It is important to point out that the preliminary annual targets set in July for the following year often deviated from those set for the current year. Similarly, the annual targets set in February often differed from the preliminary targets established at the July meeting in the previous year. Finally, Table 1 does not report targets for M1 beginning in 1987 because the Federal Reserve ceased targeting M1 at this time.

In addition to annual monetary targets, the Federal Reserve has also set near-term targets since 1975. Prior to October 1979, near-term target ranges were established at each monthly FMOC meeting and set with one month horizons. Beginning in October of 1979, the FMOC met less frequently and the horizon for near-term targets was lengthened to three months. The near-term targets were intended to be a tool for achieving the annual targets. If the money stock moved outside one of the annual ranges, the near-term target was suppose to be set to bring the money stock back into the range. If the money stock remained within the annual ranges, the near-term target was set to keep it there. However, as Meulendyke (1988, p. 13) points out the FMOC "sometimes approved growth rates that stretched out the period for bringing money back on track, and on occasion it acknowledged that target growth probably would not be achieved within the year." According to, Meulendyke the FOMC allowed the money stock to deviate from the annual target ranges for two reasons. First, they were often skeptical about staff forecasts. Second, they were frequently unwilling to pay the high cost associated with raising the federal funds rate to the level needed to bring the money stock back into line.

B. Actual Versus Targeted Money Stocks

The ability of the Federal Reserve to hit their monetary growth targets has received considerable attention from economists, with increased attention

usually given at times when there have been large divergences. To measure the Federal Reserve's success in hitting the targets, we proceed in two stages. First, we subtract the target money stock (the stock implied by the midpoint of the annual target ranges) from the from the actual money stock and divide this difference by the target money stock. Second, a four-quarter summation of these percentage deviations is calculated to control for differences due solely to seasonal factors. That is, the percentage deviations should be larger on average towards the end of the year if the money stock does not follow a mean-reverting process. To facilitate comparison with the near-term targets discussed below, monthly money stock data is used.

Four-quarter moving summations of the percentage deviations of M1 and M2 from their target levels (DEV1SUM and DEV2SUM) are illustrated in Figures 1 and 2 respectively. Figure 1 shows that M1 remained relatively close to the midpoint of its target up to 1981, then drifted persistently above the target level beginning in 1981. Interestingly, the M1 deviations reach their highest level in 1986, the last year in which the Federal Reserve formally announced annual M1 targets. The narrower range for M2 deviations illustrated in Figure 2 suggests that the Federal Reserve has had greater success targeting this aggregate. However, M2 was generally above the midpoint of its target ranges prior to 1987 and M2 has continually drifted below the target level in recent years. The Federal Reserve ceased announcing M2 targets in 1993. As was the case for M1, deviations in this aggregate reached their highest level (in absolute value) immediately before the Federal Federal stopped targeting it.

C. The Source of Deviations

The fact that the Federal Reserve stopped establishing M1 and M2 targets following periods when these aggregates deviated from their target by increasing magnitudes raises two questions. First, did reduced controlability

lead to large and persistent deviations and subsequently to the deemphasis of M1 and then M2 targeting in monetary policy? Or, alternatively, did a reduced desire by the Federal Reserve to control the aggregates lead to the deviations illustrated in Figures 1 and 2?

One way to address these questions is to utilize the near-term targets to separate deviations of the monetary aggregates from their annual targets into desired and undesired components. As discussed earlier, desired deviations arise either because the FMOC is skeptical about staff forecasts or they are unwilling to face the high cost associated with bringing the money stock back into line.[6] The primary source of undesired deviations of money stocks from the target levels is lack of monetary control.

To demonstrate how deviations of the money stock from the target level can be decomposed into desired and undesired components, Figure 3 shows a hypothetical path for the money stock and the midpoints of the annual and near-term target ranges. The Figure shows that the near-term target set in the third quarter is consistent with moving the money stock to the annual target level by the end of the quarter. At the end of the third quarter the actual money stock exceeds the level implied by the near-term and annual targets and this difference is the undesired deviation. The near-term target set for the fourth quarter implies base drift; money growth targeted over the quarter is such that the money stock is expected to reach a level that exceeds the annual target level. The difference between near-term and annual target levels at the end of the quarter is the desired deviation. The difference between the actual money stock and the near-term target level is the undesired deviation.

Four-quarter summations of the percentage undesired deviations for M1 and M2 are illustrated in Figures 1 and 2 respectively.[7] The Figures show that a relatively small proportion of the money stocks deviations are undesired.

This finding suggests that most of deviation of the money stocks from annual target levels over the last two decades can be accounted for by base drift and not by lack of monetary control. However, there are several interesting exceptions. First, undesired M2 deviations rose persistently between 1979 and 1981. This was most likely due to uncontrollability caused by the emergence of NOW accounts and deregulation. Second and more importantly, note that a large fraction of the M1 deviation in 1986 was undesired. This finding suggests that lack of controlability may have been an important factor contributing to the Federal Reserve's decision to cease formal targeting of M1 at this time.[8] A similar lack of monetary control is not observed for M2 in 1993 when targets for it are no longer set.

3. Measuring Money Growth Expectations

To measure money growth expectations, we use survey data collected on a quarterly basis by the *Washington Bond & Money Market Report* (the *Report*).[9] Starting in 1978, the *Report* has collected money growth forecast from a group of financial sector economists at the end of each quarter.[10] The forecasts are quarter-over-quarter projections of money growth one and two quarters into the future. Figure 4 illustrates the mean forecasts of the group for one and two quarter horizons. To our knowledge this is the only survey that provides money growth forecasts over these relatively long horizons.

Three features of the survey data warrant discussion. First, the money stock forecasted by the group changes over the sample; the group forecasts M1 growth from 1978:Q2 to 1983:Q3 and 1984:Q3 to 1987:1 (the shaded periods in Figure 4), and M2 growth from 1982:Q4 to 1984:Q2 and 1987:Q2 to 1993:Q4.[11] Since the money stock forecasted by the group generally coincides with the aggregate emphasized by the Federal Reserve in it targeting efforts,[12] a finding that the targets do not influence expectations can not occur because

the group and the Federal Reserve are focusing on different aggregates.

Second, the group forecasts money growth using the current quarter money stock as the base before it is known. Fortunately, the *Report* provides the group with a projected growth rate of the money stock for the current quarter. Using this projection and knowledge of the previous quarter's money stock, the current quarter money stock can be estimated.

Third, a common criticism leveled at the use of survey data to measure expectations is that members of the forecast group do not have an incentive to provide well-informed forecasts. It is difficult to ascertain whether this is true or not with regard to the forecasts provided by the *Report*. However, several researcher have found that the interest rate forecasts provided by the *Report* provide consistent results.[13] Moreover, the forecast group is composed of financial market participants and this is precisely the group that should be most concerned about the credibility of the Federal Reserve's targets.

4. Empirical Specifications

The Federal Reserve's monetary targets should influence money growth expectations if they are credible. To examine this effect on expectations, we propose the following model:

$$\dot{m}^{e}_{t,t+i} = \begin{cases} \dot{m}^{T}_{t,t+i} & \text{with probability } \beta_t \\ \dot{m}^{NT}_{t,t+i} & \text{with probability } (1-\beta_t) \end{cases} \qquad i = 1,2 \qquad (1)$$

where $\dot{m}^{e}_{t,t+i}$ is the market's money growth expectation, obtained from the *Report*, at time t for i quarters into the future; $\dot{m}^{T}_{t,t+i}$ is expected money growth when the monetary targets are perfectly credible (the target model); $\dot{m}^{NT}_{t,t+i}$ is expected money growth based on some alternative (non-target) model; and β_t $(0 \leq \beta_t \leq 1)$ is the probability that money growth is governed by the target model. That is, β_t measures target credibility.

To estimate $\dot{m}^{T}_{t,t+i}$, we take the annualized growth rate between the money stock at t and the level implied by the midpoint of the target range at the end of the calendar year. This approach is illustrated in Figure 5 for the two-quarter-ahead forecast. Note that preliminary targets for the following year are used in the construction of $\dot{m}^{T}_{t,t+2}$ in the third quarter and fourth quarters. For example, the two-quarter-ahead money growth expectation from the target model at the end of the third quarter of 1980 is:

$$\dot{m}^{T}_{80:3,81:1} =$$

$$\frac{4}{2}\cdot\left(\left[1 + .5(\dot{m}^{U}_{80} + \dot{m}^{L}_{80})\right]\left[1 + .25[.5(\dot{m}^{PU}_{81} + \dot{m}^{PL}_{81})]\right]\cdot M_{79:4} - M_{80:3}\right)/M_{80:3}$$

where $\dot{m}^{U}_{80}$ and $\dot{m}^{L}_{80}$ are, respectively, the upper and lower annual money growth ranges for 1980 announced in February; $\dot{m}^{PU}_{81}$ and $\dot{m}^{PL}_{81}$ are, respectively, the preliminary upper and lower ranges for 1981 announced in July of 1980; and $M_{79:4}$ and $M_{80:1}$ are money stock levels in the fourth quarter of 1979 and the first quarter of 1980 respectively. One-quarter-ahead money growth forecasts are constructed in an analogous manner.

Many different specifications could be used to represent the non-target model. Its seems reasonable, however, to limit the analysis to simple time series models augmented with important state variables that are believed to drive money growth. One such state variable is the deficit. When there is a non-zero probability that the Federal Reserve will monetize the deficit, larger deficits should lead to expectations of higher monetary growth. Given this consideration, the non-target model we consider is:

$$\dot{m}^{NT}_{t,t+i} = \alpha + \gamma_1\dot{m}_t + \gamma_2\dot{m}_{t-1} + \lambda\cdot DEF_t + u_t \qquad i = 1,2 \qquad (2)$$

where $u_t \sim N(0, \sigma^2)$; $\dot{m}_t$ and $\dot{m}_{t-1}$ are contemporaneous and lagged money growth; and DEF_t is the ratio of the federal government deficit to gross domestic

product.

Combining the target and non-target models, money growth expectations can be written as:

$$\dot{m}^{e}_{t,t+i} = \beta_t \dot{m}^{T}_{t+i} + (1-\beta_t)\left(\alpha + \gamma_1 \dot{m}_t + \gamma_2 \dot{m}_{t-1} + \lambda \cdot DEF_t + u_t\right) \qquad i = 1,2 \qquad (3)$$

or

$$\dot{m}^{e}_{t,t+i} = a_t + \beta_t \dot{m}^{T}_{t+i} + c_t \dot{m}_t + d_t \dot{m}_{t-1} + e_t DEF_t + \varepsilon_t \qquad i = 1,2 \qquad (4)$$

where:

$a_t = \alpha(1-\beta_t)$,
$c_t = (1-\beta_t)\gamma_1$,
$d_t = (1-\beta_t)\gamma_2$,
$e_t = (1-\beta_t)\lambda$,
$\varepsilon_t = (1-\beta_t)u_t$ with $\varepsilon_t \sim N(0, (1-\beta_t)^2\sigma^2)$

Two features of (4) warrant comment. First, the coefficient estimate for $\dot{m}^{T}_{t+i}$ measures the credibility of the monetary targets. If the credibility of the monetary targets changes over time, then β_t should be time-varying. Second, the existence of time-varying credibility causes the disturbance term of the reduced form equation to display heteroscedaticity.

5. Empirical Results

A. Time-Invariant Model

Table 2 reports estimates of equation (4) under the assumption that the coefficients are not time-varying. Due to the potential for heteroscedaticity generated by time-varying credibility, the models are estimated with method-of-moment techniques to obtain consistent estimates of the covariance matrix and standard errors. Also, error terms in models that use two-quarter-ahead forecasts should follow, at a minimum, a first-order moving-average process because the forecast horizon in these models is longer than the observation

interval. This potential source of serial correlation is taken into account when the method-of-moment procedure is used.[14] Data from the second quarter of 1978 to the second quarter of 1993 is used to estimate the models.

The first rows in panel A and B of Table 2 show regression results for the empirical model that only includes a constant and the target model money growth expectation. The results are highly inconsistent with the hypothesis that the monetary targets have had a gravitational pull on money growth expectations. Instead, the negative and highly significant estimates of β suggest that money growth expectations rose when $\dot{m}^{T}_{t+i}$ fell. However, the high level of serial correlation (evidenced by the low Durbin-Watson and large Q statistics) suggest that these models exclude important explanatory variables and are thus misspecified.

Two important variables missing from regression 1 are contemporaneous and lagged money growth. In fact, one possible explanation for the negative β estimates in Table 2 is that $\dot{m}^{T}_{t,t+i}$ tends to fall and become negative when recent money growth has been high and has moved the money stock above the midpoint of the target range. In this case, variation in $\dot{m}^{T}_{t,t+i}$ might be picking up recent movements in money growth which are themselves important determinants of money growth expectations as hypothesized in equation (4).

Regression 2 includes contemporaneous money growth rate and regression 3 includes contemporaneous and lagged money growth.[15] The growth rates have a positive and highly significant impact on expected money growth and their inclusion into the models eliminates much of the serial correlation. Also, panel A shows that β is insignificantly different from zero in regressions that use one-quarter-ahead forecasts. In contrast, panel B shows that β is positive and significantly different from zero at the five percent level when two-quarter-ahead forecasts are used. When lagged money growth is included, the size of β rises and it becomes more significant. This is an important

finding. It suggests that while the monetary targets have had little impact on shorter-term money growth expectations, they have had a strong effect on longer-term expectations. Thus there is evidence that the monetary targets were credible over the 1978 to 1993 sample.

Regression 4 in Table 2 adds the deficit-GDP ratio to the model. The results show that the deficit-GDP ratio has a positive impact on money growth expectations at both the one- and two-quarter horizons. Note also that the diagnostic statistics used to test for serial correlation improve somewhat when the deficit variable is added and that the t-statistic for β rises in the two-quarter-ahead model. This last finding is somewhat surprising because it suggests that the targets remained credible even when the fiscal landscape of the 1980s was changing dramatically. Apparently the economists surveyed by the *Report* believed that part of the deficit increase during the 1980s was going to be monetized.

B. The Time-Varying Model

Equation (4) shows that fluctuations in credibility cause the reduced form coefficients linking money growth expectations to its determinants to become time-varying. To examine whether this is fact the case, we employ Kalman filter techniques to recursively estimate regression 4 in Table 2. Estimates over the 1978:Q2 to 1980:Q4 period were used to initialize the Kalman filter. Figures 6 and 7 illustrate the coefficient evolution from the models estimated with one- and two-quarter forecast horizons respectively. The solid lines represent the coefficients, while the dashed lines show the 95-percent confidence intervals obtained by adding and subtracting two times standard errors to the coefficients.

Three interesting findings emerge from Figures 6 and 7. First, the coefficients on contemporaneous money growth are significantly positive

throughout the sample and begin a continuous rise in 1982. A similar pattern is observed for the lagged money growth coefficients. Second, the deficit-GDP coefficient rises and becomes significantly different from zero in 1982.

Third, while the β coefficient is not significantly different from zero for the one-quarter-ahead forecasts for most of the sample, it is for the two-quarter-ahead forecasts. In fact, β is insignificantly different from zero for the two-quarter-ahead forecasts only in the six quarter period beginning in 1981:Q1 and the insignificance over this period may be due to the small number of observations available early in the sample. The high level of target credibility exhibited for the 1978:Q2 to 1980:Q4 period is somewhat surprising given the general consensus in the literature (for example, see Friedman, 1988, p. 53) that market participants did not take the monetary targets seriously until sometime after the announced policy change in October of 1979. However, given the small number of observations upon which the estimates over this initial period are made, this finding needs to be viewed with a great deal of caution. Overall, the results suggest that the money targets had a declining impact on expectations beginning in 1985 and the influence of the targets was replaced by the other variables in the model.

6. Explaining Time-Varying Credibility

The findings of the previous section raise an important question: why has the credibility of the monetary targets varied over time? The next section examines factors discussed in the literature that might account for time-varying credibility and outlines the empirical approach we use to quantify these effects.[16] The following section discuss the empirical results.

A. Theoretical and Empirical Issues

The first factor that might account for changes in credibility is the

operating procedure followed by the Federal Reserve. From October 1979 to October 1982, the Federal Reserve placed greater emphasis on controlling the money supply. To achieve this objective, it targeted nonborrowed reserves and allowed the federal funds rate to fluctuate in a much wider range then in the past. In addition, the Federal Reserve implemented other more technical measures designed to enhance control over the money supply. To the extent that these procedural changes were perceived as successful by the public, the credibility of the monetary targets should have increased. In contrast, the Federal Reserve placed less emphasis on the monetary targets in the period ending September 1979 and the period beginning October 1982.[17] These shifts in emphasis suggest that, *ceteris paribus*, credibility should have been higher in the 1979:Q4-1982:Q3 period than in the others.

However, everything else may not have been held constant across the policy regimes. As Friedman (1988, p. 55) points out, the actual behavior of money supply during the nonborrowed reserve regime might have undermined the credibility of the targets. In particular, he contends that many observers viewed the dramatic rise in money growth volatility during the 1979:Q4-1982:Q2 period as "casting doubt on the strength of the central bank's commitment to money growth targets..." Given this possible effect, it is not clear that the 1979:Q4-1982:Q3 period should have been characterized by higher credibility.

A second important factor that might affect the credibility of monetary policy is the stance of fiscal policy. Everything else held constant, the public should have less confidence that the Federal Reserve will keep money growth within low target ranges when it is expected to accommodate the Treasury and the latter is running large deficits. As Blackburn and Christensen (1989) point out, there is some historical and empirical evidence that the coherence between monetary and fiscal policy is an important source of credibility.[18]

A third potential source of credibility is reputation. One of the important contributions to the theoretical literature on credibility is the idea that memory is an important element in repeated games between policy makers and the public who behaves strategically. For example, Rogoff (1987) builds a model where private sector inflationary expectations are set equal to the target level if inflation was equal to the target level in the past, and expected inflation is increased if actual inflation exceeded the target level. In the context of our study, this implies that the annual monetary targets should be less credible following periods when there have been large and persistent deviations from the targets.

To examine whether these three factors help to explain the time-varying credibility observed in Figure 7, we construct interaction terms using money growth expectations based on the target model ($\dot{m}^{T}_{t,t+i}$) and variables (X_t) that are intended to capture the effects discussed above. These terms are then introduced into the time-invariant version of equation (4):[19]

$$\dot{m}^{e}_{t,t+i} = a + \beta\cdot\dot{m}^{T}_{t,t+i} + c\cdot\dot{m}_{t} + d\cdot\dot{m}_{t-1} + e\cdot DEF_{t} + g\cdot X_{t}\dot{m}^{T}_{t,t+1} + \varepsilon_{t} \quad i = 1,2 \quad (5)$$

rearranging, we get

$$\dot{m}^{e}_{t,t+i} = a + (\beta + g\cdot X_{t})\cdot\dot{m}^{T}_{t,t+i} + c\cdot\dot{m}_{t} + d\cdot\dot{m}_{t-1} + e\cdot DEF_{t} + \varepsilon_{t} \quad i = 1,2 \quad (6)$$

This equation illustrates that a positive coefficient on the interaction term, $g > 0$, provides evidence that credibility rises when X_t increases.

Three different variables are used for X_t. The first is a dummy variable (7982_t) that has values of one when the Federal Reserve was emphasizing the monetary targets (1979:Q4 to 1982:3) and zero in the other periods. The second is the deficit-GDP ratio discussed earlier. The third attempts to measure the reputation effect and is constructed from the four-quarter sums of percentage deviations of the money stock from the target levels discussed in

Section 3. Specifically, we combine DEV1SUM and DEV2SUM (estimated with quarterly data) into one series employing, in each quarter, the series that is constructed from the monetary aggregate being projected by the forecast group. This variable, $DEVSUM_t$, is illustrated in Figure 8 with the shaded regions in indicating when the group was forecasting M1.[20] Recall that it rises when base drift increases or the monetary aggregates become less controllable. Both factors should reduce the Federal Reserve's reputation and undermine the credibility of the targets.

B. Empirical Results

Before investigating the impact of these three variables on credibility, we first examine whether credibility changes when the particular monetary aggregate forecasted by the *Report* group changes. This is accomplished by constructing one additional interaction term created by multiplying $\dot{m}^T_{t,t+i}$ by a dummy variable, $M1_t$, that is equal to one when the *Report* group forecasts M1 and zero when they forecast M2. A positive coefficient on this interaction term implies that the Federal Reserve had greater credibility when the group was forecasting M1 (or the periods, approximately, when the Federal Reserve was targeting M1). The results from panel A of Table 3 suggest that the coefficient on this interaction term is equal to zero for the one-quarter-ahead forecasts. In contrast, panel B shows that this coefficient is positive and significantly different from zero at the five percent level when two-quarter-ahead forecasts are considered. This last finding provides some evidence that the M1 targets had higher credibility than the M2 targets.

Rows 2 through 4 of Table 3 report results for regressions that include the other interaction terms. The results presented in row 2 of both panels suggest that credibility was not higher during the 1979:Q4 to 1982:Q3 period. That is, g is not significantly different from zero when X_t is set equal to

the 7982_t dummy. One explanation for this finding is that $M1_t$ and 7982_t are highly correlated (i.e., the forecast group forecasted M1 for the entire 1979:Q4-1982:Q3 period) and that this multicollinearity lowers the t-statistic for g. When the model was re-estimated (results not reported) leaving the money-type interaction term out of the model, g remained insignificant in the panel A regression but its t-statistic rose to 1.66 (significant at the 10 percent level) in panel B. Therefore, there is some evidence, albeit weak, that credibility was marginally higher in the 1979:Q4-1982:Q3 period.[21] The weakness of the results suggests that the Federal Reserve was only partially successful in convincing the public that they were serious about controlling the money supply following the change in operating procedures in 1979. As Friedman has suggested, it is possible that the increased volatility of money growth following the change in procedures undermined the Federal Reserve's credibility.

Row 3 in panel A and B shows results for a model that includes an interaction term with X_t equal to the deficit-GDP ratio. Panel A shows that the coefficient g is negative and significant at the five percent level. Interestingly, the β coefficient is positive and significant for the first time in the regression that includes the deficit interaction term. Panel B shows that g is negative and significant at only the ten percent level. Overall, the results provide some evidence that the higher deficits of the 1980s caused the credibility of the monetary targets to fall.

The final regressions attempt to determine whether the Federal Reserve's past performance in hitting their monetary targets, or reputation, has an impact on its credibility. The bottom row in panel A and B of Table 3 shows results for models that include the interaction term with $X_t = DEVSUM_t$. Interestingly, the coefficient on this interaction term, g, is negative and significantly different from zero at the five percent level in regressions

that use the one- and two-quarter forecasts. This finding suggests that the credibility of the targets increased following periods when the Federal Reserve had been relatively successful hitting the targets.

This effect is visible by comparing the lower-right panel of Figure 7 and Figure 8. In particular, note that β_t falls from about .17 to .09 from the middle of 1985 to the end of 1986. This is the same period when M1 rises dramatically above the target ranges as can be seen in Figure 8. Thus these findings suggest that reputation is an important factor determining monetary target credibility.

Conclusion and Policy Implications

This paper examined the credibility of the Federal Reserve's monetary targets over the 1978 to 1993 sample period. To do this, we explored the extent to which the targets influenced money growth expectations measured using survey data. The paper also investigated different factors that might explain variations in Federal Reserve credibility over time. In the end, two two main findings emerge from the empirical work.

First, there is strong evidence that the monetary targets had a significant and time-varying impact on longer-term money growth expectations over the 1978 to 1993 sample period. As many Fed watchers might expect, the targets were more credible in the pre-1985 period than the post-1985 period. Perhaps more surprising, however, is the finding that the targets continued to be credible in the post-1985 period even though they were deemphasized by the Federal Reserve during this time.

Second, we show that two factors had a significant impact on credibility. The first is the federal government deficit — higher deficits lead to lower target credibility. This finding suggests that the stance of fiscal policy can undermine a central bank's credibility when it is expected to monetize a

portion of the deficit. The second factor is Federal Reserve reputation of controlling money growth within the target ranges. The paper finds that the more the actual money stock has deviated from the target level in the past, the lower is Federal Reserve credibility. This result suggests that central banks can raise their credibility by doing what they say they are going to do.

What policy implications should be drawn from these findings? If there was a strong empirical relationship between money growth and inflation, then these findings could provide a rationale for central banks to emphasize monetary growth targets. By taking the targets seriously and allowing them to constrain money growth, disinflationary policies could be pursued at lower social costs and long-term price level uncertainty and its associated costs could be reduced.

However, many economists have become increasingly skeptical about the existence of a stable empirical relationship between money growth and inflation. The experience of unstable money demand in the 1980s and empirical studies which demonstrate that the money growth-inflation correlation has deteriorated in recent years have gone a long way to persuade economists that the monetary aggregates do not provide useful intermediate targets for the conduct of monetary policy. In fact, these developments have gone a long way in convincing the Federal Reserve in recent years that it should pay less attention to the aggregates when conducting policy.

In light of the fact that monetary aggregates now play a reduced role in the conduct of monetary policy in the U.S., one may question the relevance of empirical work that examines the historical experience of monetary target credibility. In fact, the findings of this paper are relevant to the current policy debate because public perception of central bank credibility is a crucial factor in the success of any policy regime, whether it is one that targets monetary aggregates or any other variable. By better understanding

the factors that have influenced monetary target credibility in the past, we can obtain greater insight into how central banks can achieve credibility for the variables they choose to target in the future.

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Table 1 - Money Growth Targets

Year	Month/Day of FMOC Meeting	Ranges for Current Year			Preliminary Ranges for Following Year		
		M1	M2	Period	M1	M2	Period
1975	4/14-15	5.0-7.5	8.5-10.5	75.03-76.03	.	.	.
	6/16-17	5.0-7.5	8.5-10.5	75.06-76.06	.	.	.
	7/15	5.0-7.5	8.5-10.5	75Q2-76Q2	.	.	.
	10/21	5.0-7.5	7.5-10.5	75Q3-76Q3	.	.	.
1976	1/20	4.5-7.5	7.5-10.5	75Q4-76Q4	.	.	.
	4/20	4.5-7.0	7.5-10.0	76Q1-77Q1	.	.	.
	7/19-20	4.5-7.5	7.5-9.5	76Q2-77Q2	.	.	.
	11/20	4.5-6.5	7.5-10.5	76Q3-77Q3	.	.	.
1977	1/17-18	4.5-6.5	7.0-10.0	76Q4-77Q4	.	.	.
	4/19	4.5-6.5	7.0-9.5	77Q1-78Q1	.	.	.
	7/19	4.0-6.5	7.0-9.5	77Q2-78Q2	.	.	.
	10/17-18	4.0-6.5	6.5-9.0	77Q3-78Q3	.	.	.
1978	2/28	4.0-6.5	6.5-9.0	77Q4-78Q4	.	.	.
	4/18	4.0-6.5	6.5-9.0	78Q1-79Q1	.	.	.
	7/18	4.0-6.5	6.5-9.0	78Q2-79Q2	.	.	.
	10/17	2.0-6.0	6.5-9.0	78Q3-79Q3	.	.	.
1979	2/6	1.5-4.5	5.0-8.0	78Q4-79Q4	.	.	.
	7/11	1.5-4.5	5.0-8.0	78Q4-79Q4	1.5-4.5	5.0-8.0	79Q4-80Q4
1980	2/4-5	3.5-6.0[1]	6.0-9.0	79Q4-80Q4	.	.	.
	7/9	3.5-6.0	6.0-9.0	79Q4-80Q4	3.0-5.5	N.A.	80Q4-81Q4
1981	2/2	3.5-6.0[2]	6.0-9.0	80Q4-81Q4	.	.	.
	7/6-7[3]	3.5-6.0	6.0-9.0	80Q4-81Q4	2.5-5.5	6.0-9.0	81Q4-82Q4
1982	2/1-2	2.5-5.5	6.0-9.0	81Q4-82Q4	.	.	.
	7/1[4]	2.5-5.5	6.0-9.0	81Q4-82Q4	2.5-5.5	6.0-9.0	82Q4-83Q4
1983	2/8-9	4.0-8.0	7.0-10.0	82Q4-83Q4[5]	.	.	
	7/12-13	5.0-9.0	7.0-10.0	82Q4-83Q4[6]	4.0-8.0	6.5-9.5	83Q4-84Q4
1984	1/30-1[7]	4.0-8.0	6.0-9.0	83Q4-84Q4	.	.	
	7/16-17	4.0-8.0	6.0-9.0	83Q4-84Q4	4.0-7.0	6.0-8.5	84Q4-85Q4
1985	2/12-13[8]	4.0-7.0	6.0-9.0	84Q4-85Q4	.	.	.
	7/9-10	3.0-8.0	6.0-9.0	84Q4-85Q4[9]	4.0-7.0	6.0-9.0	85Q4-86Q4
1986	2/11-12	3.0-8.0	6.0-9.0	85Q4-86Q4	.	.	.
	7/8-9[10]	3.0-8.0	6.0-9.0	85Q4-86Q4	3.0-8.0	5.5-8.5	86Q4-87Q4
1987	2/10-11	N.A.	5.5-8.5	86Q4-87Q4	.	.	
	7/7[11]	N.A.	5.5-8.5	86Q4-87Q4	N.A.	5.0-8.0	87Q4-88Q4
1988	2/9-10	N.A.	4.0-8.0	87Q4-88Q4		.	.
	6/29-7/30	N.A.	4.0-8.0	87Q4-88Q4	N.A.	3.0-7.0	88Q4-89Q4
1989	2/7-8	N.A.	3.0-7.0	88Q4-89Q4	.	.	
	7/5-6	N.A.	3.0-7.0	88Q4-89Q4	N.A.	3.0-7.0	89Q4-90Q4

Table 1 continued

Year	Month/Day of FMOC Meeting	Ranges for Current Year			Preliminary Ranges for Following Year		
		M1	M2	Period	M1	M2	Period
1990	2/6-7	N.A.	3.0-7.0	89Q4-90Q4	.	.	.
	7/2-3	N.A.	3.0-7.0	89Q4-90Q4	N.A.	2.5-6.5	90Q4-91Q4
1991	2/5-6	N.A.	2.5-6.5	90Q4-91Q4	.	.	.
	7/2-3	N.A.	2.5-6.5	90Q4-91Q4	N.A.	2.5-6.5	91Q4-92Q4
1992	2/4-5	N.A.	2.5-6.5	91Q4-92Q4	.	.	.
	6/30-7/1	N.A.	2.5-6.5	91Q4-92Q4	N.A.	2.5-6.5	92Q4-93Q4
1993	2/2-3	N.A.	2.0-6.0	92Q4-93Q4	.	.	.
	7/6-7	N.A.	1.0-5.0	92Q4-93Q4	N.A.	N.A.	.

NOTES:

[1]The target is for M1-A.

[2]The target is for M1-B.

[3]The FMOC announced at the July meeting that growth in M1-B near the end of its range would be "acceptable and desirable."

[4]The FMOC stated at the July 1 meeting that growth of the monetary aggregates "around the top of the indicated ranges would be acceptable in light of the relatively low base period for the M1 target and other factors, and that it would tolerate for some period of time growth somewhat above the target range should unusual precautionary demands form money and liquidity be evident in light of current economic uncertainties."

[5]A February-March base period was established for M2.

[6]A second quarter of 1983 base period was established for M1.

[7]The FMOC stated at the January meeting that M1 would be given less weight than the broader aggregates due to changes in the M1 velocity and changed composition of M1.

[8]The FMOC agreed that "growth in the monetary aggregates in the upper part of their ranges for 1985 may be appropriate..."

[9]A second quarter of 1985 base period was established for M1.

[10]Although the M1 range was not formally altered, the FMOC stated that they would allow money growth to exceed the upper bound.

[11]The FMOC "agreed that growth in these [the M2] aggregates around the lower ends of their ranges might be appropriate, depending on the circumstances.

SOURCE: *Federal Reserve Bulletin*

Table 2

Regression Results for
Money Growth Expectation Equations

$$\dot{m}^{e}_{t,t+i} = a + \beta \cdot \dot{m}^{T}_{t,t+i} + c \cdot \dot{m}_{t} + d \cdot \dot{m}_{t-1} + e \cdot DEF_{t} + u_{t} \qquad i = 1,2$$

Sample: 1978:Q2-1993:Q2

#	a	β	c	d	e	D-W	Q(15)	$\bar{R}^2$
			A. 1-Quarter Forecast Horizon (i=1)					
1.	.066 (25.05)[a]	-.198 (5.33)[a]	—	—	—	.66	67.0[a]	.20
2.	.034 (11.31)[a]	-.015 (0.50)	.400 (12.11)[a]	—	—	1.32	20.8	.75
3.	.026 (8.45)[a]	.024 (0.84)	.358 (12.57)[a]	.141 (4.97)[a]	—	1.46	17.4	.81
4.	.022 (6.40)[a]	.020 (0.77)	.348 (11.21)[a]	.134 (4.75)[a]	.150 (1.80)[c]	1.50	14.7	.82
			B. 2-Quarter Forecast Horizon (i=2)					
1.	.067 (16.74)[a]	-.202 (2.91)[a]	—	—	—	.55	84.6[a]	.11
2.	.033 (10.24)[a]	.084 (2.02)[b]	.352 (10.42)[a]	—	—	1.48	26.1[b]	.72
3.	.024 (8.56)[a]	.142 (4.05)[a]	.307 (14.56)[a]	.145 (6.28)[a]	—	1.60	16.6	.83
4.	.020 (7.30)[a]	.126 (4.75)[a]	.293 (11.31)[a]	.136 (6.41)[a]	.172 (2.32)[b]	1.64	16.0	.84

NOTES: $\dot{m}^{e}_{t,t+i}$ is the mean forecast of money growth over the next i quarters from the *Report*; $\dot{m}^{T}_{t,t+i}$ is money growth over the next i quarters assuming that the money stock converges to the midpoint of the target range by years end; $\dot{m}_{t}$ and $\dot{m}_{t-1}$ are contemporaneous and lagged money growth; DEF_{t} is the ratio of the federal deficit to gross domestic product.

Significance at the one, five and ten percent levels given by a, b and c respectively.

Table 3

Regressions to Explain Time-Varying Credibility

$$\dot{m}^{e}_{t,t+i} = a + \beta\cdot\dot{m}^{T}_{t,t+i} + c\cdot\dot{m}_{t} + d\cdot\dot{m}_{t-1} + e\cdot DEF_{t}$$
$$+ f\cdot M1_{t}\cdot\dot{m}^{T}_{t,t+i} + g\cdot\dot{X}_{t}\cdot m^{T}_{t,t+i} + u_{t} \qquad i = 1,2$$

Sample: 1978:Q2-1993:Q2

X_t	β	c	d	e	f	g	D-W	Q(15)	$\bar{R}^2$
			A. 1-Quarter Forecast Horizon (i=1)						
	.004 (.11)	.346 (11.40)[a]	.131 (4.76)[a]	.171 (2.08)[b]	.025 (.61)	——	1.52	13.8	.82
7982_t	.009 (0.26)	.345 (11.42)[a]	.135 (4.36)[a]	.174 (2.06)[b]	.013 (0.31)	.032 (0.41)	1.49	14.7	.82
DEF_t	.139 (2.32)[b]	.346 (12.56)[a]	.136 (5.12)[a]	.282 (3.22)[a]	.032 (0.91)	-3.334 (2.32)[b]	1.55	15.9	.83
$DEVSUM_t$	.045 (1.23)	.346 (12.74)[a]	.148 (5.05)[a]	.185 (2.32)[b]	.078 (1.83)[c]	-.623 (2.51)[b]	1.54	16.0	.83
			B. 2-Quarter Forecast Horizon (i=2)						
	.097 (3.28)[a]	.291 (11.34)[a]	.129 (6.16)[a]	.226 (3.02)[a]	.072 (2.11)[b]	——	1.69	10.1	.85
7982_t	.103 (3.49)[a]	.291 (11.27)[a]	.133 (6.12)[a]	.227 (3.02)[a]	.053 (1.38)	.042 (0.72)	1.66	10.6	.85
DEF_t	.233 (2.94)[a]	.291 (12.22)[a]	.132 (6.30)[a]	.351 (4.04)[a]	.073 (2.39)[b]	-3.366 (1.67)[c]	1.66	11.0	.85
$DEVSUM_t$	.139 (4.05)[a]	.294 (11.62)[a]	.143 (6.48)[a]	.244 (3.48)[a]	.114 (2.87)[a]	-.636 (2.11)[b]	1.69	10.9	.85

NOTES: $M1_t$ is a dummy variable that takes on values of one when the *Report* group is forecasting M1 and zero otherwise. X_t is one of three different variables: 7982_t is a dummy variable that takes on values of one for the quarters 1979:Q4 to 1982:Q3 and zero otherwise; $DEVSUM_t$ is the absolute value of the four quarter summation of the percentage deviations of the money stock from annual target levels; and DEF_t is the ratio of the federal deficit to real gross domestic product. All other variables are described in the notes to Table 2.

Significance at the one, five and ten percent levels given by a, b and c respectively.

FIGURE 1

M1 Deviations from Annual Target Midpoints

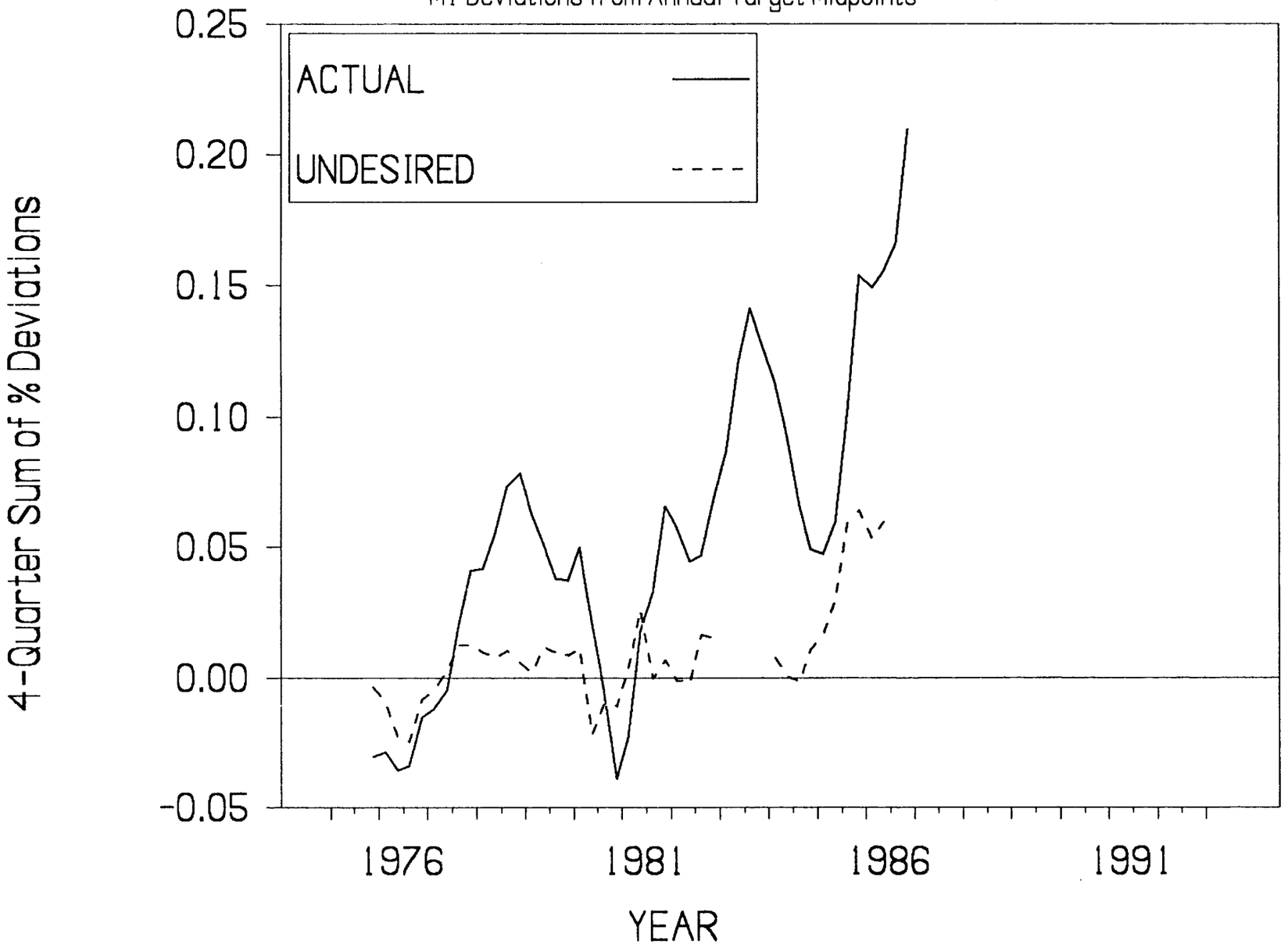


FIGURE 2

M2 Deviations from Annual Target Midpoints

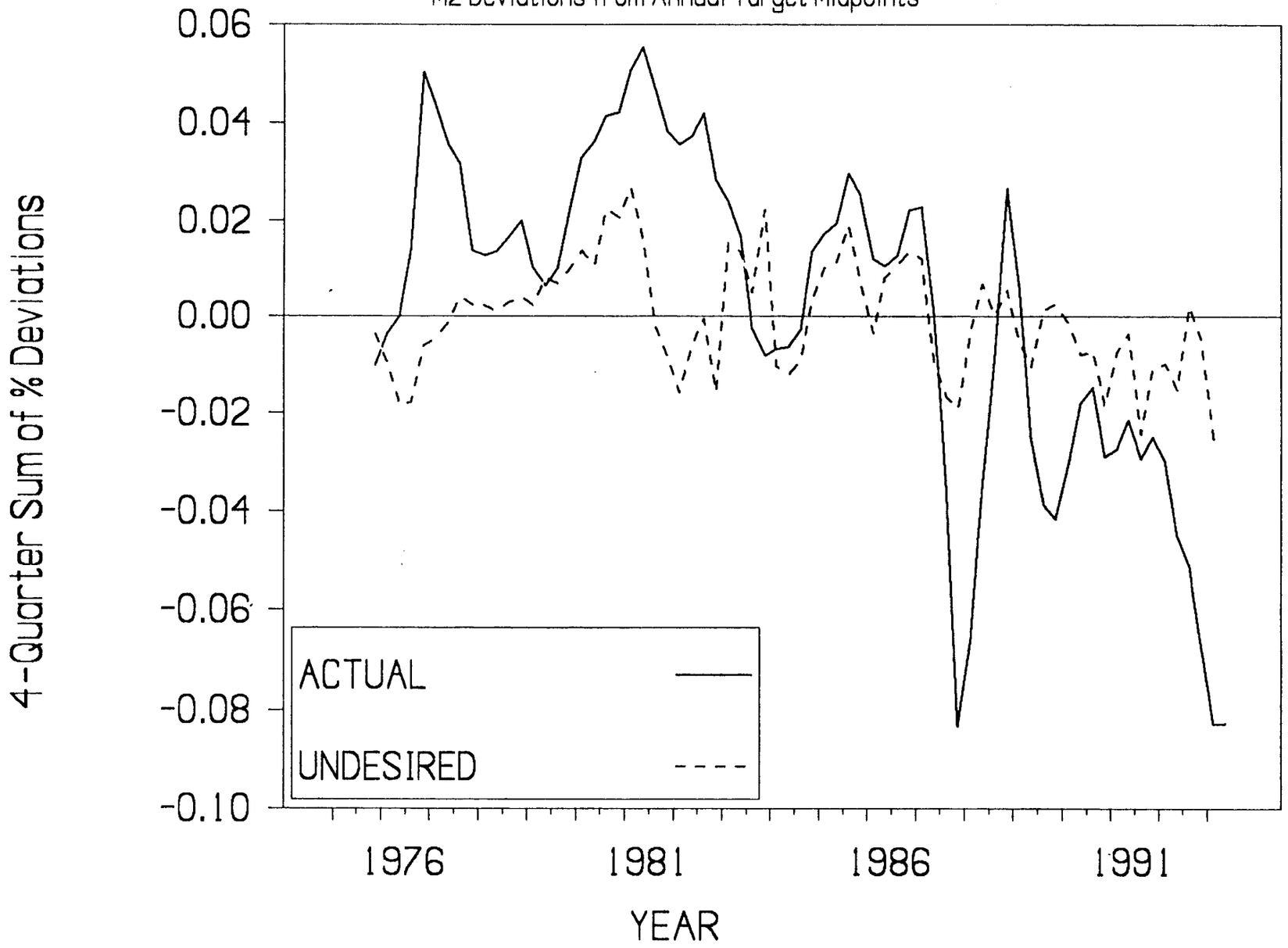


Figure 3
Deviations of Money Stock from Targets

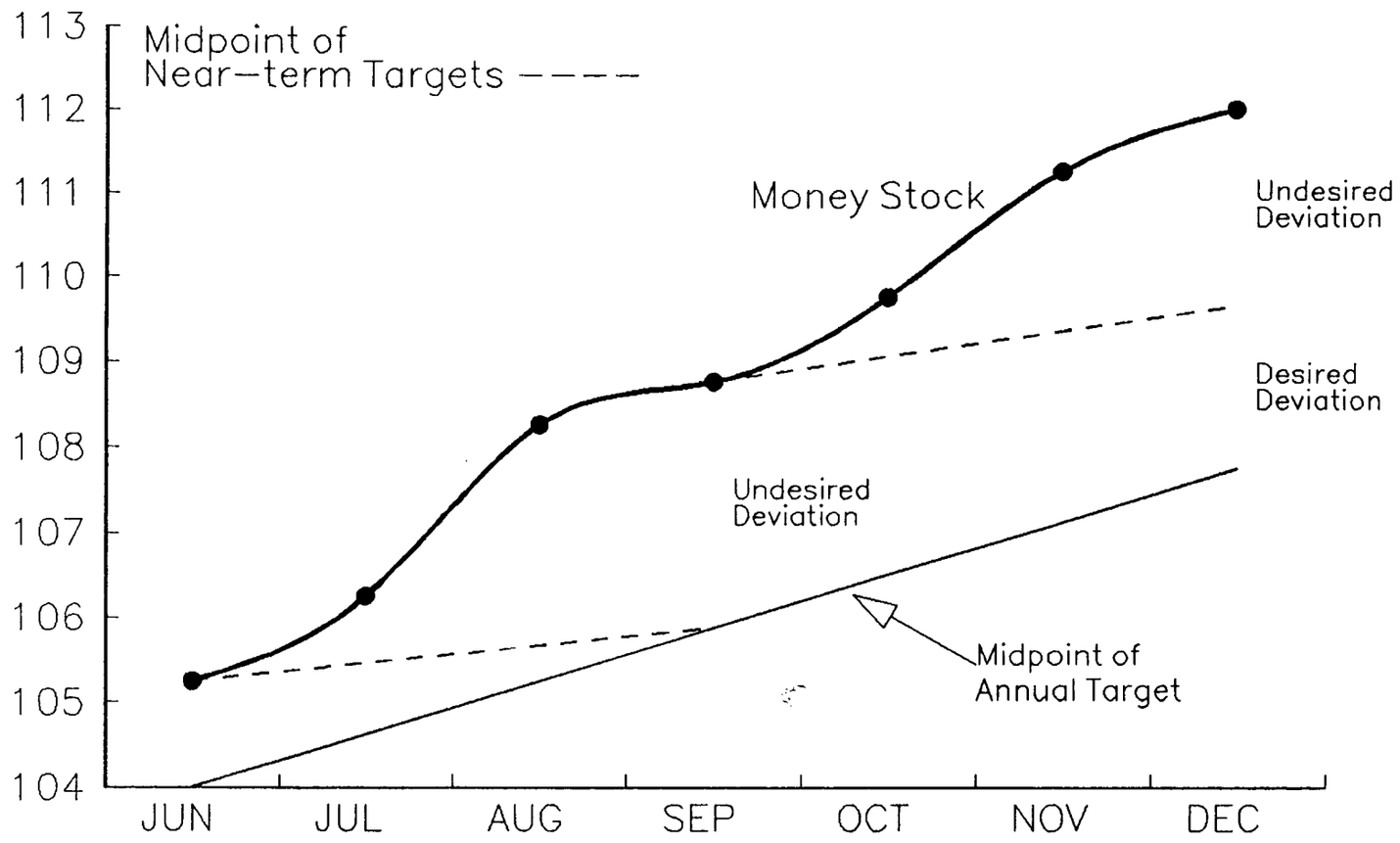


FIGURE 4

Money Growth Forecasts from the REPORT

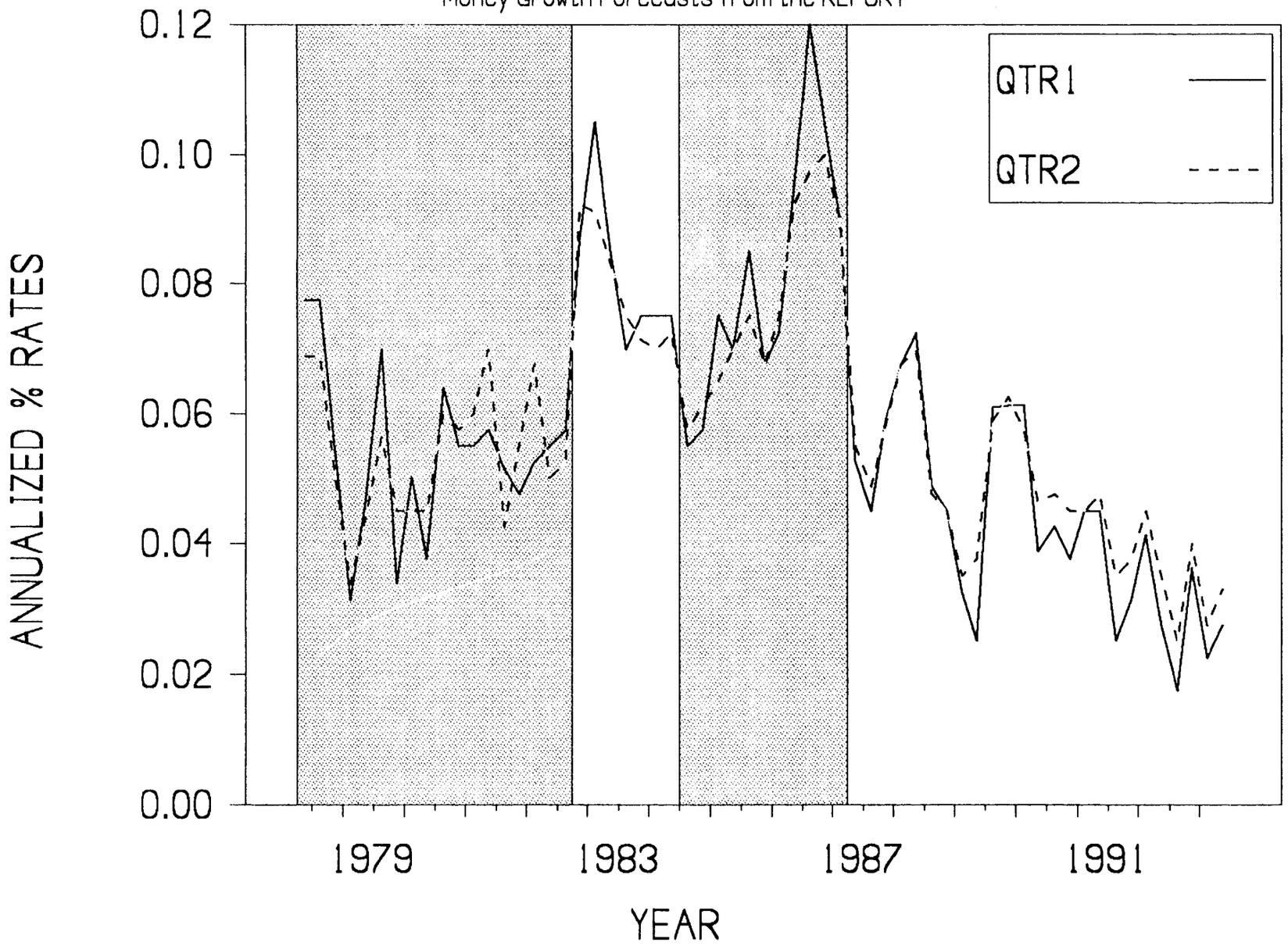


Figure 5

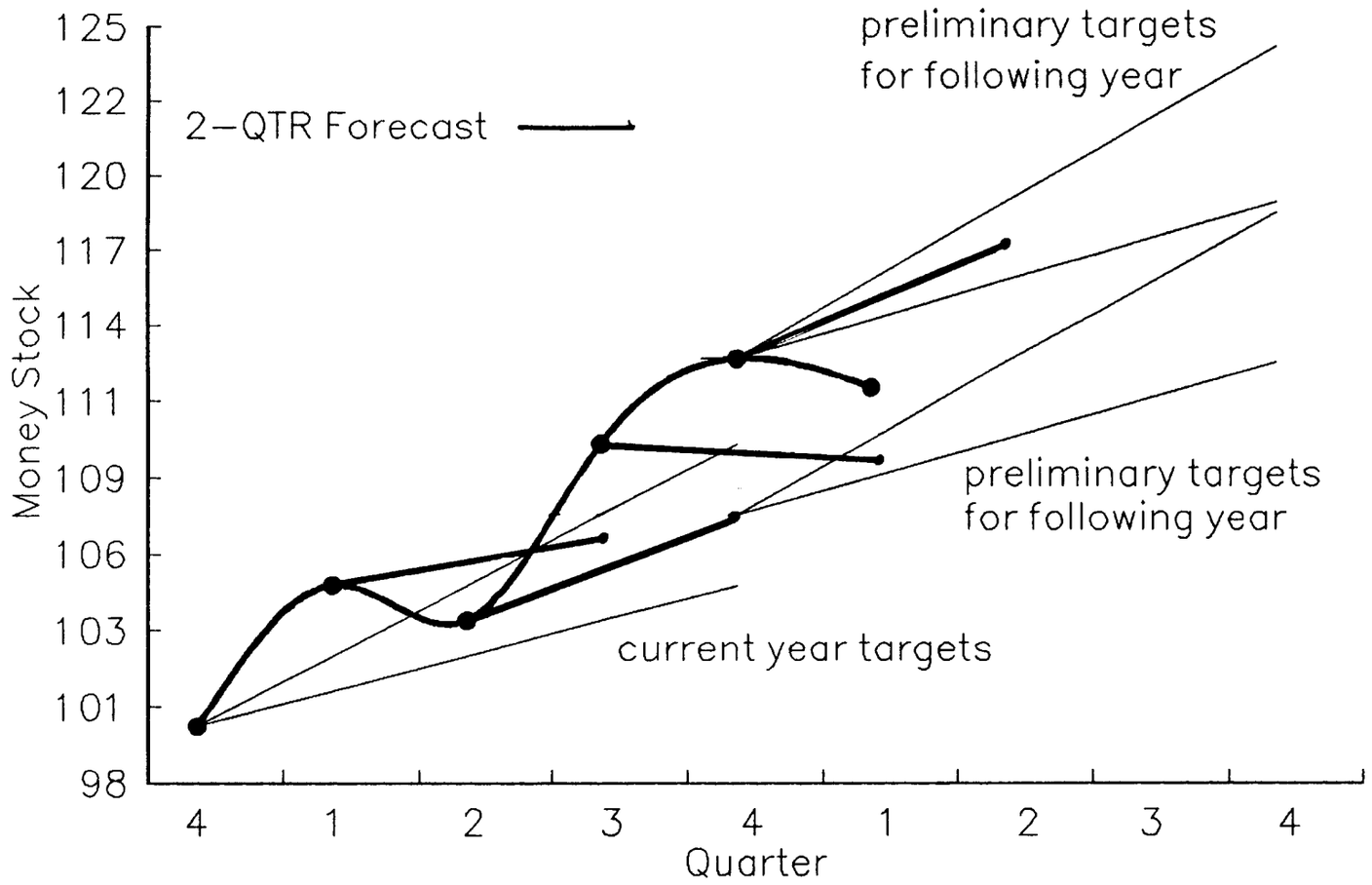

125
122
120
117
114
111
109
106
103
101
98
Money Stock
2–QTR Forecast
preliminary targets
for following year
preliminary targets
for following year
current year targets
4
1
2
3
4
1
2
3
4
Quarter

FIGURE 6

Kalman Filter Estimates of Coefficients & 95% Confidence Intervals for Money Growth Expectation Models:

1-Quarter Forecast Horizon

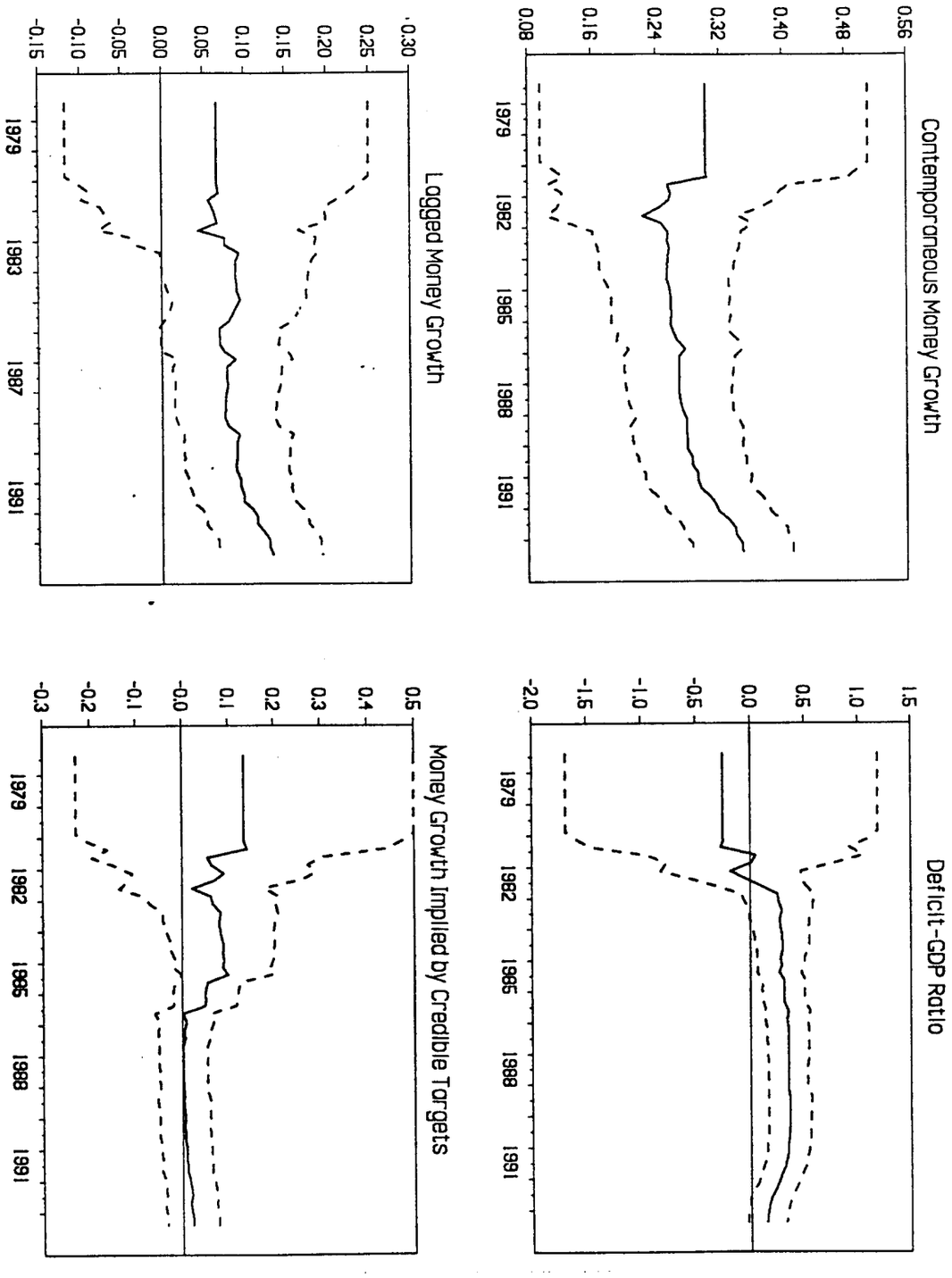


FIGURE 7

Kalman Filter Estimates of Coefficients & 95% Confidence Intervals for Money Growth Expectation Models:

2-Quarter Forecast Horizon

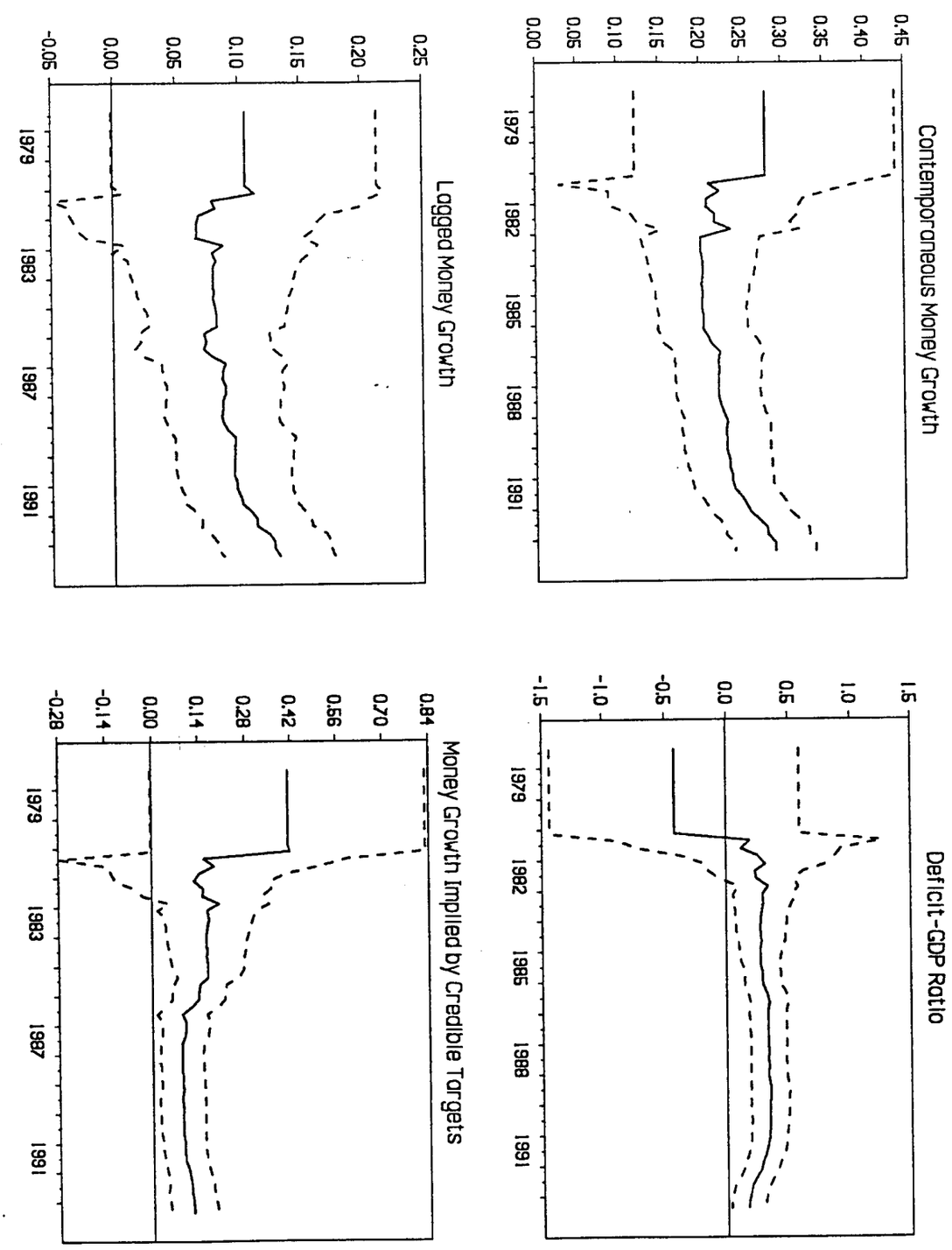
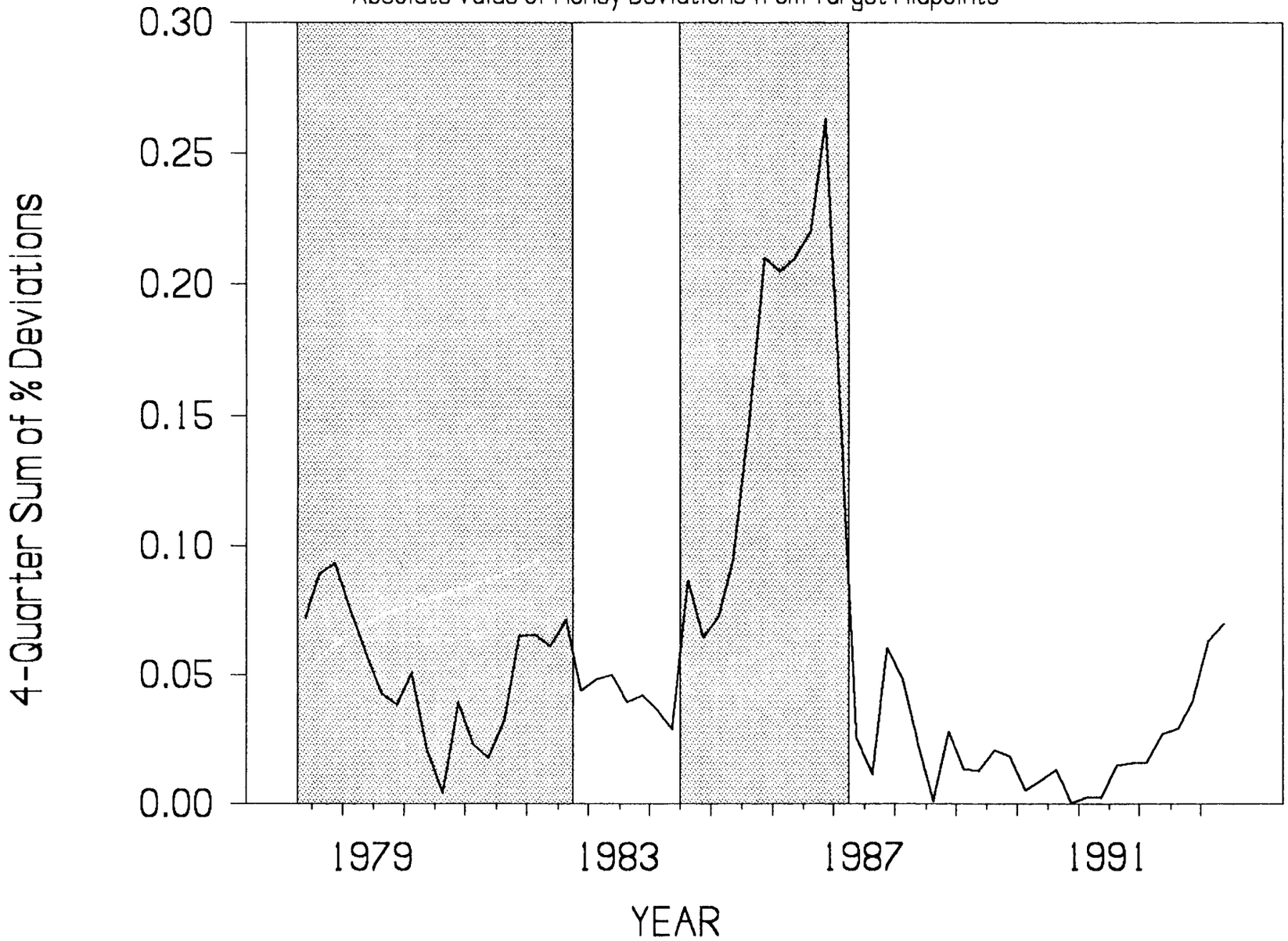


FIGURE 8

Absolute Value of Money Deviations from Target Midpoints



Endnotes

[1]Bernanke and Mishkin (1992) discuss the historical experience with monetary targeting in several countries including the U.S. The argue that not only do monetary targets provide an important signal to the public, but they also help to insulate central banks from political pressure to pursue more expansionary policies.

[2]This idea has a long history in economics, dating back at least to Irving Fisher (1925). For a more recent discussion of this issue, see Leijonhufvud (1985). The theoretical link between monetary target credibility and price level uncertainty is modeled by Ireland (1993).

[3]To guard against this possibility, Hardouvelis and Barnhart also examine the response of a short-term interest rate to unanticipated growth in the money supply. As long as money surprises have a positive and significant impact on nominal interest rates, money surprises have not lost their information content and the commodity price responses contain information about the credibility of Federal Reserve policy. Although Hardouvelis and Barnhart find a significant positive relationship between interest rates and money surprises for most of their sample, the relationship begins to deteriorate in 1983 and 1984 thus suggesting a gradual loss in the information content of M1 announcements.

[4]The Federal Reserve began using quarterly averages of the money stock rather than monthly averages beginning in July of 1975. This was done in recognition of the fact that monthly fluctuations were excessively volatile.

[5]In addition, the Humphrey-Hawkins Act required the Federal Reserve to explain deviations from the targets to Congress. This measure was intended to make the Federal Reserve accountable for movements in the money supply.

[6]In the face of persistent and unexpected changes in velocity, the cost associated with bringing the money stock back into the target ranges rises. Thus Base drift and persistent deviations of the money stock from its target level may be the desired policy in the face of unexpected changes in velocity. See Walsh (1986) for a discussion of this issue.

[7]For the period prior to October 1979 when the FMOC set near-term targets with one month horizons, we use the money stock for the second month of the quarter and apply the near-term target to it to get the desired deviation at the end of the quarter.

[8]The minutes from the FMOC meetings during 1986 suggest that the large money stock deviations were due to both desired and undesired sources. For example, at the July meeting the FMOC acknowledged that changes in M1 velocity forced them to let M1 money growth exceed the target levels:

> Because of the substantial uncertainties surrounding the behavior of M1 in relation to economic activity and prices and the substantial decline in velocity in the first half of the year, the Committee decided that M1 growth in excess of the previously established 3 to 8 percent range would be acceptable for the year.

However, the issue of controlability rises at the August 19 meeting:

> ...growth in M1 was expected to moderate from the exceptionally large increase during the second quarter. With the prospective behavior of M1 remaining subject to unusual uncertainty, the Committee again decided not to specify a rate of expected growth in the operational paragraph of the directive...

[9]Formally known as *The Goldsmith-Nagan Bond and Money Market Letter.*

[10]The *Report* usually mails the surveys on the second or third Friday of the last month of the quarter. Most surveys are returned and the mean forecasts published within two weeks after the surveys are distributed.

[11]The group forecasts M1-A growth during 1980 and M1-B growth during 1981.

[12]For example, the group stopped forecasting M1 and began forecasting M2 during the fourth quarter of 1982 following Federal Reserve Chairman Volker's October 1982 announcement that the M1 target was no longer in effect.

[13]For example, see Froot (1989) and Ferderer and Shadbegian (1993). The latter paper show that term premia estimated using interest rate forecasts from the *Report* are more sensitive to changes in market risk than are term premia estimated using other measures of expectations.

[14]This involves using the ROBUSTERRORS option in the RATS LINREG command with LAGS set equal to 1.

[15]Contemporaneous money growth is measured using the projected money growth over the quarter provided by the *Report*. We use this measure rather than actual money growth because the latter is not known by the group when they make their forecasts.

[16]See Blackburn and Christensen (1989) for a good discussion of these factors.

[17]For this reason, Friedman (1988, p. 65) concludes that "After mid-1982 there was no reason for anyone to find the Federal Reserve's commitment to its stated money growth targets credible."

[18]In particular, they discuss the work of Sargent (1981) and Baxter (1985). Sargent argues that the severe hyperinflations in Austria, Germany, Hungary and Poland in the 1920s were brought to an end with small real costs because the regime put in place to eliminate the inflation was credible. This credibility was achieved by: i) a return to the gold standard; ii) the establishment of independent central banks, and iii) government commitments to balance their budgets. Baxter focuses on the anti-inflation policy reforms undertaken in Argentina and Chile in the late 1970s. To measure the credibility of these reforms, she uses a Bayesian approach to measure the public's subjective probability that the reforms would be maintained. The results suggest that the government in Argentina was not able to maintain credibility because they undertook actions that were inconsistent with the new regime. That is, unscheduled devaluations and large government deficits.

[19]Figures 6 and 7 indicate that coefficients on all explanatory variables in (4) are time-varying and this finding suggests that X_t should be interacted with each of these variables. However, this approach is not practical given the limited number of available observations.

[20]In contrast to Figures 1 and 2, the series used to construct the one show in Figure 8 are estimated using the quarterly average of the money stocks rather than the money stock in the last money of each quarter. The latter approach was used earlier in the paper so that we could compare near-term and annual targets. However, since the third quarter of 1975 the Federal Reserve has specified that the annual targets apply to quarter-over-quarter growth.

[21]The fact that we used the 1978:Q2 to 1980:Q4 sample to initialize the Kalman filter estimates makes it difficult to evaluate the evolution of credibility prior to 1981 in Figure 7. However, if the β coefficient followed a smooth path over the initialization period, a path that connects the initialization period coefficient at 1979:Q3 and the Kalman filter value observed in 1981:Q1, its average value over the 1979:Q4 to 1982:3 period is not much different from the full sample average.