ARE PRELIMINARY ANNOUNCEMENTS OF THE MONEY STOCK RATIONAL FORECASTS?*

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We develop a theoretical framework of analyzing preliminary announcements of economic data and then apply this framework to the money stock. We find that preliminary announcements of the money stock are best characterized as measured with classical errors-in-variables. That is, the revision is not correlated with the true value of the series. The revision is, however, forecastable using information available at the time of the preliminary announcement. Our ability to forecast the revision implies that preliminary announcements are not rational estimates of the true money stock.

1. Introduction

Economic policy-makers, market participants, and econometricians must often make decisions or inferences based on preliminary or incomplete data. Each agent faces a problem of judging the informational content of preliminary announcements. In this paper, we develop a framework for analyzing preliminary announcements of economic data and apply it to the money stock.

We consider two mutually exclusive hypotheses regarding the preliminary announcement. The first hypothesis is that the preliminary announcement is simply the true variable measured with error (classical errors-in-variables). In this case, the preliminary announcement is an unconditionally unbiased but irrational forecast of the true value. That is, the revision is correlated with known variables. In particular, it is correlated with the preliminary announcement itself. The second hypothesis is that the preliminary announcement is a rational forecast of the true variable. In this case, the revision is a rational

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forecast error and is therefore uncorrelated with known information. We show how to test these two hypotheses using the series of preliminary announcements and final revisions.

We also show how to construct a rational forecast of the true variable when the preliminary announcement is not itself a rational forecast. The optimal forecast is a weighted average of the preliminary announcement and of the other known variables, if any, that determine the true variable. The greater the variance of the measurement error, the more the preliminary announcement is discounted.

Section 2 presents the theoretical framework. Section 3 discusses the implementation of the framework for data on the money stock. Section 4 gives the results of the tests. Section 5 discusses the implications of our findings for other research. Section 6 offers some concluding observations.

2. Theoretical framework

Many economic time series are subject to revision at both regular and irregular intervals. We discuss four concepts for studying the revision of a time series, \( x_t \). They are summarized in table 1. We denote the true value of the series as \( x_t^* \). Presumably, economic policy-makers seek to affect the true value rather than the announced value per se. The true value, however, is not observable until some later date.

The original measurement of \( x_t^* \) at time \( t \) is denoted \( x_t^0 \). The measurement \( x_t^0 \) is typically a weighted average of raw data provided by private agents. In the case of the money stock, it is an aggregation of reports provided by financial institutions and of an estimate of the currency stock. We assume that the variable \( x_t^0 \) is equal to the true value plus an error term. Thus the data collector observes

\[
x_t^0 = x_t^* + u_t,
\]

(1)

<table>
<thead>
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<th>Table 1</th>
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<td>Definitions of variables</td>
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| \( x_t^* \) | True value of \( x \) at time \( t \) |
| \( x_t^0 \) | Value of \( x \) at time \( t \) as measured at time \( t \) |
| \( x_t^? \) | Value of \( x \) at time \( t \) as announced at time \( t \) |
| \( x_t^f \) | Optimal forecast at time \( t \) of \( x_t^* \) |
| \( v_t \) | The measurement error \( x_t^* - x_t^0 \) (the noise) |
| \( e_t \) | The disturbance in the structural equation (2) for \( x_t^* \) (the signal) |
| \( w^2 \) | The variance of \( v_t \) |
| \( s^2 \) | The variance of \( e_t \) |
The only restrictions we place on $e_t$ are that it have zero mean and that it be uncorrelated with the true value $x_t^*$.\(^1\)

The data collector makes a preliminary announcement concerning $x_t^*$ at time $t$. Denote the preliminary announcement as $x_t^p$. The preliminary announcement may or may not equal $x_t^o$. That is, the data collection agency might just announce the raw data, or it might attempt to provide a better estimate of the true value, $x_t^*$. Let $x_t^f$ denote the optimal (minimum variance) forecast of $x_t^*$. The forecast is made conditional on information available at time $t$. The information includes, in particular, the preliminary announcement, $x_t^p$.

Suppose that the true structural model of the variable is

$$x_t^* = W_t a + e_t,$$ \hspace{1cm} (2)

where $a$ is a vector of parameters and $W_t$ is in the set of information available at time $t$. In practice, the true specification of eq. (2) is not known with certainty. Incorrect specification of the structure does not invalidate our results because they do not depend on the structural interpretation of (2). Abel and Mishkin (1983) show that rationality tests such as ours only require that $W_t$ is a subset of the full set of relevant information.

We consider and test two hypotheses about the preliminary announcements, $x_t^o$ and $x_t^p$. Since $x_t^o$ is unobservable by the econometrician, the tests are indirect. Of course, if $x_t^o$ and $x_t^p$ were known to be equal, no test would be needed.

2.1. Hypothesis 1: Classical errors-in-variables

Suppose that the data collection agency does announce the measured data, so

$$x_t^p = x_t^o.$$ 

The revision, $x_t^* - x_t^p$, is then uncorrelated with the true value $x_t^*$. Suppose we estimate a regression of the form

$$x_t^p = a_0 + a_1 x_t^*.$$ \hspace{1cm} (3)

It is straightforward to show that, under Hypothesis 1, $E\hat{a}_0 = 0$ and $E\hat{a}_1 = 1$. Under departures from Hypothesis 1, $\hat{a}_1$ will in general diverge from 1. Acceptance of Hypothesis 1 implies that preliminary announcements can be considered an example of the errors-in-variables problem.

\(^1\)This restriction is reasonable. For example, suppose a data collector is estimating the sum of two identically (though not necessarily independently) distributed random variables. He might sample one of these random variables and then double it to correct for sample size. The error in his estimate would be uncorrelated with the true value.
If Hypothesis 1 is correct, the preliminary announcement, $x^p_t = x^*_t$, is a conditionally biased forecast of the true value $x^*_t$. Note that the measured data are an unconditionally unbiased forecast of the true value. That is,

$$E(x^o_t) = E(x^*_t).$$

As becomes clear below, however, this forecast is biased conditional on other information available at time $t$. In particular, $E(x^*_t | x^o_t)$ is not equal to $x^o_t$. Therefore, $x^*_t$ is not a rational forecast of $x^*_t$.

2.2. Constructing an optimal forecast

Define the optimal linear forecast of $x^*_t$ given the information $(x^o_t, W_t)$ to be

$$x^f_t = \hat{b}_1 x^o_t + W_t \hat{b}_2. \tag{4}$$

The values of $\hat{b}_1$ and $\hat{b}_2$ are found by applying least squares to the equation

$$x^*_t = b_1 x^o_t + W_t b_2, \tag{5}$$

over a period of which $x^*_t$ is known. The data collection agency, which knows $x^o_t$, could estimate the equation; the econometrician could estimate it under the maintained hypothesis that the preliminary announcement $x^p_t$ equals $x^o_t$ (Hypothesis 1). Both $x^o_t$ and $W_t$ are imperfect indicators of $x^*_t$, which is unobservable at time $t$. Because in general they are not perfectly correlated, each is of use in forecasting $x^*_t$.

Least squares picks the optimal weights $\hat{b}_1$ and $\hat{b}_2$. The estimated coefficients have expectations

$$E\hat{b}_1 = s^2/(s^2 + w^2),$$

and

$$E\hat{b}_2 = a\left[1 - s^2/(s^2 + w^2)\right],$$

where $a$ is the regression coefficient in (2), $s^2$ is the variance of $e$, and $w^2$ is the variance of $e$. The quantity $s^2/(s^2 + w^2)$ is a well-known function of the signal-to-noise ratio. (The signal is the part of $x^*$ orthogonal to $W$. If $x^*$ has a constant expectation, then $s^2$ is just its variance.)

The optimal forecast is a weighted average of the original measurement $x^o_t$ and the conditional mean, $W_t a$, of the variable being measured. In other words, the optimal forecast exhibits the well-known property of regression toward the mean. The signal-to-noise ratio determines the weights. The greater the variance of the measurement error $v$, the less weight should be put on $x^o_t$. 
and the more weight should be put on other observable data. It is optimal to give a weight of one on the preliminary observation only if there is no measurement error.

2.3. Hypothesis 2: The preliminary announcement as a rational forecast

Suppose that instead of simply announcing the measured data \( x_t^o \), the data collection agency optimally adjusts the data so that

\[
x_t^p = x_t^f.
\]

That is, the agency announces the best estimate of \( x_t^* \) conditional on the information set \( \{ W_t, x_t^o \} \). Consider the results of estimating

\[
x_t^* = b_1 x_t^p + W_t b_2
\]

under Hypothesis 2. It is straightforward to verify that if \( x_t^p = x_t^f \), then \( E b_1 = 1 \) and \( E b_2 = 0 \). These restrictions imply that the revision, \( x_t^* - x_t^p \), is orthogonal to the information set \( \{ W_t, x_t^p \} \). Such restrictions are familiar from rational expectations modeling. The test of Hypothesis 2 is a test for the rationality of \( x_t^p \) as a forecast of \( x_t^* \).

Note that Hypothesis 1 and Hypothesis 2 are mutually exclusive. If the agency announces \( x_t^o \), the revision, which then equals the measurement error, is uncorrelated with the true value and correlated with the preliminary announcement. If, on the other hand, \( x_t^f \) is announced, the revision is a rational forecast error. It is therefore correlated with the true value but uncorrelated with the preliminary announcement. Moreover, it is straightforward to show that the two hypotheses also have opposite implications for the relative variances of the two observable series. Hypothesis 1 implies that \( \text{var}(x_t^p) > \text{var}(x_t^*) \), while Hypothesis 2 implies that \( \text{var}(x_t^p) < \text{var}(x_t^*) \).

3. Empirical implementation

We apply the above framework to data on growth of \( M1 \). The data are quarterly, not seasonally adjusted, for 1954 through 1978. We proceed as if there will be no further revision of the data. That is, we take the finally revised data to be the 'true' values.

The Fed revises the money stock figures for two different reasons. The first reason for the revisions is that it receives additional data on the money stock and corrects computational and reporting errors. The Fed has current information on demand deposits and vault cash for all member banks, but does not have similar data for non-member banks. The deposits and cash of those banks
are estimated on the basis of infrequent reports. The data from these reports are processed irregularly, with a lag of up to a year. The lack of accurate information on the liabilities of non-member banks is a source of persistence in the errors of the estimate of the money stock.

The second reason for the revisions is that the Fed occasionally changes the definition of a particular money measure. Many of the important revisions in the definition of M1 apply only after 1978 and are therefore outside of our sample. Moreover, studying the rate of money growth rather than the level of the money stock should reduce the problem caused by redefinitions. Although a definitional change would show up as a persistent error in the money stock, it need not show up as an error in the rate of money growth. Define the preliminary announcement of the rate of money growth, \( z_t \), in terms of the stock, \( x_t \), to be

\[
z_t^p = 100 \log \left( \frac{x_t^p}{x_{t-1}^p} \right),
\]

where the leading subscript indicates the time of the announcement. Note that the numerator and denominator are both measured at time \( t \). The redefinition equally applies to the current and lagged observations so the log of the ratio reflects the growth rate of a variable consistently measured across time. Hence, we assume that under the preliminary and revised definitions, money grows at the same rate. Since the new components added to M1 were small relative to the original M1, this assumption is approximately correct. The variables \( z_t^*, z_t^p, z_t^p \), and \( z_t^l \) are defined as in section 2. (See table 1.)

The Federal Reserve Board reports the preliminary money stock in the Federal Reserve Bulletin and in statistical release H.6. We use Boschen and Grossman’s (1982) data on the preliminary announcements, \( x_t^p \), and the first revisions, \( x_{t-1}^p \), of M1. The data on preliminary announcements are the stock at the end of the first month of the quarter. Until 1960, the stock is reported for the last Wednesday of the month. From 1960 to 1965, it is reported for an average of the days in the last two weeks of the month. From 1965 on, it is an average of the days of the last week of the month.4

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2 In the early part of the sample, the estimates were based on semi-annual reports (see Federal Reserve Bulletin, July 1965, p 934) More recently, there have been quarterly reports (see Federal Reserve Bulletin, June 1976, p 23). The estimates of the non-member (mostly small, country) banks’ deposits are based on a combination of trend and seasonal extrapolation and the historical relation between member and non-member banks. The Fed’s choice of weights in this procedure determines whether this part of the money stock behaves as under Hypothesis 1 or 2. Currently, all banks report to the Fed regardless of their membership.

3 See Federal Reserve Bulletin, February 1980, p 111

4 See Federal Reserve Bulletin, October 1960, p. 1104 and July 1965, p. 933 Reportin lags are also longer toward the beginning of our sample. When we perform our tests with data only since 1965, the results are very similar to those using the entire sample.
The 'final' announcement of money growth is \( z_t^* = 100 \log (x_t / x_{t-1}) \)
where \( T \) is April 1983 and where \( x_t \) is the monthly money stock for the first
month of the quarter.

We use two financial variables in constructing a forecast of the final money
growth given available information. They are the average yield on three-month
Treasury bills the month before the money stock announcement and the
percent change of the New York Stock Exchange composite index over the
three months preceding the announcement. An important advantage of these
two variables is that their contemporaneous measurement is precise.

4. Results

Table 2 presents some sample statistics. Two related facts are relevant for
assessing the empirical validity of the hypotheses. First, the variance of the
preliminary announcements \( z_t^p \) is substantially greater than the variance of the
final series \( z_t^* \). Second, the revision, \( z_t^* - z_t^p \), is correlated with the preliminary
announcement, \( z_t^p \), but uncorrelated with the true value \( z_t^* \). Both observations
suggest that the data are consistent with the errors-in-variables hypothesis, but
are inconsistent with the rational forecast hypothesis.

We can formally test the two hypotheses in a regression framework. Under
Hypothesis 1, the revision is uncorrelated with the final series. A regression of
the preliminary announcement on a constant and the final announcement
should obey the restriction that the constant is zero and the coefficient of the
final announcement is one.\(^5\) Consider this regression estimated from 1954:I to
1978:IV:

\[
\begin{align*}
    z_t^p &= 0.068 + 0.957 \; z_t^*, \\
     (0.128) & \quad (0.060)
\end{align*}
\]

\[
D.W. = 2.53, \quad S.E.E. = 1.12, \quad \overline{R}^2 = 0.72.
\]

Standard errors are in parentheses. The \( F \)-test of the joint hypothesis that the
constant term is zero and the coefficient of \( z_t^* \) is one has a marginal signifi-
cance level of 0.758. Therefore, we cannot reject Hypothesis 1, that is, that
\( z_t^p = z_t^* \). The preliminary announcements appear to fit into the standard
errors-in-variables paradigm.

Similarly, under Hypothesis 2, the revision is uncorrelated with the
preliminary announcement. A regression of the final announcement on a constant

\(^5\)Our theory does not require that the error be serially uncorrelated. The serial correlation arises
because the final data are unknown for some time after the preliminary announcement. Thus, the
white-noise restrictions common in rational expectations models do not obtain. When we perform
our regressions with a serial correlation correction, the results are almost identical to those
reported.
Table 2
Quarterly growth of the money stock. Final, preliminary, and revision; sample statistics

<table>
<thead>
<tr>
<th></th>
<th>(z_t^*)</th>
<th>(z_t^p)</th>
<th>(z_t^* - z_t^p)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>1.03</td>
<td>1.05</td>
<td>-0.02</td>
</tr>
<tr>
<td>Variance</td>
<td>3.55</td>
<td>4.50</td>
<td>1.25</td>
</tr>
<tr>
<td>Correlation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>with (z_t^*)</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(z_t^p)</td>
<td>0.85</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>(z_t^* - z_t^p)</td>
<td>0.07</td>
<td>-0.46</td>
<td>1.00</td>
</tr>
</tbody>
</table>

and the preliminary announcement should obey the restriction that the constant is zero and the coefficient on the preliminary announcement is one. The estimated regression is

\[
z_t^* = 0.233 + 0.756 \cdot z_t^p, \\
(0.111) \quad (0.047)
\]

\(D.W. = 2.69, \quad S.E.E. = 1.00, \quad \bar{R}^2 = 0.72.\)

The \(F\)-test of the joint hypothesis that the constant is zero and the coefficient of \(z_t^p\) is one has a marginal significance level of less than 0.001. Thus, we can reject Hypothesis 2, that is, \(z_t^p = z_t^*\). The preliminary announcement is not a rational forecast of the true value.

These two regressions indicate that the preliminary announcements are an example of errors-in-variables. That is, \(z_t^p = z_t^o\). We show in section 2.2 how to construct a rational forecast conditional on \(z_t^o\) and other information \(W_t\). Regression (8) is hence a forecasting equation in which \(W_t\) includes only a constant. The coefficient on \(z_t^p\) is equal to the variance of the signal divided by the variance of the signal plus the variance of the noise. That is, \(b_2 = s^2/(s^2 + w^2)\). (The signal should be understood as the part of \(z_t^*\) not explained by the exogenous variables \(W_t\).) The estimated coefficient is 0.756. Under this simple specification that the conditional expectation of money growth is constant, the signal-to-noise ratio \((s^2/w^2)\) is 3.1.

Table 3 introduces other known variables that might be useful in forecasting the true money stock. For comparison, we reproduce regression (8) in line (a). In line (b), we introduce seasonal dummies and a trend. Including them reduces the residual variance of \(z_t^*\) and therefore reduces the signal-to-noise ratio. The signal-to-noise ratio implied in line (b) is the much lower 0.75. In line (c), we also include the Treasury bill interest rate. It too is strongly significant. The signal-to-noise ratio is further reduced to 0.65. Finally, in line (d), we introduce the rate of return on the stock market. Adding it reduces the signal-to-noise ratio to 0.56. Failure to take into account this extra information
leads the observer mistakenly to attribute too much information (signal) to the preliminary announcement.

Consider the adjusted $R^2$ of the equations. The explanatory power of the forecasts constructed with the extra information far exceeds the explanatory power of the naive forecast based on the preliminary announcement alone. In particular, the regression reported in line (d) cuts in half the residual variance compared with the naive regression in line (a). The trend and seasonal dummies rather than the financial variables do the most to improve the forecasts.\(^6\)

From these tests, we can conclude that preliminary announcements of the money stock are not rational forecasts. Instead, the preliminary announcements are an example of classical errors-in-variables. For additional confirmation, we examine two other data sets. First, Barro and Hercowitz (1980) provide data on the annual average money stock. Although the signal-to-noise ratio is much greater with annual data, we reach the same qualitative conclusion. Second, we examine the twelve seasonally-adjusted monthly growth rates for 1982 provided by Hafer and Hein (1983). Even these few data points strongly confirm our conclusion. This latter finding demonstrates that recent changes in Fed operating procedure have not altered the fundamental character of preliminary announcements.

5. Implications

Many recent studies use data on preliminary announcements of the money stock. These studies examine a variety of phenomena for diverse purposes. In

\(^6\)We have also constructed out-of-sample forecasts based on rolling regressions. These forecasts also confirm our conclusion that the preliminary announcement is not an efficient estimate of the true value.
this section, we briefly consider several of these studies. We explore the implications of our result that preliminary announcements are not rational forecasts.

5.1. Tests of neutrality

In some models, such as the one King (1981) presents, the inability of private agents to know precisely the contemporaneous money stock plays a central role in the generation of business cycles. In contrast to some earlier models in which only unanticipated money has real effects, in these models, since noisy contemporaneous data are available, only unperceived money has real effects. Our empirical results suggest that the contemporaneous money stock is not known precisely. Indeed, the preliminary announcement of quarterly money growth contains more noise than signal. Although this fact in itself does not confirm these theories, it does confirm that the uncertainty upon which these models are founded is prevalent.

Both Barro and Hercowitz (1980) and Boschen and Grossman (1982) present tests of these models using preliminary money data. The model tested in these papers relates output \((y)\) or a similar variable to unperceived money. In our notation, the model is the following:

\[
y_t = d_0 + d_1 (z_t^* - z_t^1).
\]

(9)

In practice, the authors assume that \(z^*_t = z^1_t\), that is, they assume our Hypothesis 2, which we reject. It is straightforward to show that, under our Hypothesis 1 \(z^*_t = z^1_t\), the procedure used leads to an estimate such that

\[
\text{Ed}_1 = d_1 \left[ s^2 / (s^2 + w^2) \right].
\]

Thus, the estimate of \(d_1\) is biased toward zero. The failure of Barro and Hercowitz (1980) and Boschen and Grossman (1982) to find a significant value of \(d_1\) in (9) is potentially attributable to this bias. Our results thus cast some doubt upon the conclusions reached by these authors.

Boschen and Grossman present a second test. The model (9) implies that output should not be affected by known monetary disturbances. If we regress output on the preliminary announcement, we should obtain a zero coefficient. This test only requires that the preliminary announcement is known informa-

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7 Grossman (1982) provides an illuminating review and discussion.

8 We can in principle correct for the bias once \(s^2\) and \(w^2\) are known. The standard error of the estimate of \(d_1\) is much greater under Hypothesis 1 with the bias correction that it would have been had Hypothesis 2 been correct. It is thus less likely under Hypothesis 1 that an econometrician will find evidence in favor of (9) even if it is the correct model.
tion, not that it is an optimal predictor. Hence, Boschen and Grossman’s rejection of the null hypothesis that this coefficient is zero cannot be explained by an appeal to our results.

5.2. Tests of announcement effects

‘Event studies’ also often use preliminary money data. These papers, which include those of Cornell (1983), Frankel and Hardouvelis (1983) and Shiller, Campbell and Schoenholtz (1983), examine the reaction of some variable, such as an interest rate or a commodity price, to the money stock announcement. The difference between the announced value of the money stock and the expectation based on a market survey is the ‘money surprise’.

How do our results affect these tests of announcement effects? In our framework, we can interpret the money surprise as the change in expectation due to new information. In particular, the surprise is

$$E(x^*_t | x^o_t, W_t) - E(x^*_t | W_t).$$

The second term is the expectation prior to the preliminary announcement. This surprise equals

$$\left[ s^2 / (s^2 + w^2) \right] (v_t + e_t).$$

In practice, these papers use

$$x^p_t - E(x^*_t | W_t)$$

to measure the surprise. Under Hypothesis 1, this expression equals $$(v_t + e_t)$$. Hence, the variable actually used in these papers is proportional to the true money surprise. Because these studies typically stress the sign and significance of the estimated coefficient, rather than its magnitude, their conclusions are not affected by our results.

5.3. Tests of market efficiency

The informational efficiency of asset prices has received much attention. Rozell (1974) surveys the many studies that examine whether stock returns can be forecast using available information on money growth. He concludes that the evidence confirms the efficient markets hypothesis.

Rozell stresses that such tests must use preliminarily announced data rather than revised data. Indeed, our results confirm that the revised money data

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9In the regressions of announcement effects, in contrast to those of neutrality tests, no noise is added to the regressors.
contain much information that is not available to market participants at the time of the preliminary announcements. Tests that use the revised figures are not valid tests of the efficient markets hypothesis.

Rozeff finds that stock prices not only reflect all available information, but also anticipate future money growth. In other words, lagged stock prices contain information on the current money stock independent from data announced by the Fed. This conclusion is consistent with our finding that asset prices help forecast the true money stock.

6. Conclusion

We find that the preliminarily announced rate of money growth is not an efficient predictor of the actual rate of money growth. Preliminary announcements are an example of the classical errors-in-variables problem. The optimal forecast is a weighted average of the preliminary announcement and the conditional mean of the underlying variable. The efficiency of the forecast is increased by conditioning on a larger set of relevant information. We find that a constant, trend, and seasonal dummies are very important in forecasting the true rate of money growth. The interest rate on Treasury bills and an index of stock market value also are helpful in the forecast. When the deterministic and financial variables are used in the forecast, the weight placed on the preliminary announcement is substantially less than fifty percent.

Even were it the goal of policy-makers to stabilize the rate of money growth, they should include other variables than money in their policy rule. Although it is difficult to judge the quantitative significance of this conclusion without an explicit model of monetary control, the additional variables are indicators that should help policy-makers stick to their targets even though measurement error makes the true money growth unobservable. Disregarding the measurement error problem could lead policy-makers to over-react to spurious fluctuations in measured money growth. We do not suggest, however, that data collection agencies should filter their raw figures to make them more like rational forecasts. Rather, policy-makers, market participants, and econometricians should systematically take into account available information to evaluate the content of preliminary announcements.

References


