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Robert J. Barro

Zvi Hercowitz

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Summary

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An important "empirical regularity" is the strong positive effect of money shocks on output and employment. One strand of business cycle theory relates this finding to temporary confusions between absolute and relative price changes. These models predict positive output effects of unperceived monetary movements, but the quantitative importance of unperceived shifts in nominal aggregates is subject to question. Another strand of theory, based on long-term nominal contracts and analogous price-setting institutions, generates output effects from unanticipated, but not necessarily contemporaneously unperceived, money shocks. However, the real effects of unpredicted, but contemporaneously understood, monetary changes are not obviously consistent with efficient institutional arrangements. The present paper provides some empirical evidence on the two types of theories by analyzing the output effects associated with revisions in the money stock data, where the revisions are interpreted as components of unperceived monetary movements. The revisions turn out to have no significant explanatory power for output. Previous findings that innovations from an estimated money growth equation have a significant output effect remain intact when the revisions are included as separate explanatory variables. Overall, the study provides a small amount of evidence against the special role of unperceived, as opposed to unanticipated, money movements as a determinant of business fluctuations.

Economics Department, The University of Rochester, Rochester, NY 14627

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Business cycle theories of the sort constructed by Friedman (1968), Phelps (1970), Lucas (1972, 1973, 1975), and Barro (1976, 1978b) assume that individuals can be temporarily confused between absolute and relative price changes. Monetary surprises have transitory real effects in these models because these disturbances are temporarily misperceived as real shocks. The dependence of these theories on unperceived movements in nominal variables may be a shortcoming. In particular, if more rapid observation of general price indices or money stock measures would substantially lessen the amplitude of business cycles, then it is surprising that this more rapid observation does not take place through a combination of individual information-gathering efforts and improved government reporting. One counter-argument is that individual fortunes may be much more dependent on relative price and income changes than on general business fluctuations. In this circumstance it may not pay for individuals to spend a great deal of effort in assessing contemporaneous movements in global variables except to assist in gaining a clearer view of local changes.

Another argument is that, for example, the existing money stock data provide conceptually inappropriate measures of the pertinent underlying "nominal" disturbances. This view seems to underlie the approach of Sargent and Sims (1977), who model the business cycle as being generated by inherently unobservable shocks. However, this approach does not account for the apparently strong explanatory power of monetary shocks--as measured from standard money stock definitions--for the business cycle, as reported, for example, in Barro (1977a, 1978a).

A different theoretical argument is that purely nominal shocks influence real behavior not because these shocks are contemporaneously unperceived, but rather because these shocks were unpredictable at earlier dates. The imposition of unanticipated, but not necessarily contemporaneously unperceived, money movements on an economy with long-term nominal contracts is viewed as a source of business fluctuations in models constructed by Gray (1976) and Fischer (1977), among others. These models have the strength of relying on unpredictable money movements--which can plausibly be assumed to be of substantial magnitude--rather than on unperceived monetary changes. The shortcoming of these theories, as discussed in Barro (1977b), is that the real effects of unpredicted, but contemporaneously perceived, monetary changes are not obviously consistent with efficient contractual arrangements.

The empirical analysis in Barro (1977a, 1978a) reports substantial effects on unemployment and output of discrepancies between actual money growth and the growth that could have been predicted from a set of explanatory variables. These results are consistent with either the unperceived money or unpredicted money models (with predictions generated one year earlier) and do not discriminate between these two varieties of business cycle theories.

Therefore, a comparison of these theories--which have some differences in terms of policy implications--requires some additional empirical evidence.

One part of monetary surprises that seems classifiable as temporarily unperceived is the amount that corresponds to revisions in the published data. Further, these changes--even measured in terms of growth rate effects, rather than as changes in the measured levels of the money stock (which sometimes apply equally to past dates)--are occasionally substantial, amounting to as much as 1-2% of M1 on an annual average basis. However, the average magnitude of the revisions, in terms of growth rate discrepancies, turns out to be only about .004 on an annual average basis from 1948 to 1975.

The objective in the present paper is to test whether "unanticipated money growth," as measured in the research cited above, has explanatory value for unemployment and output because it proxies for unperceived money growth, as measured by the data revisions. However, this test cannot fully discriminate between the unperceived versus unpredicted monetary-effects models, since a one-to-one identification of unperceived money growth with the data revisions does not seem reasonable. To preview the results, it turns out that the measures of unperceived money growth based on the data revisions have no significant explanatory value for unemployment and output.

Measure of Data Revisions

Regular revisions of the money stock data published by the Federal Reserve involve refinements (benchmark adjustments) to estimates of deposits and vault cash at non-member banks. Changes in seasonal adjustment factors are not considered in the present analysis, which deals only with annual average data. Some other revisions involve shifts in concepts--for example, the change in October 1960 to include in the money stock the demand deposits that are due to mutual savings banks and foreign banks--or shifts in procedures, such as the change in October 1969 that eliminated the (incorrect) subtraction of cash items in the process of collection at foreign branches of U.S. banks. Another important change was the shift in October 1960 to daily average figures, as applied ex post to data starting in 1947.

Definitional changes that produce a shift in the overall level of the measured money stock seem unlikely to have significant real effects, especially since estimates of different concepts of money could already have been generated prior to the revisions. In order to filter out this type of effect, we base our analysis on monetary growth rates. Our basic series is the growth rate that could have been calculated from the annual average of the first reports of money for each month (which appeared with a one- to two month lag over the sample period), relative to the annual average of money applicable to dates 12 months previous. That is, for year t, the first reports on M1 for each month are averaged to obtain the contemporaneously perceived level, ${}_tM_t$, where the first time subscript denotes the date at which estimates are made to apply to the date indicated by the second subscript. The values for each month in the preceding year--as reported at the time of the first report for each corresponding month this year--are averaged to obtain ${}_tM_{t-1}$. The annual average perceived money growth rate is then calculated as ${}_tDM_t \equiv \log({}_tM_t/{}_tM_{t-1})$.

The perceived money growth rate is compared with the estimate of money growth that is available later based on "final" revised figures, $DM_t \equiv \log(M_t/M_{t-1})$, to obtain the contemporaneous measurement error, $\varepsilon_t \equiv DM_t - {}_tDM_t$. The time series over the post-World War II period for ${}_tM_t$, ${}_tM_{t-1}$, M_t, ${}_tDM_t$, DM_t, and ε_t are contained in table 1. The notes to the table provide some detail on sources and on the nature of the principal data revisions. The largest values for ε_t since 1947[1] appear in 1960 (.010), 1969 (.017), and 1973 (.010). The average value from 1948 to 1975 is positive--.0025--and the average magnitude is .0038.

We have also considered an alternative concept of measurement error for money growth rates denoted ε'_t (table 1, col. 10) that comprises only the benchmark adjustments to the money stock. For example, this concept eliminates the effect of the conceptual and procedural changes in 1960 and 1969 that implied large "revisions" for those years. With only benchmark changes considered, the average revision in money growth rates is close to zero and the average absolute value is .0013--only about one-third of the broader revision concept. The largest magnitude values are now 1973 (.010), 1972 (.007) and 1970 (-.003). Values greater than .001 apply to only 6 of the years from 1947 to 1975.

The aim of this investigation is to assess the explanatory power for unemployment and output of unperceived money growth, as measured by ε_t or ε'_t, in comparison with that of "unanticipated" money growth, DMR_t, as measured previously and also tabulated in table 1. The sample average value of DMR_t is close to zero by construction, and the average magnitude from 1948 to 1975 is .0109--about three times that of ε_t. The correlation between DMR_t and ε_t from 1948 to 1975 is negligible--+.01--although that of DMR_t with the benchmark revisions, ε'_t, is +0.38.

Effects on Economic Activity

Equations for unemployment and output (real GNP) from 1950-75 are shown in table 2. The forms of the equations parallel those of previous research (Barro, 1977a, 1978a). The contemporaneous and two annual lag values of unanticipated money growth DMR, as measured before,[2] have substantial explanatory value for the unemployment rate (table 2, line 1) and real GNP (line 4).[3]

With the DMR variables excluded from the equation, the contemporaneous and two annual lag values of "unperceived" money growth, ε or ε', have insignificant effects (lines 2, 3, 5, 6).

A test that the set of variables, $(\varepsilon_t, \varepsilon_{t-1}, \varepsilon_{t-2})$, is jointly insignificant, given the inclusion of the set, $(DMR_t, DMR_{t-1}, DMR_{t-2})$, yields the statistic, $F^3_{18} = 1.5$ for the unemployment rate equation, and $F^3_{17} = 1.4$ for output (5% critical values = 3.2). For the case of the ε' variables, the corresponding F-values are 1.4 and 2.5. The exclusion of the set of DMR variables, given the inclusion of the ε or ε' variables, can be decisively rejected, with F-values ranging from 6 to 24. The overall conclusions are, first, the measures of unperceived money growth based on the data revisions add nothing to the explanation of unemployment and output, and second, the measure of unanticipated money growth (DMR) does not have explanatory power because of a proxying for the unperceived money growth measures.

Relation of Initial and Final Money Stock Data

We have briefly considered the possibility that the initially published money stock figures are not efficient predictions for the "final" data. An estimated equation over 1950-75 yields

$$(1)\quad DM_t - {}_tDM_t = \underset{(.001)}{.002} + \underset{(.34)}{.23}\,({}_tDM_{t-1} - {}_{t-1}DM_{t-1}),$$

$$R^2 = .02,\ \text{D-W} = 1.3,\ \hat{\sigma} = .005,$$

where $\hat{\sigma}$ is the standard-error-of-estimate, standard errors of the coefficient estimates are shown in parentheses, and ${}_tDM_{t-1}$ is the value for money growth from date t-2 to t-1, as perceived at date t (table 1, col. 9). The measurement error for last year as perceived currently, $({}_{t}DM_{t-1} - {}_{t-1}DM_{t-1})$, does not have significant explanatory value for this year's error. Although the constant in eq. (1) differs significantly from zero, the addition of a constant to the ε-values would not alter the above analysis of monetary effects on economic activity. The variable, ${}_{t}DM_{t-1}$, and monetary variables referring to earlier dates are also insignificant in equations with $(DM_t - {}_{t}DM_t)$ as the dependent variable.

The Durbin-Watson Statistic for equation (1), 1.3, indicates significant positive serial correlation in the residuals--in particular, the final residual for date t-1, $(DM_{t-1} - {}_{t-1}DM_{t-1})$, does have significant explanatory value for the current error, $(DM_t - {}_{t}DM_t)$. However, last year's residual, which depends on DM_{t-1}, is not observable at date t.

Conclusions

The principal conclusion is that the discrepancy between initial and final reports on money growth rates has no explanatory power for unemployment and output. A possible interpretation is that unanticipated money growth, as measured in earlier studies, has strong explanatory power because it reflects unpredicted monetary movements, rather than unperceived money growth, per se.[4] This interpretation is disturbing because the strongest theoretical arguments for real monetary effects depend on confusions between relative and absolute price changes, which require the underlying money shocks to be temporarily unperceived. However, because of a time lag in the initial monetary reports and the possibility that nominal shifts are not effectively perceived as soon as they are reported, the present evidence cannot fully discriminate between the unperceived versus unpredicted monetary-effects models.

FOOTNOTES

[1]Our series on initial and final money stock reports begins with 1947 because of the changes instituted in the October 1960 Federal Reserve Bulletin, which were not applied ex post to data before 1947. "Final" money reports are not yet available for 1976-77, but the main revisions for 1975 and earlier years have probably already occurred.

[2]$DMR_t \equiv DM_t - \widehat{DM}_t$, where $\widehat{DM}_t$ is the estimated money growth rate from an equation of the form used in the 1978a paper, p. 551, which has been updated to include 1977 data.

[3]A minimum wage rate variable, used in the unemployment equation in the 1977a paper (p. 107), has been omitted. This variable turns out to be insignificant for samples that exclude the 1946-48 years.

[4]Another suggestion is that measurement errors in the money stock have not had much significance for the business cycle. Therefore, improvements in reporting procedures, such as more frequent sampling of non-member banks (or the information gains yielded by an increase in Federal Reserve membership), would not have important implications for the behavior of unemployment and output.

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Table 1
DATA ON MONEY STOCK REVISIONS

	(1) ${}_tM_t$	(2) ${}_{t+1}M_t$	(3) M_t	(4) ${}_tDM_t \equiv \log({}_tM_t/{}_tM_{t-1})$	(5) $DM_t \equiv \log(M_t)-\log(M_{t-1})$	(6) $\varepsilon_t \equiv DM_t - {}_tDM_t$	(7) $\widehat{DM}_t$	(8) $DMR_t \equiv DM_t - \widehat{DM}_t$	(9) ${}_{t+1}DM_t \equiv \log({}_{t+1}M_t/{}_{t+1}M_{t-1})$	(10) ε'_t
1947	109.4	109.3	111.8	-	-	-	-	-	-	-.001
1948	109.7	109.6	112.3	.004	.004	.000	.004	.000	.003	-.001
1949	108.6	108.5	111.2	-.009	-.010	-.001	.002	-.012	-.010	.000
1950	111.7	111.6	114.1	.029	.026	-.003	.003	.022	.028	.000
1951	117.2	117.2	119.2	.049	.044	-.005	.031	.013	.049	.000
1952	123.1	123.1	125.2	.049	.049	.000	.040	.009	.049	.000
1953	126.0	126.0	128.3	.023	.024	.001	.042	-.018	.023	.000
1954	127.8	127.7	130.3	.014	.015	.001	.020	-.004	.014	.000
1955	132.3	132.2	134.4	.035	.031	-.004	.025	.006	.035	.000
1956	133.8	133.9	136.0	.012	.012	.000	.024	-.012	.012	.001
1957	134.4	134.5	136.8	.004	.005	.001	.019	-.014	.004	.001
1958	135.9	136.1	138.4	.010	.012	.002	.017	-.004	.012	.002
1959	140.3	140.5	143.7	.030	.037	.007	.029	.007	.031	.001
1960	139.0	140.3	143.5	-.011	-.001	.010	.034	-.035	-.014	-.002
1961	142.4	142.8	146.5	.015	.021	.006	.024	-.004	.015	.000
1962	145.6	146.0	149.8	.019	.022	.003	.035	-.014	.019	.000
1963	150.4	150.5	154.1	.030	.029	-.001	.032	-.003	.030	.000
1964	156.4	156.3	160.3	.038	.039	.001	.035	.004	.038	-.001
1965	162.4	162.6	167.1	.038	.042	.004	.038	.004	.040	.001
1966	169.7	169.9	174.7	.043	.044	.001	.042	.002	.042	-.001
1967	176.2	176.4	181.6	.037	.039	.002	.041	-.003	.038	.001
1968	187.6	188.2	194.3	.062	.068	.006	.040	.028	.064	.001
1969	196.7	199.0	206.5	.044	.061	.017	.046	.015	.052	.002
1970	205.4	210.0	214.5	.032	.038	.006	.046	-.008	.040	-.003
1971	224.0	224.1	228.9	.065	.065	.000	.043	.021	.065	.000
1972	238.0	246.2	245.0	.060	.068	.008	.058	.010	.063	.006
1973	262.0	263.8	263.3	.062	.072	.010	.061	.011	.072	.010
1974	278.8	278.7	277.7	.055	.053	-.002	.059	-.005	.055	.000
1975	291.1	289.5	289.5	.043	.042	-.001	.057	-.016	.042	-.001
1976	304.1	304.2	304.2	.049	.049	-	.060	-.010	.049	-
1977	324.6	-	324.6	.065	.065	-	.058	.006	-	-

Notes to Table 1:

The basic data are three different monthly series of M1, obtained from the Federal Reserve Bulletin from January 1945 to March 1978. The first series consists of first reports on M1, made a month or two after the date to which the figures correspond. The second is the money stock as published 12 months after the first report. These figures include, therefore, the revisions made to the M1 measures during these one-year periods. The third series consists of the "final" figures for M1--that is, they include all the revisions through March 1978.

The annual averages of the three series appear in Table 1, where ${}_tM_t$ in column 1 is the first reported money stock, ${}_{t+1}M_t$ in column 2 is the one reported one year later, and M_t in Column 3 is the final measure of M1.*

${}_tDM_t \equiv \log({}_tM_t/{}_tM_{t-1})$ in column 4 measures the annual average growth rate of the money stock as it could be computed during year t with the data published up to that time. $DM_t \equiv \log(M_t/M_{t-1})$ in column 5 is the growth rate of M_1 based on the "final" reports for

*Before October 1960 the monthly reports referred only to the last Wednesday of each month. The annual averages in columns 1 and 2 for this period were approximated by averaging these figures.

M1. ε_t in column 6 equals $DM_t - {}_tDM_t$.

The other figures are: column 7, $\widehat{DM}_t$, the estimated value of DM_t from an equation of the form in Barro (1978a, p.551) updated to include 1977 data.

Column 8, $DMR_t \equiv DM_t - \widehat{DM}_t$.

Column 9, ${}_{t+1}DM_t \equiv \log({}_{t+1}M_t / {}_{t+1}M_{t-1})$, where ${}_{t+1}M_{t-1}$ is the annual average of M1 as reported with a two-year lag. A lagged value of ${}_{t+1}DM_t$ is used in equation (1) of the text.

Column 10, the discrepancy between DM_t and ${}_tDM_t$ with only benchmark revisions to the money stock data considered.

The revisions made to the reported money stock are of four types: a) Benchmark adjustments, b) Revisions concerning "cash items in the process of collection" and Federal Reserve float, c) Changes in coverage and d) Updating of seasonal adjustment factors. The last type is not considered in the present analysis of annual average data.

Benchmark adjustments:

Daily data on demand deposits and vault cash held at member banks are reported to the Federal Reserve for the purpose of computing required reserves. Since similar data are not available for non-member banks, their deposits and vault cash are estimated by the Federal Reserve based on call reports made twice a year, or since 1973 four times a year, and from current data from member banks. These adjustments were made regularly during the entire period of the sample. By their nature, these revisions affect only the current growth rate without changing past levels of M1.

The largest benchmark revisions correspond to February 1973--an increase in the reported money stock for 1972 by $1.6 billion, or 0.7 per cent; and to February 1974--an increase in the reported M1 figure for June-October 1973 by 2,5 billion, or 1.0 per cent. A large downward adjustment was made in December 1970, which produced a decrease in the reported M1 figure for June-October 1970 by about $1 billion. However, this revision was obscured by an even larger upward "cash items" adjustment. See below.

"Cash items in process of collection" and Federal Reserve float adjustments:

Until the clearing of checks is completed, the amounts involved appear as demand deposits in the books of two banks at the same time. Double-counting is avoided by subtracting these items and the Federal Reserve float* from gross demand deposits. However, the "cash items" reported by banks contain amounts that should not be subtracted from demand deposits--for example, checks credited to the account of a commercial bank. The large revisions

*The Federal Reserve float is the credit that member banks have received for checks forwarded to a Federal Reserve Bank for collection, before the collection has been accomplished. The float was first subtracted from the reported M1 figures with the October 1960 revisions.

made in October 1969 and December 1970 were aimed at correcting downward biases in measurement of M1 because of excessive "cash items" deductions. The February 1973 revision involved a similar bias in the Federal Reserve float.

In the late 1960's the accelerating amount of Eurodollar borrowings and repayments inflated the "cash items." Before July 1969 "cash items" at foreign branches of U.S. banks were subtracted from the domestic bank demand deposits for the purposes of determining reserves and money stocks.* The October 1969 revision corrects this bias in the reported money stock. Since these "cash items" were rapidly increasing, the correction implied that M1 was growing in 1968 and 1969 much faster than had been reported previously.

The similar revision of December 1970 involved the clearing of checks of some increasingly active financial corporations.** This revision implied an even faster reported growth rate of M1 for 1969 and a higher rate for 1970 than reported initially. This change was partially offset by the large downward benchmark adjustment in 1970, as mentioned above.

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*These "cash items" corresponded mainly to repayments of Eurodollar borrowings made by U.S. banks to their own foreign branches. See the Federal Reserve Bulletin, October 1969 and December 1970.

**See the Federal Reserve Bulletin, December 1970.

Changes in coverage:

Deposits held by foreign and mutual savings banks were added to the M1 measure in the October 1960 revision. In August 1962 foreign balances held at Federal Reserve banks, including those due to foreign governments, central banks and international institutions were added to the M1 measure. (The appropriateness of these changes can be debated, but the amounts involved are small). In December 1970, deposits held in U.S. agencies of foreign banks and in internationally-oriented agencies of U.S. banks were added to M1.

These extensions of coverage did not materially affect the measured growth rates of M_1.

Table 2

ESTIMATED UNEMPLOYMENT AND OUTPUT EQUATIONS

	Const.	DMR_t	DMR_{t-1}	DMR_{t-2}	ε_t	ε_{t-1}	ε_{t-2}	ε'_t	ε'_{t-1}	ε'_{t-2}	MIL	t	R^2	D-W	$\hat{\sigma}$
(1)	-.263 (.05)	-4.4 (1.6)	-11.7 (1.6)	6.7 (1.7)							-6.0 (0.7)		.86	2.5	.113
(2)	-2.93 (.15)				-1.1 (10.4)	-2.4 (12.0)	23.6 (12.4)				-2.5 (1.7)		.43	1.1	.228
(3)	-2.77 (.12)							-2.7 (21.7)	-32.8 (20.9)	33.5 (23.4)	-4.2 (1.6)		.46	0.9	.223
(4)	2.94 (.07)	.94 (.23)	1.22 (.24)	.62 (.25)							.58 (.14)	.0355 (.0006)	.997	1.5	.0165
(5)	2.79 (.15)				-.78 (1.48)	-.15 (1.47)	-3.66 (1.66)				.33 (.25)	.0373 (.0013)	.991	0.7	.0279
(6)	2.88 (.12)							1.94 (2.68)	2.43 (2.47)	-5.61 (2.91)	.43 (.22)	.0362 (.0011)	.992	0.6	.0262

Notes:

The sample is 1950-75 on annual data. The dependent variable for lines 1-3 is log(U/1-U), where U is the unemployment rate in the total labor force. The dependent variable for lines 4-6 is log(y), where y is real GNP in 1972 prices. The DMR, ε and ε' variables are shown in table 1. MIL is a military conscription variable and t is a time trend. Detailed descriptions of variables appear in Barro (1977a, pp. 102-3; and 1978a, pp. 532, 554).

$\hat{\sigma}$ is the standard-error-of-estimate. D-W is the Durbin-Watson Statistic. Standard errors of the coefficients