NBER WORKING PAPERS SERIES

ANOTHER LOOK AT THE EVIDENCE ON MONEY-INCOME CAUSALITY

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Working Paper No. 3856

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
October 1991

This paper is part of NBER's research program in Financial Markets and Monetary Economics. Any opinions expressed are those of the authors and not those of the National Bureau of Economic Research.

NBER Working Paper #3856
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ABSTRACT

Stock and Watson's widely noted finding that money has statistically significant marginal predictive power with respect to real output (as measured by industrial production), even in a sample extending through 1985 and even in the presence of a short-term interest rate, is not robust to two plausible changes. First, extending the sample through 1990 renders money insignificant within Stock and Watson's chosen specification. Second, using the commercial paper rate in place of the Treasury bill rate renders money insignificant even in the sample ending in 1985.

A positive finding is that the difference between the commercial paper rate and the Treasury bill rate does have highly significant predictive value for real output, even in the presence of money, regardless of sample.

Alternative results based on forecast error variance decomposition in a vector autoregression setting confirm these findings by indicating a small and generally insignificant effect of money, and a large, highly significant effect of the paper-bill spread, on real output.

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Revised
July, 1991

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Whether fluctuations in the stock of money anticipate fluctuations in income is an important question, with implications for both economic theory and economic policy. In a widely cited paper, James Stock and Mark Watson (1989) offered new evidence for the United States showing that money, as measured by the narrow M1 aggregate, does have statistically significant marginal predictive value for real income, as measured by industrial production. Wholly apart from the useful methodological contribution represented by the new testing strategy that they proposed in their paper, Stock and Watson's empirical findings were especially noteworthy for two reasons: First, in contrast to the popular impression that familiar money-income relationships (and, for that matter, money-price relationships too) had broken down in the 1980s, their results showed a continuing significant relationship in a sample extending through 1985. Second, in contrast to earlier researchers (most prominently, Christopher Sims) who had found a significant relationship between money and real income in a bivariate context but not after also allowing for fluctuations in interest rates, Stock and Watson's results showed that money had significant marginal predictive value for income even in the presence of a short-term interest rate.

Evidence presented below shows, however, that Stock and Watson's findings are not robust in two ways, corresponding in turn to each of these aspects of their results that made them so interesting in the first place: First, merely extending the sample period through the remainder of the 1980s renders money no longer significant in predicting income, even within their chosen specification.[1] Hence the widespread impression that the money-income relationship has weakened, if not collapsed altogether, is closer to the truth. Second, even for data through 1985 only, the Stock-Watson finding turns out to depend on the use in the analysis of a particular interest rate, the Treasury bill rate. Using instead the commercial paper rate, another short-term interest rate which apparently is superior in capturing the information in financial prices that matters for the determination of real income, sharply weakens the Stock-Watson result.

Applying the Stock-Watson Test to Different Samples

Following Sims (1980) and other researchers, Stock and Watson conducted their investigation of the money-income relationship in the context of a four-variable monthly vector autoregression system including not only money and real income (proxied by industrial production) but also prices and a short-term interest rate. On the basis of a careful analysis of the univariate trend properties of these series, in conjunction with the absence of evidence of co-integration among these four variables, they selected as their preferred specification the first-differenced form

$$\Delta y_t = \alpha + \sum_{i=1}^{6} \beta_i \Delta m_{t-i} + \sum_{i=1}^{12} \gamma_i \Delta y_{t-1} + \sum_{i=1}^{12} \delta_i \Delta p_{t-i}$$

$$+ \sum_{i=1}^{12} \theta_i \Delta r_{t-i} + f(t) + u_t \qquad (1)$$

where the regressors are as listed above, f(t) is a polynominal function of time, and u is a standard disturbance term.

Stock and Watson argued for the inclusion of the f(t) regressor in (1) on the basis of their finding that nominal money growth is well described as stationary about a small but statistically significant trend term. Including f(t) in the regression is equivalent to detrending each variable individually. Hence with the trend included, the standard causality tests for the significance of lagged money focus on the predictive power of detrended money growth. Stock and Watson estimated each of their causality-test equations in three forms: with no time trend, including a linear trend, and including both linear and quadratic trends. At the methodological level, the careful treatment of time trends and their implications is a major contribution of the Stock-Watson paper.

Finally, while the choice of lag length 12 is standard in much of the vector autoregression literature based on monthly data, Stock and Watson estimated one version of (1) including the standard 12 lags on all variables and another, as written above, with only 6 lags on money and 12 lags on the other variables. They found that the F-statistic for the joint significance of the coefficients on money falls off sharply when the full 12 lags are included. Hence the use of lag length 6 for money, in the results presented here, favors Stock and Watson's conclusion that money has significant marginal predictive power for income.

Table 1 presents sets of F-statistics, corresponding to three different sample periods, for the null hypothesis that all of the β_i coefficients -- that is, all of the coefficient values on lagged values of money -- are zero in (1). Following Stock and Watson, for each sample period there are three variants of the equation, differing only according to the time trends included. In addition, each of the four variables in the equation is defined throughout as in Stock and Watson's analysis: the index of industrial production (seasonally

Table 1
F-Statistics for Effect of Money in Stock-Watson Tests

Trends Included	Sample: 1960:2–1985:12	1960:2–1979:9	1960:2–1990:12
None	2.270 (0.037)	2.2504 (0.023)	1.242 (0.284)
Linear	2.879 (0.010)	1.434 (0.204)	1.567 (0.156)
Linear, Quadratic	2.280 (0.037)	1.347 (0.238)	0.896 (0.498)

Note: Numbers in parentheses are marginal significance levels.

adjusted, 1987 = 100), M1 (seasonally adjusted), the producer price index for all commodities (not seasonally adjusted, 1982 = 100), and the secondary market rate on three-month Treasury bills (not seasonally adjusted).

The results shown in the first column of the table closely replicate Stock and Watson's findings for their 1960:2-1985:12 sample.[2] Money has significant marginal predictive value for income for all three renderings of f(t), and especially so for the linear-trend case. Analogous results shown in the second column are for data spanning 1960:2-1979:9 -- that is, until just before the Federal Reserve System's adoption of new monetary policy procedures in October 1979. Stock and Watson, who in their paper paid careful attention to questions of sub-sample stability, also presented results for this sample, and the values shown in Table 1 again closely replicate theirs.[3] The point of including results for this sub-sample here is simply to highlight the sample-specific nature of Stock and Watson's findings about the role of time trends. Given the comparison between the first two columns of the table, it is hardly surprising that the pre-1980s literature on the money-income relationship did not emphasize inclusion of trends.

The third column of Table 1 shows analogous F-statistics based on data through 1990. Merely extending the sample for the remainder of the 1980s renders money not marginally significant in predicting real income, even at the .10 significance level, regardless of whether the Stock-Watson trend terms are included. Moreover, results (not shown) for the 1960:2-1990:12 sample but based on other specifications that Stock and Watson proposed reconfirm these results more broadly. Nor is the F-statistic for money significant in analogously specified equations for prices, or for nominal income (proxied by the product of the producer price index and the index of industrial production). Whatever these relationships may have been before 1980, they have apparently deteriorated to such an extent that they no longer appear in samples that include the 1980s.

The object of this paper is to document the robustness (actually, the lack of robustness) of Stock and Watson's positive findings, not to explain in substantive terms whatever changes in the money-income relationship have occurred. Even so, it is useful in passing at least to recall briefly some of the main arguments along these lines advanced in the voluminous literature of this subject generated during the last decade.[4] Much of this literature has focused on reasons why the public's demand for money balances, expressed as a function of income, interest rates and other variables, has plausibly shifted. The development that has figured most prominently in this discussion is the introduction of new forms of deposit holding -- most importantly, new deposits that make irrelevant the old distinction between transactions balances and saving balances -- in response to deregulation and to innovations in technologies (like communications and data processing) relevant to financial intermediation. Other familiar arguments have focused on the response of deposit holders to the rapid increase and then decline of price inflation, the far greater volatility of market interest rates that accompanied the Federal Reserve's new operating procedures for monetary policy, and various implications of the increasing globalization of financial markets. Finally, a different but also familiar perspective is that the money-income relationship was never all that reliable anyway, and that the experience of the 1980s merely highlighted what should have been evident in the first place.

<u>Treasury Bill Rate Versus the Commercial Paper Rate</u>

Following the work of Sims (1980), it has become customary in tests for effects of money on real income to control for the effect of interest rates. A typical finding in such work is that whether money has significant marginal predictive value for income is highly sensitive to whether the analysis includes an interest rate. One especially interesting feature of Stock and Watson's findings, therefore, was the limited nature of this sensitivity that they reported. True, deleting the interest rate from their preferred specification for 1960:2-1985:12 raised the F-statistic for the coefficients on lagged money from 3.04 to 3.50. But the more important point, as emphasized above, is that even the smaller value, for the system including the interest rate, was highly significant.

Although the inclusion of a short-term interest rate in empirical work of this kind is now standard enough, there has been little discussion in the literature of just which short-term rate is appropriate. Moreover, what little discussion there is has mostly focused on such matters as the difference between long-term rates (with their inherently anticipatory properties) and short-term rates, rathered than on apparently more mundane questions like which short-term rate is more relevant.[5] Nor has actual practice been uniform in this respect. Sims (1980) and Friedman (1983) both used the commercial paper rate, while Litterman and Weiss (1985) and Eichenbaum and Singleton (1986) -- and Stock and Watson (1989) -- all used the Treasury bill rate.[6] None of these authors, however, offered substantive arguments in support of the selection made.

Just as different monetary aggregates correspond to different conceptual ways of measuring financial market quantity information, different interest rates correspond to different conceptual ways of measuring financial market price information. As Friedman and Kuttner (1990) explained in some detail, in the case of the commercial paper rate -- that is, the interest rate on short-term unsecured borrowing by corporations in nonfinancial lines of business -- and the Treasury bill rate -- that is, the analogous unsecured borrowing rate for the U.S. Government -- there are substantive grounds on which to question which one provides the better gauge of the financial prices that matter for the determination of real economic activity.

At the most obvious level, the commercial paper rate more directly reflects the cost of finance corresponding to potentially interest-sensitive expenditure flows than does the Treasury bill rate. To the extent that interest rates matter for nonfinancial economic activity primarily because they affect the spending behavior of private-sector borrowers, therefore, any influence that causes these two rates to covary imperfectly will make the commercial paper rate superior to the Treasury bill rate as a measure of this effect. For example, when changes in the perceived creditworthiness of the average business alter the spread between the rate on potentially defaultable commercial paper and that on presumably default-free Treasury bills, as happens over the course of a typical business cycle, it is the commercial paper rate that conveys more information about the borrowing costs that may affect spending flows. By contrast, to the extent that interest rates matter for nonfinancial activity primarily by affecting the behavior of those who save and invest, rather than of those who borrow, the Treasury bill rate is plausibly more relevant because it more nearly represents the returns available to most savers. In the end, however, for purposes of this paper what is of interest is the empirical implication, for Stock and Watson's results, of using one of these rates versus the other.

Table 2 presents evidence that the use of one of these two short-term interest rates versus the other has an important bearing on the Stock-Watson findings about the marginal predictive value of money for real income. The table shows F-statistics for tests of the null hypothesis that all of the coefficients on money are zero, and also for (separate) tests of the null hypothesis that all of the coefficients on the interest rate are zero in (1) estimated for the 1960:2-1985:12 sample. The table shows results based on using

Table 2
Implications of Alternative Interest Rates
in Stock-Watson Tests, 1960–1985

	Treasury Bills	Commercial Paper
No Time Trend		
F-Statistic for Money	2.270	1.165
	(0.037)	(0.326)
F-Statistic for Interest Rate	0.841	1.296
	(0.608)	(0.220)
Linear Time Trend		
F-Statistic for Money	2.879	1.593
	(0.010)	(0.149)
F-Statistic for Interest Rate	0.823	1.161
	(0.627)	(0.312)
Linear, Quadratic Time Trends		
F-Statistic for Money	2.280	1.279
	(0.037)	(0.267)
F-Statistic for Interest Rate	0.860	1.165
	(0.589)	(0.309)

Notes: Numbers in parentheses are marginal significance levels.
The sample is 1960:2–1985:12.

the three month Treasury bill rate as the model's short-term interest rate, as in Stock and Watson's work, and alternative results based on using the rate on six-month dealer-placed prime commercial paper (also not seasonally adjusted).

Although the F-statistics for the effect of <u>the interest rate</u> on income are uniformly larger for the commercial paper rate than for the Treasury bill rate, in no case does the change render this effect significant at any plausible level. By contrast, which short-term interest rate the model includes does affect the significance of the effect of <u>money</u> on income. In no case is the effect of money significant even at the .10 level in the presence of the commercial paper rate.

Hence even within their own 1960-85 sample, Stock and Watson's positive findings hinge crucially on the use of the Treasury bill rate rather than the commercial paper rate to represent financial market price information. Not surprisingly, as Table 3 shows, simultaneously extending the sample <u>and</u> substituting the commercial paper rate for the Treasury bill rate overwhelms Stock and Watson's positive results altogether.

<u>An Alternative Way of Incorporating Interest Rates</u>

Although it may be tempting to interpret these results as a straightforward indication that the commercial paper rate is simply superior to the Treasury bill rate in capturing information about financial effects on nonfinancial economic activity, further investigation shows that the relevant interactions may in fact be more subtle. Table 4 presents F-statistics for several tests of an expanded version of (1) in which the Treasury bill rate is replaced by both the commercial paper rate (r_P) and the <u>spread</u> between the commercial paper rate and the Treasury bill rate (r_B):

Table 3
Implications of Alternative Interest Rates in Stock-Watson Tests, 1960–1990

	Treasury Bills	Commercial Paper
No Time Trend		
F-Statistic for Money	1.242	0.630
	(0.284)	(0.706)
F-Statistic for Interest Rate	0.972	1.654
	(0.476)	(0.076)
Linear Time Trend		
F-Statistic for Money	1.567	0.834
	(0.156)	(0.545)
F-Statistic for Interest Rate	0.945	1.586
	(0.502)	(0.094)
Linear, Quadratic Time Trends		
F-Statistic for Money	0.896	0.537
	(0.498)	(0.780)
F-Statistic for Interest Rate	1.049	1.641
	(0.403)	(0.079)

Notes: Numbers in parentheses are marginal significance levels.
The sample is 1960:2–1990:12.

Table 4
F-Statistics for Expanded Stock-Watson Equation

	1960:2–1985:12	1960:2–1990:12
F-Statistic for Money	1.403	0.627
	(0.214)	(0.708)
F-Statistic for Paper Rate	0.872	1.117
	(0.576)	(0.346)
F-Statistic for Paper-Bill Spread	4.531	3.596
	(10^{-6})	(10^{-4})
F-Statistic for Constraint	4.529	3.967
	(10^{-6})	(10^{-5})

Notes: Numbers in parentheses are marginal significance levels.

The constraint forces the paper-bill spread terms to cancel the terms in the differenced paper rate, leaving only those terms involving the differenced the Treasury bill rate.

$$\Delta y_t = \alpha + \sum_{i=1}^{6} \beta_i \Delta m_{t-i} + \sum_{i=1}^{12} \gamma_i \Delta y_{t-i} + \sum_{i=1}^{12} \delta_i \Delta p_{t-i}$$

$$+ \sum_{i=1}^{12} \theta_i \Delta r_{P,t-i} + \sum_{i=1}^{12} \phi_i (r_P - r_B)_{t-i} + \mu t + u_t. \qquad (2)$$

Here the spread variable appears in level form because univariate unit root tests indicate that it is stationary without differencing (that is, I(0)). By contrast, univariate unit root tests typically indicate that the levels of most interest rates, including the paper rate and the bill rate, are difference stationary (that is, I(1)) -- as are, for that matter, income, money and prices. The table shows results for both the 1960-85 and the 1960-90 sample periods, but only for Stock and Watson's preferred specification including the linear time trend as indicated in (2). (Corresponding results for the variants with no trend and with both linear and quadratic trends are highly similar.)

Neither the F-statistic testing the effect of money nor that testing the effect of the commercial paper rate is significant, at any plausible level, in either sample. By contrast, what is startling is that the paper-bill spread is significant at the .0001 level or better in both sample periods.[7] At the same time, the F-statistic for the (separate) null hypothesis that the coefficients on the paper-bill spread just cancel the corresponding coefficients on the differenced commercial paper rate -- so that the net result is equivalent to simply including the Treasury bill rate, as in Stock and Watson's work -- warrants rejecting this constraint at even stronger significance levels in both sample periods.[8]

These additional results do not contradict the conclusion that, between the Treasury bill rate and the commercial paper rate, the latter is superior for purposes of assessing financial influences on nonfinancial activity, nor do they affect the parallel conclusion that Stock and Watson's finding of a strongly statistically significant effect of money on real output depends on their use of the Treasury bill rate instead of the commercial paper rate. They do suggest, however, that the sources of imperfect covariation between these two interest rates capture more of the relevant information about what aspects of financial markets matter for the determination of real income than do movements in either interest rate by itself -- or fluctuations in money.[9] (Moreover, these results do not merely reflect Stock and Watson's focus on the narrow M1 money stock. The monetary base, the M2 money stock and total domestic nonfinancial credit all fail to be significant in this context as well.)

Just what those sources of imperfect covariation are that seem so informative about subsequent fluctuations in income is an interesting question in its own right. Friedman and Kuttner (1991) have argued that three distinguishing features of commercial paper and Treasury bills -- the default risk on paper, the favorable tax treatment of bills at the state and municipal level, and the superior liquidity of bills -- not only render these two instruments imperfect portfolio substitutes but also readily account for the <u>average</u> paper-bill spread observed over time. They also found evidence supporting several different (albeit not mutually exclusive) hypotheses to explain why the <u>variation</u> of the paper-bill spread over time has predictive content with respect to income: one driven by changing default probabilities, one by changes in monetary policy, and one by changes in nonfinancial corporations' cash flows. Unraveling the role of these (and perhaps other) explanations for this phenomenon remains an object for further research, well beyond the scope of this paper.

Does Money Matter? Another Metric for Judging the Issue[10]

Following Stock and Watson, the discussion above of the relationships among income, money and interest rates focuses on questions of statistical significance: Are the coefficients in a distributed lag on money significantly different from zero in equations for real income that also include one or more interest rates? If so, over what sample? How does the choice among interest rate affect this significance level? By contrast, the metric by which Sims (1980) judged the importance of money versus interest rates was the relative and absolute share of these variables in the income forecast error variance decomposition in a vector autoregression setting.

Table 5 reports the results of evaluating Stock and Watson's preferred equation (again, the version of (1) including a linear time trend) according to this alternative criterion. For both the 1960-85 and 1960-90 samples, and for both the Treasury bill rate and the commercial paper rate chosen as the relevant interest rate, the table shows the respective contributions of money and the interest rate in accounting for the forecast variance of income. the vector autoregression system underlying this decomposition includes income, prices, money and the interest rate, with the equation for each variable specified as in (1). The table reports percentages of output error variance accounted for at 12- and 24-month forecast horizons, together with approximate 95% confidence intervals.[11] Just as the lag structure chosen by Stock and Watson (and used throughout this paper as well) favors the significance of money by limiting its lag to length 6, versus 12 for all other variables, here too these variance decompositions _favor_ the contribution of money by always ordering money, ahead of the interest rate variable for purposes of orthogonalization.

Applying the variance decomposition yardstick to the Stock-Watson equation is revealing in two ways. First, doing so confirms the substantive findings

Table 5
Implications of Alternative Interest Rates and Sample for Variance Decompositions

Sample: 1960:2–1985:12	Treasury Bills		Commercial Paper	
Percentage of output variance	$\Delta\ln(M1)$	Δr_B	$\Delta\ln(M1)$	Δr_P
12 months ahead	7 ± 6	7 ± 5	4 ± 4	10 ± 7
24 months ahead	8 ± 7	9 ± 6	5 ± 5	12 ± 8
Sample: 1960:2–1990:12	Treasury Bills		Commercial Paper	
Percentage of output variance	$\Delta\ln(M1)$	Δr_B	$\Delta\ln(M1)$	Δr_P
12 months ahead	3 ± 4	6 ± 4	2 ± 2	10 ± 6
24 months ahead	4 ± 4	7 ± 5	3 ± 2	11 ± 7

Notes: Variance decompositions are computed via Monte Carlo, with 500 draws.
Ranges indicated represent approximate 95% confidence intervals.
The orthogonalization order is: output, price index, money, interest rate.

supported by the declining significance levels in Tables 1-3 above. Money's share in accounting for the forecast error variance of income declines with the extension of the sample to 1990 (that is, moving downward in Table 5) and also with the substitution of the commercial paper rate for the Treasury bill rate (that is, moving from left to right). It especially does so with both of these changes simultaneously.

Perhaps more importantly, the contribution of money in this context is never very large in any case. It is greatest, of course, for Stock and Watson's original 1960-85 sample and use of the Treasury bill rate. But even here, the point estimates of money's share are below 10% at both forecast horizons, and they are merely comparable to the corresponding estimates for the interest rate share despite the ordering of money before the interest rate.

Finally, the results presented in Table 6, for an expanded vector autoregression system also including the paper-bill spread, confirm in this alternative setting the conclusions drawn on the basis of the significance tests reported in Table 4. The role of money in determining income is trivial in the presence of the commercial paper rate and the paper-bill spread, regardless of whether money is ordered before these two variables or after them. Conversely, the spread plays a much more important role in this context, even when it is ordered last.

Table 6

Variance Decompositions for Expanded Stock-Watson Equation

Ordering: output, price index, money, paper rate, paper–bill spread

Percentage of output variance	$\Delta \ln(M1)$	Δr_P	$r_P - r_B$
6 months ahead	1 ± 2	7 ± 5	5 ± 4
12 months ahead	2 ± 2	13 ± 7	9 ± 6
24 months ahead	3 ± 3	14 ± 7	11 ± 6
36 months ahead	3 ± 3	15 ± 8	11 ± 6

Ordering: output, price index, paper–bill spread, paper rate, money

Percentage of output variance	$r_P - r_B$	Δr_P	$\Delta \ln(M1)$
6 months ahead	8 ± 5	5 ± 4	1 ± 1
12 months ahead	16 ± 7	7 ± 5	2 ± 1
24 months ahead	16 ± 8	9 ± 6	3 ± 2
36 months ahead	17 ± 8	10 ± 6	3 ± 3

Notes: Variance decompositions are computed via Monte Carlo, with 1000 draws.
Ranges indicated represent approximate 95% confidence intervals.
Sample is 1960:2–1990:12.

<u>Footnotes</u>

*Harvard University and The Federal Reserve Bank of Chicago, respectively. The authors are grateful to the editors of this journal, and to two anonymous referees, for helpful comments on an earlier draft, and to the National Science Foundation, the General Electric Foundation and the Harvard Program for Financial Research for research support. The views presented here are the authors'; they do not necessarily reflect the official position of the Federal Reserve Bank of Chicago.

1. The draft of this paper that circulated as a working paper showed that merely extending the sample through 1988 (that is, adding just three years to Stock and Watson's sample) was sufficient to find this result; see Friedman and Kuttner, "Another Look at the Evidence on Money-Income Causality," Federal Reserve Bank of Chicago Working Paper 90-17.

2. The F-statistics reported by Stock and Watson, in the order shown in the table, were 2.39, 3.04 and 2.50. The differences are attributable to subsequent data revisions.

3. The F-statistics reported by Stock and Watson were, in order, 2.68, 1.75 and 1.49.

4. For a more extensive discussion, and references to that literature, see Friedman (1988).

5. See Friedman (1984) for a comparative treatment of long- versus short-term interest rates, and Eichenbaum and Singleton (1986) for a discussion of equity prices, in this context.

6. Eichenbaum and Singleton were incorrect in stating (p.125) that Sims had used the Treasury bill rate; see Sims (p.252).

7. It would be incorrect to suppose that the paper-bill spread is significant here merely because it is a proxy for interest rate levels (which are excluded from the regression by the use of the difference form for either interest rate individually). Friedman and Kuttner (1991) projected the paper-bill spread onto the bill rate level and showed that the remainder is also highly significant in equations for real income.

8. For purposes of testing this constraint it is necessary to extend the lag on the paper-bill spread to length 13. Given that the paper rate and the paper-bill spread enter (2) in differences and in levels, respectively, the form of the constraint being tested is

$$\phi_1 + \theta_1 = 0$$

$$\phi_2 + \theta_2 - \theta_1 = 0$$

$$\vdots$$

$$\phi_{12} + \theta_{12} - \theta_{11} = 0$$

$$\phi_{13} - \theta_{12} = 0$$

Hence the constraint embodies 13 restrictions.

9. Although the regressions reported here rely on the three-month Treasury bill rate (for consistency with Stock and Watson's work) and the six-month commercial paper rate, Friedman and Kuttner (1991) reported essentially identical results based on six-month bills and six-month paper. These results are consistent with those reported by Stock and Watson (1990) in a different paper, in which they report that several spreads between a private (defaultable) and a public (nondefaultable) interest rate not only perform well in predicing output fluctuations but also eliminate the predictive content of monetary aggregates. For example, using the spread between the Baa corporate bond rate and the 10-year Treasury bond rate in equations like those reported in Table 4 results in an F-statistic of 3.35 or the spread terms (versus 3.60, as shown in the table, with the paper-bill spread). As Stock and Watson (1990) noted, among private-versus-public interest rate spreads, those measured at the short end of the maturity spectrum typically exhibit the best performance.

10. We are grateful to an anonymous referee for suggesting the work reported in this section.

11. The variance decompositions are computed from Monte Carlo simulations with 500 runs. The confidence intervals reported are the intervals bounded by two standard deviations. (When the share indicated is close to the 0% lower bound, the normal approximation does not closely describe the relevant distribution.)

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