ANOTHER LOOK AT THE EVIDENCE ON MONEY-INCOME CAUSALITY

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Benjamin M. Friedman and Kenneth N. Kuttner*

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 Ml 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 1988 renders money no longer significant in predicting income, even within their chosen specification. 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.

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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.[1] 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

$$\Delta y_t = \alpha + \sum_{i=1}^{6} \beta_i \, \Delta m_{t-i} + \sum_{i=1}^{12} \gamma_i \, \Delta y_{t-i} + \sum_{i=1}^{12} \delta_i \, \Delta p_{t-i} + \sum_{i=1}^{12} \theta_i \, \Delta r_{t-i} + f(t) + u_t \quad (1)$$

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, actually *favors* the 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

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

Trends Included	Sample: 1960:2–1985:12	1960:2–1979:9	1960:2–1988:12
None	2.187	2.493	1.084
	(0.045)	(0.024)	(0.372)
Linear	2.774	1.427	1.356
	(0.012)	(0.206)	(0.232)
Linear, Quadratic	2.181	1.339	1.019
	(0.045)	(0.241)	(0.413)

Note: Numbers in parentheses are marginal significance levels.

in the equation is defined throughout as in Stock and Watson's analysis: the index of industrial production (seasonally 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 1988. Merely extending the sample for an additional three years into the 1980s renders money not marginally significant in predicting real income, at any plausible significance level, regardless of whether the Stock-Watson trend terms are included. Moreover, results (not shown) for the 1960:2–1988:12 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 Treasury Bill Rate versus the Commerical Paper Rate

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. Sims (1980) and Friedman (1983) both used the commercial paper rate, while Litterman and Weiss (1985), Eichenbaum and Singleton (1986) and Stock and Watson (1989) all used the Treasury bill rate.[4] 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. For purposes of this paper, however, 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 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 *the interest rate* 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 *money* 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 strongly 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 *and* substituting the commercial paper rate for the Treasury bill rate overwhelms Stock and Watson's positive results altogether.

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 and the *spread* between the commercial paper rate and the Treasury bill rate. The table shows results for both the 1960–85 and the 1960–88 sample periods, but only for Stock and Watson's preferred specification including the linear time trend. (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. At the same time, the F-statistic for the (separate) null hypothesis that the respective pairs of coefficients on the commercial paper rate and the paper-bill spread are each equal in magnitude and opposite in sign (so that the net result is equivalent to simply including the Treasury bill rate,

Table 2

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

Trends Included	Treasury Bills	Commercial Paper
No Time Trend		
F-Statistic for Money	2.187	1.085
	(0.045)	(0.372)
F-Statistic for Interest Rate	0.829	1.288
	(0.620)	(0.225)
Linear Time Trend		
F-Statistic for Money	2.774	1.498
	(0.012)	(0.179)
F-Statistic for Interest Rate	0.811	1.154
	(0.639)	(0.316)
Linear, Quadratic Time Trends		
F-Statistic for Money	2.181	1.189
	(0.045)	(0.312)
F-Statistic for Interest Rate	0.847	1.157
	(0.602)	(0.314)

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

Table 3

Implications of Alternative Interest Rates in Stock-Watson Tests, 1960–1988

Trends Included	Treasury Bills	Commercial Paper
No Time Trend		
F-Statistic for Money	1.084	0.573
	(0.372)	(0.752)
F-Statistic for Interest Rate	0.842	1.603
	(0.607)	(0.090)
Linear Time Trend		
F-Statistic for Money	1.356	0.700
	(0.232)	(0.650)
F-Statistic for Interest Rate	0.813	1.499
	(0.637)	(0.123)
Linear, Quadratic Time Trends		
F-Statistic for Money	1.019	0.591
	(0.413)	(0.737)
F-Statistic for Interest Rate	0.884	1.498
	(0.563)	(0.123)

Note: Numbers in parentheses are marginal significance levels.
The sample period is 1960:2–1988:12.

Table 4
F-Statistics for Expanded Stock-Watson Equation

	1960:2–1985:12	1960:2–1988:12
F-Statistic for Money	1.425 (0.205)	0.539 (0.779)
F-Statistic for Paper Rate	0.786 (0.665)	0.913 (0.535)
F-Statistic for Paper-Bill Spread	3.419 (0.0001)	3.249 (0.0002)
F-Statistic for Constraint	3.787 (0.00002)	3.973 (0.00001)

Note: Numbers in parentheses are marginal significance levels.
Constraint forces coefficients on the paper rate and the paper-bill spread to be equal in magnitude and opposite in sign.

as in Stock and Watson's work) warrants rejecting this constraint at even stronger significance levels in both sample periods.

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. As Friedman and Kuttner (1990) emphasized in a different context, however, they do suggest that the sources of imperfect covariation between these two interest rates — presumably including an important role for a default premium that varies over time as perceptions of business creditworthiness change — 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.

Footnotes

1 Instead using long-term interest rates or equity prices would make interpreting positive results more problematic because of the inherently anticipatory nature of long-lived asset markets. 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.

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

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