Stock Returns and Monetary Aggregates

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Abstract

This paper examines the relationship between stock returns and money growth using the regression framework of Sims and Akaike's final prediction error criterion. Stock returns are found to lead unexpected money growth. Investors seem to base their decisions on "anticipated" short run monetary policy. Empirical results suggest that the market is efficient, although returns for large firms seem to adjust to new information faster than their smaller counterparts.

I. Introduction

Economists in general agree that a definite relation exists between money supply and financial asset prices. However, there is no consensus regarding the direction of influence and the existence of "feedback" in the literature. The quantity theory of money first proposed by Friedman and Schwartz (1963), among other monetarists, suggests that money supply changes affect economic variables including income since they create a temporary disequilibrium condition. Thus, other economic activities should lag behind money supply changes. Early research by Homa and Jaffe (1971), Hamburger and Kochin (1972), etc., has shown that such a lagged relationship exists between stock returns and money supply disturbances.

These previous works were later disputed by Cooper (1974), Rozeff (1974), Sorensen (1982), and others. Employing various econometric techniques, these researchers demonstrate that the causal relation may actually run from stock prices to money supply. Rogalski and Vinso (1977) contend that the causal relationship is bi-directional. Investigating the relation between stock returns and inflation, Fama (1982), and Geske and Roll (1983), show that stock returns signal real activity changes which in turn may lead to monetary responses.

The purpose of this study is to examine the relationship between stock returns and money supply. Unlike previous research which usually employs broad indices, this paper includes size portfolio returns to delineate the influence due to firm size. A monetary growth model by Barro (1977) is used to decompose the money supply growth into expected and unexpected series. This paper differs from Sorensen (1982) in that Barro's equation has been completely re-estimated and monthly instead of quarterly data are used. This should result in more refined estimations. Also, final prediction error (FPE) criterion by Akaike (1969) is employed as an alternative technique to examine the bi-directional relation between stock returns and money supply. The findings should yield new insights.

II. Methodology and Data

A. Methodology

This study consists of three phases. First, Barro's money supply growth model (1977) is re-estimated to generate monthly series of unanticipated and anticipated money growth rates. Unanticipated or unexpected money growth is taken to be the residuals from the money growth equation. Naturally, anticipated money growth is obtained as the prediction of the equation. This simple money growth model has been shown to explain satisfactorily the relations between money and other economic variables such as unemployment, output, and the price level [see Barro (1977)]. It is thus appropriate to use money supply shock (i.e. unanticipated money growth) and expected money growth rate as explanatory variables to assess the causal relation between stock returns and monetary changes in the second phase of the study. To corroborate the results, realized money growth is also employed as a regressor.

The last part of this investigation inquires the proposition of a bi-directional relationship between stock returns and monetary changes. To determine the optimal lag structure for the autoregressive equation, Hsiao's (1981) procedure which applies Akaike's minimum final prediction error criterion is used. The method in this paper deviates from Hsiao's procedure slightly. Instead of combining the FPE criterion and the Granger causality (1969) concept directly, Hsiao's procedure is utilized only to determine the best lag structure. Ordinary Least Squares estimation is then applied on the "best" autoregressive equation and the results are interpreted in the usual way. Inferring causality by this way is deemed more appropriate, since causality as generally implied in the money supply and stock returns literature is not entirely consistent with Granger's statistical definition. Finally, all analyses are repeated using different size portfolio returns.

B. Data

Monthly data from June, 1963 to December, 1985 are used. Stock returns are retrieved from the CRSP tape. Twelve returns measures, namely, the New York Stock Exchange value weighted returns (VW), the NYSE equally weighted returns (EW), and the returns on ten size portfolios as defined by CRSP (i.e. P1, P2, ..., P10, where P1 is the value weighted return on portfolio 1 consisting of firms with smallest capitalization) are investigated. Other data are gathered from Federal Reserve Bulletin and Survey of Current Business.

III. Empirical Analysis

A. Barro's Money Growth Model

Since the hypothesis of no serial correlation in Barro's money growth model is rejected at the 5% level, this analysis uses the generalized differencing procedure to eliminate the dependence between the disturbances. The computer technique employs a grid search method and the estimated variances are then calculated by applying Dhrymes' Theorem 7.1 (1971, pp. 199-120). This procedure has the same asymptotic properties as the Maximum Likelihood estimators. In this study, the estimated adaptation coefficient for the expected normal level of government expenditure is 0.3. This value minimizes the squared errors of the money growth equation over the permissible range of 0 to 1. The regression explains almost 81% of the variations in the data. All but one of the explanatory variables are significant at the 5% level with the expected positive sign. (To conserve space, the resulting estimation is available from the author upon request and is not reported here.)

B. Regression Tests of Returns with Unanticipated, Anticipated and Realized Monetary Growth

To analyze the relationship between stock prices and monetary changes, stock returns are regressed upon unanticipated money growth ($RESI_t$). The same regression is then performed with anticipated money growth rates ($PRED_t$) and realized growth rates ($ACTU_t$) as the explanatory variables. Twelve different return measures are analyzed. First differences of PRED and ACTU are used to reduce the problem of multicollinearity among the regressors. Regression results with unanticipated money growth are reported in **Table 1.**

There is a significantly negative lagged relationship in some of the smaller size portfolios. The F2 statistics (H_0: $\beta_{-1} = \beta_{-2} = \beta_{-3} = \beta_{-4} = 0$) are significant for P2, P3, P4, P6, and EW at the 5% level. A significant third lag is present in all cases with the exception of the two largest size portfolio returns and the value weighted returns. Sorensen has also docu-

TABLE 1
REGRESSION OF STOCK RETURNS UPON UNANTICIPATED MONEY GROWTH*

$$R_t = \alpha_0 + \sum_{i=-4}^{4} \beta_i RESI_{t+i} + e_t$$

	α_0	β_{-3}[a]	β_0	β_{+1}	β_{+2}	DW	R^2	F**	F1[b]	F2[c]
VW	0.007 (2.76)	-0.40 (-1.65)	0.30 (1.24)	0.87 (3.62)	0.50 (2.08)	1.98	0.08	2.47	4.51	0.95
EW	0.01 (3.19)	-0.75 (-2.46)	0.73 (2.38)	1.21 (3.96)	0.65 (2.15)	1.83	0.11	3.48	4.88	2.30
P1	0.01 (3.20)	-0.19 (-2.22)	1.11 (2.69)	1.43 (3.48)	0.73 (1.79)	1.89	0.09	2.91	3.55	1.86
P2	0.01 (3.31)	-0.88 (-2.42)	0.91 (2.51)	1.40 (3.85)	0.83 (2.31)	1.88	0.11	3.51	4.58	2.49
P3	0.01 (3.17)	-0.91 (-2.60)	0.86 (2.47)	1.30 (3.73)	0.74 (2.14)	1.84	0.11	3.41	4.40	2.47
P4	0.01 (3.49)	-0.92 (-2.86)	0.76 (2.36)	1.25 (3.87)	0.74 (2.30)	1.80	0.12	3.71	4.96	2.78
P5	0.01 (3.25)	-0.74 (-2.38)	0.69 (2.21)	1.17 (3.77)	0.67 (2.16)	1.82	0.11	3.31	4.84	2.20
P6	0.01 (3.18)	-0.80 (-2.68)	0.59 (2.00)	1.22 (4.12)	0.65 (2.20)	1.81	0.12	3.73	5.35	2.75
P7	0.01 (3.06)	-0.65 (-2.22)	0.56 (1.90)	1.11 (3.79)	0.66 (2.26)	1.81	0.10	3.04	4.74	1.86
P8	0.01 (3.10)	-0.64 (-2.31)	0.44 (1.61)	1.12 (4.06)	0.63 (2.31)	1.90	0.10	3.23	5.12	2.03
P9	0.01 (2.73)	-0.50 (-1.90)	0.33 (1.24)	1.01 (3.87)	0.57 (2.18)	1.88	0.09	2.80	4.68	1.59
P10	0.01 (2.44)	-0.28 (-1.22)	0.19 (0.81)	0.72 (3.14)	0.41 (1.80)	2.08	0.07	1.97	3.76	0.56

* t-values are in parentheses.
** The critical value of $F(4,\infty)$ at 5% = 2.37, $F(9,\infty)$ at 5% = 1.88.
a β_{-4}, β_{-2}, β_{-1}, β_{+3}, and β_{+4} are insignificant for all return measures.
b F1 is the test statistic for H_0: $\beta_{+1} = \beta_{+2} = \beta_{+3} = \beta_{+4} = 0$.
c F2 is the test statistic for H_0: $\beta_{-1} = \beta_{-2} = \beta_{-3} = \beta_{-4} = 0$.

mented similar results using quarterly S & P 500 returns. He contends that "these lagged negative coefficients for unanticipated money growth may suggest anticipatory behavior by market participants who expect the Federal Reserve to counter the most recent unpredicted direction of the money supply." (1982, p.656)

However, why a significant relation existed only in the smaller size portfolios is puzzling (note that small firms have significant weights on the EW portfolio). Perhaps this indicates the market is not very efficient (in the semi-strong form sense) for smaller firms. Returns on smaller firms do not fully reflect the latest information swiftly. Then why is only the third lag significant? A plausible answer is that unanticipated money supply has a strong correlation with other economic variables such as GNP, prices, etc., as documented by Barro (1977), and some major economic indicators are readily available only on a quarterly basis. As returns are clearly impacted by more than money supply alone, significant third lag of money growth may actually be serving as a proxy for other economic variables. Further empirical verification is needed to provide a definite explanation.

In contrast, the first and second future leads of the money growth shock are significant for all return measures. This does not necessarily mean that stock returns influence/induce money supply. Rather, the results tend to support the theory of "anticipatory behavior" by the investors. Moreover, if the Federal Reserve signals its intentions on money growth before executing the policy, as Rozeff (1974) points out, the stock market may react quickly to this information and "anticipate" the future monetary policy in the short run. It will explain the relationships shown in Table 1.

Interestingly, contemporaneous unexpected money growth is not significantly related to the largest four size portfolio returns and value weighted return. This apparent discrepancy strengthens the contention that the market is more efficient for larger firms. Data on unemployment, government expenditure, M1 (on the last Wednesday of each month), and other variables may be known to resourceful investors before the last trading day of the month. If the market is very efficient for large firms, information will be disseminated quickly and reflected in the "month-end" returns. The relation between returns and contemporaneous unanticipated money growth will not, therefore, be significant at all.

Results in **Table 2** also indicate a causal relationship between current returns and the current and future changes in realized money growth. Results using realized money growth are very similar to those reported in Table 1 except the third lags are insignificant. Indeed, no lagged relationship should appear in an efficient market since stock prices have already incorporated past information on money growth. The current term is not significant for the largest size portfolio. Again, this supports the existence of a more efficient market for larger firms.

Regressions with anticipated money growth changes are also performed. To conserve space, statistical results are available only upon request. The findings suggest that market behavior is consistent with the efficient market hypothesis. All current anticipated money growth and past lags are insignificant. On the other hand, there are significant first, second, and third future leads. Since these future leads can be viewed as market forecasts on short run monetary policy, the results provide important evidence supporting the "anticipatory" theory that current returns incorporate anticipations of future monetary policy. Since this analysis uses end-of-month returns, current anticipated money growth changes should not be significant as the "forecast" of time zero money growth would be obsolete by the end of the month.

IV. Causality Testing: An Alternative Approach

So far this article has been using Sims' (1972) scheme to test unidirectional causality. Treatment of the lead/lag structure is rather ad hoc,

TABLE 2
REGRESSION OF STOCK RETURNS UPON THE FIRST DIFFERENCES OF REALIZED MONEY GROWTH*

$$R_t = \alpha_0 + \sum_{i=-4}^{4} \beta_i ACTU_{t+i} + e_t$$

	α_0	β_0[a]	β_{+1}	β_{+2}	DW	R^2	F**	F1[b]	F2[c]
VW	0.006 (2.53)	0.53 (2.25)	1.07 (4.57)	0.61 (2.64)	2.02	0.10	3.21	6.47	0.26
EW	0.01 (3.00)	1.03 (3.47)	1.48 (5.00)	0.84 (2.86)	1.86	0.13	4.24	7.47	0.63
P1	0.01 (3.06)	1.41 (3.52)	1.73 (4.32)	0.94 (2.37)	1.92	0.11	3.40	5.32	0.62
P2	0.01 (3.12)	1.25 (3.53)	1.71 (4.85)	1.04 (2.97)	1.92	0.13	4.18	7.03	0.76
P3	0.01 (2.98)	1.20 (3.55)	1.61 (4.77)	0.98 (2.90)	1.88	0.13	4.15	6.94	0.78
P4	0.01 (3.29)	1.11 (3.54)	1.59 (4.99)	0.95 (3.07)	1.83	0.14	4.53	7.76	0.92
P5	0.01 (3.06)	1.01 (3.35)	1.47 (4.90)	0.88 (2.93)	1.85	0.13	4.09	7.55	0.44
P6	0.01 (3.02)	0.92 (3.20)	1.51 (5.26)	0.85 (2.97)	1.84	0.14	4.53	8.37	0.74
P7	0.01 (2.87)	0.88 (3.10)	1.39 (4.91)	0.85 (3.00)	1.85	0.12	3.90	7.49	0.34
P8	0.01 (2.92)	0.73 (2.75)	1.36 (5.08)	0.79 (2.99)	1.94	0.13	3.96	7.67	0.50
P9	0.01 (2.56)	0.59 (2.31)	1.23 (4.85)	0.71 (2.80)	1.91	0.11	3.47	6.97	0.32
P10	0.005 (2.19)	0.38 (1.68)	0.89 (3.97)	0.50 (2.25)	2.11	0.08	2.55	5.11	0.32

* t-values are in parentheses.
** The critical value of $F(4,\infty)$ at 5% = 2.37, $F(9,\infty)$ at 5% = 1.88.
a β_{-4}, β_{-3}, β_{-2}, β_{-1}, β_{+3}, and β_{+4} are insignificant for all return measures.
b F1 is the test statistic for H_0: $\beta_{+1} = \beta_{+2} = \beta_{+3} = \beta_{+4} = 0$.
c F2 is the test statistic for H_0: $\beta_{-1} = \beta_{-2} = \beta_{-3} = \beta_{-4} = 0$.

although similar results are obtained under a large number of different lead/lag structures. In this section, an efficient method which applies the Akaike minimum final prediction error (FPE) criterion is used to determine the best lag structure and to test the bidirectional causal relation. Instead of relying upon a priori knowledge (such as assuming an Almon lag structure), this method simply let the data determine the optimal specification. [See Judge et al (1982) for a concise description of the procedure.]

In this analysis, the bivariate autoregression system is presented as:

$$r_t = \Phi_{11}(L)r_t + \Phi_{12}(L)s_t + u_t \quad (1)$$

$$s_t = \Phi_{21}(L)r_t + \Phi_{22}(L)s_t + v_t \quad (2)$$

where $\Phi_{ij}(L) = \sum_{k=1}^{M_{ij}} \Phi_{ijk}L^k$, and L is the lag operator,

r_t = stock market returns,

s_t = unexpected money growth shock, and

M = the maximum prespecified order for Φ_{ij}.

An arbitrary maximum order of 6 (i.e. M = 6) is specified. Instead of applying Granger causality and FPE criterion directly to determine the causal relation as proposed by Hsiao (1981), this paper employs OLS estimations once the optimal lag structures are identified. This modification provides a more common interpretation of causality in light of the literature. Empirical results are summarized in **Table 3**.

It is obvious that past unanticipated money growth does not "cause" current returns. While some of the return measures exhibit a weak relationship with past unexpected money supply according to the minimum FPE criterion and Granger's definition of causality, none of the coefficients have a significant t value at the 5% level. The results thus rule out past money supply as a causal variable. On the contrary, a significant relationship between current unanticipated monetary growth and past returns emerges from the table. One can safely infer from the results that stock returns are related to future money growth, at least on an ex post basis. Results using realized and anticipated money growth also support this conclusion. Such findings certainly add credence to the empirical results of prior research by Cooper (1974) and Rozeff (1974), and those in the previous section.

V. Conclusions

The causal relationship between stock returns and monetary aggregates has been subjected to much debate. This paper presents results that are clearly consistent with the hypothesis of an efficient market. The methodology employed in the third section of the article is similar to Sorensen's (1982). However, the results here are more general. This analysis does not specify an Almon lag structure and monthly data are used. Returns of different size portfolios are included in the investigation. Results confirm that changes in stock prices lead unexpected monetary growth.

Investors seem to incorporate their anticipations of future monetary policy into their current investment decision process. Further substantiation of the results are provided through an alternative testing procedure based upon Akaike's FPE criterion. Discrepancies in results on size portfolio returns indicate that larger firms may be more informational efficient. In short, this paper has introduced new evidence to support the propositions that the market is efficient and that investors' expectations on future monetary policy affect current stock returns.

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TABLE 3
CAUSALITY TEST USING THE FPE CRITERION AND OLS REGRESSION

Returns	Optimal Lag Structure Equation (1)	FPE_{r_3} x 10^{-3}	t^a	Optimal Lag Structure Equation (2)	FPE_{s_4} x 10^{-4}	$F1^b$
VW	(1,0)	1.8181	-----	(2,3)	1.1719	8.30
EW	(1,1)	2.9245	-1.64	(2,3)	1.1678	8.78
P1	(1,1)	5.2385	-1.45	(2,3)	1.1852	6.75
P2	(1,1)	1.0824	-1.74	(2,3)	1.1703	8.49
P3	(1,1)	3.7990	-1.71	(2,3)	1.1752	7.91
P4	(1,1)	3.2635	-1.62	(2,3)	1.1702	8.50
P5	(1,1)	2.9245	-1.48	(2,3)	1.1719	8.21
P6	(1,1)	2.9245	-1.61	(2,3)	1.1678	9.52
P7	(1,0)	2.6764	-----	(2,3)	1.1709	8.41
P8	(1,0)	2.3957	-----	(2,3)	1.1614	9.54
P9	(1,0)	2.1449	-----	(2,3)	1.1679	8.77
P10	(1,0)	1.6306	-----	(2,3)	1.1852	6.79

[a] When the optimal lag structure is identified as (1,1), the equation is given as:

(1') $r_t = \beta_0 + \beta_1 r_{t-1} + \beta_2 s_{t-1} + u_t$

The t-value reported above is for β_2, coefficient for the lagged unanticipated money growth. None of the return measures are significantly related to past unexpected money growth.

[b] The equation estimated is as follows:

(2') $s_t = \tau_0 + \tau_1 r_{t-1} + \tau_2 r_{t-2} + \tau_3 s_{t-1} + \tau_4 s_{t-2} + \tau_5 s_{t-3} + v_t$

* F1 is the test statistic for H_0: $\tau_1 = \tau_2 = 0$

The critical value for $F1(2,\infty)$ at 5% = 3.00. Since all of the F1 statistics are significant, there is a causal relation from stock returns to monetary changes.

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