Money and Stock Prices

By Robert D. Auerbach

It is frequently argued that movements in aggregate indices of common stock prices can be predicted from prior changes in the money supply. This belief has been supported by a number of statistical studies which appeared during the 1960's and early 1970's. These studies purported to show that changes in the quantity of money have an important and explicit influence on movements in equity prices. Recently, however, doubts have arisen regarding the accuracy of this simplistic linkage between money and stock prices. Underlying these doubts are concerns about certain analytical underpinnings of the linkage as well as the statistical methodologies used to support the linkage.

This article further explores the relationship between money and stock prices. The first part of the article briefly reviews and comments on some of the earlier studies that have dealt with this relationship. The second part offers additional empirical evidence on the relationship in an attempt to correct some of the deficiencies of earlier studies. In general, the results presented here indicate that, while money is related to stock prices, the relationship is much weaker than claimed in some earlier studies. Also, changes in stock prices are found to be statistically related to both current and future changes in the money supply but not to past changes in money. Thus, the common belief that stock prices can be simply predicted by prior changes in the money supply would appear to be unfounded.

A REVIEW OF EARLIER STUDIES

One of the first studies to draw popular attention to the simple relation between money and stock prices was conducted by Beryl Sprinkel in 1964.[1] In his book, **Money and Stock Prices,** Sprinkel used the simple quantity theory of money to explain equity asset pricing. Changes in the money supply, he held, would influence the public's desire to substitute money balances for other financial assets, including stocks. This substitution process, in turn, would generate pressures leading to changes in the prices of stocks.

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[1] Beryl W. Sprinkel, *Money* and *Stock Prices* (Homewood, Ill.: Richard Irwin, Inc., 1964).

To examine this relation, Sprinkel compared the level of an index of stock prices with a moving average of rates of change in the narrowly defined money supply (M1).[2] He then compared selected turning points in each of these two series with turning points in the business cycle. By visual examination of the data, he observed that changes in both money and stock prices led business cycle turning points. He also observed that changes in money had a longer lead time over business cycle turning points than over stock price changes. Hence, money supply changes appeared to lead stock price changes. From these observations, Sprinkel asserted:

> . . . the average lead of changes in monetary growth prior to the business cycle peak is about 19 months compared to a 4-month average lead of stock prices. Changes in monetary growth lead cyclical upturns by an average period of about 7 months, whereas stock price upturns occur about 5 months prior to business upturns on average. Therefore, changes in monetary growth lead changes in stock prices by an average of about 15 months prior to a bear market and by about 2 months prior to bull markets.[3]

There are three fundamental problems with Sprinkel's technique for relating money to stock prices and the business cycle. First, there is the problem of determining which movements in the time series data on money and stock prices are significant turning points. Visual inspection of the data, as Sprinkel has done, is less exact than other statistical techniques. The second problem concerns the determination of whether it is money or stock prices that change first. It is not clear, as evidence presented later shows, that money supply changes always precede related stock price changes. The third problem pertains to Sprinkel's use of averages, which raises the following question: Are the average time lags he finds between the change in one variable and the change in the second variable stable time lags? In other words, over repeated episodes will these lags tend to approach the same average time period? As a matter of arithmetic, it is always possible to compute an average time lag between turning points in two series that do not have synchronous turning points. However, it is not the existence of such a lag but rather the stability of the lag which supports the view that the two series are related. In view of these problems, subsequent researchers have sought to employ better statistical techniques to examine the relation between money and stock prices.

A more rigorous statistical examination of money and stock prices was made by Michael Keran in 1971.[4] He began his analysis by using the standard formulation for theoretically explaining stock prices. This formulation holds that the price of a share of common stock is equal to the present discounted value of the earnings the stock is expected to produce in the future. The standard formulation is represented by the following equation:

$$(1) \qquad SP_t = \sum_{i=1}^{\infty} \frac{E_i}{(1+r)^i},$$

where SP_t is the price of a stock at the beginning of period (t), E is expected future corporate earnings, and r is the rate of interest used to discount expected earnings. According to the formula, a rise in earnings serves to

2 M1 includes demand deposits adjusted plus currency in the hands of the public.

3 Sprinkel, *Money and Stock Prices,* p. 119. Also, his "Monetary Growth as a Cyclical Indicator," *The Journal of Finance.* September 1956, pp. 333-46, presents similar methodology.

4 Michael Keran, "Expectations, Money, and the Stock Market," Federal Reserve Bank of St. Louis *Review.* January 1971.

increase stock prices and a rise in the interest rate decreases prices.

In Keran's model, proxy variables were used as substitutes for expected earnings (E) and the interest rate **(r).** For expected earnings, he substituted current and past values of corporate earnings. For the interest rate, he substituted the determinants of the corporate bond rate, which he held to be current and past rates of growth of real income ($\dot{y}$), the price level ($\dot{P}$), and the real money supply **(m).** The level of stock prices, therefore, was expressed as a function of these variables in the following manner:

$$SP = f\,(E, y, P, m). \tag{2}$$

Given this equation, Keran postulated that increases in real income and the price level serve to increase interest rates which, in turn, act to decrease stock prices. Also, an increase in the real money supply lowers interest rates which acts to increase stock prices. In brief, the level of stock prices was expected to be positively related to the level of corporate earnings and the rate of change in money and negatively related to the rate of change in real income and the rate of change of prices.

Using regression analysis, Keran estimated the values of his stock price equation employing quarterly data for the time period 1957-70.[5] His equation explained a remarkable 98 per cent of the variation in the Standard and Poor's composite stock price index. Keran also found: "A 1 per cent acceleration in real money will lead to a 1.31 per cent increase in the stock price index." He described this direct effect of money on stock prices as significant but relatively small. However, he also claimed that money has an important influence on the other variables explaining stock prices, i.e., real output, prices, and earnings. "Through this process," he concluded, "changes in money are the dominant factor, both direct and indirect, influencing stock prices."

In another study, also appearing in 1971, Kenneth Homa and Dwight Jaffee focused more explicitly on the direct relationship of money and stock prices.[6] In the context of the standard valuation formula of equation (1), they theorized that money should serve as a proxy for both explanatory variables, expected earnings and the interest rate. That is, the money supply should be positively related to corporate earnings and negatively related to the interest rate. Consequently, the level of stock prices, they felt, should be positively related to the money supply as shown in the following functional equation:

$$SP = f\,(M). \tag{3}$$

To test this relationship, Homa and Jaffee estimated an equation that related the level of stock prices to the level of the money supply **(M)** and the rate of growth of the money supply ($\dot{M}$).[7] They used Standard and Poor's composite index as a measure of stock prices,

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[5] **The estimated equation is:**

$$SP_t = -30.68 + \underset{(9.84)}{} \sum_{i=0}^{19} \underset{(20.00)}{4.80}\, E^o_{t-i} + \sum_{i=0}^{2} \underset{(4.14)}{1.31}\, \dot{m}_{t-i}$$

$$- \sum_{i=0}^{7} \underset{(5.67)}{5.37}\, \dot{y}_{t-i} - \sum_{i=0}^{16} \underset{(7.93)}{11.96}\, \dot{P}_{t-i}$$

$R^2 = .98$ D-W = 1.71.

R^2 is the per cent of variation in the dependent variable which is explained by variations in the independent variables. The "t" statistics, enclosed by parentheses, are for the sum of the coefficients of each variable and are significant at the 95 per cent level of confidence. D-W is the Durbin-Watson statistic.

[6] **Kenneth E. Homa and Dwight M. Jaffee, "The Supply of Money and Common Stock Prices,"** ***The Journal of Finance.*** **December 1971.**

[7] **Their estimated equation is:**

$$SP = -\underset{(1.11)}{26.77} + \underset{(4.13)}{0\,61}\, M_t + \underset{(3.16)}{3.14}\, \dot{M}_t + \underset{(1.46)}{1.46}\, \dot{M}_{t-1} + 0.87u_{t-1}$$

$R^2 = .968$ D-W = 1 82

M1 as a measure of money, and employed quarterly data for the period 1954-69. Homa and Jaffee were able to explain as much as 96 per cent of the variation in stock prices by using the nominal money supply as the only explanatory variable.

The surprisingly high degree of explanatory power obtained in the tests by both Keran and Homa and Jaffee are suspect, however, due to their statistical methodologies. Both of these studies suffer from a common problem in the statistical analysis of variables. This problem arises when an attempt is made to quantify the relationship between variables that are marked in their time series behavior by a common long-run trend and by common movements during business cycles. Adequate procedures must be employed to carefully take account of these common trends and cycles in the variables; otherwise, statistical tests may tend to support a close relationship between the variables even though they are basically unrelated.

To illustrate this point, the following test was conducted. An artificial series having no economic significance was constructed by adding a series of random numbers to a simple trend variable. This artificial series was then used in a regression test to explain the quarterly levels of stock prices (again measured by the Standard and Poor's index) from 1959 through 1974. The results showed that this single artificial variable was able to explain 86 per cent of the change in stock prices.[8] The finding that such an artificial variable can explain nearly as much of the variation in stock prices as obtained in the previous studies underscores the possibility of producing results that are statistical illusions when trends in the data are ignored.[9]

A further problem with the studies by Keran, Homa and Jaffee, as well as by Sprinkel, is that they only tested one-way causation with money predicting future changes in stock prices. They did not consider that changes in stock prices may lead changes in money. This latter sequence is embodied in a widely accepted view regarding the determination of stock prices known as the "efficient market hypothesis."[10] According to this hypothesis, the stock market is said to be efficient in that stock prices are determined by market participants on the basis of all available information. The stock market also is said to be efficient in that the adjustment of stock prices to new information is so rapid that it can be treated as being almost instantaneous. Taken together, these conditions mean that if the public "expected" a change in the money supply to occur that would ultimately affect price levels, corporate profits, etc., the public would immediately buy and sell stocks at prices that take account of these expected effects. That is, expected changes in money would immediately be discounted into the prices of stocks. Consequently, if subsequent changes in money were to occur as

8 With the artificial series denoted by X, and the trend variable at an annual rate of 2.5 per cent, the estimated equation is:

$$SP = -49647\ 3 + 0\ 11X \qquad R^2 = 86.$$
$$(18.74)$$

9 Further criticism of Keran's work is made by Merton H. Miller, "Discussion." *Pupers and Proceedings of the 13th Annual Meeting of the Americun Finunce Association. The Journal of Finance*, May 1972, pp. 294-98; and James E. Pesando, "The Supply of Money and Common Stock Prices: Further Observations on the Econometric Evidence," *The Journal of Finance*, June 1974, pp. 904-21. Pesando finds that Keran's model predicts an unabated persistent decline in stock prices from 1970:3 to 1972:2 while stock prices actually rose in the second half of 1970. leveled off in 1971, and advanced in 1972.

10 For a review of the efficient market hypothesis literature, see Eugene F. Fama. "Efficient Capital Markets: A Review of Theory and Empirical Work." in *Puprrs und Proceedings of the 28th Annual Meeting of rhe American Finance Association, Thr Journal of the American Finance Association*. May 1970. pp. 383-416; and Charles D. Kuehner. "Efficient Markets and Random Walk." *Financial Analysts Handbook*. ed.. Suniner N. Levine (Homewood, Ill.: Dow Jones-Irwin. Inc.. 1975). pp. 1226-95.

expected, stock prices would change before and not after observed changes in money.

Another aspect of the efficient market hypothesis involves an "unexpected" change in the money supply. In this case, the hypothesis holds, when the public observes an unexpected monetary change they would immediately discount this information into stock prices. Hence, an unexpected money supply change would produce a synchronous relationship, or at most a very short lag, between money supply changes and stock prices.[11] The efficient market hypothesis; therefore, by combining expected and unexpected changes in money, holds that stock prices should tend to be related to current and future changes in money and not to past money changes.

A recent study by Richard Cooper examined the issue of leads and lags between money and stock prices.[12] Using the framework of equation (3) cited previously, which relates stock prices directly to the money supply, Cooper estimated the following equation:

$$SP_t = \sum_{i=-6}^{12} a_i \dot{M}_{t-i}, \qquad (4)$$

where SP is the percentage change in stock prices adjusted for dividend yields and M is the percentage change in money. He referred to the stock price variable as the "stock yield" since it combines the percentage change in the price of a stock with its dividend yield. Stock yields, Cooper claimed, were a better measure of returns on stocks than just the percentage change in stock prices. In brief, Cooper related the stock yield to the current percentage change in money, to past percentage changes in money for up to 12 months, and to future percentage changes in money for up to 6 months. Using regression analysis, he estimated the relation using monthly data for the period 1947-70. Chart 1 depicts the monthly stock yields used by Cooper for the 1947-70 period.

Cooper's regression tests showed a weak relationship between stock yields and rates of change of the money supply. His estimated equation using current, past, and future percentage changes in money (M1) explained only about 7 per cent of the monthly variation in stock yields." Moreover, the money supply variable in the current period was found to be not statistically significant in explaining stock yields. This result tended to contradict the efficient market hypothesis which liolds that a synchronous adjustment of stock yields should occur if the market is efficient. Cooper also found only one of the lagged money supply variables and only two of the future money variables to be statistically significant in explaining stock yields. On the basis of these inconclusive results, Cooper concluded it was difficult to assess the significant lead and lag relationships from regression analysis.[14]

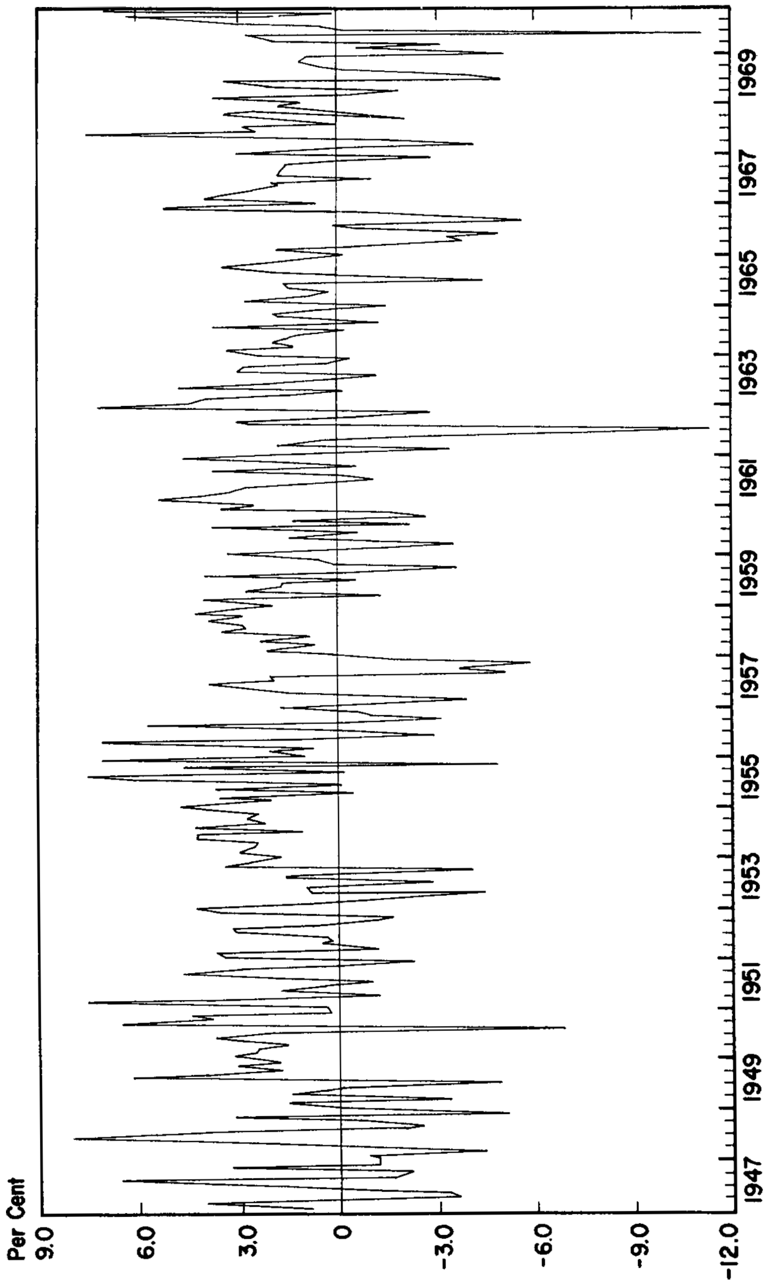
11 Transactions and decisionmaking costs may produce lags between monetary changes and stock prices.

12 Richard V. L. Cooper, "Efficient Capital Markets and the Quantity Theory of Money." *The Journal of Finance.* June 1974, pp. 887-908.

13 Cooper also tested his equation using quarterly and annual data. While the explanatory power of these tests rose somewhat relative to the use of monthly data, all of his tests were probably seriously flawed by the existence of trends in the data and nonrandom residuals. If the dependent variable, SP_t, in equation (4) above is not related to any of its prior values, which is almost the case, then it can be shown that the regression residuals may be nonrandom. Thus, a test for the randomness of the residuals must be conducted but no such test was made by Cooper.

14 Cooper then proceeded to use the more sophisticated spectral analysis technique to examine the relation of money and stock prices in the frequency domain. These results showed that stock returns led money changes but did not lag money changes. On this basis, he felt his results offered support for the concept of market efficiency. Cooper's evaluation of his spectral results, however, is somewhat doubtful due to his own admitted difficulty in interpreting the lead-lag relationships. (See Cooper, p. 898.)

Chart 1
STOCK YIELDS
Monthly, 1947-70
(Standard and Poor's Common Stock Indexes)



FURTHER TESTS

Results of additional tests on the relation between money and stock prices are presented in this section. As in Cooper's study, the tests explicitly examine the lead-lag relation between money and stock prices. The variables **used in** the tests are also the same as those used by Cooper, the stock yield and the'rate of change in the money supply. M1 is used as a measure of money and stock yields are defined as the percentage change in stock prices adjusted for dividend yields.

Two modifications, however, were made in the approach used by Cooper. First, the data for the variables were examined for evidence of trends and cycles. The examination revealed that both variables contained trend and cycle elements which may have tended to bias the results obtained by Cooper. Thus, the trend and cycle components of each variable were **removed.**[15] Secondly, to examine the degree of **association between** the money supply and the stock yield, simple cross correlation tests were performed rather than regression **analysis.**[16] The correlation coefficient, which is a measure of the degree to which two variables are related, can vary from +1 to −1. For example, if two variables display little or no association the coefficient would approach zero; if there is perfect positive association the coefficient would be +1; and with perfect negative association it would be −1;

Using simple correlation analysis, therefore, the cross'correlation was computed between the current stock yield and the current money variable. Next, cross correlations were calculated between the current stock yield and the money variable in each of 60 prior monthly periods. Finally, to test whether stock yields lead money, the variables were reversed and cross correlations were computed between the current money variable and the stock yield in eachof 60 prior monthly periods. These tests were conducted using monthly data for the period 1947-70.

Table 1
SIMPLE CROSS CORRELATIONS

PERIOD	CURRENT STOCK YIELD WITH PERCENTAGE CHANGE IN M1
Synchronous	.18*
1 month prior	−.03
2 months prior	.07
3 through 60 months prior	None significantly different from zero
PERIOD	**CURRENT PERCENTAGE CHANGE IN M1 WITH STOCK YIELD**
Synchronous	.18*
1 month prior	.12*
2 months prior	.20*
3 through 60 months prior	None significantly different from zero

"Significantly different from zero.

As shown in Table 1, the cross correlations between the current stock yield and 60 prior values of the money **variable** were not statistically significant.[17] **Only the synchronous**

15 For a description of the autoregressive technique used to remove the trends and cycles, see Robert D. Auerbach and Jack L. Rutner. "Time and Frequency Domain Tests of Some U.S.-Canadian Relationships Under an Autoregressive Filter," Applied *Economics* (forthcoming). If the levels of stock prices used in the previously cited studies were transformed to first differences of its logarithmic values in an attempt to eliminate its trend, the variable would be in exactly the same form as the stock yield used by Cooper and very similar to the stock variable used in these additional tests except for the dividend adjustment.

16 The use of simple cross correlations bypasses the statistical problems mentioned in footnote 12.

17 A chi square statistic due to G. E. Box and David Pierce, "Distribution of Residual Autocorrelations in Autoregressive-Integrated Moving Average Time Series," **Journal of the American Statistical Association,** December 1970. p. 1510, was used to test for significance in groups. The correlations in the righthand column. .18, .12, and .20, taken as a group of three or as a group of two with the synchronous cross correlation deleted, were significant at the 99.5 per cent level. All other lagged coefficients taken in groups of three for successive cumulative tests were not significantly different from zero at the 95 per cent level of confidence.

cross correlation was statistically significant at a value of .18. When the variables were reversed to test whether stock yields lead money, the synchronous cross correlation was equal to .18, as expected. Cross correlations between the current money variable and stock yields in each of the previous 2 months also were found to be statistically significant. Specifically, stock yields 1 and 2 months in the past had significant cross correlations with the current percentage change in money of .12 and .20, respectively. Taken together, the current stock yield and-the two prior stock yields serve to "explain" about 8.7 per cent of the variation in the current percentage change in money.[18]

The results of these further tests support the following conclusions:

1. Rates of change of the money supply are not related to future stock yields.

2. Stock yields are related to synchronous and future rates of change in the money supply.

3. The relation between stock yields and synchronous and future rates of change in the money supply is weak, with stock yields associated with only about 9 per cent of the variation in the money supply.

Theoretically, these findings are consistent with the efficient market hypothesis and the belief that the public is knowledgeable about a relationship between money and other variables—such as the price level—as Cooper suggested. The public tends to anticipate some money supply changes and discounts this information into stock prices 1 or 2 months before the money supply changes. Unanticipated money supply changes are discounted into stock prices in the same month as the monetary change occurs.

One reservation for this explanation of the results concerns the public's ability to forecast the monetary variable in advance. Since trends and periodicities have been removed from the money series, the public would be required to predict deviations from the trend and past periodicities. Prior values of the money supply series would provide no useful information for this forecast. It is questionable, however, that the public has the ability to predict more than a very minor component of these monetary changes. Thus, other explanations might underlie these results.

An alternative explanation is that the relationship between prior and synchronous stock yield changes and current rates of change in money is the result of actions taken by the central bank. Suppose, first, that stock yields, or some variable related to stock yields, is used by the central bank as an indicator of business cycle fluctuations. Suppose further that the central bank acts to partially accommodate movements in the cycle. Then, during an economic expansion, for example, the central bank would attempt to accommodate increased business activity by providing for an increase in the money supply. Under these conditions, stock yields would increase slightly earlier and synchronously with monetary expansion, and one would observe the findings reported in these tests.[19]

18 Squaring and adding these cross correlations produce a statistic equal to .0868, which in concept is roughly equivalent to a multiple correlation coefficient in regression analysis. Since the percentage change of M1 has been prewhitened, the values of this series in different periods are approximately independent so that the simple cross correlations are similar to partial correlations. The differences in degrees of freedom for each simple cross correlation and the possibility of slight violations of the white noise hypothesis for the variables make this relationship approximate.

19 If the public also uses stock yields or a related variable to signal business cycle fluctuations in the same way as the central bank, the public would be able to forecast monetary changes and this explanation would not differ from the first explanation.

CONCLUSION

Other studies which have reported a strong relation between money and stock prices with money supply changes related to future stock prices appear to be incorrect. These studies have probably measured the effects of common trends and cycles in each variable rather than a causal relationship between the variables. In addition, these tests may also include relationships between stock prices and future monetary changes which have been mistakenly identified as a relation between money and future stock price changes. Theoretically, these studies appear to have incorrectly assumed that the public was slow in discounting information about monetary changes into stock prices so that monetary changes precede related stock price changes. The evidence here indicates that the public rapidly discounts any useful information about monetary changes into stock prices so that past monetary changes no longer contain information about present or future stock prices.