Expectations, Money, and the Stock Market*

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In recent years, increasing attention has been given to analyzing influences of expectations and monetary actions on the course of economic activity. This article examines the response of the general level of stock market prices (measured by the quarterly average of the Standard and Poor's 500 Daily Index) to these two influences. Attention is given exclusively to explaining the general movement of stock prices rather than to explaining very short-run movements in the level of stock prices or changes in the prices of individual stocks.

The standard theory of stock price determination – discounting to the present the value of expected future earnings – is used to extend the St. Louis model to include relationships which influence the level of stock prices. The discounting procedure involves the use of an interest rate to determine the present value of expected corporate earnings over some future time horizon.

The statistical estimates of the stock market relationships lead to the conclusion that the general level of stock prices is influenced mainly by expected corporate earnings and expectations of inflation. An increase in expected corporate earnings leads to a higher level of stock prices. Expectations of increasing inflation were found to lower the level of stock prices and not to raise it as is commonly argued. Inflationary expectations increase both expected corporate earnings and the interest rate at which these earnings are discounted. Evidence is presented in this study, however, that changes in inflation expectations exert a much greater influence on the rate of discount than on expected corporate earnings. This explains the negative relationship found between the general level of stock prices and expectations of inflation.

Expectations are formed on the basis of current and past events. Corporate earnings expectations, according to this study, are formed on the basis of actual earnings over the preceding five years. Inflation expectations are formed on the basis of actual rates of inflation over the past four years. Since these formation periods are quite long, fundamental changes in expectations occur slowly.

According to the St. Louis model (this Review*, April 1970), monetary actions, measured by changes in the money stock, exercise an important influence on gross national product, the price level, and real output. Since movements in these three economic magnitudes are basic factors in the formation of expectations in the stock market, the expanded model developed in this article is used to examine the response of the general level of stock prices to changes in the rate of monetary expansion. The major influence of changes in money on the level of stock prices was found to be indirect – operating through induced changes in expectations.*

THE STOCK MARKET is perhaps the most talked about and the least understood of all major economic phenomena. The primary reason for this is the major influence which expectations play in determining stock market prices. The lack of knowledge about how expectations are formed and how they operate on the stock market has been the major impediment to empirical research in this area.

In a pioneering work in 1964, Beryl Sprinkle handled this problem by essentially leapfrogging the expectations issue and analyzing the relationship directly between changes in the money stock and movements in the aggregate stock price index.[1] Sprinkle observed that at least since World War I the stock price index has moved systematically with changes in the money stock. He explained this phenomenon as an element in the quantity theory of money.

In a recent article, Malkiel and Cragg have explicitly introduced expectations into the determination of stock prices of individual corporations.[2] They surveyed a cross section of security analysts with respect to their forecasts for corporate earnings and compared these forecasts with the actual stock price at the time of the forecast. They concluded that earnings expectations were an important influence on the stock price of a corporation. Clearly, investors put their money where their expectations are.

It is the intention of this article to integrate the money supply and expectations approaches to determination of the aggregate stock price index. In the first part of the article, a very simple stock market model is developed which incorporates a method of measuring corporate earnings expectations. The empirical estimation of this model indicates that the earnings expectations variable and the long-term interest rate are the dominant factors in stock price formation. Next, the article considers the factors which determine interest rates and corporate earnings. Using the factors which were found to determine interest rates (which includes changes in money), the stock price equation is re-estimated in a "semi-reduced form" specification. Using this alternative stock price equation and the "St. Louis" econometric model, a number of dynamic *ex post* and *ex ante* simulation experiments are performed. The results of these experiments conform closely to the actual stock price movement in most time periods tested.

The Stock Market Model

The Theory — The theory of stock price determination has always been clear in concept but weak in application. Conceptually, the price an individual is willing to pay for an equity share is equal to the discount to present value of both expected future dividends and the discount to present value of the expected stock price at the time of sale. In its simplest form, this relationship can be represented by the following equation:[3]

$$(1)\quad SP_t = \frac{D^e_{t+1}}{(1+R)} + \frac{D^e_{t+2}}{(1+R)^2} + \ldots + \frac{D^e_{t+n}}{(1+R)^n} + \left[\frac{SP^e_{t+n}}{(1+R)^n}\right]$$

where:

SP_t = Stock Price today — as valued by the individual investor.

SP^e_{t+n} = Stock Price expected at time of sale

D^e = Dividends expected

R = Interest Rate expressed in decimal form (8.1% is written as .081)

The value which an individual will place on equities today will rise if dividends are expected to rise or if the stock price is expected to be higher at the date of sale (so-called capital gains). The value an individual attaches to equities today will fall if the interest rate increases, because the rate at which one discounts expected future dividends and capital gains has risen, and consequently the present value is lower.[4]

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[1]See Beryl Sprinkle, *Money and Stock Price* (Homewood, Illinois, Richard D. Irwin Co., 1964). James Meigs investigates the Money-Stock Price issue with more sophisticated statistical methods in his manuscript in preparation.

[2]Burton Malkiel and John Cragg, "Expectations and the Structure of Share Prices," *American Economic Review*, September 1970. This article also includes an extensive and up-to-date bibliography on the stock market.

[3]This formulization asserts that each investor has an explicit time horizon which is equivalent to the date he expects to sell his stock. It is not necessary that the investor actually sell the stock in period t+n. It is possible that his expectations about the future stock price and dividends are not realized, which would cause the actual sale date to change.

A simplifying assumption is that the attitudes about risk are unchanged, or are accurately incorporated into the interest rate. In addition, some individual's opportunity cost may not be adequately measured by market interest rates. The interested reader is referred to Eugene M. Lerner and Willard T. Carleton, *A Theory of Financial Analysis* (New York: Harcourt, Brace & World, 1966), especially chapters 7-9, and Fred B. Renwick, *Introduction to Investment and Finance; Theory and Analysis,* (New York: McMillan, January 1971) for a more complete and formal analysis of stock price determination.

[4]There are a number of important factors which are common in their effects on the interest rate and the stock price. Thus, any statistical analysis (such as presented in this article)

An economic decision-making unit will wish to invest its portfolio in such a way as to maximize the discounted value of returns from alternative investments. This implies that the last dollar invested in the equity market should give the same expected rate of return as the last dollar invested in alternative markets. If the price of bonds falls because of a shift in the supply schedule, interest rates have risen, and some investors will find it to their advantage to switch out of the stock market and into the bond or other markets. Other things equal, this switching will have a depressing effect on stock prices.

Aggregation Issues – When one moves from a description of individual investor behavior to a description of aggregate or average investor behavior, the formulation of the discount to present value theory is somewhat modified.[5] In the case of the individual investor, the price of the stock is given and the investor will either buy or sell, depending upon whether his individual evaluation of expected return (discounted to present value) is greater or less than the market price of the stock. In the case of aggregate investor behavior, it is the current quantity of equities outstanding which is relatively fixed in the short run and the stock price which must move to clear the market. Therefore, the average investor evaluation of expected returns (discounted to present value) will determine the price of the stock.

which is designed to explain the stock price with interest rates as one of the important arguments, must consider the simultaneous interaction among certain variables. For example, inflation expectations can lead to both higher earnings expectations and to higher interest rates. Or, an increase in the real growth rate can also lead to both higher interest rates and higher earnings expectations.

In the former case, the problem can be handled by distinguishing between real and nominal interest rates and expected earnings. This is done later in the article, especially in equation (16). In the latter case, no explicit separation can be made. However, given the way in which real earnings expectations are developed in this article, it is implicitly accounted for.

There are, of course, other ways of separating the common elements in the interest rate and the stock price than those employed here. The test, however, of the appropriateness of any procedure is its degree of success in explaining the past and forecasting the future movement in the stock price.

[5]The determination of stock prices on the basis of discounting expected future returns would be generally accepted by most economists. However, there is considerable professional controversy with respect to the proper interpretation of this theory. To a large extent, the debate is over the factors which affect behavior of the individual investor or individual firm share price. This article is concerned with the factors which affect aggregate investor behavior and the average stock price of all firms. While there is obviously a substantial overlap, there are a number of factors that are important in the individual case but tend to average out in the aggregate, such as the quality of management, the ratio of debt to equity, and the time horizon of the individual investor. As long as these basic factors are unchanged on average, they would not be expected to cause changes in the aggregate stock price index.

For the individual investor it is reasonable to assume that investment decisions are made on the basis of an explicit or implicit time horizon, t+n. For average investor behavior, one must assume something approaching an infinite time horizon, because the longest time horizon of the individual investor will dominate the time horizon of the average investor, (where the average investor is merely the weighted sum of the individual investors).[6] Thus, we can re-write the average investor equation with respect to the stock price as:

$$(2)\quad SP_t = \frac{(D^e+\Delta SP^e)_{t+1}}{(1+R)} + \frac{(D^e+\Delta SP^e)_{t+2}}{(1+R)^2}\ldots$$

where:

ΔSP^e = expected change in the stock price in each time period;

$\Delta SP^e_{t+1} = SP^e_{t+1} - SP_t$

$\Delta SP^e_{t+2} = SP^e_{t+2} - SP^e_{t+1}$

etc.

A shift in emphasis also occurs when one moves from determination of the stock price for one firm to determination of the average stock price of all firms. The primary factor in investor expectations of increases in the stock price, ($\Delta SP^e>0$) in the case of the single firm, is the relative competence of management in productively employing new capital. This is irrespective of whether the new capital is financed by retained earnings or by debt issues. In the case of the average stock price of all firms, however, the differential management factor tends to remain constant. In this case it is not unreasonable to postulate that the major factor in expected capital gains is the rate at which retained earnings are plowed back into the firm.[7] If (k) is defined as the ratio of dividends to earnings (the expected payout ratio), then (1–k) is the expected retained earnings ratio, and the ag-

[6]There are a whole range of interest rates representing maturities at different points in time. Discounting the present value of the expected flow one time period in the future should be at the interest rate for instruments which mature one time period in the future. Discounting the expected flow "n" time periods in the future should be at the interest rate for bonds which mature in the n^{th} time period. Discounting with one "representative" interest rate introduces a potential bias into the stock price estimate, because the term structure of interest rates is not flat. However, the least bias will occur if a long rate is used. According to Meiselman, the long rate is the weighted average of expected short-term rates. For example, the current rate on a 10-year bond is a function of the current rate on a 1-year bond and the expected rate on one-year bonds in the second through tenth years. See David Meiselman, *The Term Structure of Interest Rates* (Chicago: University of Chicago Press, 1963).

[7]The return on investment financed with debt instruments can, as a first approximation, be considered as equal to the average interest rate paid on these instruments when all firms are aggregated. This assumption allows us to ignore the source of financing new capital equipment.

gregate stock price, equation (2) can be re-written as follows:

$$(3)\ SP_t = \frac{[kE^e + (1-k)E^e]_{t+1}}{(1+R)} + \frac{[kE^e + (1-k)E^e]_{t+2}}{(1+R)^2} \cdots$$

which simplifies to

$$= \frac{E^e_{t+1}}{(1+R)} + \frac{E^e_{t+2}}{(1+R)^2} \cdots$$

or

$$= \frac{\sum_{i=1}^{\infty} E^e_{t+i}}{(1+R)^i}$$

where E^e stands for expected future corporate earnings.[8] This formulation allows us to omit explicit consideration of expected capital gains. Expected earnings will be used either to pay expected dividends (k) or to add to expected capital growth (1–k).[9]

Estimation Issues – One of the major problems in applying the stock price theory described in equation (3) to an analysis of actual stock price movement is to determine how earnings expectations are formed. There are two approaches to analyzing expectations. If the future is expected to be roughly similar to the recent past, then the "adaptive expectations hypothesis" is used. This hypothesis asserts that in forming expectations about the future, decision-making units are strongly influenced by current and recent past experience. As time goes on and new facts become available, expectations are adapted to accommodate them.

If, however, the future is expected to be sharply different from the recent past, then expectations will be formed on the basis of some similar historic period rather than on the most recent past. For example, when the United States economy switched from war to peacetime conditions in early 1946, expectations were formed more on the basis of what happened before World War II than on what was occurring during World War II.[10]

In most "normal" periods it is reasonable to postulate that the adaptive expectations hypothesis is the most plausible description of expectations behavior. On this basis we will assert that expected corporate earnings, and through this the stock price, are significantly dependent upon the actual level of current and past corporate earnings. The Almon distributed lag approach is used to estimate expectations.

To put the stock price theory into a form which separates the earnings expectations hypothesis from the interest rate effect, it is specified as follows:[11]

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[8]This formulation is in terms of nominal expected earnings. An alternative formulation would separate this into expectations of real earnings and expectations of inflation. This latter formulation would also require the interest rate to be separated into real and inflation expectation components. In this case, the stock price formulation would look as follows:

$$(3\text{-A})\ SP_t = \frac{\sum_{i=1}^{\infty} E^{*e}_{t+i}\,(1+\dot{P}^e)^i}{(1+R^*)^i\,(1+\dot{P}^e)^i}$$

where $\dot{P}^e$ represents inflation expectations, E^{*e} represents expected real earnings, and R^* is the real interest rate today. If inflation expectations are the same for earnings and interest rates, then the inflation effect on stock prices will be zero. That is, the numerator and denominator will rise by the same proportion, and the ratio (which determines the stock price) will be unchanged.

This would be the case in the long-run steady state solution when expected inflation ($\dot{P}^e$) equals actual inflation ($\dot{P}$) for a sufficiently long period that all decision-making units had completely adjusted. Short of this steady state solution, however, the "gap" between real and nominal values could be achieved in systematically different ways in earnings and interest rates. Then the stock price would not be invariant to inflation expectations. For example, if the gap between real and nominal earnings is achieved by a fall in real earnings and a constant level of nominal earnings, while the gap between real and nominal interest rates is realized by constant real interest rates and rising nominal rates, then the stock price will fall.

Another factor which could affect the stock price is a once-and-for-all increase in goods prices. This would not affect inflation expectations because the rise in prices is not expected to continue. Such an event would lead to an increase in nominal earnings and therefore to an increase in earnings expectations, but would not lead to an increase in the interest rate. In this circumstance, the stock price formulation in equation 3-A would tend to understate the actual stock price.

This conceptually possible event is not probable in the real world, short of a major war or natural disaster which would make any analysis of stock prices redundant. If the change in goods prices is in relatively small increments, and the increase in factor prices occurs with a lag (both plausible statements), then the practical bias in equation 3-A can be considered negligible.

For an interesting discussion of how to diminish the market distortions related to strong inflation expectations, see David Meiselman, "Institutional Reforms to Moderate the Effects of Variable Price Levels," *Journal of Economic Issues*, June/September 1970, pp. 77-86.

[9]The individual tax rate on expected dividends (kE^e) will be higher than on expected capital gains ($1-kE^e$) in the United States. Thus, even if expected earnings are unchanged, a decrease in the dividend rate (k) would shift earnings into a form in which the tax rate is lower, which would tend to raise the stock price. The formulation in equation (3) implies that the expectations about k at any one point in time (t) is stable for the time horizon of the typical investor. This implication is reasonable, given that k in the period 1947-70 has had no secular trend.

[10]See Thomas Sargent, "Some New Evidence on Anticipated Inflation and Asset Yields" (Unpublished Manuscript), National Bureau of Economic Research, August 1970.

[11]The equation was also estimated in a nonlinear additive form, and the results were virtually the same, except that the R^2 and S.E. were somewhat better in the linear form used in the text.

$$(4)\quad SP_t = a_0 + \sum_{i=0}^{1} a_1 R_{t-i} + a_2 E^e_t$$

$$(5)\quad E^e_t = \left[\sum_{i=0}^{n} w_i\right] E_{t-i}$$

Equation (4) states that the stock price in the current time period (SP_t) is a function of interest rates in the current and one lagged time period, and current expectations about future corporate earnings (E^e). The one-quarter lag in (R) is designed to capture the possible lag in investor awareness of, and response to, changes in rates. We postulate that the value a_1 is negatively related to the stock price, and that the value a_2 is positively related to the stock price.

Equation (5) states that expectations of future corporate earnings after taxes are a weighted sum (Σ) of current and past corporate earnings after taxes. The value w_i represents the weights applied in forming earnings expectations at various periods in the past, and "n" indicates how many periods in the past are relevant in forming earnings expectations.

Substituting equation (5) into equation (4) yields a form of the equation which can be estimated empirically:[12]

$$(6)\quad SP_t = a_0 + \left[\sum_{i=0}^{1} a_1\right] R_{t-i} + \left[\sum_{i=0}^{n} a_2 w_i\right] E_{t-i}$$

The stock price equation was estimated with quarterly data for time periods as short as 1960-70 to as long as 1952-70. The longest time period which gave statistically significant results was 1956-70.[13] That result is presented in equation (7).

[12]In this aggregate formulation of stock price determination, earnings expectations (E^e) do not take into account the degree of confidence or risk the average investor has with respect to how accurately his expectations will be realized. If this basic risk factor should change, then this adaptive expectation approach would not be sufficient to determine the stock price.

It would be desirable to include another variable in this equation to indicate the degree of confidence the average investor has about his earnings expectations. Experimentation with a number of proxies for investor confidence were tried, without success. Thus, the usefulness of this stock price formulation is dependent upon the absence of a major change in the average investor's confidence in his expectations of future earnings. By the same token, the length of time for which this equation explains the stock price indicates the period for which the confidence or risk factor of the average investor remained unchanged.

[13]The stock price equation with data from I/1952 to II/1970 predicts the stock price index as well as equation (7), when a dummy variable is added. The dummy variable assumes a value of 1 from I/1952 to II/1955, and zero thereafter. This result implies that the specified behavior was the same in both periods, but that some other factor (roughly measured by the dummy variable) was also important. This additional behavioral factor is most likely related to a change in attitude about risk. Stock price estimates could not be made prior to I/1952 because of data limitations. Specifically, earnings data (which has a 19-quarter lagged effect) were available quarterly since 1947.

STOCK PRICE EQUATION

Sample Period: I/1956 - II/1970

(Summary Results)

$$(7)\quad SP_t = \underset{(3.08)}{12.33} - \sum_{i=0}^{1} \underset{(4.48)}{16.27}\, R_{t-i} + \sum_{i=0}^{19} \underset{(8.69)}{4.44}\, E_{t-i} \qquad R^2 = .94 \quad S.E. = 4.70 \quad D\text{-}W = .74$$

(Detailed Results)

R_0 =	−19.30	(4.04)
R_1 =	3.03	(.60)
ΣR_i =	−16.27	(4.48)

E_0 =	1.65	(7.42)	E_{11} =	.14	(2.15)
E_1 =	.32	(3.67)	E_{12} =	.05	(.91)
E_2 =	−.30	(2.48)	E_{13} =	.01	(.21)
E_3 =	−.46	(5.10)	E_{14} =	.05	(.73)
E_4 =	−.36	(5.92)	E_{15} =	.17	(2.25)
E_5 =	−.15	(2.35)	E_{16} =	.36	(4.54)
E_6 =	.06	(.92)	E_{17} =	.57	(5.84)
E_7 =	.23	(3.90)	E_{18} =	.69	(5.24)
$E_8{}^*$ =	.31	(6.13)	E_{19} =	.58	(4.37)
E_9 =	.30	(5.31)	ΣE_i =	4.44	(8.69)
E_{10} =	.24	(3.58)			

Constraints: 6th Degree Polynomial for E
2nd Degree Polynomial for R

$E_{t+1} \neq 0 ; E_{t-n} = 0$

$R_{t+1} \neq 0 ; R_{t-n} = 0$

Note: "t" statistics appear wi h each regression coefficient, enclosed by parentheses. An estimated coefficient is considered statistically significant if its accompanying "t" statistic is 1.95 or larger. R^2 is the per cent of variation in the dependent variable which is explained by variations in the independent variables. S.E. is the standard error of the estimate. D-W is the Durbin-Watson statistic.

The stock price (SP) is measured by Standard and Poor's 500 Index.[14] The interest rate (R) is measured by the corporate Aaa bond yield on seasoned issues.[15] Earnings (E) are measured as corporate profits after taxes in billions of dollars from the national income accounts.

This specification explains 94 per cent of the variance in the level of the stock price index.[16] Both

[14]Standard and Poor's Stock Price Index is defined as follows:

$$\text{Index} = \frac{\Sigma Q_1 P_1}{\Sigma Q_0 P_0} \cdot (10)$$

where P_0 and Q_0 are the stock price and quantity in the base years 1941-43, P_1 is average price in the current period, and Q_1 is the volume of stock outstanding in the current period. The index is also adjusted for stock splits.

[15]A stock price equation with a roughly similar interest rate specification can be found in the MIT-FRB model. See Frank de Leeuw and Edward Gramlich, "The Federal Reserve MIT Econometric Model," Federal Reserve *Bulletin*, January 1968, pp. 11-40.

[16]All equations in this article are estimated by the Almon distribution lag technique. By constraining the distribution of coefficients to fit a polynomial curve of n degree, it is designed to avoid the bias in estimating distributed lag coefficients which may arise from multicollinearity in the lag values of the independent variables. The theoretical justification for this procedure is that the Almon constrained

the expected corporate earnings variable (E) and the interest rate variable (R) have the expected sign and are statistically significant. Expectations about future earnings are based on the actual level of reported earnings in the current and 19 lagged quarters. The earnings expectations coefficient has a high degree of statistical significance and explains a major share of the movement in stock prices from 1956 to 1970.[17]

One weakness of the stock price specification in equation (7) is the low Durbin-Watson (D-W) statistic. This implies that the estimated value of the stock price is systematically above or below the actual stock price. This problem will be dealt with later in the article.

The Stock Market and the Economy

If we wish to understand how the stock market fits into the larger economic picture, we must consider the factors which explain long-term interest rates (R) and corporate earnings (E).

Interest Rates[18] – An analysis of the price of bonds will not only be of value because it is an important argument in the stock price equation, but because it is important for its own sake. In perpetuity (like British consols), the price of bonds can be represented as the reciprocal of the interest rate,

$$(8)\ BP = \frac{1}{R}$$

where BP represents the current bond price and R the current rate of interest. The following analysis will be explicitly in terms of long-term interest rates. However, because of the direct transformation illustrated in equation (8), we can also interpret the results in terms of the effect on bond prices.

The explanation of interest rates can be illustrated with three equations:

$$(9)\ R_t = R^*_t + \dot{P}^e_t$$

$$(10)\ R^*_t = c_0 + c_1 \dot{M}^*_t + c_2 \left[\sum_{i=0}^{n} u_i \right] \dot{X}_{t-i}$$

$$(11)\ \dot{P}^e_t = \left[\sum_{i=0}^{n} z_i \right] \dot{P}_{t-i}$$

Equation (9) states that the observed market long-term interest rate (R_t) is equal to the real rate of interest (R^*_t) and the expected rate of change in prices ($\dot{P}^e_t$). Equation (10) says that the real rate of interest is a function of a short-run liquidity effect and a real growth component. The real growth component is measured as a weighted average rate of change in real GNP, ($\dot{X}$): u_i indicates the weights applied to past time periods, and "n" indicates how many time periods are relevant in determining the real growth rate. The coefficient c_2 indicates the effect of the real growth rate on the interest rate; c_2 is postulated to be positive.

The short-run liquidity effect is measured by the current rate of change in the real money stock ($\dot{M}^*_t$). The real money stock is defined as the nominal money stock (M) divided by the price index (P):

$$M^* = \frac{M}{P}$$

This liquidity effect results from current investment being temporarily financed from sources other than intended savings, which is possible as a consequence of the creation of new money. This should have a negative effect on the rate of interest, and is sometimes referred to as the "Wicksell effect."

Equation (11) says that the expected rate of change in prices ($\dot{P}^e_t$) is a function of past price changes, where z_i is the weight or importance attached to each past time period in the formation of price expectations, and "n" is the number of past time periods that are relevant in forming price expectations. Actual price changes are measured by the GNP implicit price deflator.[19]

estimate is superior to the unconstrained estimate, because it will create a distribution of coefficients which more closely approximates the distribution derived from a sample of infinite size. In order to minimize the severity of the Almon constraint, the maximum degree of the polynomial was used in each case. The maximum degree is equal to one more than the number of lags of the independent variables up to five lags. This follows the convention established by Shirley Almon, "The Distributed Lag Between Capital Appropriations and Expenditures," *Econometrica*, January 1965. The lag on earnings (E) was selected on the basis of minimum standard error (S.E.) of estimate.

[17]The coefficient 4.44 on the earnings expectations variable consists of two components; w_i, the weights applied to current and past actual earnings to generate expected earnings, and a_2, the effect on stock prices of a given level of expected earnings. There is no reason to assume that $\Sigma\ w_i = 1$. Therefore, we cannot separate ($a_2 \cdot w_i$) into its component parts. Fortunately for purposes of estimating the stock price index, such separation is not necessary. This observation also applies to equation (16), where other expectation variables are used.

[18]The discussion in this section relies heavily on the work of Yohe and Karnosky, "Interest Rates and Price Level Changes, 1952-69" this *Review* (December 1969), and Anderson and Carlson, "A Monetarist Model for Economic Stabilization" this *Review* (April 1970).

[19]The effect of price expectations on interest rates has had a long history in economic literature. As early as 1910, Irving Fisher published a study relating the impact of price expectations on interest rates. Because of his pioneering work in this area, such price expectation effects on interest rates are referred to as the "Fisher effect."

Substituting equations (10) and (11) into equation (9) yields the form of the equation which was estimated:

$$(12)\quad R_t = c_0 + c_1 \dot{M}^*_t + \left[\sum_{i=0}^{n} c_2 u_1\right] \dot{X}_{t-i} + \left[\sum_{i=0}^{n} v_1\right] \dot{P}_{t-i}$$

Equation (12) asserts that the interest rate in the bond market is influenced by three factors. Expectations of inflation ($\dot{P}$) is measured by the adaptive expectations approach, and should be positively related to interest rates. The real growth of the economy ($\dot{X}$) should be positively related to the interest rate. The liquidity effect ($\dot{M}^*$), on the other hand, is postulated to be negatively related to interest rates. To test the various elements of the hypothesis contained in equation (12), it was estimated using quarterly data from I/1955 to II/1970. R is measured by the Corporate Aaa bond rate on seasoned issues.

LONG-TERM INTEREST RATE EQUATION

Sample Period: I/1955 - II/1970

(Summary Results)

$$(13)\quad R_t = \underset{(4.63)}{1.22} - \underset{(3.55)}{.06}\,\dot{M}^*_t + \sum_{i=0}^{16} \underset{(2.11)}{.15}\,\dot{X}_{t-i} + \sum_{i=0}^{16} \underset{(20.31)}{1.00}\,\dot{P}_{t-i} + \underset{(12.56)}{1.60}\,Z_t$$

$R^2 = .94$
S.E. = .30
D-W = .74

(Detailed Results)

$\dot{X}_0$ = .02 (3.20)	$\dot{X}_6$ = .01 (1.87)	$\dot{X}_{12}$ = .00 (.79)
$\dot{X}_1$ = .02 (3.55)	$\dot{X}_7$ = .01 (1.57)	$\dot{X}_{13}$ = .00 (.70)
$\dot{X}_2$ = .02 (3.58)	$\dot{X}_8$ = .01 (1.34)	$\dot{X}_{14}$ = .00 (.63)
$\dot{X}_3$ = .01 (3.24)	$\dot{X}_9$ = .01 (1.15)	$\dot{X}_{15}$ = .00 (.57)
$\dot{X}_4$ = .01 (2.73)	$\dot{X}_{10}$ = .01 (1.01)	$\dot{X}_{16}$ = .00 (.52)
$\dot{X}_5$ = .01 (2.25)	$\dot{X}_{11}$ = .01 (.89)	$\Sigma\dot{X}_i$ = .15 (2.11)
$\dot{P}_0$ = .01 (.53)	$\dot{P}_6$ = .08 (17.81)	$\dot{P}_{12}$ = .07 (9.24)
$\dot{P}_1$ = .03 (2.20)	$\dot{P}_7$ = .08 (14.68)	$\dot{P}_{13}$ = .06 (8.85)
$\dot{P}_2$ = .04 (4.95)	$\dot{P}_8$ = .09 (12.66)	$\dot{P}_{14}$ = .05 (8.53)
$\dot{P}_3$ = .05 (9.85)	$\dot{P}_9$ = .08 (11.33)	$\dot{P}_{15}$ = .03 (8.28)
$\dot{P}_4$ = .07 (17.68)	$\dot{P}_{10}$ = .08 (10.41)	$\dot{P}_{16}$ = .02 (8.06)
$\dot{P}_5$ = .07 (21.17)	$\dot{P}_{11}$ = .08 (9.75)	$\Sigma\dot{P}_i$ = 1.00 (20.31)

Constraints: 2nd Degree Polynomial for $\dot{X}$, $\dot{P}$,

$\dot{X}_{t+1} \neq 0;\ \dot{X}_{t-n} = 0$

$\dot{P}_{t+1} \neq 0;\ \dot{P}_{t-n} = 0$

Note: "t" statistics appear with each regression coefficient, enclosed by parentheses. An estimated coefficient is considered statistically significant if its accompanying "t" statistic is 1.95 or larger. R^2 is the per cent of variation in the dependent variable which is explained by variations in the independent variables. S.E. is the standard error of the estimate. D-W is the Durbin-Watson statistic.

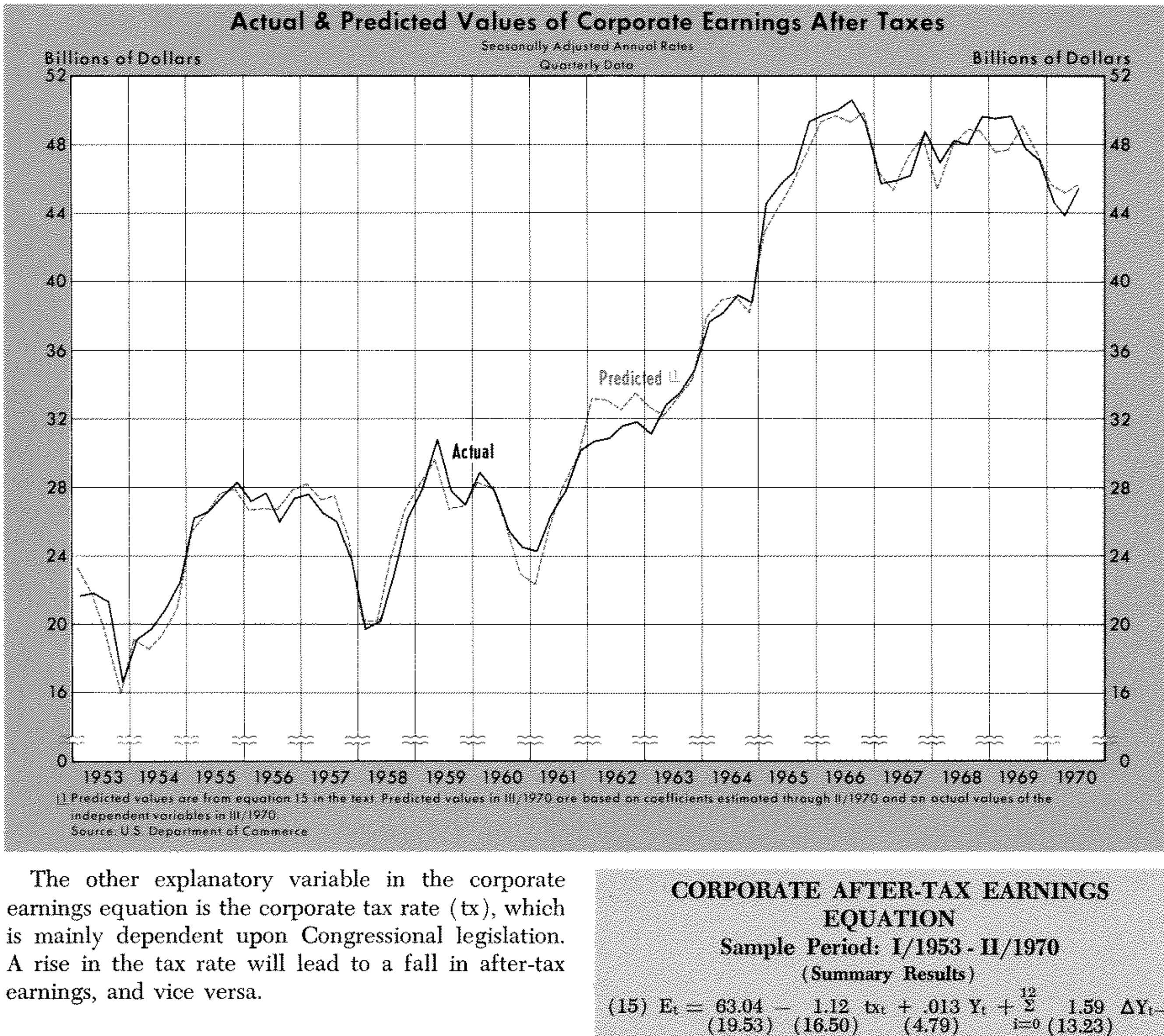
The equation as specified explains 94 per cent of the variance in long-term interest rates (R). All coefficients are statistically significant and have the theoretically expected sign. The estimated coefficients indicate that for every 1 per cent annual rate acceleration in the real money stock, interest rates will decrease by 6 basis points; for every 1 per cent acceleration in the real growth rate of the economy, the interest rate will increase 15 basis points; and for every 1 per cent acceleration in expected prices, interest rates will increase 100 basis points.[20]

A dummy variable, Z_t, assumes the value of "0" from 1955 to 1960, and the value of "1" from 1961 to 1970. This variable is intended to partially account for an apparent shift in the financial market relationships which distinguished the 1950's from the 1960's.

Corporate Earnings – Corporate earnings can be thought of as the return to risk-taking capital. For any one corporation, the competence of the management, the costs of factor inputs, and the demand for the product are the key variables in explaining earnings. However, for the economy as a whole, the management factor tends to change only slowly, and the major dynamic factors are the strength of total demand and factor costs. Because total demand and costs move systematically with each other, and because the monetarist model, discussed below, does not have an explicit supply equation, we will only consider total demand factors.

In the short run, earnings are a residual after other costs of production have been accounted for, and therefore are sensitive to both changes in total demand and to the level of total demand. The most comprehensive measure of total demand is nominal GNP: it is the most important explanatory variable in our earnings equation. We will assert that the current level of total demand (Y_t), and changes in total demand in the current and past quarters $\left(\sum_{i=0}^{n} \Delta Y_{t-i}\right)$, have distinct and positive influences on earnings in the current period (E_t). If total demand is rising, but at a declining rate, then earnings may fall, as in the first half of 1970. This roughly captures cost-push effects on earnings.

[20]Following Andersen and Carlson, the current and lagged values of the price variable have been divided by the unemployment rate, on the assumption that price expectations are influenced not only by past movements in prices but by the relative slack of economic activity measured by the unemployment rate. In contrast to Andersen and Carlson, changes in real money rather than nominal money are used to measure the liquidity effect.



[1] Predicted values are from equation 15 in the text. Predicted values in III/1970 are based on coefficients estimated through II/1970 and on actual values of the independent variables in III/1970.
Source: U.S. Department of Commerce

The other explanatory variable in the corporate earnings equation is the corporate tax rate (tx), which is mainly dependent upon Congressional legislation. A rise in the tax rate will lead to a fall in after-tax earnings, and vice versa.

The corporate after-tax earnings equation is specified in general terms as follows:

$$(14)\quad E_t = b_0 + b_1\, tx_t + b_2\, Y_t + b_3 \sum_{i=0}^{n} \Delta Y_{t-i}$$

where

E = Corporate earnings after taxes (billions of dollars)

tx = Corporate tax rate

Y = Nominal GNP (billions of dollars)

ΔY = Change in nominal GNP (billions of dollars)

We postulate that (b_1) is negative and that (b_2) and (b_3) are positive.

CORPORATE AFTER-TAX EARNINGS EQUATION

Sample Period: I/1953 - II/1970

(Summary Results)

$$(15)\quad E_t = \underset{(19.53)}{63.04} - \underset{(16.50)}{1.12}\, tx_t + \underset{(4.79)}{.013}\, Y_t + \sum_{i=0}^{12} \underset{(13.23)}{1.59}\, \Delta Y_{t-i}$$

$R^2 = .99$

S.E. = 1.11

D-W = .98

(Detailed Results)

$\Delta Y_0 = .26$ (13.35)	$\Delta Y_7 = .10$ (7.25)
$\Delta Y_1 = .27$ (15.95)	$\Delta Y_8 = .07$ (5.78)
$\Delta Y_2 = .20$ (12.93)	$\Delta Y_9 = .04$ (3.33)
$\Delta Y_3 = .14$ (9.38)	$\Delta Y_{10} = .03$ (2.59)
$\Delta Y_4 = .12$ (8.52)	$\Delta Y_{11} = .05$ (3.65)
$\Delta Y_5 = .12$ (8.10)	$\Delta Y_{12} = .07$ (3.87)
$\Delta Y_6 = .12$ (7.63)	$\Sigma \Delta Y_i = 1.59$ (13.23)

Constraints: 6th Degree Polynomial
$\Delta Y_{t+1} = 0;\ \Delta Y_{t-n} = 0$

Note: "t" statistics appear with each regression coefficient, enclosed by parentheses. An estimated coefficient is considered statistically significant if its accompanying "t" statistic is 1.95 or larger. R^2 is the per cent of variation in the dependent variable which is explained by variations in the independent variables. S.E. is the standard error of the estimate. D-W is the Durbin-Watson statistic.

This equation explains 99 per cent of the variance in after-tax corporate earnings.[21] All of the coefficients are statistically significant and have the theoretically expected signs. As illustrated in the preceding chart, the estimated values of corporate earnings after taxes are very close to the actual values. Every cyclical turning point in corporate earnings, as well as most of the magnitude, is accounted for.

In a later section of this article we will be interested in real corporate earnings (E^*). Real corporate earnings can be defined as nominal corporate earnings (E) divided by the price index (P):

$$E^* = \frac{E}{P}.$$

To estimate real corporate earnings, it is only necessary to estimate nominal earnings as described in equation (15) and to divide this value by an estimate of the price index. (The method of estimating the price index is described later in the article when the stock market model is linked to the "St. Louis" econometric model.)

Direct Measures of Expectation Effects

What insights into the stock market can be acquired from the theoretical and empirical evidence developed above? It can be said with some confidence that the stock price is strongly influenced by expectations, and that these expectations are both rational and quantifiable. This should not be confused with the vague and random expectations typically associated with day-to-day movements in stock prices.

As estimated in equation (7), earnings expectations E^e play a key *direct* role in forming stock prices. Inflation expectations play an important *indirect* role in forming stock prices through their effect on interest rates. These expectations effects on stock prices, along with changes in real money and real growth (which are also important arguments in the interest rate equation), can be made explicit by going to a "semi-reduced form" equation which directly relates the rates of change in real money, real output, and price variables to stock prices. However, we would expect these variables ($\dot{M}^*$, $\dot{X}$, $\dot{P}$) to have signs with respect to the stock price (SP) that are the reverse of those with respect to interest rates (R). This is because the interest rate in equation (7) is negatively related to the stock price.

When we move to a semi-reduced form estimate, one issue which had been considered only in a footnote in the previous discussion must now be given explicit consideration. As mentioned in footnote (8), inflation expectations not only will affect the current level of interest rates but will also affect current expectations of future nominal earnings. In a sense, one can consider expectations of nominal earnings to consist of two components: an expectation of future real earnings, and an expectation of future inflation.

If inflation expectations raise current nominal interest rates and expected nominal earnings by the same proportion, then they will have no effect on the stock price. Put in a slightly different way, if inflation expectations, operating through nominal earnings, raise the stock price and, operating through current interest rates, lower the stock price by the same proportion, then the net impact on the stock price is zero.

It is not necessary, however, that inflation expectations should just offset each other with respect to the stock price except in the long-run equilibrium case when actual and expected inflation are equal. First, it is consistent with economic theory that the average investor in the bond market may evaluate inflation expectations differently than the average investor in the stock market, because of a different time horizon. This would imply that the gap between real and nominal interest rates and real and nominal expected earnings would be different. Second, even if expectations of the average investor in the stock market and the bond market were identical, it is possible that inflation may have a systematic effect on the spread between real interest rates and expected real earnings. This would be the case if inflation led to expectations of cost increases in excess of price increases, so that real earnings expectations would be lowered relative to real interest rates. With these considerations in mind, the reduced form stock price equation should be estimated with the following variables:

1) Changes in the real money stock ($\dot{M}^*$), because this is an argument in the interest rate equation;

2) Changes in real growth measured by changes in current and lagged real GNP ($\dot{X}$), because this is also an argument in the interest rate equation;

3) Changes in expected inflation measured by changes in current and lagged prices ($\dot{P}$).[22] This is

[21]Equation (15) is designed only as a method of estimating current earnings. This equation should not be considered an attempt to measure the *behavior* of the major decision-making units which affect corporate earnings. That objective would require a more sophisticated model than that presented here.

[22]For reasons discussed in footnote (15), P is divided by the unemployment rate.

both an argument in the interest rate equation and an element in the nominal earnings expectations variable. Thus, its net impact on the stock price could be plus, minus, or zero, for the reasons discussed above;

4) Expected real corporate earnings (E^{*e}) are measured as current and lagged values of real corporate earnings. We use real earnings expectations in this equation because that element of expected nominal earnings associated with inflation expectations should be captured by the inflation variable.

We would expect the coefficients associated with the rate of change in the real money stock ($\dot{M}^*$) and level of expected real earnings (E^*) to be positive, and the coefficient associated with real growth ($\dot{X}$) to be negative. The coefficient measuring expectations of inflation ($\dot{P}$) could be either positive or negative. The equation is estimated with quarterly data for the same time period as equation (7).[23]

Equation 16 explains 98 per cent of the variance in the level of the stock price index over the last fifteen years.[24] Each of the sum coefficients is statistically significant and has the expected sign. In this reduced form estimate of the stock price, all of the expectation variables are explicitly accounted for. Changes in real money ($\dot{M}^*$) and expected real earnings (E^*) have a positive effect on the stock price, while real growth ($\dot{X}$) has a negative effect on the stock price. Inflation expectations ($\dot{P}$) have a negative effect on the stock price.

This result is contrary to much popular thinking which asserts that inflation will help the stock price. The difference arises from the confusion between expected inflation and actual inflation. When inflation occurs, but is not expected to continue, there may be some increase in observed earnings of corporations, which would tend to raise earnings expectations and the stock price. However, when inflation is expected to continue, real earnings expectations are apparently not significantly influenced. This can be seen from comparing the sum coefficient for real corporate earnings expectations in equation (16) with the sum

[23]The lags in equation (16) are not exactly those derived from equation (7) and (13). The major difference is with respect to $\dot{X}$. The longer lags on $\dot{X}$ in equation (13) had small and statistically insignificant coefficients and have been eliminated from equation (16).

[24]The R^2, SE, and D-W of equation (16) should be viewed in the light of comparable values when the stock price is regressed only with respect to a time trend. In this case $R^2 = .87$, SE = 6.77 and D-W = .30.

ALTERNATIVE STOCK PRICE EQUATION

Sample Period: I/1956 - II/1970

(Summary Results)

$$(16)\ SP_t = \underset{(9.84)}{-30.68} + \sum_{i=0}^{2} \underset{(4.14)}{1.31}\ \dot{M}^*_{t-i} - \sum_{i=0}^{7} \underset{(5.67)}{5.37}\ \dot{X}_{t-i} - \sum_{i=0}^{16} \underset{(7.93)}{11.96}\ \dot{P}_{t-i} + \sum_{i=0}^{19} \underset{(20.00)}{4.80}\ E^*_{t-i}$$

$R^2 = .98$
S.E. = 2.49
D-W = 1.71

(Detailed Results)

$\dot{P}_0$ =	−0.48 (1.84)	E^*_0 =	1.17 (9.36)
$\dot{P}_1$ =	−0.37 (1.73)	E^*_1 =	1.16 (9.25)
$\dot{P}_2$ =	−0.22 (1.39)	E^*_2 =	0.64 (8.00)
$\dot{P}_3$ =	−0.29 (1.29)	E^*_3 =	0.05 (0.84)
$\dot{P}_4$ =	−0.61 (2.18)	E^*_4 =	−0.40 (5.53)
$\dot{P}_5$ =	−1.07 (3.75)	E^*_5 =	−0.60 (7.08)
$\dot{P}_6$ =	−1.52 (5.58)	E^*_6 =	−0.56 (6.99)
$\dot{P}_7$ =	−1.84 (6.80)	E^*_7 =	−0.34 (5.24)
$\dot{P}_8$ =	−1.90 (7.06)	E^*_8 =	−0.04 (0.79)
$\dot{P}_9$ =	−1.69 (6.62)	E^*_9 =	0.25 (4.72)
$\dot{P}_{10}$ =	−1.25 (5.38)	E^*_{10} =	0.48 (8.19)
$\dot{P}_{11}$ =	−0.69 (3.11)	E^*_{11} =	0.58 (9.73)
$\dot{P}_{12}$ =	−0.16 (0.69)	E^*_{12} =	0.56 (9.46)
$\dot{P}_{13}$ =	0.18 (0.74)	E^*_{13} =	0.44 (7.26)
$\dot{P}_{14}$ =	0.22 (0.87)	E^*_{14} =	0.29 (4.43)
$\dot{P}_{15}$ =	−0.01 (0.02)	E^*_{15} =	0.16 (2.46)
$\dot{P}_{16}$ =	−0.27 (0.98)	E^*_{16} =	0.11 (2.04)
$\Sigma\dot{P}_i$ =	−11.96 (7.93)	E^*_{17} =	0.18 (3.28)
		E^*_{18} =	0.31 (4.28)
$\dot{X}_0$ =	−.60 (4.13)	E^*_{19} =	0.36 (4.74)
$\dot{X}_1$ =	−.89 (5.96)	ΣE^*_i =	4.80 (20.00)
$\dot{X}_2$ =	−1.05 (6.55)		
$\dot{X}_3$ =	−1.08 (6.46)	$\dot{M}^*_0$ =	0.57 (3.62)
$\dot{X}_4$ =	−0.93 (5.96)	$\dot{M}^*_1$ =	0.52 (4.14)
$\dot{X}_5$ =	−0.61 (4.60)	$\dot{M}^*_2$ =	0.21 (1.30)
$\dot{X}_6$ =	−0.23 (1.88)	$\Sigma\dot{M}^*_i$ =	1.31 (4.14)
$\dot{X}_7$ =	0.04 (0.29)		
$\Sigma\dot{X}_i$ =	−5.37 (5.67)		

Constraints: 6th Degree Polynomial for E^*, $\dot{P}$, $\dot{X}$

3rd Degree Polynomial for $\dot{M}^*$

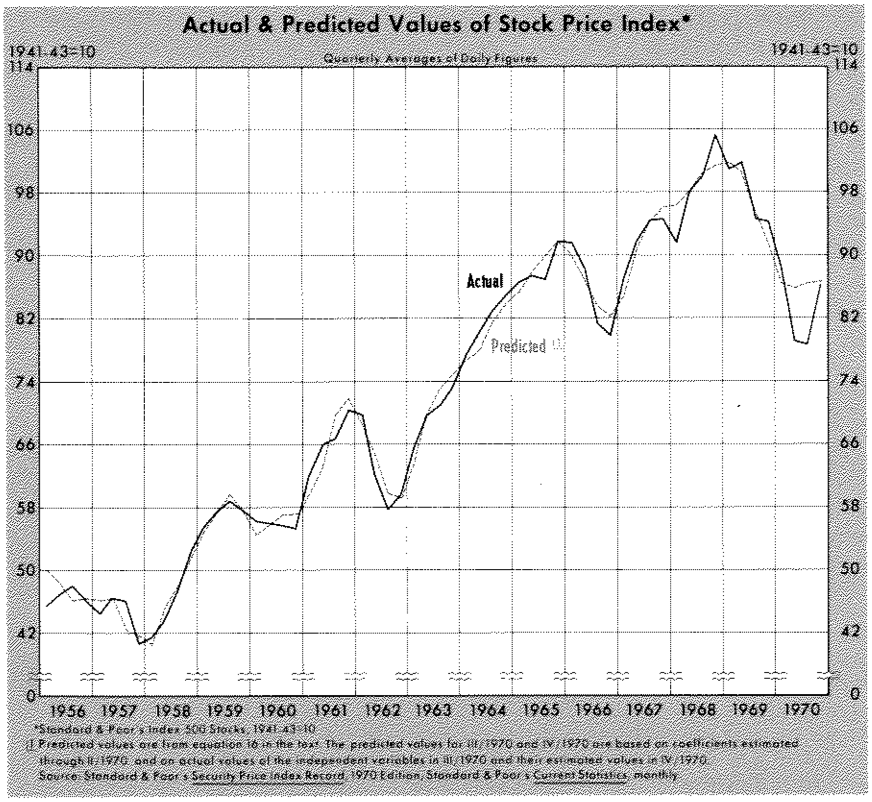
$\dot{X}_{t+1} = 0$; $\dot{X}_{t-n} = 0$

$\dot{P}_{t+1} = 0$; $\dot{P}_{t-n} = 0$

$E^*_{t+1} = 0$; $E^*_{t-n} = 0$

$\dot{M}^*_{t+1} = 0$; $\dot{M}^*_{t-n} = 0$

Note: "t" statistics appear with each regression coefficient, enclosed by parentheses. An estimated coefficient is considered statistically significant if its accompanying "t" statistic is 1.95 or larger. R^2 is the per cent of variation in the dependent variable which is explained by variations in the independent variables. S.E. is the standard error of the estimate. D-W is the Durbin-Watson statistic.



Actual & Predicted Values of Stock Price Index*

Quarterly Averages of Daily Figures

*Standard & Poor's Index 500 Stocks, 1941-43=10

Predicted values are from equation 16 in the text. The predicted values for III/1970 and IV/1970 are based on coefficients estimated through II/1970, and on actual values of the independent variables in III/1970 and their estimated values in IV/1970.

Source: Standard & Poor's Security Price Index Record, 1970 Edition; Standard & Poor's Current Statistics, monthly

coefficient for nominal corporate earnings expectations in equation (7). These values are not significantly different in a statistical sense. But, as indicated in equation (13), inflation expectations increase the interest rate which tends to depress the stock price. Thus, it is possible in the early stages of an inflation, when expectations have not become strong, for the stock price to rise. But when inflation continues long enough that the major decision-making units in the economy expect further inflation, the stock price will fall.

It is interesting to note the role of money in this reduced form stock price equation. A 1 per cent acceleration in real money will lead to a 1.31 point increase in the stock price index. This indicates a significant, but relatively small, direct influence on stock prices. If growth in real money moved from a zero to 5 per cent annual rate, the stock price index would increase by about 7 points over several quarters and have no further direct effect.

The relatively modest direct role of money can be seen by comparing it with real earnings expectations, which has an eight times larger impact on the stock price, and with inflation expectations, which has a 4½ times greater impact than money.[25]

There are, however, important indirect influences of money on stock prices which clearly exceed the direct influence. Money, as will be described in the next section, has an important influence on real output, prices, and earnings. Through this process, changes in money are the dominant factor, both direct and indirect, influencing stock prices.

The actual stock price, and values predicted by equation (16), are shown in the adjacent chart. This shows how closely equation (16) has been able to track major movements in the stock price from I/1956 through IV/1970.

The largest "miss" in the chart occurred in II/1970 and III/1970, when the estimated stock price was 7 and 8 points above the actual stock price index. The actual and estimated stock prices in IV/1970 returned to their normal close relation.[26] This event implies that an important but basically random shock pushed the stock price down temporarily in II/1970, which was not reversed until IV/1970.

The inability of the stock price equation to capture the major decline in II/1970 should caution the reader about applying this model to forecasting. No matter how well the model has explained past stock price movements, the emergence of essentially noneconomic events, such as the Cambodian incursion and the campus riots of May 1970, may at least temporarily affect stock prices.[27] The major utility of the model lies in its use in systematically analyzing the basic factors which history has shown to determine the long-term trend in stock prices.

Experiments with the Stock Market Model

If the stock market model described above is integrated into a larger econometric model of the United States, it will provide some insights into the interrelationships between the stock market and the rest of the economy. The econometric model, which is

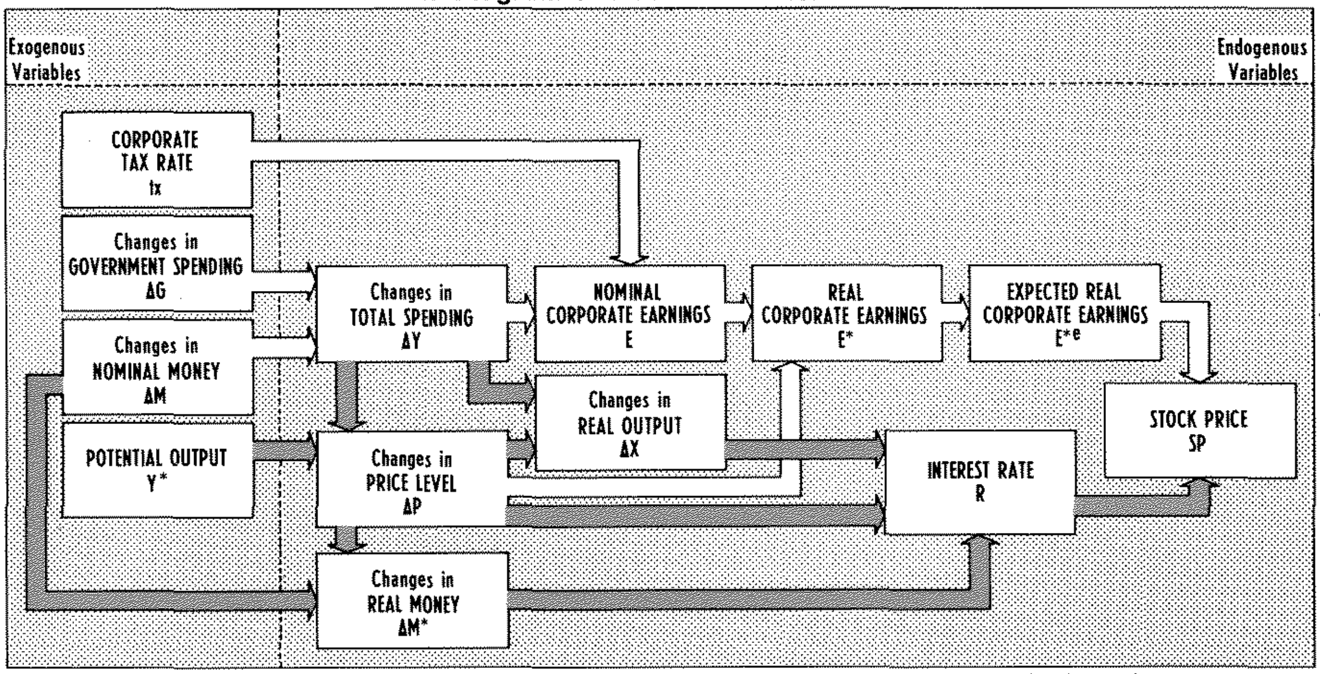
[25]These relationships are derived from the beta coefficients of the respective variables: $\dot{M}^* = .20$, $E^* = 1.65$, $\dot{P} = -.90$.

[26]The stock price estimates in III/1970 and IV/1970 were derived from the coefficients estimated through II/1970.

[27]The ability of stock price equation (16) to pick the major quarterly movements from I/1956 to I/1970 would indicate that other "famous" random shocks to the stock market have tended to average out over a quarter.

Exhibit I

Flow Diagram of Stock Price Determination



Note: For a complete flow diagram of the St. Louis model, see "A Monetarist Model for Economic Stabilization," this Review (April 1970), p.10. In the flow diagram above, changes in real output (ΔX), the price level (ΔP), and real money (ΔM*) affect the interest rate (R), which then affects the stock price (SP). This flow sequence is designed to show the logic of the relationships rather than the actual method of simulation. The simulation experiments described in the text are based on the stock price equation 16, where the interest rate variable is not included directly in stock price formation. Changes in X, P, and M* affect the stock price directly rather than indirectly through the interest rate. It must be remembered, however, that these variables operate conceptually through the interest rate, as shown in the flow diagram.

used to link the stock market to the rest of the economy, is the one developed by Andersen and Carlson and published in this *Review* in April 1970. It is small by the standards of most econometric models, containing only eight equations. However, it includes all of the variables that are necessary to experiment with our stock market "sub-model."

Linking with St. Louis Model — Before describing the simulation experiments relating the stock market submodel to the econometric model, it would be useful to consider the linkages implied by tying the models together. Schematically, the link with the econometric model is illustrated in the Exhibit above.[28]

There are three independent or exogenous policy variables in the combined model: monetary policy measured by changes in nominal money (ΔM), and fiscal policy measured by changes in government expenditures (ΔG), and the tax rate on corporate profits (tx). There is one nonpolicy exogenous variable, the capacity of the economy (Y*), which is estimated by the Council of Economic Advisors to grow at about a 4 per cent annual rate. All the other variables are determined within the model and are called dependent or endogenous variables.

There are two channels by which the exogenous policy variables (ΔM and ΔG) affect stock prices. First, changes in money and Government expenditures will affect total spending (ΔY). The current level and lagged changes in total spending plus the current corporate tax rate (tx) determine nominal corporate earnings (E). Real earnings (E*) are derived by deflating nominal earnings by the price index (P). Current and lagged values of real earnings generate expected real earnings (E^{*e}) which, in turn, will have a positive influence on the stock price (SP).

The other influence of the policy variables (ΔM and ΔG) operates through interest rates. The change in total spending (ΔY) induced by the change in money and government spending, combined with the initial conditions with respect to capacity of the economy (Y*) and past changes in prices, will determine current changes in prices (ΔP). The difference between current changes in total spending (ΔY) and current changes in prices (ΔP) will determine current changes in real output (ΔX). Current and past changes in real output and prices will generate expectations about inflation and real growth, which will in turn influence the current rate of interest (R). The interest rate is also influenced by current changes in real money (ΔM*). Finally, interest rates will have a negative influence on the stock price (SP).

[28]For a complete description of the model see Andersen and Carlson, pp. 7-25. Each equation in this article was re-estimated using the November 1970 revision of the money stock series.

In the following experiments we will be interested to see whether, by merely manipulating the exogenous policy variables in the model, nominal money, government spending, and the corporate tax rate, combined with the initial conditions at the beginning of each experiment, we can simulate the actual movements in the stock price index over an extended time period.

The stock price equation has been estimated with two different specifications. In equation (7) it is estimated on the basis of interest rates and expected corporate earnings. An equivalent specification is given in equation (16) as a semi-reduced form. In this case, rather than directly employing interest rates to determine stock prices, the factors which affect interest rates, as specified in equation (13), are used to estimate the stock price.

The stock price specification in equation (16) has a number of desirable statistical properties which are not present in the stock price estimate in equation (7). The Durbin-Watson (D-W) statistic in equation (16) indicates the absence of autocorrelation in the error term. The D-W statistic in equation (7) implies the existence of autocorrelation. This means that the estimated value of stock prices in equation (16) does not deviate consistently on one side or the other from the actual value of stock prices, while in equation (7), such a deviation does exist.

In addition, the standard error of equation (16) is only about half as large as the standard error of equation (7); 2.49 versus 4.70. This means that 64 per cent of the time (one standard deviation), the estimated value of the stock price is within 2.49 points of the actual value of the stock price in equation (16). By contrast, in equation (7), in 64 per cent of the observations the estimated value of the stock price is within 4.70 points of the actual value.

For these reasons the *ex post* and *ex ante* simulations presented below will be conducted using the coefficients estimated in equation (16).

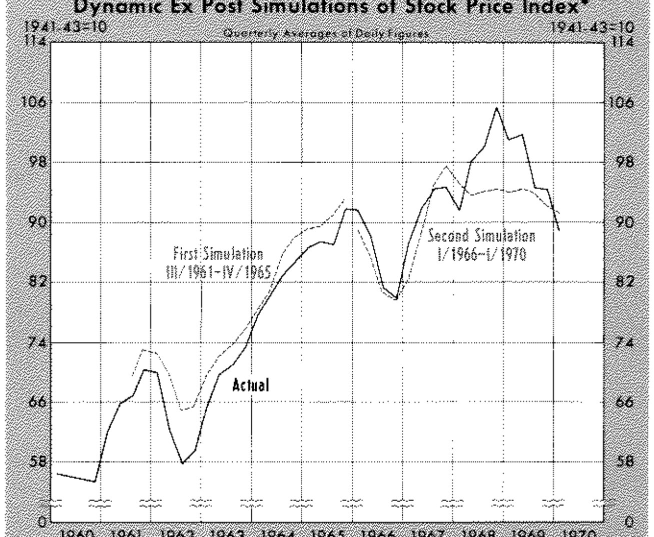
Dynamic Ex Post Simulations – *Ex post* simulation experiments are conducted within the data period used to estimate the equations. For example, in the model used here (and illustrated in Exhibit I), the shortest data period is for the stock price equation (I/1956 through II/1970). Therefore, the *ex post* simulations are conducted within this time span. The variable we wish to simulate is the stock price. Only the actual values of the policy variables (ΔM, ΔG, and tx) are fed into the computer and, when combined with the estimated coefficients (which are given as "detailed results"), simulated values of endogenous variables are generated in the same sequence of cause and effect as described in Exhibit I. A comparison of the simulated values for the stock price with actual values enables one to judge how well the complete model performs as an integrated unit.

The time spans selected to conduct the dynamic *ex post* simulations were designed to represent diverse periods in the United States economy. The first dynamic *ex post* simulation was III/1961 through IV/1965, and the second from I/1966 through I/1970. During the first time span, the economy went from early stages of economic recovery with relatively high unemployment and stable prices, to a period of economic boom and a decline in the unemployment rate below 4 per cent. In the second time span, the economy went from the stage of economic boom with low unemployment and relatively stable prices to the early stages of a recession with a high degree of inflation.

During both of these time spans there were major rises and falls in the stock price. A good test of the relevance of our model with respect to the stock market would be its ability to "track" the movement in the stock price index against the background of such diverse general economic conditions.

Both *ex post* simulations are illustrated in the chart below. The simulation starting with III/1961 tracks the last stages of the rising bull market, picks the peak in the first quarter of 1962, and the decline in stock

Dynamic Ex Post Simulations of Stock Price Index*



*Standard & Poor's index 500 Stocks, 1941-43=10
These simulations are based on equations 15 and 16, described in the text, as well as on updated estimates of the St. Louis Model described in the text and published in this *Review*, April 1970.
Source: Standard & Poor's *Security Price Index Record*, 1970 Edition, Standard & Poor's *Current Statistics*, monthly

prices in the second and third quarters of 1962. However, it overstates the stock price index at both the peak and trough. The simulation does a good job of measuring the rising market from early 1963 through 1965.

The second dynamic *ex post* simulation starts with the first quarter of 1966 and continues through the first quarter of 1970. It accurately tracks the decline in the stock price through the fourth quarter of 1966 and its recovery during 1967. However, it does not capture the rise in the stock price which occurred after the first quarter of 1968. Again, it does a reasonable job of tracking the moderate decline in the stock market in the last half of 1969 and the first quarter of 1970.

In general, we can see that these dynamic *ex post* simulations tended to track the major turning points in the stock market rather well, and were moderately successful in indicating the size of movements in the stock price after each turning point.[29] Moreover, it is only two years after the beginning of a simulation that errors tend to become large.

Dynamic Ex Ante Simulation — The acid test of any economic model is its ability to forecast the future. This test can be performed experimentally by what is called a dynamic *ex ante* simulation. This operates in much the same way as a dynamic *ex post* simulation, with one significant difference. The *ex ante* simulation predicts values of the stock price index beyond the time period in which the model was statistically estimated.

The statistical estimates of the model presented in this article were performed with data through II/1970. To perform dynamic *ex ante* simulations, therefore, it was necessary to re-estimate all of the equations in the stock market model and in the larger St. Louis econometric model with data through shorter time periods. In this way it would be possible to compare the *ex ante* simulation with the actual movements in the stock price index.

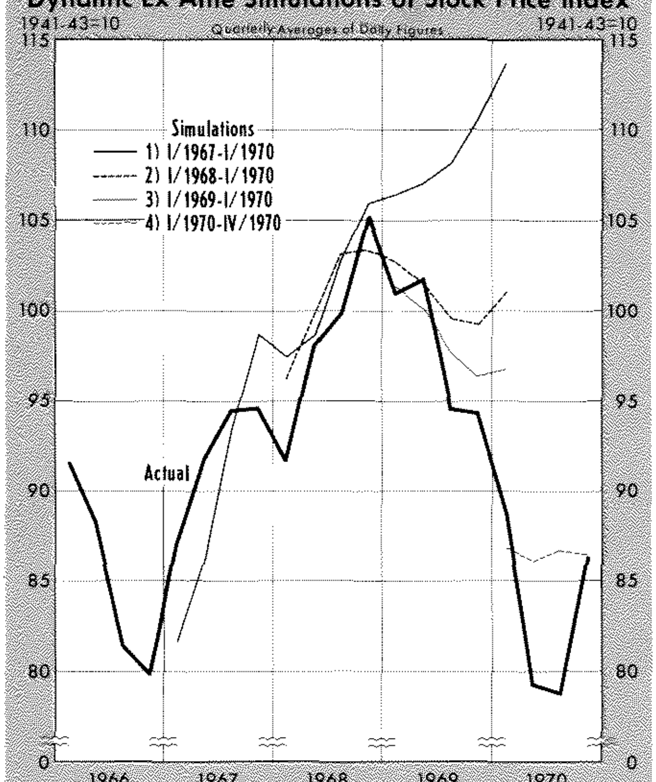
[29]More technically, this can be seen from the fact that the standard error of equation (16) was 2.49, while the standard error of dynamic ex post simulations are higher. The first simulation (III/1961 through IV/1965) had a standard error of 3.9, and the second simulation (I/1966 through I/1970) had a standard error of 4.7. This indicates that the simulated value of the stock price (which uses the simulated values for all the variables in the stock price equation, equation 16) gives a less accurate measure of the stock price than the estimated equation, using the actual variables. This result, of course, is not surprising. It reminds us that simulations of this type are of use in picking turning points in the stock price, but are less reliable in measuring the quarter-by-quarter movement in stock prices.

Four dynamic *ex ante* simulations are performed. For each *ex ante* simulation all of the coefficients in the model were re-estimated with data through four different terminal dates, IV/1966, IV/1967, IV/1968 and II/1970. With these different sets of model estimates, four alternative *ex ante* simulations of the stock price index were made:

1) *ex ante* simulation from I/1967 to I/1970.
2) *ex ante* simulation from I/1968 to I/1970.
3) *ex ante* simulation from I/1969 to I/1970.
4) *ex ante* simulation from I/1970 to IV/1970.

The results of these *ex ante* simulations are presented in the chart below. Simulation 1 (which is based on coefficients estimated with data through IV/1966 and simulates the stock price from I/1967) accurately measures the rapidly rising market in the four quarters of 1967. It picks the small decline in first quarter of 1968 and the rise for the rest of the year. For 1969 and 1970, however, this first simulation trails upward while the actual stock price falls substantially. The accuracy of this dynamic *ex ante* simulation diminishes

Dynamic Ex Ante Simulations of Stock Price Index*



*Standard & Poor's Index 500 Stocks, 1941-43=10

These simulations are based on re-estimates of equation 15 and 16 in the text: simulation 1 is based on coefficients estimated with data through IV/1966, simulation 2 through IV/1967, simulation 3 through IV/1968, and simulation 4 through IV/1969. Comparable re-estimates of the St. Louis Model were also used for these simulations.

Source: Standard & Poor's Security Price Index Record, 1970 Edition; Standard & Poor's Current Statistics, monthly as we move more than eight quarters away from the initial point of the simulation.

In simulation 2 all of the coefficients of the model were estimated with data through IV/1967, and the simulation was commenced in I/1968. This second simulation tracks the stock price rise during 1968 and, contrary to simulation 1, it also tracks the decline in 1969; however, it tended to understate the magnitude of the fall.

In simulation 3, all of the coefficients in the model are estimated with data through IV/1968, and the simulation starts with I/1969. This simulation indicates a decline in the stock price during the four quarters of 1969. It measures the magnitude of the decline better than simulation 2, but still understates it.

In simulation 4, all of the coefficients are estimated through II/1970 and the simulation runs from I/1970 through IV/1970. It differs from other simulations in that it is a combination *ex post* and *ex ante* simulation. The simulation is reasonably accurate at forecasting I/1970 and IV/1970, but overstates II/1970 and III/1970 by a substantial margin. The cause of this discrepancy has already been discussed. It appears that investor behavior (estimated in equation 16), which dominated stock price movements since the middle 1950's, broke down in II/1970 and III/1970, but apparently resumed its previous pattern in IV/1970.

In general, these *ex ante* simulations tend to perform well in the first four to eight quarters after they are started, but then gradually drift away from the actual value of the stock price. Considering that the periods used for the simulations were those in which stock prices reached highs not observed in the data period used to estimate the coefficients, the simulations performed relatively well.

A final dynamic *ex ante* simulation is conducted using coefficients estimated with data through II/1970. Simulations are conducted for the period IV/1970 through IV/1972. Because the actual value of the policy variables is unknown, the following assumptions are made:

(1) The corporate tax rate is assumed to be unchanged from the level of the third quarter of 1970. (At this printing, depreciation allowances have been liberalized, effective January 1, 1971. This reduction in the effective tax rate is not incorporated in the accompanying stock price simulations;)

(2) The growth in Government spending through the second quarter of 1971 is estimated from the Government budget. Thereafter, it is assumed to grow at a 6 per cent annual rate;

(3) The money stock is assumed to grow at four alternative rates: 0 per cent, 3 per cent, 6 per cent, and 9 per cent.

Because changes in the nominal money stock is the most significant policy variable in the model, it is the only one which is postulated at alternative growth rates.

These *ex ante* simulations should not be treated as exact forecasts of stock prices. There are some important factors which would make the actual stock price movement substantially different from any one of the simulated stock price movements.

First, all of these results are based on quarterly averages of the stock price, and movements in the stock price in any one week or month can deviate significantly from a quarterly average value. For example, on a monthly basis the most recent trough in the stock index was May 1970. However, on a quarterly average basis, the trough occurred in III/1970.

Second, the simulations are based on assumed constant rates of growth in the major policy variable (money). However, there in fact can be substantial variance in the growth of money, either because economic policy may change, or because of random factors which may influence the quarter-to-quarter pattern of money growth. If money should grow at a steady 3 per cent annual rate from I/1971 to IV/1972, the simulated stock price is as predicted in the table below. However, if money growth should vary between 6 per cent and 0 per cent, with an average of 3 per cent, the simulated stock price movement would be substantially different.

Third, the *ex ante* simulation is based on the assumption that the average economic behavior of the

DYNAMIC EX ANTE SIMULATIONS OF STOCK PRICE INDEX[1]

	Alternative Rates of Money Growth			
Quarter	0%	3%	6%	9%
1970/IV	84.3	85.9	87.5	89.1
1971/I	82.2	85.5	88.7	91.9
II	79.9	84.2	88.4	92.6
III	76.1	80.9	85.6	90.3
IV	75.5	80.6	85.6	90.5
1972/I	78.6	83.4	88.1	92.7
II	81.4	85.5	89.5	93.4
III	84.1	87.5	90.8	94.0
IV	85.5	88.3	91.1	93.5

[1]Levels of Standard & Poor's Index 500 Stocks, 1941-43 = 10.
Note: Projections are based on equations (15) and (16) in the text, and on the St. Louis Model.

past fifteen years will continue into the future. If there is a major structural shift in investor behavior from that implied in equation (16) (as temporarily occurred in II-III/1970), then these *ex ante* simulations will provide misleading predictions.

Finally, simulations are generally better at picking the timing of a turning point in the stock price than indicating the size of the movement after the turning point.

Conclusion

The intent of this article is threefold. First, it seeks a rational explanation for movements in stock prices which is consistent with standard economic price theory, and which can be tested against historical observations. It is shown that the standard theory of stock price determination, that is, discounting to present value expected future earnings, provides a solid theoretical base for a reasonably good empirical explanation of stock price movements in the past fifteen years. The major factors determining stock prices are shown to be expected corporate earnings and current interest rates. The interest rate in turn is determined by expectations of inflation, the real growth rate, and the change in real money. Increased earnings expectations tend to increase the stock price, while increased interest rates tend to depress the stock price. According to this analysis, changes in the nominal money stock have little direct impact on the stock price, but a major indirect influence on stock prices through their effect on inflation and corporate earnings expectations.

The second objective of this article is to test the interrelationships between the stock price hypothesis and a monetarist econometric model of the United States. By integrating the stock price submodel into the monetarist model to obtain a combined model, it is possible to better understand the link between Federal Reserve actions (measured by changes in the nominal money supply) and the resulting effect on the stock and bond markets.

A final objective is to illustrate how a small monetarist econometric model can be used to analyze subsectors of the economy. In this regard, the article can be viewed as an application of a monetarist model to issues with which the model was not originally intended to deal. The fact that it has worked with relative success provides further evidence on the usefulness of the monetarist model and its potential for further application in explaining other subsectors of the economy.

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