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AN ANALYSIS OF THE EARNINGS-PRICE INDEX AS AN INVESTMENT TOOL

BY

RAYMOND J. WOOD

A thesis submitted
in partial fulfillment of the requirements for the
degree Master of Science, Major in
Economics, South Dakota
State University

1974

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AN ANALYSIS OF THE EARNINGS-PRICE
INDEX AS AN INVESTMENT TOOL

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Thesis Advisor Date

Head, Economics Department Date

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Chapter 1

INTRODUCTION

The development of models to explain movements in equity share prices have become more realistic and sophisticated in recent years. These developments have been made possible primarily through advances in theoretical economics. In particular, advances in interest rate theory have played a significant role.[1]

Equity share price models prior to about 1958 concentrated on microeconomic variables and usually did not consider aggregate economic variables, i.e., level of income, money supply, rate of interest, etc. The microeconomic variables usually considered were directly associated with the firm. However, sole dependence on the use of microeconomic variables to explain movements in equity share prices may prove to be misleading. For example, it is entirely possible that an analysis of a firm's stock through the use of a microeconomic model might indicate that the firm was performing satisfactorily. However, due to the influence of aggregate economic variables, conditions are such that stocks in general are declining. If swings in the price of the equity share

[1]Michael Keenan, "Models of Equity Valuation: The Great SERM Bubble," The Journal of Finance, Vol. 25, No. 2, (May, 1970), p. 245.

are not identified in the equity share price model, then the model's usefulness as a forecasting tool is limited. Obviously a model which fails to consider aggregate economic variables will not reflect the overall economic conditions and therefore will not reflect changes in the stock market indices.

Economists and financial analysts have developed equity share price models based on the monetarist school of thought. Monetarist theory contends that the stock of money and changes in the stock of money play a predominant role in determining the level of economic activity.

Changes in the stock of money influence such aggregate variables as the rate of interest, level of income, etc., which creates an imbalance in an investor's portfolio. Each investor must redistribute his holdings of assets to regain equilibrium based on his preferences for risk. Since monetary theory is based on an exchange of one financial asset for another, changes in the money stock do not immediately increase or decrease existing wealth. However, changes in the stock of money do generate a wealth effect which may be very important.[2]

Since open market operations are a primary tool used by the Federal Reserve System in adjusting the stock of money, this discussion will be restricted to the use of open market operations. For example, if the Federal Reserve decides to

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[2]Warren L. Smith, Macroeconomics, (Homewood, Illinois: Richard D. Irwin., 1970), p. 318.

exert downward pressure on interest rates it would purchase government securities. Investors would then find that adjustments in their portfolios are required since the capital gains to be enjoyed from holding bonds are associated with the declining interest rates.

When a bond is originally issued it is sold at a given price with a fixed annual return. In order for bonds of all maturities to be competitive, each bond's price must vary since the annual return is fixed. In other words, each bond may be marketed prior to its maturity in such a way as to keep its yield in line with the prevailing interest rates.

Equity shares, like bonds, must also vary in price given changes in the interest rate. Whereas the yield on bonds is functionally related to the interest rate, the earnings yield on common stocks is the eventual rate of return that the investor receives from holding common stocks in their portfolio. For earnings yields to remain in line with yields from other forms of wealth, an adjustment must take place in the earnings-price ratio if the yields from other forms of wealth are changing. In the short run, earnings may be considered a constant. Therefore, when interest rates are falling stock price must rise, resulting in a decline in the earnings yield. If an earnings-price index (earnings yield) is indicative of market conditions, then accurate forecasts of an earnings-price index is of obvious and practical value for determining the timing of stock market investment strategies.

THE PROBLEM

An investor maintains a portfolio containing various quantities of such items as money, bonds, securities, or other physical goods which comprise his wealth. Assuming that the investor attempts to maximize his wealth subject to his preferences toward risk, then the investor must make a change in his portfolio to maintain equilibrium if there is a change in the condition affecting either risk, appreciation, rate of return or any of the assets in his portfolio. As a result, the rates of return of the various forms of wealth become very important, i.e., the expected rate of return on bonds vis-a-vis the expected rate of return on other securities. How then can the investor determine which course of action to take to regain equilibrium given a change in specific aggregate conditions?

More specifically, what generalized conditions may be used to determine the buy and sell conditions for equity shares? In other recent studies aggregate variables were regressed against a stock price index. In this study aggregate variables were regressed against an earnings-price index.

STUDY OVERVIEW

The study presented in this paper was an exploratory analysis of the relationship between the earnings-price index and real gross national product, interest rates, and expectations of the real money supply and inflation. An adaptive expectations mechanism utilizing the Almon distributed lag technique was used to capture the effects of expectations.[3] One of the problems associated with using the distributed lag technique was determining the number of time-periods to include in the lag structure. Since there was little a priori information available on the point of truncation, a number of regressions were fitted with alternative lag structures.

In Chapter 2, a review and critique of previous studies of both equity share price models and interest rate theory is presented. The model is developed in Chapter 3. Chapter 4 contains a presentation of the empirical results. The conclusions of this study and recommendations for future studies are presented in Chapter 5.

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[3] Jan Kmenta, Elements of Econometrics, (New York: The MacMillan Company, 1971), pp. 473-495.

Chapter 2

REVIEW OF RELATED STUDIES

As stated in Chapter 1, equity share price models prior to about 1958 primarily considered microeconomic variables. In later equity share price models, concentration was on macroeconomic variables. The Durand model, developed in 1952, was an attempt to measure the relative importance of variables that might affect the market price of bank stocks.[1] In his analysis, Durand examined a number of variables but found that the only significant variables influencing bank equity shares were net income, dividends, and net worth. The results of this model indicated that the estimates of the parameters were almost completely sample sensitive. Durand's failure to include any macroeconomic variables would indicate that he did not consider any general economic influences such as the interest rate, changes in gross national product, etc., as having an impact on bank stocks. This omission of macroeconomic variables by Durand appears to this writer to be the primary shortcoming of the model.

A very elaborate equity share price model was developed

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[1]Keenan, op. cit., pp. 245-249.

by Myron Gordon.[2] Gordon considered six variables that he felt were possible contributors to an equity valuation process. The variables were dividends per share, expected growth rate of dividends, a measure of earnings stability, a measure of a firm's leverage, an index of operating assets liquidity and a measure of a firm's size. In addition, his inclusion of the interest rate makes this model one of the first to consider a macroeconomic variable. Gordon's study was an in-depth analysis of microeconomic variables on equity share prices. However, the primary limitation of the model was due to the absence of macroeconomic variables.

Until the monetarist school of thought began to re-emerge in recent years, little work had been done in developing a model to relate macroeconomic variables to an index of common stock prices. Beryl W. Sprinkel, in his book _Money and Stock Prices_, noted that there appeared to be a relationship between the money supply and stock prices. By comparing the turning points in the growth rate of money (narrowly defined with a six month moving average), Sprinkel formulated an investment rule that, "a bear market in stock prices was predicted 15 months after each peak in monetary growth, and that a bull market was predicted two months after each

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[2]Myron J. Gordon, _The Investment, Financing, and Valuation of the Corporation_, (Homewood, Illinois: Richard D. Irwin, Inc., 1962), pp. 115-117.

monetary growth trough was reached."[3]

The obvious shortcoming of Sprinkel's study was that he failed to develop a stochastic model that would corroborate the observed relationship between changes in the money supply and stock prices.[4] Their objective was to develop and estimate a stochastic model emphasizing the relationship between the supply of money and an index of common stock prices and then evaluate the model's usefulness as a forecasting tool for investment strategies.

The model they developed incorporated three variables: the level of stock prices, the level of the money supply, and the rate of growth of the money supply. Having little a priori information concerning the form of the relationship, a number of lag structures of the money supply and monetary growth rate were regressed. The equation which yielded the best fit was:

$$SP_t = \underset{(1.11)}{-26.77} + \underset{(4.13)}{.61}\, M_t + \underset{(3.16)}{3.1}\, G_t + \underset{(1.46)}{1.46}\, G_{t-1} + .87\, U_{t-1} \qquad (1)$$

$$R^2 = .968$$
$$S.E. = 3.70$$
$$D.W. = 2.14$$

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[3]Beryl W. Sprinkel, Money and Markets, A Monetarist View, (Homewood, Illinois: Richard D. Irwin, Inc., 1971) p. 120.

[4]Kenneth E. Homa and Dwight M. Jaffee, "The Supply of Money and Common Stock Prices," The Journal of Finance, Vol. 26, No. 5 (December, 1971), pp. 1045-1066.

Where:

SP = level of stock prices (based on Standard and Poor's 500 index, measured on the last Friday of the quarter)

M = level of money supply (quarterly average of seasonally adjusted demand deposits and currency)

G = growth rate of money supply (percentage change)

U = lagged residual used to correct for serial correlation

As noted in the results, over 96 per cent of the variation in the dependent variable was explained by the money supply variables. All variables had the expected sign and the level and growth rate of the money supply were statistically significant. To offset the high serial correlation, the coefficient of serial correlation was estimated by including the lagged error term in the regression.[5]

The money supply variables have both a direct and an indirect influence on the stock level. As indicated by Keran, the role of money has a relatively small direct influence on stock prices but is very important with regard to its indirect effects.[6] Changes in the money supply exerts its influence on stock prices through real output, prices, earnings and interest rates.

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[5]The lagged error term was estimated by the Cochrane and Orcutt technique.

[6]Michael W. Keran, "Expectations, Money and the Stock Market," Federal Reserve Bank of St. Louis Review, Vol. 53, No.1, (January, 1971), p. 26.

One of the major problems encountered by Homa and Jaffee was forecasting movements in the money supply. This was a major prerequisite to the model's use as a forecasting tool. The coefficients of the demand variables were found to be unstable and not statistically significant and therefore only the supply variables were included in the specification. The serial correlation coefficient was estimated by the Cochrane and Orcutt technique to eliminate the problem of serial correlation which was found in preliminary examination. The specification was:

$$G = a_0 + a_1 U^2_{t-1} + a_2 P_{t-1} + a_3 BOP_{t-1} + a_4 G_{t-1} + a_5 u_{t-1} \qquad (2)$$

Where:

G = growth rate of the seasonally adjusted money supply (M_1)

U = civilian unemployment rate from the Bureau of Labor Statistics Household Survey

P = the rate of inflation (private output price deflator from the National Income Accounts)

u = lagged residual used to correct for serial correlation

BOP = the ratio of U.S. reserve assets (gold stock and IMF reserve position) to total U.S. short term liabilities to foreigners, measured as a deviation from a four quarter moving average.

Certain assumptions had to be made with regard to Federal Reserve policy actions to determine the sign of U, P, and BOP. If the Federal Reserve increases the growth rate of the money supply in periods of high unemployment and periods of good international reserve position, then the coefficients of U and BOP should be positive. Assuming the Federal Reserve decreases the growth rate of the money supply during periods of inflation, then the coefficient of P should be negative.

The regression was estimated using a moving average of quarterly observations over different time periods. The coefficients of determination ranged from .529 to .692. The coefficient estimates in some cases were not significant and in some cases did not have the correct sign.[7] The estimated equations were as follows:

1955-1 to 1959-4

$$G = \underset{(1.62)}{-.53} + \underset{(2.65)}{2.61}\, U^2_{t-1} + \underset{(.73)}{.20}\, P_{t-1} + \underset{(.47)}{.58}\, BOP_{t-1} + \underset{(1.31)}{.36}\, G_{t-1} + .01\, u_{t-1} \qquad (3)$$

$$R^2 = .529 \quad S.E. = .413 \quad D.W. = 1.6.$$

1960-1 to 1964-4

$$G = \underset{(1.23)}{.70} + \underset{(.40)}{.60}\, U^2_{t-1} + \underset{(.12)}{.15}\, P_{t-1} + \underset{(1.79)}{6.06}\, BOP_{t-1} + \underset{(1.26)}{.26}\, G_{t-1} + .11\, u_{t-1} \qquad (4)$$

$$R^2 = .544 \quad S.E. = .385 \quad D.W. = 2.12$$

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[7] Homa and Jaffee, op. cit., pp. 1053-1054.

1965-1 to 1969-4

$$G = \underset{(1.97)}{3.07} - \underset{(.87)}{8.47}\, U^2_{t-1} - \underset{(3.43)}{14.17}\, P_{t-1}$$

$$+ \underset{(.26)}{.12}\, BOP_{t-1} + \underset{(1.99)}{.37}\, G_{t-1} + .58\, u_{t-1} \qquad (5)$$

$$R^2 = .692$$
$$S.E. = .447$$
$$D.W. = 2.02$$

Homa and Jaffee based their stock price equation solely on the level and growth rate of the money supply. This would indicate that "only money matters". Granted, money is important; however, there are other influences which must be taken into consideration such as other variables determining the level of aggregate economic activity.

The most comprehensive model devised to explain stock market movements is that of Michael W. Keran.[8] Keran develops the equity share price model based on the theory of stock price determination; that is, stock price is a function of expected future dividends discounted to present value and the discount to present value of the expected stock price at the time of the sale. He explicitly incorporates such factors as the money supply, expectations of earnings and inflation, and interest rate effects. Keran found that the major variables influencing stock prices were expected corporate earnings and current interest rates. The interest rate was shown to be determined by the expected rate of change in prices, the real growth rate, and changes in real money supply.

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[8] Keran, op. cit., pp. 16-31.

Keran's reduced form stock price equation is as follows:

$$\dot{SP}_t = -\underset{(9.84)}{30.68} + \sum_{i=0}^{2} \underset{(4.14)}{1.31} \dot{M}_{t-i} - \sum_{i=0}^{7} \underset{(5.56)}{5.37} \dot{X}_{t-i}$$

$$- \sum_{i=0}^{16} 11.96 \dot{P}_{t-i} + \sum_{i=0}^{19} \underset{(20.0)}{4.80} E_{t-i} \qquad (6)$$

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

Where:

$\dot{M}_{t-i}$ = percentage change in the real money supply (M_1 divided by the GNP implicit price deflator)

$\dot{X}_{t-i}$ = rate of change in real GNP

$\dot{P}_{t-i}$ = percentage change in prices (GNP implicit price deflator)

E_{t-i} = real corporate earnings (nominal earnings divided by the GNP implicit price deflator)

Ninety-eight percent of the variation in stock prices was explained by the independent variables. All of the coefficients were statistically significant and had the expected sign.

As noted in the results, increased earnings expectations tend to increase the stock price index, while increased interest rates tend to decrease the index. Changes in the nominal money stock has little direct influence but major indirect influence through its effect on inflation and earnings expectations and interest rates.

As previously stated, the Durand and Gordon models did not include aggregate economic variables. The later

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models concentrated on the influence of macroeconomic variables. They did not, however, attempt to specify the equilibrating mechanism between interest rates and an equity share price index. The determinates of interest rates must be established to develop an equilibrating mechanism.

The early economists examined the determination of interest rates by equilibrating the supply and demand of real saving and real investment.[9] In 1930, Irving Fisher postulated that the nominal rate of interest was primarily a function of the real rate of interest and expectations regarding the rate of inflation.[10] The Fisher effect or, alternately the price expectations effect is the relationship between nominal interest rates and the expected rate of change in prices. A real capital loss results to the lender if there is price inflation during the period of the loan. If the lender anticipates a rise in the general level of prices, he will try to protect himself by charging a higher price for the use of his funds. Borrowers who also expect prices to rise will be willing to pay the higher charges since the real assets acquired with the funds will also increase in value. Therefore, Fisher argued that if both lenders and borrowers

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[9]Paul A. Samuelson, "Money, Interest Rates, and Economic Activity: Their Interrelationship in a Market Economy," Monetary Economics: Readings on Current Issues, William E. Gibson and George G. Kaufman, (McGraw-Hill, Inc., 1971), p.51.

[10]William E. Gibson, "Price-Expectations Effects on Interest Rates," The Journal of Finance, Vol. 25, (March, 1970), p. 19.

have the same expectations with regard to price levels, the nominal rate of interest will exceed the real rate by the expected rate of price increase.[11]

Many earlier studies[12] ignored the real interest rate variable in Fisher's equation and regressed nominal interest rates directly on past price changes or used a surrogate variable for the real rate of interest such as equity yields.[13] In a recent study by Thomas J. Sargent, an attempt was made to correct this deficiency.[14] Sargent decomposed the real interest rate into two components; the equilibrium real rate which equates saving and investment, and the deviation of the current real market rate from the real equilibrium rate.[15] As a result, a proxy for the real interest rate can be determined by deriving the determinates of the above two components. The equation as developed by Sargent is:

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[11]Fisher also included a third term which was the expected rate of depreciation of the interest payments. This will not be considered since it is of negligible significance.

[12]William P. Yohe and Denis S. Karnosky, "Interest Rates and Price Level Changes," Monetary Economics: Readings on Current Issues, William E. Gibson and George G. Kaufman, (McGraw-Hill, Inc., 1971), p. 368.

[13]Patric H. Hendershott and James C. Van Horne, "Expected Inflation Implied by Capital Market Rates," The Journal of Finance, Vol. 28, (May, 1973), p. 301.

[14]Thomas J. Sargent, "Commodity Price Expectations and the Interest Rate," Quarterly Journal of Economics, Vol. 83, (February, 1969), pp. 127-140.

[15]The market rate of interest (rm_t) is the nominal rate of interest adjusted for expected inflation.

$$rn_t = re_t + (rm_t - re_t) + (rn_t - rm_t) \tag{7}$$

Where:

re_t = the real rate (equilibrium rate) which equates the flows of desired saving and investment.

rm_t = the real market rate of interest at time t.

rn_t = the nominal interest rate at time t.

The equilibrium rate may be obtained by solving the real exante saving and investment functions simultaneously.

$$\frac{I_t}{P_t} = f(rm_t, Y_t - Y_{t-1}), \quad \frac{\partial f}{\partial rm_t} < o, \quad \frac{\partial f}{\partial Y_t - Y_{t-1}} > o \tag{8}$$

$$\frac{S_t}{P_t} = g(rm_t, Y_t), \quad \frac{\partial g}{\partial rm_t} > o, \quad \frac{\partial g}{\partial Y_t} > o \tag{9}$$

Where:

$Y_t - Y_{t-1}$ = the change in real income.

Y_t = real income at time t.

Full equilibrium is attained when the excess demand function equals zero.

$$ED_t = \frac{I_t}{P_t} - \frac{S_t}{P_t} = 0 \tag{10}$$

The rate re_t is the rate which solves the excess demand equation. The result of the solution produces the equilibrium equation:

$$re_t = f(Y_t - Y_{t-1}, Y_t), \quad \frac{\partial f}{\partial Y_t - Y_{t-1}} > o, \quad \frac{\partial f}{\partial Y_t} < o \tag{11}$$

A rise in the rate of increase in income stimulates the demand for funds for investment and thus drives up the equilibrium rate of interest as indicated by equation (11). A one-time increase in income, however, generates a larger volume of saving and, therefore, diminishes the equilibrium rate of interest.

The deviation of the market rate from the equilibrium rate ($rm_t - re_t$) is created by the monetary authority increasing or decreasing the money supply. Based on the contention that it is relative changes in the real money stock that creates the gap, the following relationship was established:

$$(rm_t - re_t) = f\left(\frac{m_t - m_{t-1}}{m_{t-1}}\right), \; f' < o \qquad (12)$$

Where:

M_t = the real money stock at time t.

The real market rate of interest is inversely related to the real money supply by the restriction placed on it.

The last term in Sargent's indentity is the deviation of the nominal rate of interest from the real market rate ($rn_t - rm_t$), which is the same as the "Fisher Effect", or rate of inflation expected. Or:

$$(rn_t - rm_t) = P_t^e \qquad (13)$$

Where:

P_t^e = expected rate of inflation at time t.

Substituting the functionally related parts of equations (11), (12), and (13) into equation (7) yields:

$$rn_t = f(Y_t - Y_{t-1}, Y_t, \dot{M}_t, \dot{P}^e_t, \varepsilon) \qquad (14)$$

The impact of monetary and real factors on the level of nominal interest rates is summarized in equation (14)

SUMMARY

The examples shown in this review have indicated that stock price models were developed initially based on microeconomic variables. As interest began to rekindle in monetarist theory, the emphasis shifted from micro-theory.

Durand was one of the first economists to derive a quantitative equity share price model. The objection raised to his study was that he considered only microeconomic variables.

Gordon's contribution to the equity share price model was through the introduction of the interest rate, a macroeconomically determined variable. His main emphasis was to test and explain the microeconomic variables.

Within the context of monetarist theory, Sprinkel developed an explanation of equity valuation by inspecting historical data. The main objection to his work was the lack of any mathematical model to substantiate his analysis.

Homa and Jaffee attempted to rectify Sprinkel's omission by regressing the level and growth rate of the money supply against stock prices. This indicated that the money supply plays a significant role in stock price movements.

Their next problem was developing a method of forecasting movements in the money supply. Since they could not develop an accurate method for forecasting movements in the money supply, the stock price equation did not meet the objective as a forecasting tool for investment strategies.

Keran's analysis, devised to capture the effects of expectations on stock price levels, was successful. The major factors he found that were instrumental in determining the general level of stock prices were expected corporate earnings and current interest rates. In Keran's model, the interest rate was determined to be functionally related to inflation expectations, the real growth rate of gross national product and changes in the real money supply.

Equity share price analysis has progressed from the development of models to explain movements in individual stock price to movements in the general level of stock prices. In most cases the interest rate has been a key element in explaining these movements. In like fashion, the model presented in Chapter 3 will be based on the theory of interest rates.

Past equity share price models have concentrated on explaining movements in equity share prices through the use of macroeconomic variables. This author attempted to establish an equilibrating mechanism between the interest rate and the earnings-price index based on a portfolio adjustment mechanism.

Chapter 3

THE MODEL

As previously stated, the factors which determine long-term interest rates must be considered to develop an equation designed to explain movements in an index of earnings-price ratios, since the earnings-price index is a function of interest rates. Utilizing a Wicksellian loanable funds model as it has been employed by Sargent, the interest rate becomes a function of current and lagged rates of changes in real income, the rate of growth in the real money supply, and the expected rate of change in prices.

Most Keynesians and some monetary theorists argue that there is an inverse relationship between the magnitude of the money stock and interest rates. However, it has been noted that there have been extended periods of rising interest rates accompanied by increases in the money stock.[1] Gibson, an English Financial writer, emphasized the high positive correlation between prices and interest rates. This relationship has since become known as "the Gibson Paradox." As a result, economists have also included in their analysis the effects of income and price expectations on interest rates.

[1]Sargent, op. cit., p. 127.

Since price expectations can lead to higher interest rates and income expectations, inflation must be accounted for by distinguishing between real and nominal interest rates and real and nominal income.

The following equation is postulated to explain movements in an aggregate earnings-price index:

$$\frac{E_t}{P_t} = f(rn_t, e_t) \tag{15}$$

Where:

$\frac{E_t}{P_t}$ = an aggregate earnings-price index in time period t.

rn_t = nominal interest rate at time t.

e_t = a stochastic element representing shocks and disturbances from other sources.

From Chapter 2, Sargent argued very effectively that

$$rn_t = g\,[(Y_t - Y_{t-1}),\ Y_t,\ \dot{M}_t,\ \dot{P}^e_t,\ e_t] \tag{16}$$

Where:

$Y_t - Y_{t-1}$ = the change in real income,

Y_t = real income at time t,

$\dot{M}_t$ = percentage change in the real money stock at time t,

$\dot{P}^e_t$ = expected rate of inflation at time t.

substituting (16) into (15) yields

$$\frac{E_t}{P_t} = f(g\ (Y_t - Y_{t-1}),\ Y_t,\ \dot{M}_t,\ \dot{P}^e_t,\ e_t) \tag{17}$$

and therefore,

$$\frac{E_t}{P_t} = \theta((Y_t - Y_{t-1}), Y_t, \dot{M}_t, \dot{P}^e_t, e_t) \tag{18}$$

PRICE EXPECTATIONS

Since price expectations are not directly observable, we must formulate an explanation of the process of adjustment. Expectations must have a known relation to something that is itself known or predictable, so therefore, the following equation is asserted for the price expectations variable:

$$\dot{P}^e_t = \lambda(\dot{P}_{t-1} - \dot{P}^e_{t-1}) + P^e_{t-1}, o < \lambda < 1 \tag{19}$$

Expected prices in the current time period are equal to expected prices in the previous time period plus a constant proportion of the difference between actual and expected prices in the previous period. If actual prices exceeded expected prices in the previous time period, then consumers would revise their expectations of the price level upward in the current time period.

In order for equation (19) to be useful, the expectation on the right side must be eliminated. This is accomplished by solving for the expected value in each preceeding time period and substituting to derive:

$$\dot{P}^e_t = \sum_{i=1}^{\infty} \lambda(1 - \lambda)^{i-1} \dot{P}_{t-i}, o < \lambda < 1 \tag{20}$$

Price expectations are dependent on past price levels.

DESIRED CHANGES IN THE REAL MONEY SUPPLY

In Sargent's analysis, the percentage change in the real money supply was found to be a significant factor. However, Sargent only considered the money supply variable in the current time period. This author attempted to incorporate a dynamic adjustment mechanism based on desired changes in the real money supply. The Federal Reserve attempts to control the money supply based on current policy and review of the effects of their past actions. Therefore, a dynamic adjustment mechanism may be developed to capture the influence of desired changes in the real money supply on the earnings-price index. The following dynamic adjustment mechanism is asserted for changes in the real money supply:

$$\dot{M}_t^d = \phi \ (\dot{M}_{t-1} - \dot{M}_{t-1}^d) + \dot{M}_{t-1}^d, \quad o < \phi < 1 \qquad (21)$$

The adjustment mechanism may be explained by noting that the Federal Reserve is shooting at a target i.e., a specified percentage increase or decrease in the real money stock in each time period based on the results of the previous time period. As noted in equation (21), the desired percentage change in the real money supply is equal to the desired change in the previous time period plus a constant proportion of the difference between the actual and expected change in the previous period.

As before, the expectation on the right side of equation (21) is eliminated by solving for the expected value in each preceding time period and substituting, therefore:

$$\dot{M}_t^d = \sum_{i=1}^{\infty} \phi(1 - \phi)^{i-1} M_{t-i}, \quad o < \phi < 1 \qquad (22)$$

A priori, one would expect the summed regression coefficients of desired changes in the real money supply to be greater than one. This occurs because of the Federal Reserve's inability to make exact changes in the money supply. Some authors have also argued that the Federal Reserve has historically over-responded when attempting to manipulate the stock of money.[2]

The expected signs of the coefficients for real income, changes in the real money supply, and price level changes are discussed below.

An increase in the rate of increase in real income drives up nominal interest rates. Rising interest rates result in declining bond prices. Investors now find that their portfolios are no longer in equilibrium. To regain equilibrium, investors shift from common stocks and other assets to bonds, thereby reducing the demand for stocks. These transactions result in declining stock prices. The earnings-price index is, therefore, positively related to changes in real income.

Since stock prices tend to respond to long-run earnings and not current reported earnings, a one-shot increase

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[2]Milton Friedman, "A Program for Monetary Stability --Part 1," James A. Crutchfield, Charles H. Henning, William Piggott, Money, Financial Institutions, and the Economy. (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1965), pp. 295-308.

in real income will have a small upward influence on the earnings-price index.[3]

As argued previously, the nominal interest rate is positively correlated with the rate of inflation. If the percentage increase in nominal earnings is less than the percentage increase in nominal interest rates, then stock prices will decline and earnings-price ratios will increase. Thus, earnings-price ratios might be expected to move monotonically with the expected rate of inflation.

An increase in the rate of increase in the real money supply results in downward pressure on nominal interest rates. Declining nominal interest rates result in an upward movement in stock prices. If the percentage increase in nominal earnings is less than the percentage increase in stock prices, then earnings-price ratios will be negatively related to percentage changes in the real money supply.

For the purpose of empirical implementation, the variables must be put into a form that is compatible with the technique of ordinary least squares. It is, therefore, convenient to assume that the dependent variable is a linear function of the independent variables.

By replacing the percentage change in the real money supply ($\dot{M}_t$) with the distributed lag resulting from the dynamic

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[3]Myron S. Scholes, "Discussion," The Journal of Finance, Vol. 28, (May, 1973), p. 316.

adjustment mechanism (M_t^d), equation (16) becomes:

$$\frac{E_t}{P_t} = h\ (Y_t - Y_{t-1},\ Y_t,\ \dot{M}_t^d,\ \dot{P}_t^e,\ e_t)$$

$$\frac{\partial h}{\partial Y_t - Y_{t-1}} > 0,\ \frac{\partial h}{\partial Y_t} > 0,\ \frac{\partial h}{\partial \dot{P}_t^e} > 0,\ \frac{\partial h}{\partial \dot{M}_t^d} < 0 \qquad (22)$$

Equation (22) in linear form becomes:

$$\frac{E_t}{P_t} = a + b_1\ (Y_t - Y_{t-1}) + b_2\ (Y_t) + b_3\ \dot{M}_t^d$$

$$+ b_4\ \dot{P}_t^e + e_t \qquad (23)$$

The data and empirical results are presented in Chapter 4.

Chapter 4

DATA, EMPIRICAL RESULTS AND COMMENTS

Direct estimation of an unconstrained distributed lag function tends to result in wildly fluctuating coefficients due to multicollinearity. The relationship was regressed using the Almon distributed lag technique to reduce this fluctuation.

DATA

The relationship was regressed using quarterly data from the fourth quarter, 1962, to the third quarter, 1973.[1] The following variables were used to empirically fit the equation.

Price Level

The Gross National Product (GNP) Price Deflator was used to represent the price level since it is a more inclusive index than the Consumer Price Index. The GNP price deflator is used to compare what a basket of goods costs today with

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[1] All time series data was obtained from Data Resources, Incorporated, Lexington, Massachusetts, with the exception of the Earnings/Price index. The Earnings/Price index was obtained from back issues of the Federal Reserve Bulletin.

what the same basket cost in a base year. That is, the price of each commodity is multiplied by the quantity of that commodity included in GNP, and the results are summed to give nominal GNP in time t. Next the same goods and services that were produced in time period t are priced according to the prices for some base year. The base year price is then multiplied by the quantity of that commodity in the current year's GNP, and the results are summed to give real GNP in time period t. The GNP price deflator is then calculated as nominal income in time period t divided by real income in time period t. This series was available in a quarterly index. The series was used to deflate quarterly nominal values.

Rate of Inflation

The rate of inflation was calculated by transforming the GNP price deflator into a percentage change value. The rate of inflation was obtained by subtracting the previous quarter's GNP price deflator from the current quarter's GNP deflator and dividing by the previous quarter's GNP price deflator.

Real Income and Changes in Real Income

Income was represented by Gross National Product (GNP) which includes personal consumption expenditures, gross private and domestic investment, net exports of goods and services, and Government purchases of goods and services. This data was available in a quarterly series. Quarterly GNP was divided by the quarterly GNP price deflator to obtain an estimate for real quarterly income at annual rates. To obtain changes in real income, the previous quarter's level of real income was subtracted from the current quarter's level of real income.

<u>Percent Change in the Real Money Supply</u>

The total money supply includes coin and currency, demand deposits, and time deposits. The total money supply was used to represent the nominal money supply. The monthly values were arithmetically averaged to obtain quarterly data. The quarterly money supply was then divided by the quarterly GNP price deflator to obtain the real money supply. By subtracting the previous quarter's real money supply from the current quarter's real money supply, the percent change in the real money supply was obtained.

<u>Earnings/Price Ratio</u>

Standard and Poor's 500 stock average represented the price index. Quarterly earnings were seasonally adjusted at annual rates. The data was available in a quarterly series.

DATA LIMITATIONS

The money supply was available only in a monthly series. The monthly series was arithmetically averaged over each quarter to obtain quarterly data. The averaging technique introduced a degree of bias that will tend to shift the regression either upward or downward, thus distorting the true relationship. Arithmetic averaging will smooth deviations over the time period being considered. This will result in the estimated regression line being distorted and the population regression line being misrepresented.

A second limitation results from using the GNP price deflator to determine inflationary effects. Whereas the consumer price index overstates inflation, the GNP price deflator understates inflation.[2] This occurs because the substitution effect is not explicitly considered in the GNP price deflator.

REGRESSION RESULTS

The linearized equation presented in Chapter 3 was fitted to quarterly data from the fourth quarter, 1962, through the third quarter, 1973. The regression was run using different time lags, different degree polynomials, and different constraints. The results did not meet a priori expectations. The results of a constrained third degree polynomial regression lagged six quarters are presented below:

$$\frac{E_t}{P_t} = \underset{(1.4355)}{6.0987} - \underset{(.0213)}{.0064}(Y_t - Y_{t-1}) - \underset{(.0019)}{.0001}\, Y_t$$

$$+ \underset{(.2983)}{.7816}\, \dot{P}_t + \underset{(.4067)}{1.0145}\, \dot{P}_{t-1} + \underset{(.4357)}{.8613}\, \dot{P}_{t-2}$$

$$+ \underset{(.4803)}{.4848}\, \dot{P}_{t-3} + \underset{(.545)}{.0477}\, \dot{P}_{t-4} - \underset{(.5501)}{.2872}\, \dot{P}_{t-5}$$

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[2] Charles W. Baird, Macroeconomics, (Chicago, Illinois: Science Research Associates, Inc., 1973), p. 30.

$$- \underset{(.3987)}{.3574} \dot{P}_{t-6} + \underset{(.0975)}{.0029} \dot{M}_t - \underset{(.125)}{.0246} \dot{M}_{t-1}$$

$$- \underset{(.1183)}{.065} \dot{M}_{t-2} - \underset{(.1103)}{.1007} \dot{M}_{t-3} - \underset{(.1092)}{.1143} \dot{M}_{t-4}$$

$$- \underset{(.1034)}{.0883} \dot{M}_{t-5} - \underset{(1509)}{.0053} \dot{M}_{t-6} \qquad (24)$$

$$R^2 = .2674$$
$$S.E. = .570$$
$$D.W. = 1.1903$$
$$\bar{R}^2 = \text{Less than zero}$$

It is apparent that the degree of explanatory power of equation (24) is minimal. This makes it difficult to make any statements with regard to statistical relevance. However, based on the results obtained, an analysis was attempted.

The regression coefficients of real income and changes in real income were negative and, therefore, did not meet a priori conditions. The parameter estimates of price level changes were positive and met a priori conditions except for the last two quarters, neither of which were statistically significant. The regression coefficients of percentage changes in the real money supply were negative and met a priori conditions except for the initial time period. The only parameter estimates found to be statistically significant were the intercept, initial, first and second lagged quarters of price level changes. Positive serial correlation was found to be present based on the Durbin-Watson test.

In an attempt to improve the regression results, other variables were tried, such as the Federal Reserve Capacity Utilization index, Moody's Baa bond yield index and dummy Variables representing the Vietnam strength buildup and the price-wage freeze. None of these by themselves or together contributed to the regression.

Time lags ranging from four to eight quarters were attempted. Equations were computed with the near and far side being constrained. Constraints were placed on the near and far sides of the gross national product price deflator and the real money supply. It was found that the real money supply created an unstable influence on the regression and was reduced to a non-Almon variable. When the gross national product price deflator was lagged four quarters, the best results were obtained. The regression results are presented below:

$$\frac{E_t}{P_t} = \underset{(1.0065)}{5.9693} + \underset{(.0209)}{.0001}(Y_t - Y_{t-1}) - \underset{(.002)}{.0001}Y_t$$
$$+ \underset{(.310)}{.1123}\dot{P}_t + \underset{(2289)}{.5321}\dot{P}_{t-1} + \underset{(.1802)}{.223}\dot{P}_{t-2}$$
$$- \underset{(.253)}{.2747}\dot{P}_{t-3} - \underset{(.2648)}{.4208}\dot{P}_{t-4} - \underset{(.1168)}{.1466}\dot{M}_t \qquad (25)$$

$$R^2 = .2323$$
$$S.E. = .4711$$
$$D.W. = 1.2847$$
$$\bar{R}^2 = .0532$$

The regression coefficient of changes in real income was positive and, therefore, met a priori conditions. The regression coefficient of real income was negative and did not meet a priori conditions. The regression coefficient of the percentage change in the real money supply was negative and met a priori conditions. The parameter estimates of changes in real income percentage change in the real money supply did not prove to be statistically significant. The summed regression coefficient of inflationary expectations was positive and also met a priori conditions. Only one time period was found to be statistically significant. Positive serial correlation is present as indicated by the Durbin-Watson test.

If inflation occurs and is not expected to continue, then stock price will rise at a greater rate than earnings which may account for the negative regression coefficients noted in the price change variable. If inflation continues, interest rates rise and equity share prices decline resulting in the positive regression coefficients.

The mean lag of inflationary effects has been growing shorter over time which provides some justification for the shorter lag structure found. Earlier studies concluded that the effect of price level changes have a mean lag of anywhere from seven to thirty years. However, the more recent studies have yielded mean lags of less than a year.[3] Friedman and Schwartz contend that the period used to form expectations depends on the characteristics of price behavior, in particular, the "variability in the behavior of the general level of prices."[4]

The variables under consideration were also regressed

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[3]Yohe and Karnoski, op. cit., p. 362.

[4]Ibid., p. 367.

using ordinary least squares. Regressions were run lagging price level changes and money supply changes four, six, and eight quarters. When the coefficients for each of the distributed lagged variables was constrained to one, the regressions resulted in the adjusted coefficient of determination equaling less than zero. The results of the unconstrained cases are presented below:

$$
\begin{aligned}
\frac{E_t}{P_t} = {} & \underset{(1.0776)}{5.5754} + \underset{(.023)}{.0085}\,(Y_t - Y_{t-1}) + \underset{(.0024)}{.0013}\,Y_t \\
& + \underset{(.3965)}{.1612}\,\dot{P}_t + \underset{(.3331)}{.3090}\,\dot{P}_{t-1} + \underset{(.3676)}{.2322}\,\dot{P}_{t-2} \\
& - \underset{(.3066)}{.3586}\,\dot{P}_{t-3} - \underset{(3018)}{.5965}\,\dot{P}_{t-4} - \underset{(.1795)}{.092}\,\dot{M}_t \\
& - \underset{(.2247)}{.227}\,\dot{M}_{t-1} + \underset{(.2539)}{.1283}\,\dot{M}_{t-2} - \underset{(.2463)}{.1521}\,\dot{M}_{t-3} \\
& - \underset{(.1907)}{.0708}\,\dot{M}_{t-4} \qquad (26)
\end{aligned}
$$

$$
\begin{aligned}
R^2 &= .4793 \\
S.E. &= .4722 \\
D.W. &= 1.3883 \\
\bar{R}^2 &= .2294
\end{aligned}
$$

$$
\begin{aligned}
\frac{E_t}{P_t} = {} & \underset{(1.4609)}{5.2543} + \underset{(.0038)}{.0012}\,Y_t + \underset{(.0304)}{.0146}\,(Y_t - Y_{t-1}) \\
& + \underset{(.4617)}{.0391}\,\dot{P}_t + \underset{(.4254)}{.2778}\,\dot{P}_{t-1} + \underset{(.4938}{.6712}\,\dot{P}_{t-2} \\
& - \underset{(.3764)}{.3773}\,\dot{P}_{t-3} - \underset{(3703)}{.2688}\,\dot{P}_{t-4} - \underset{(.345)}{.363}\,\dot{P}_{t-5} \\
& - \underset{(.419)}{.2648}\,\dot{P}_{t-6} - \underset{(.2071)}{.0619}\,\dot{M}_t - \underset{(2547)}{.2352}\,\dot{M}_{t-1} \\
& + \underset{(.284)}{.2475}\,\dot{M}_{t-2} - \underset{(.2934)}{.2468}\,\dot{M}_{t-3} + \underset{(.2947)}{.1725}\,\dot{M}_{t-4}
\end{aligned}
$$

$$- \underset{(.2763)}{.3755}\ \dot{M}_{t-5} + \underset{(.2278)}{.2947}\ \dot{M}_{t-6} \qquad (27)$$

$R^2 = .5707$
S.E. = .4861
D.W. = 1.1819
$\bar{R}^2 = .2091$

$$\frac{E_t}{P_t} = \underset{(3.341)}{5.0256} + \underset{(.034)}{.0335}\ (Y_t - Y_{t-1}) + \underset{(.0085)}{.0057}\ Y_t$$
$$- \underset{(.5673)}{.1813}\ \dot{P}_t + \underset{(4984)}{.3323}\ \dot{P}_{t-1} + \underset{(.6332)}{.5492}\ \dot{P}_{t-2}$$
$$- \underset{(.52)}{1.0625}\ \dot{P}_{t-3} - \underset{(.4551)}{.4957}\ \dot{P}_{t-4} - \underset{(.394)}{.3532}\ \dot{P}_{t-5}$$
$$- \underset{(.5389)}{.4978}\ \dot{P}_{t-6} - \underset{(.6348)}{.3065}\ \dot{P}_{t-7} - \underset{(1.0237)}{.0662}\ \dot{P}_{t-8}$$
$$- \underset{(.2771)}{.3214}\ \dot{M}_t - \underset{(.2734)}{.2821}\ \dot{M}_{t-1} + \underset{(.3359)}{.2717}\ \dot{M}_{t-2}$$
$$- \underset{(.3251)}{.5232}\ \dot{M}_{t-3} + \underset{(.3178)}{.075}\ \dot{M}_{t-4} - \underset{(.3451)}{.5812}\ \dot{M}_{t-5}$$
$$+ \underset{(.3248)}{.348}\ \dot{M}_{t-6} - \underset{(.3003)}{.1024}\ \dot{M}_{t-7} - \underset{(.2777)}{.3212}\ \dot{M}_{t-8} \qquad (28)$$

$R^2 = .6934$
S.E. = .4831
D.W. = 1.6733
$\bar{R}^2 = .2218$

Although the goodness of fit has improved, the results are not entirely satisfactory. Very few parameter estimates may be considered statistically significant.

As previously indicated, the real money supply was found to be an unstable influence on the regression. The results obtained by lagging the percentage change in the real money supply against the earnings-price index are presented below:

$$\frac{E_t}{P_t} = \underset{(.1715)}{6.1915} - \underset{(.1094)}{.3802}\,\dot{M}_t + \underset{(.0796)}{.0952}\,\dot{M}_{t-1}$$

$$+ \underset{(0593)}{.1104}\,\dot{M}_{t-2} - \underset{(.0606)}{.0596}\,\dot{M}_{t-3} - \underset{(.0604)}{.1292}\,\dot{M}_{t-4}$$

$$+ \underset{(.1131)}{.1711}\,\dot{M}_{t-5} \qquad (29)$$

R^2 = .2234
S.E. = .4628
D.W. = 1.2629
$\bar{R}^2$ = .9082

This regression was an unconstrained third degree polynomial, lagged five quarters. As noted in equation (29), the regression coefficients oscillate. The only statistically significant money supply variable was in time period t.

Equation (23) was also regressed without percentage changes in the real money supply included and the following results were obtained:

$$\frac{E_t}{P_t} = \underset{(.9751)}{5.3029} - \underset{(.0164)}{.0101}\,(Y_t - Y_{t-1}) + \underset{(.0013)}{.001}\,Y_t$$

$$+ \underset{(.2421)}{.7553}\,\dot{P}_t + \underset{(.2687)}{1.0546}\,\dot{P}_{t-1} + \underset{(.3355)}{.9759}\,\dot{P}_{t-2}$$

$$+ \underset{(.387)}{.675}\,\dot{P}_{t-3} + \underset{(.3835)}{.3075}\,\dot{P}_{t-4} + \underset{(.348)}{.0292}\,\dot{P}_{t-5} \qquad (30)$$

R^2 = .3132
S.E. = .4578
D.W. = 1.3743
$\bar{R}^2$ = .1415

An analysis of equation (30) indicates a slight improvement in the goodness of fit. Changes in real income, however, has the wrong sign and is not statistically significant. This may be explained by the fact that earnings are based on long-run expectations and are more stable than stock prices. Therefore, short-run increases in real income induce stock prices up at a faster rate than earnings.

Conclusions from this study and recommendations for further study are presented in Chapter 5.

Chapter 5

SUMMARY AND CONCLUSIONS

Changes in the stock of money have been found to be a significant influence on such aggregate economic variables as the rate of interest, level of income, etc. Changes in the various macroeconomic variables lead to disequilibrium in each investor's portfolio. Each investor now finds that the relative yield of equity shares are no longer in line with other forms of wealth. Therefore, each investor must redistribute his holdings of assets to regain equilibrium based on his preferences for risk.

In this study an attempt was made to develop an equation that explicitly incorporates the desired monetary and expectational price change factors that affect interest rates which in turn affect the earnings-yield. The hypothesis was established that the earnings-price index was a function of the interest rate. Sargent's analysis established that the interest rate was determined by real income, changes in real income, percentage changes in the real money supply, and inflationary expectations. By incorporating a dynamic adjustment mechanism for changes in the real money supply, the earnings-price index was determined to be a function of real income, changes in real income, desired changes in the real money supply, and inflationary expectations.

Real income, changes in real income, desired changes in the real money supply, and inflationary expectations were regressed against an earnings-price index utilizing an Almon distributed lag technique with an adaptive expectations mechanism. Because of a lack of information on the specific form of the relationship, a number of regressions were fitted with alternative lag structures.

From the results obtained in this study, it is apparent that the proposed hypothesis does not hold in the form specified. Therefore, in terms of the value of equation (23) for real investment decision making, it is clear that equation (23) does not provide the predictive capability desired.

RECOMMENDATIONS

Since averaging tends to smooth observations within a quarter and introduces a degree of interdependence within the quarter, another technique would be desirable if it eliminates this problem. A more accurate description of the interaction of the macroeconomic variables and the earnings-price index might be obtained if a technique other than averaging were used to obtain the required quarterly index for the nominal money supply.

One technique might be to select the last figure of the last day of the quarter and letting that observation be representative of all observations for the quarter, a degree of independence would be introduced to the quarterly observations.

Although future study in this area following the line of endeavor attempted by this author does not appear promising, perhaps a more accurate method would be to analyze the regression in terms of monthly rather than quarterly data. Monthly observations would enable the investigator to more readily capture fluctuations not only in the dependent variable but also in the independent variables as well.

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