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The Stock Market as a Leading Economic Indicator: An Application of Granger Causality

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An Application of Granger Causality

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I. Introduction

The stock market has traditionally been viewed as an indicator or "predictor" of the economy. Many believe that large decreases in stock prices are reflective of a future recession, whereas large increases in stock prices suggest future economic growth.

The stock market as an indicator of economic activity, however, does not go without controversy. Skeptics point to the strong economic growth that followed the 1987 stock market crash as reason to doubt the stock market's predictive ability. Given the controversy that surrounds the stock market as an indicator of future economic activity, it seems relevant to further research this topic.

Theoretical reasons for why stock prices might predict economic activity include the traditional valuation model of stock prices and the "wealth effect." The traditional valuation model of stock prices suggests that stock prices reflect expectations about the future economy, and can therefore predict the economy. The "wealth effect" contends that stock prices lead economic activity by actually causing what happens to the economy.

The purpose of this paper, then, is to evaluate stock prices as a leading indicator of economic activity. Time-series analysis and the notion of "Granger causality" are used in this project to estimate relationships between stock prices and the economy, and to see if they are consistent with theory.

In this paper, we explore the following questions. First, does the stock market lead the real economy, in the sense that variation in

its past values explains some of the variation in the real economy? Second, does the stock market "Granger-cause" the real economy, in which case past values of stock prices improve the prediction of future economic activity? And third, does the real economy "Granger-cause" the stock market, in that past values of economic activity improve the prediction of the stock market?

II. Can The Stock Market Predict Economic Activity?

The question of whether the stock market can predict the economy has been widely debated. Those who support the market's predictive ability argue that the stock market is forward-looking, and current prices reflect the future earnings potential, or profitability, of corporations. Since stock prices reflect expectations about profitability, and profitability is directly linked to economic activity, fluctuations in stock prices are thought to lead the direction of the economy. If the economy is expected to enter into a recession, for example, the stock market will anticipate this by bidding down the prices of stocks.

The "wealth effect" is also regarded as support for the stock market's predictive ability. Pearce (1983) argues that since fluctuations in stock prices have a direct effect on aggregate spending, the economy can be predicted from the stock market. When the stock market is rising, investors are more wealthy and spend more. As a result, the economy expands. On the other hand, if stock prices are declining, investors are less wealthy and spend less. This results in slower economic growth.

Critics, however, point to a number of reasons not to trust the stock market as an indicator of future economic activity. Some argue that the stock market has previously generated "false signals" about the economy, and therefore, should not be relied on as an economic indicator. The 1987 stock market crash is one example in which stock prices falsely predicted the direction of the economy. Instead of entering into a recession which many were expecting, the economy continued to grow until the early 1990's (See Figure 1).

Figure 1: Does The Stock Market Predict The Economy?

S&P500 and Real GDP
1970:IQ-1994:IIIQ
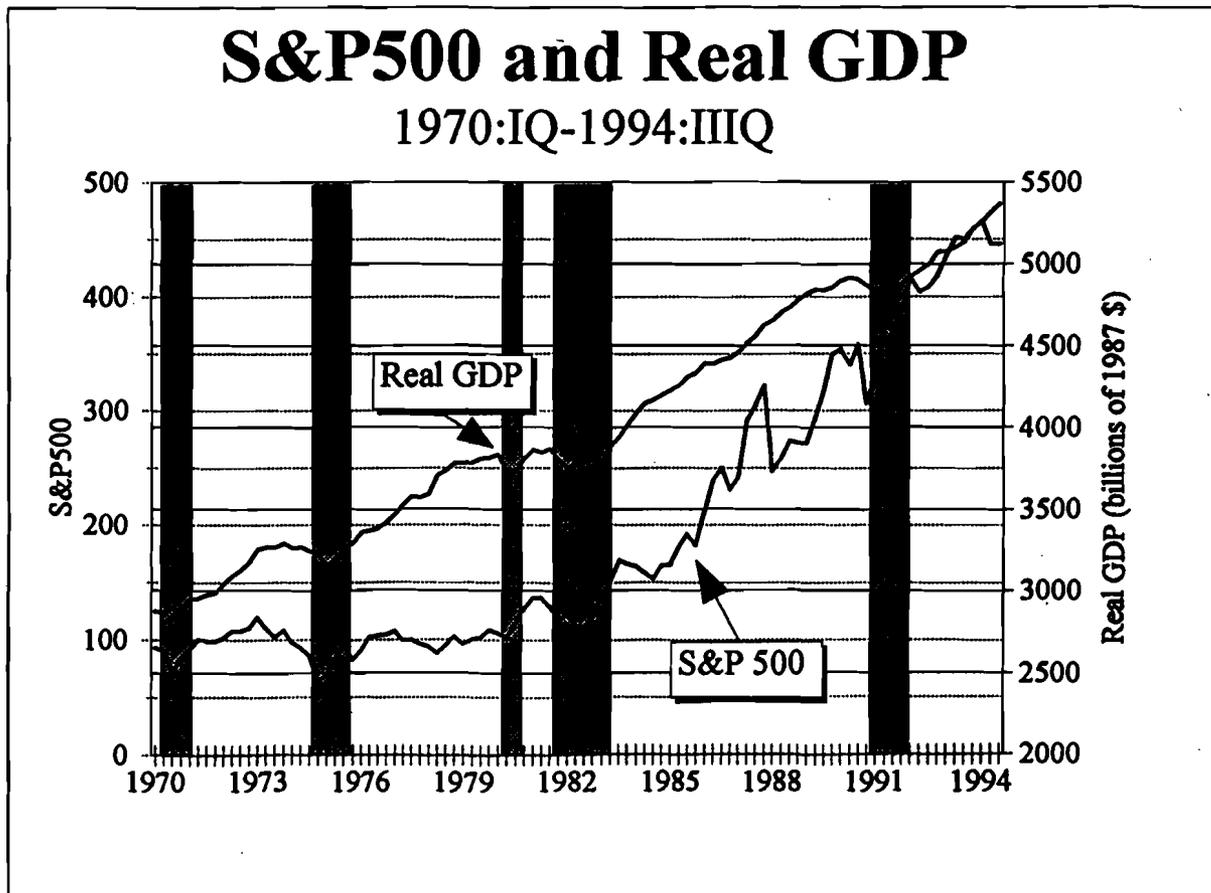
Another reason why skeptics do not trust the stock market as an indicator of the economy is because of investors' expectations. Critics reason that expectations about future economic activity are subject to human error, which in many cases, causes stock prices to deviate from the "real" economy. Since investors do not always anticipate correctly, stock prices will sometimes increase before the economy enters into recession and decrease before the economy expands. As a result, the stock market will often mislead the direction of the economy.

Even when stock prices do precede economic activity, a question that arises is how much lead or lag time should the market be allowed. For example, do decreases in stock prices today signal a recession in six months, one year, two years, or will a recession even occur?

An examination of historical data yields mixed results with respect to the stock market's predictive ability. Douglas Pearce (1983) found support for stock prices leading the direction of the economy. His study discovered that from 1956-1983, stock prices generally started to decline two to four quarters before recessions began. Pearce also found that stock prices began to rise in all cases before the beginning of an economic expansion, usually about midway through the contraction.

Other studies have found evidence that does not support the stock market as a leading economic indicator. A study by Peek and Rosenberg (1988), for example, indicates that between 1955 and 1986, out of eleven cases in which the Standard and Poor's Composite Index of 500 stocks (S&P500) declined by more than 7 percent (the

smallest pre-recession decline in the S&P500), only six were followed by recessions. Furthermore, a study conducted by Robert J. Barro (1989) found that stock prices predicted three recessions for the years 1963, 1967, and 1978, that did not occur.

III.   Why Stock Prices Might Lead The Economy?

One theoretical reason why stock prices might lead economic activity is based on the traditional equity valuation model shown below (Brealey and Myers 1988):

$$\text{Stock Price} = \sum_{t=1}^{\infty} \frac{\text{Expected Profitability}_t}{(k + 1)^t}$$

where profitability is the expected amount of corporate earnings, and k is the rate at which profitability is discounted. It is usually assumed that k is constant.

According to this equation, stock prices equal the present value of a company's expected future profits. If profitability is expected to increase (holding k constant), the price of the stock will increase. Conversely, if investors are expecting a firm's profits to decline in the future, then the price of the stock will decrease in value.

Since a firm's profits are directly linked to the behavior of the real economy, stock prices will be affected by expectations about the future economy. For example, if investors expect the economy to enter into recession, then expected profits will be diminished and stock prices will decrease in value. On the other hand, if investors anticipate economic growth, then expected profits will improve and

stock prices will increase. Thus, investors have an interest in predicting the future real economy. And, if they are somewhat successful in their predictions, then stock price movements will lead the direction of the economy.

An issue to point out here is how investors form their expectations. There are a number of models that attempt to explain how expectations are formed (See, for example, DeBondt and Thaler 1985, and Pearce and Roley 1985). Such models include the adaptive expectations model and the rational expectations model. Adaptive expectations models suggest that expectations are developed through past experience, whereas rational expectations models pose that expectations are formed using all current information that is available. Although these models are not the focus of this paper, it is important to understand that stock prices are highly dependent on investors' expectations. To some extent, these models assume that expectations arise out of experience or historical data. A change in recent experience, then, can cause investors to change their expectations about the future real economy, which then causes them to bid up or down the prices of stocks. To the extent that these models are true, the economy may also lead the stock market.

The "wealth effect" from fluctuations in stock prices is another theoretical argument for why stock prices might lead the economy. Traditional macroeconomic models often assume that consumption depends not just on income, but also on wealth. Increases and decreases in stock prices raise and lower wealth, which in turn raise and lower aggregate consumption. And, because consumption is a large part of the economy, changes in the real economy are observed.

In summary, according to fundamental valuation models, stock prices depend on expectations about the future economy. Therefore, expected changes in the real economy cause the values of stock prices. According to the wealth effect, however, changes in stock prices cause the variation in the real economy. It is important to point out that, while the causation in the two theories is different, both theories suggest that the stock market predicts the economy.

IV. Data

The sample data cover the period 1970:IQ-1994:IIIQ and contain a total of 99 quarterly observations. The variable that is used to measure movements in stock prices is the quarterly percent change in the Standard and Poor's Composite Index of 500 stocks (SP500). The reason for choosing the S&P500 rather than other stock indexes is because it is a fairly representative measure of the stock market. Other indexes such as the Dow Jones Industrial Average, which measures the performance of only 30 blue-chip companies, are less representative. The fact the S&P500 Index is a "value-weighted" as opposed to a "price-weighted" index is another reason this index was chosen. One final reason for choosing the S&P500 Index is because it is included as one of the twelve components in the Department of Commerce's index of leading economic indicators.

The variable used to measure changes in real economic activity is the quarterly percent change of real Gross Domestic Product (GDP). In using real values of GDP, the year 1987 is used as the base year for the implicit price deflator. Other studies utilized percent changes

in the Index of Industrial Production as their proxy for economic growth, but did not indicate that it was a better measure of economic activity.

V. Testing For Granger Causality

The procedure for testing statistical causality between stock prices and the economy is the direct "Granger-causality" test proposed by C. J. Granger in 1969. Granger causality may have more to do with precedence, or prediction, than with causation in the usual sense. It suggests that while the past can cause/predict the future, the future cannot cause/predict the past.

According to Granger, X causes Y if the past values of X can be used to predict Y more accurately than simply using the past values of Y. In other words, if past values of X statistically improve the prediction of Y, then we can conclude that X "Granger-causes" Y.

It should be pointed out that given the controversy surrounding the Granger causality method, our empirical results and conclusions drawn from them should be considered as suggestive rather than absolute. This is especially important in light of the "false signals" that the stock market has generated in the past.

Our first step in testing for "Granger causality" is to determine whether there is a trend in our sample data. An important assumption in any time-series analysis is that the variables being tested are stationary. Figure 1 demonstrates how this assumption is violated. During the period 1970-1994, both Real GDP and the S&P500 Index follow an upward trend. In order to eliminate the

trend, we form percent changes in the two variables and then examine if the two are stationary (See Figure 2). Since the two variables do not appear to have a trend, we reason that the percent changes are stationary and proceed with the Granger test.

Figure 2: Testing For Stationarity

% Change in Real GDP
1970:IQ-1994:IIIQ

% Change in S&P 500
1970:IQ-1994:IIIQ
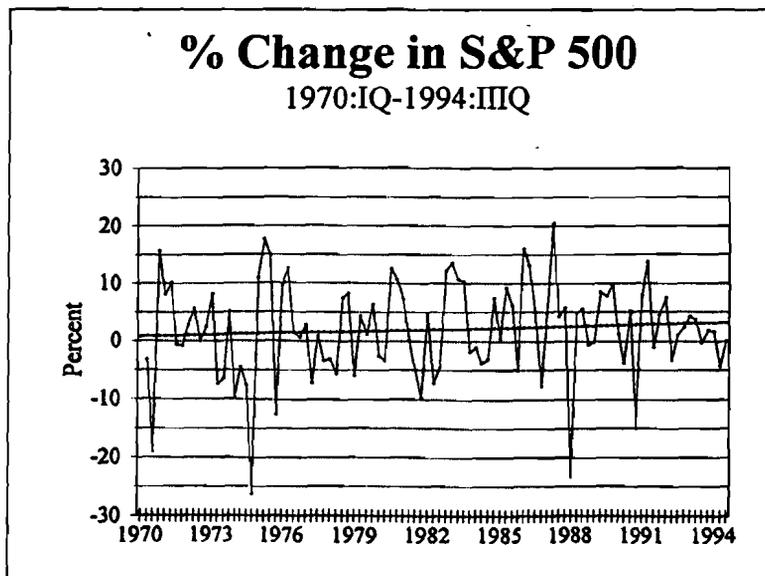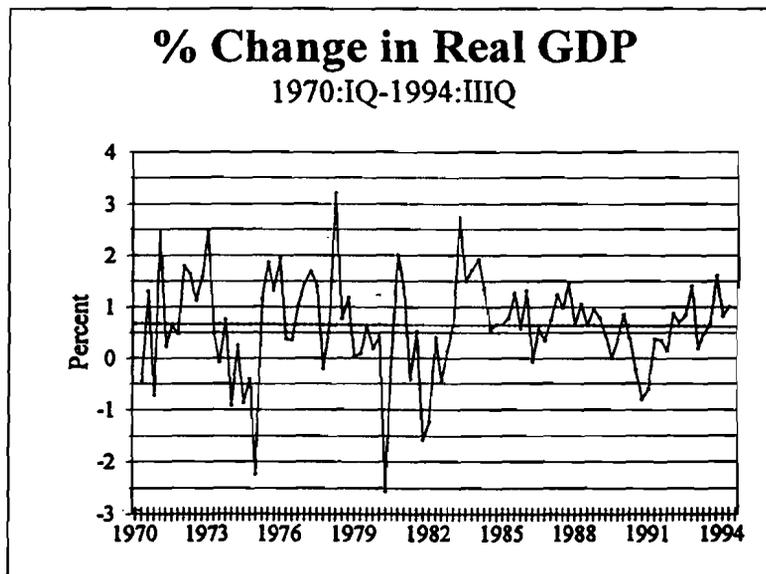
Our next step in testing for "Granger causality" is to test whether a relationship exists between stock prices and the economy. In order for causality to hold true, a relationship must already exist between the variables being tested. For example, if X was not related to Y, then how could X possibly cause the variation in Y?

To determine whether a relationship exists between stock prices and the economy, we regress %GDP on past values of %SP500, lagged back 6 quarters:

$$\%GDP = a + b(\%SP500_{-1}) + c(\%SP500_{-2}) + d(\%SP500_{-3}) +$$
$$e(SP500_{-4}) + f(\%SP500_{-5}) + g(\%SP500_{-6}) + u$$

The results of this regression are shown in Table 1 and indicate that stock prices are positively related to the economy when lagged as much as three quarters. Moreover, stock prices lagged one quarter are both positive and statistically significant at the .01 level. As a result, we conclude that there is a relationship between past values of stock prices and the economy. Thus, the results from this regression suggest that past values of stock prices do lead economic behavior, but this does not imply that stock prices "Granger-cause" the economy. Formal tests of causality are exhibited later in the paper.

TABLE 1:   <u>Dependent Variable = %GDP</u>

<u>Variable</u>	<u>Estimated Coefficient</u>	<u>T-Statistic</u>
1. %SP500-1	.0359	3.0233***
2. %SP500-2	.0167	1.4076
3. %SP500-3	.0158	1.3123
4. %SP500-4	-.0004	.0338
5. %SP500-5	.0009	.0794
6. %SP500-6	-.0076	.6757

Adjusted R^2 = .0779

*   Significant at .10 level
**   Significant at .05 level
*** Significant at .01 level

To test causality between %SP500 and %GDP and its direction the following two equations are specified:

$$(1)\ \%GDP_t = a_0 + \sum_{i=1}^{k} a_i(\%GDP)_{t-i} + \sum_{i=1}^{k} b_i(\%SP500)_{t-i}$$

$$(2)\ \%SP500_t = c_0 + \sum_{i=1}^{k} c_i(\%SP500)_{t-i} + \sum_{i=1}^{k} d_i(\%GDP)_{t-i}$$

The steps in testing whether stock prices "Granger cause" the economy (equation 1) are as follows. First, we regress %GDP on past values of %GDP, but do not include the lagged %SP500 terms. This is the restricted regression. After we run the regression, we obtain the restricted sum of squares, RSS_R.

Second, we run the regression and include the lagged %SP500 terms. This is the unrestricted regression. After we run this regression, we obtain the unrestricted residual sum of squares, RSS_{UR}.

The null hypothesis is $b_i = 0$ for all values of i. In other words, the lagged %SP500 terms do not belong in the regression. To test this hypothesis, the F-test is applied, as shown below:

$$F = \frac{(RSS_R - RSS_{UR})/k}{RSS_{UR}/(n - 2k - 1)}$$

If the F-value exceeds the critical F-value at the chosen level of significance, the null hypothesis is rejected, in which case the lagged S&P 500 variable belongs in the regression. This would imply that stock prices "Granger cause" or improve the prediction of the economy. We then use the same steps for equation 2 to test whether the economy "Granger-causes" stock prices.

Based on the results from equations 1 and 2, four possibilities representing possible causal relationships between %GDP and %SP500 may be formulated, which are defined below:

(1) The stock market "Granger-causes" economic activity if stock prices improve the prediction of the economy, and the economy does not improve the prediction of stock prices ($b_i \neq 0$ and $d_i = 0$).

(2) The economy "Granger causes" the stock market if the economy improves the prediction of stock prices, and stock prices do not improve the prediction of the economy ($b_i = 0$ and $d_i \neq 0$).

(3) A feedback relationship exists between stock prices and the economy when stock prices "Granger cause" the economy, and then, the economy "Granger causes" stock prices ($b_i \neq 0$ and $d_i \neq 0$).

(4) Independence is indicated when no causal relationships are found between stock prices and the economy ($b_i = 0$ and $d_i = 0$).

V. RESULTS

The results of Granger tests for equations 1 and 2 are presented in Table 2. In this table, the two columns represent the relationship which was being tested. In column 1, we test whether stock prices predict the economy, and in column 2, we test whether the economy predicts stock prices. Separate regressions were run for all values of k (1 to 6), and the F-statistics, along with their prob-values, were calculated from the results. Each value of k represents the maximum lag length in the regression. For both %GDP and %SP500 a maximum lag length of six quarters was tried. Past studies attempted a maximum lag length of eight quarters, but the authors reported that longer lag orders did not change the basic results in any significant way (Mahdavi and Sohrabian).

TABLE2:

k	(1) Does %SP500 predict %GDP?		(2) Does %GDP predict %SP500?	
	F-Statistic	Prob-Value	F-Statistic	Prob-Value
1	**9.4083**	**.0028*****	.1557	.6940
2	**5.1949**	**.0073*****	.6131	.5439
3	**2.8283**	**.0431****	.3426	.7946
4	1.7698	.1424	.9754	.4254
5	1.1787	.3268	.7715	.5730
6	1.2743	.2787	.6868	.6608

*   Significant at .10 level
**   Significant at .05 level
*** Significant at .01 level

As can be seen in Table 2, the F-statistics used to test causality in equation 1 are significant for lagged quarters 1, 2, and 3. These results indicate that stock prices do "Granger cause" economic activity when lagged orders of 1, 2, and 3 are used. That is, past values of %SP500 significantly contribute to the prediction of current %GDP even in the presence of past values of GDP.

In equation 2, however, the results show that the F-statistics are not sufficient to reject the null hypothesis in any of the lagged quarters. Past values of %GDP do not significantly contribute to the prediction of current %SP500. Therefore, the economy does not "Granger-cause" the stock market.

In sum, the results of the Granger-causality tests indicate a causal relationship between stock prices and the economy. Moreover, the results reveal that stock prices do "Granger-cause" economic activity, but the economy does not "Granger-cause" stock prices.

VI. Explanations for the Causality Relationship

The results suggest that stock prices do "Granger cause" economic activity. That is, the stock market does predict the economy. It is important, therefore, to review the theories that are consistent with the stock market as a leading economic indicator.

One possible explanation for why stock prices predict the economy is that stock prices actually cause what happens to the economy. This would be consistent with the wealth effect. According to this argument, fluctuations in stock prices raise and lower wealth, which in turn, raises and lowers aggregate consumption. As a result, economic activity is affected or "caused" by fluctuations in the stock market.

Another possible explanation for why stock prices "Granger cause" economic activity is that the stock market is forward-looking. If investors are truly forward-looking, then stock prices reflect expectations about future economic activity. If a recession is anticipated, for example, then stock prices reflect this by decreasing in value. Since the results indicate that the stock market improves the prediction of economic activity, and if we assume that the stock market is forward-looking, then investors' expectations about the future economy are fairly accurate. Furthermore, since the economy

does not predict stock prices, expectations about the future economy are not being formed by simply looking at past values of GDP, which is suggested by the adaptive expectations model. For the adaptive expectations model to hold true, past values of GDP would have to "Granger cause" stock prices.

It is important to note that we do not know how investors are forming their expectations. There are a number of factors which influence investors' expectations that our model does not account for. We do know from the results, however, that they are not being derived by simply looking at the past trend in the economy to form expectations about future economic activity.

VII. Summary and Conclusion

The purpose of this paper was to evaluate the stock market as a leading economic indicator and explore causal relationships between stock prices and the economy. This project used formal tests of causality developed by C. J. Granger and quarterly U.S. data for the period 1970:IQ-1994:IIIQ to investigate the relationship between the growth rate in stock prices and the growth rate in the economy.

Our results indicated a "causal" relationship between the stock market and the economy. We found that while stock prices Granger-caused economic activity, no reverse causality was observed. Furthermore, we found that statistically significant lag lengths between fluctuations in the stock market and changes in the real

economy are relatively short. The longest significant lag length observed from the results was three quarters.

One issue that needs further exploration is the actual reason for the causality relationship between the stock market and economic activity. Is the causality relationship more consistent with the wealth effect or with the forward-looking nature of the stock market? The results from this project are consistent with both the wealth effect and the forward-looking nature of the stock market, but do not prove either.

Another possibility for future research is to further evaluate where expectations about the future economy are coming from. Our results reveal that expectations for future economic activity are not simply formed by looking at the past trend in the economy as the adaptive expectations model would suggest. Expectations are being formed in other ways, but how?

In conclusion, the results of this project reveal that the stock market does help predict the future economy. Although it may not be surprising to find that fluctuations in economic activity may be preceded by changes in stock prices, our finding that changes in GDP are "Granger-caused" by changes in stock prices is important in that it provides additional support for the leading economic role of the stock market.

SOURCES

Abdullah, Dewan A. and Steven C. Hayworth, "Macroeconomics of Stock Price Fluctuations," *Quarterly Journal of Business and Economics*, Winter 1993, 32, pp. 50-63.

Bosworth, Barry, "The Stock Market and the Economy," *Brookings Papers on Economic Activity*, 2:1975, pp. 257-290.

Brealey, Richard A. and Stewart C. Myers, *Principles of Corporate Finance*, 1988, pp. 49-55.

Campbell, Harvey R. "Forecasts of Economic Growth from the Bond and Stock Markets," *Financial Analysts Journal*, September/October 1989, pp. 38-45.

Carlson, Keith M., "Monthly Economic Indicators: A Closer Look at the Coincident Index," *Federal Reserve Bank of St. Louis Review*, November 1985, pp. 20-30.

Comincioli, Brad, "The Relationship Between the Stock Market and the Macroeconomy," unpublished project conducted in 1994.

DeBondt, Werner F. M. and Richard Thaler, "Does the Stock Market Overreact?" *Journal of Finance*, July 1985, pp. 793-805.

Fama, Eugene F., "Efficient Capital Markets: A Review of Theory and Empirical Work," *Journal of Finance*, May 1970, pp. 383-417.

Fama, Eugene F., "Efficient Capital Markets: II," *Journal of Finance*, December 1991, pp. 1575-1617.

Gorton, Gary, "Forecasting With the Index of Leading Economic Indicators," *Federal Reserve Bank of Philadelphia*, November/December 1982, pp. 15-27.

Granger, C. J., "Investigating Causal Relationships by Econometrics Models and Cross Spectral Methods," *Econometrica*, Vol. 37, 1969, pp. 425-435.

Heathcotte, Bryan and Vincent P. Apilado, "The Predictive Content of Some Leading Economic Indicators for Future Stock Prices, "

Journal of Financial and Quantitative Analysis, March 1974, pp. 247-258.

Keane, Simon M., "The Efficient Market Hypothesis on Trial," *Financial Analysts Journal*, March/April 1986, pp. 58-63.

Mahdavi, Saeid and Ahmad Sohrabian, "The Link Between the Rate of Growth of Stock Prices and the Rate of Growth of GNP in the United States: A Granger Causality Test," *American Economist*, Fall 1991, pp. 41-48.

Pearce, Douglas K. and V. Vance Roley, "Stock Prices and Economic News," *Journal of Business*, January 1985, pp. 49-67.

Pearce, Douglas K., "Stock Prices and the Economy," *Federal Reserve Bank of Kansas City Economic Review*, November 1983, pp. 7-22.

Ratti, Ronald A., "A Descriptive Analysis of Economic Indicators," *Federal Reserve Bank of St. Louis Review*, January 1985, pp. 14-24.

Sims, Christopher A., "Money, Income, and Causality," *American Economic Review*, Sept. 1972, pp. 540-552.

Umstead, David A., "Forecasting Stock Market Prices," *Journal of Finance*, May 1977, pp. 427-441.