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"Multiple Regression Analysis On The S & P 500 Index"

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by: Barry White

The Standard & Poor's 500 Index is a leading indicator of economic activity. Leading indicators are those measures that are most capable of predicting peaks and troughs in the business cycle in advance. Economists use the Leading Economic Indicator approach to identify and forecast emerging stages of the current business cycle. For example, an increasing Standard & Poor's 500 Index signals an upturn in economic activity. A decreasing Standard & Poor's 500 Index signals a downturn in economic activity. According to Hildebrand (1992), an increasing S & P 500 Index leads an upturn in economic activity by nine months. However, a decreasing S & P 500 Index leads a downturn in economic activity by only three months.

It is extremely important to understand what variables affect the leading economic indicators, such as the S & P 500 Index. Lahiri and Moore (1991) state that the most important index used by business economists to forecast future economic activity is the Index of Leading Indicators. According to Lahiri and Moore (1991), between 1948-1985, the Index of Leading Indicators predicted all of the major turns in economic activity.

The Standard & Poor's 500 Index is an index of five hundred stocks that includes 425 industrials, twenty-five railroads, and fifty utilities. The relative importance of prices of the index components is determined by the value of the shares outstanding. The S & P 500 Index is known as a "base-weighted aggregative" index. The weights in the index are adjusted for stock dividends and new issues. The base year of the Standard & Poor's 500 Index is an average of its value between 1941-1943.

There are several reasons for using the S & P 500 Index as a measure of stock prices as opposed to some other stock market index. Ezra Solomon (1955, P. 214) stated, "The Standard & Poor's monthly index of industrial stocks is the most suitable measure for the purpose of establishing stock price trends that are supposed to reflect the growth of the economy". This is because the S & P 500 Index eliminates the problems of weighting and sampling associated with other indexes. The first problem is weighting. The Dow Jones Industrial Average uses an equal weighting to compose an index. This fails to show

that different firms have different market values. The S & P 500 Index is superior to the Dow Jones Industrial Average because the weights of the S & P 500 take into consideration the relative importance of prices and shares outstanding. The second problem with other indexes is sampling. Sampling errors are often present because it is possible that the stocks in the index are not representative of the entire market. The S & P 500 Index contains a broad coverage of listed stocks. According to Powers (1993), the aggregate market value of the S & P 500 stocks was eighty percent of all the stocks on the market.

The purpose of this research was to determine which, if any, financial and economic variables significantly affect the closing value of the Standard & Poor's 500 Index. The goal of finding the significant variables which affect the Standard & Poor's 500 Index was accomplished by performing a multiple regression analysis. This regression model used the closing quarterly value of the Standard & Poor's 500 Index as the dependent variable. The independent variables included the 90-day Treasury Bill rate, domestic corporate profits, and real disposable personal income. The data set for each of these variables was their closing quarterly value for the period beginning in March of 1963 and ending in December of 1987. The data were obtained from the U. S. Department of Commerce (1991). I entered the data for each variable into the computer and obtained the following linear regression equation:

$$(1) \text{ S \& P 500 Index} = -6.2449 + .6081(\text{DCP}) + .04001(\text{RDPI}) - 5.4710(\text{INT})$$

where: DCP = Domestic Corporate Profits (In Billions of Dollars)
RDPI = Real Domestic Personal Income (In Billions of Dollars)
INT = 90-Day Treasury Bill Rate (In Percent).

LITERATURE REVIEW

Past studies on the Standard & Poor's 500 Index were researched to provide a guide for the regression model. These studies also provided justification for the use of interest rates, domestic corporate profits, and real disposable personal income as the

independent variables which significantly influence the closing quarterly value of the S & P 500 Index.

INTEREST RATES

Lorie and Hamilton (1973) presented evidence to prove that interest rates and stock prices are inversely related. Lorie and Hamilton stated that the value of a corporation's stock is determined by expectations regarding future earnings and the rate at which those earnings are discounted. They concluded that the higher the discount rate, the lower the present value of earnings. The rate at which earnings should be discounted is related to, or determined by, the rate of return that can be earned on alternative investments. The relevant rate for discounting earnings is the risk-free rate, usually the 90-day or 180-day Treasury Bill rate. These rates of return are considered risk-free because the returns on these assets are guaranteed unless the United States Government defaults.

Lorie and Hamilton (1973) found an inverse relationship between the interest rate and common stock prices. Stock prices decrease with interest rate increases because earnings are discounted at higher rates, therefore reducing the present value of earnings. Lorie and Hamilton provided empirical support for their position. For instance, between the second quarter of 1969 and the second quarter of 1970, the 90-day Treasury Bill rate rose from 6.2 percent to 6.7 percent. Stock prices declined by 23.6 percent over this same time period. This research supports their theory that interest rates and stock prices are inversely related.

DOMESTIC CORPORATE PROFITS (CORPORATE EARNINGS)

Lorie and Hamilton (1973) also presented evidence to prove that corporate profits significantly affect stock prices. The authors stated (1973, P. 10), "By far the most important determinant of the level of stock prices is corporate profits". The authors provided empirical data to support their theory. They observed that during the Great Depression, both corporate profits and stock prices fell by over 75 percent. In addition,

between the second quarter of 1969 and the second quarter of 1970, corporate earnings declined by almost fourteen percent. Stock prices fell by 23.6 percent over this same time period.

REAL GROSS NATIONAL PRODUCT

Ezra Solomon (1955) hypothesized that there would be a normal relationship between Real Gross National Product and stock prices. In other words, Solomon believed that as Real Gross National Product increased, stock prices (as measured by the S & P 425 Industrials) would also increase.

To support this hypothesis, Solomon divided his period of analysis into two sub-periods: 1874-1913 and 1913-1955. The first sub-period experienced an annual growth in Real Gross National Product of four percent and a 2.667 percent increase in stock prices. The second sub-period experienced a three percent growth in Real Gross National Product and a two percent increase in stock prices. Solomon concluded that the growth in stock values proceeded at about two-thirds the rate of real growth in Gross National Product.

J. Fred Weston (1956) also studied the effect of Gross National Product on stock prices. Weston found a strong positive correlation between Gross National Product and corporate profits. He also found a relationship between dividends and stock prices. Weston concluded that there must be a positive relationship between Gross National Product and stock prices. Weston provided empirical support for his position. He found the following regression equation for the years 1909-1927 and 1933-1940:

$$\text{S \& P Industrial Index} = 15.00 + .75 (\text{Current GNP}).$$

REAL DISPOSABLE PERSONAL INCOME

Arthur F. Burns (1960) hypothesized that real disposable personal income was positively related to stock prices. He found that when real disposable personal income increases, the public will have more money available to invest in the stock market. The increased demand for stocks will, *ceteris paribus*, increase stock prices.

INFLATION (AS MEASURED BY THE CONSUMER PRICE INDEX)

Reuben A. Kessel (1956) tried to explain why inflation causes an increase in stock prices. Kessel cited three reasons why stock prices will increase during inflationary periods. First, Kessel assumed that business firms are debtors, and debtors gain during inflationary periods. Second, inflation causes wages to lag behind prices. This will redistribute income from labor to Capitalists. Finally, firms gain because they carry inventories. Inventories are sold at prices that reflect mark-ups on current prices, so the mark-up (and profit) will be higher during inflationary periods. Each of these three scenarios increases corporate profits and will cause an increase in stock prices.

To support his study, Kessel analyzed the impact of inflation and deflation on creditor and debtor firms and their stock prices. In deflationary periods between 1929-1933, creditor stocks increased in value by six percent, and debtor stocks declined in value by thirty-four percent. In inflationary periods between 1939-1948, the real value of creditor stocks declined by thirteen percent and that of debtor stocks increased by eighty-four percent. Kessel concluded that inflation and stock prices are directly related.

Other studies contradict Kessel's conclusions. Kessel and Alchian (1960) hypothesized that since wages lag behind prices, firms would reap higher profits and higher stock prices as well. These authors believed that more labor-intensive firms would enjoy greater increases in their stock prices during inflationary periods than firms that were not labor-intensive. Kessel and Alchian used the ratio of wages to equity as an indicator of the relative rise in stock prices attributable to a lag of wages behind prices. They hypothesized that the greater the wage to equity ratio, the larger the gain in equity value as a result of inflation.

Kessel and Alchian obtained results that contradicted their wage/lag theory. They found that the lower the wages to equity ratio, the greater the increase in the value of stock prices. Due to these contradictory results, many doubt the usefulness of inflation as a variable which significantly affects stock prices.

RATE OF GROWTH IN THE MONEY SUPPLY

Beryl W. Sprinkel (1971) examined how changes in the money supply led to changes in stock prices. He stated that the causes of stock price changes are related to the changing liquidity of the economy relative to the desires of the economic units. The community's demand for money grows as incomes rise and interest rates decline. This is so since the community wants to hold a larger volume of money to accommodate the larger transaction volume. As liquidity (money supply) decreases, there is an attempt to switch from less liquid to more liquid assets. This will be evidenced by fewer purchases of readily marketable assets such as stocks and a shift to more liquid assets such as Treasury Bills. When the demand for stocks decreases, stock prices decrease as well. If, on the other hand, the Federal Reserve encourages liquidity and increases the money supply, some investors give up excess liquidity and invest in assets such as stocks. In periods of liquidity (money supply) expansion, the demand for stocks increases, and therefore stock prices increase as well.

Lorie and Hamilton (1973) concluded that there is a positive relationship between the change in the rate of growth of the money supply and stock prices. They found that changes in the growth rate of the money supply have a "usually decisive" effect on stock prices. Since 1918, there have been only three sharp market declines which were not preceded by a period of monetary contraction. Contraction of the money supply preceded the decline in stock prices by about nine months.

HYPOTHESIS

The preceding review of literature leads to the following hypothesis.

$$(2) \quad S \ \& \ P \ 500 = f(\overset{-}{INT}, \overset{+}{DCP}, \overset{+}{RGNP}, \overset{+}{RDPI}, \overset{+}{INF}, \overset{+}{M1})$$

where: INT = 90-Day Treasury Bill Rate
DCP = Domestic Corporate Profits
RGNP = Real Gross National Product
RDPI = Real Disposable Personal Income
INF = Inflation (Consumer Price Index)
M1 = Change In Rate Of Growth Of The Money Supply.

Equation (2) states that the value of the S & P 500 Index is inversely related to interest rates. It is directly related to domestic corporate profits, real Gross National Product, real disposable personal income, inflation, and the change in the rate of growth of the money supply.

RESULTS

Before deciding on a given model, I ran a correlation matrix of variables (Table 2) to test for multicollinearity. The independent variables in a regression model are assumed to be independent of one another. When the assumption of independence of variables is violated, multicollinearity occurs. If variables are independent, standard errors are small and t-scores are large, resulting in statistically significant variables.

There are several signals that multicollinearity may exist in an empirical study. For example, a regression equation with a high R-square and no significant variables indicates the problem of multicollinearity. In addition, if two variables have a correlation of greater than .6, multicollinearity probably exists. In the correlation matrix of variables (Table 2), several variables are highly correlated (Correlation > .6) with one another. Multicollinear variables can not be used together to form a meaningful regression model. As Table 2 indicates, multicollinearity does not exist between interest rates, real disposable personal income, and domestic corporate profits, the variables used in my regression model.

Based on the correlation matrix of variables and the literature review, I performed the regression model using interest rates, domestic corporate profits, and real disposable personal income as the best mix of independent variables that significantly influence the closing value of the S & P 500 Index. My analysis of multicollinearity leads to the regression equation given in Equation (1):

$$\text{S \& P 500} = -6.2449 + .6081(\text{DCP}) + .04001(\text{RDPI}) - 5.4710(\text{INT})$$

where: DCP = Domestic Corporate Profits (In Billions of Dollars)
 RDPI = Real Disposable Personal Income (In Billions of Dollars)
 INT = 90-Day Treasury Bill Rate (In Percent).

To be considered a significant independent variable, that variable must have a t-score of greater than two standard deviations from the expected mean value. In this model, domestic corporate profits (DCP) had a t-score of 5.0394. The positive sign of the t-score indicates that domestic corporate profits are positively related to the S & P 500 Index. In other words, as domestic corporate profits increase, the S & P 500 Index also increases. Real disposable personal income (RDPI) had a t-score of 2.4930. The positive sign of the t-score indicates that real disposable personal income is positively related to the S & P 500 Index. In other words, as real disposable personal income increases, the S & P 500 Index increases as well. Finally, the 90-day Treasury Bill rate (INT) had a t-score of -3.9996. Therefore, interest rates are negatively related to the S & P 500 Index. In other words, as interest rates increase, the S & P 500 Index decreases. These results (shown in Table 1) were consistent with the original hypothesis.

R-SQUARE AND P-VALUE

Two other statistics are relevant in the analysis of the regression results. The first of these statistics is the R-square. The R-square value of this model was .7753 (Table 1). This indicates that 77.53 percent of the variation in the S & P 500 Index is explained by

the variation in domestic corporate profits (DCP), real disposable personal income (RDPI), and the 90-day Treasury Bill rate (INT). The second of these statistics is the P-value. The P-value indicates how confident one can be in the significance of an independent variable. For domestic corporate profits (DCP), the P-value was .0000. This indicates that one can accept domestic profits (DCP) as a significant independent variable at the 100 percent confidence level. For real disposable personal income (RDPI), the P-value was .0144. This indicates that one can accept real disposable personal income (RDPI) as a significant independent variable at the 98.56 percent confidence level. Finally, the P-value for the 90-day Treasury Bill rate was .0001. This indicates that one can accept the 90-day Treasury Bill rate (INT) as a significant independent variable at the 99.99 percent confidence level. Regression results are shown in Table 1.

CONCLUSION

This regression model shows that changes in domestic corporate profits, real disposable personal income, and the 90-day Treasury Bill rate significantly affect the value of the S & P 500 Index. The variation in the three independent variables used in the model explain over 77 percent of the variation in stock prices. The major question that arises from the results of the model is, "What explains the other 23 percent of the variation in the S & P 500 Index?" I believe that other possible variables include environmental factors such as world political and economic conditions (i.e., famine, war, trade relations). Consumer confidence in the economy is another potential variable that affects stock prices. However, finding meaningful values to represent political stability or consumer confidence is difficult, if not impossible. Therefore, these variables were not included in the regression model.

There are other problems with this regression analysis. First, the literature cited in the paper is outdated. I had difficulty locating more recent studies on the significant variables that affect stock prices. I decided to use these sources because I believed that they gave a broad and accurate representation of the variables that significantly affect

long-run stock prices. A second problem with this regression analysis is that some of the variables used in the model to explain stock prices (i.e., real disposable personal income) are also considered leading indicators of economic activity.

In spite of these problems, I believe that this regression analysis has provided a useful model. The goal of this research was to understand what factors affect the Standard & Poor's 500 Index. As previously stated, three variables were found to significantly affect the S & P 500. In that respect, the goal of the research was achieved. In conclusion, I believe that the significant variables in this model could be used by economists and investors to forecast changes not only in the stock market, but in overall economic activity as well.

TABLE 1

REGRESSION ANALYSIS RESULTS

<u>VARIABLE</u>	<u>ESTIMATED COEFFICIENT</u>	<u>STANDARD ERROR</u>	<u>T-RATIO</u>	<u>P-VALUE</u>
DCP	0.6081	0.1207	5.0394	.0000
RDPI	0.04001	0.01605	2.4930	.0144
INT	-5.4710	1.3679	-3.9996	.0001
CONSTANT	-6.2449	20.1820	-0.3094	.7577

WHERE: DCP = Domestic Corporate Profits (In Billions of Dollars)
RDPI = Real Disposable Personal Income (In Billions of Dollars)
INT = 90-Day Treasury Bill Rate (In Percent)

TABLE 2

CORRELATION MATRIX OF VARIABLES

SP500	1.0000						
RDPI	.7832	1.0000					
RGNP	.7992	.9964	1.0000				
INF	.8143	.9580	.9521	1.0000			
INT	.1844	.5709	.5661	.5717	1.0000		
M1	.1336	.1650	.1561	.1561	.0002	1.0000	
DCP	.1194	-.0985	-.0389	-.1578	-.3657	-.0147	1.0000
	SP500	RDPI	RGNP	INF	INT	M1	DCP

WHERE: SP500 = Closing Value of the S & P 500 Index
RDPI = Real Disposable Personal Income (In Billions of Dollars)
RGNP = Real Gross National Product (In Billions of Dollars)
INF = Inflation (Consumer Price Index)
INT = 90-Day Treasury Bill Rate (In Percent)
M1 = Rate of Growth In the Money Supply (In Percent)
DCP = Domestic Corporate Profits (In Billions Of Dollars)

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