THE PREDICTIVE POWER OF MACROECONOMIC VARIABLES ON STOCK MARKET RETURNS. THE CASE OF THE ATHENS STOCK EXCHANGE.

By

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Abstract

The purpose of this study is to investigate whether it is possible to predict stock market returns with the use of macroeconomic variables in the Athens Stock Exchange. The emerging stock market of Greece, is a small and relatively underinvestigated market. Hence, there is a possibility that a predictive model may exist for stock returns, violating the Efficient Market Hypothesis (E.M.H.) which states that stock market returns cannot be predicted.

In the international literature there is a wide variety of methods used for predictive purposes. In this study we have used cointegration analysis, and as explanatory variables some macroeconomic factors which are believed by economists and market practitioners, to influence stock returns. Namely the macroeconomic predictive variables are, the inflation rate measured by the Consumer Price Index, the M3 measure of money supply and the exchange rate of US Dollar/Greek Drachmae (JEL G14).

1. Introduction

According to Fama (1976), a market is efficient if prices rationally, fully, and instantaneously reflect all relevant available information and no profit opportunities are left unexploited. In an efficient market past information is of no use in predicting future prices and the market should react only to new information ("news"). However, since this is unpredictable by definition, price changes or returns in an efficient market cannot be predicted.

Under the Efficient Market Hypothesis it is true that:

$$E[(P_t - P^*_t)/I_{t-1}] = 0 \quad \text{or} \quad E(u_t) = 0 \tag{1}$$

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where I_{t-1} is the information set available at time t-1, P_t is the actual price at time t, P*t is the expected price which is based on the information set I_{t-1}, so P*t, is uncorrelated with ut, and additionally the forecast error Pt-P*t is uncorrelated with variables in the information sel I_{t-1}. Thus, price changes and consequently stock returns, under the assumptions of a constant equilibrium return and risk neutrality, are uncorrelated with variables in the information set I_{t-1} and empirical tests for market efficiency usually examine the above proposition, Cootner (1962), Fama (1965), Gowland and Baker (1970), Cutler, Poterba and Summers (1989), MacDonald and Taylor (1988, 1989).

Fama (1970), distinguished three types of market efficiency. A market is said to be *weak form efficient* if the history of prices is of no use in predicting future price changes or returns. A market is of a *semi-strong form efficient* if all publicly available information like inflation, money supply, interest rates, earnings, and other publicly available factors have no predictive power. Finally, a market is *strong form efficient* if all information is reflected on prices, including the so called "inside" information.

There have been several studies testing the E.M.H. for the Athens Stock Exchange (A.S.E.), (Niarchos 1972, Panas 1990, Alexakis P. and Petrakis 1991, Alexakis P. and Xanthakis 1995, Niarchos N. and Alexakis C. 1998).

However, up to now, there has been no research and subsequently no empirical evidence as to the relationship, if any, between stock market returns and macroeconomic variables in Greece.

In this study, the semi-strong form of efficiency is examined with respect to an information set which includes the inflation rate in Greece as measured by the Consumer Price Index (CPI), the Money Supply measured by M3 and the Greek Drachmae/ US Dollar exchange rate. We must note here that there are several other variables which are believed to influence stock prices, like national output or interest rates. Nevertheless, in this study we did not examine the predictive power of macroeconomic variables which are not available on a monthly basis for Greece or variables which were exogeneously determined in the Greek economy for the period under examination. Nevertheless, we have to admit that our information set can be expanded in future research to include more macroeconomic variables.

In section 2 of this study we analyse the theoretical relevance of our predictive variables and we also summarise some of the international evidence. In section 3 we describe the econometric methodology we use in our analysis.

In section 4 we summarise our statistical findings and finally in section 5 we present our conclusions and possible policy implications.

2. The Theoretical Framework

There has been an agreement to the proposition that the rate of return on common stocks moves directly with the rate of inflation. This proposition extends for common stock returns the Fisher Hypothesis, which states that the expected rate of return consists of the real return plus the expected inflation. Someone can also examine the reaction of stock returns on the unanticipated part of inflation defined as the difference between the actual rate of inflation at time t, and the expected part of inflation at time t under the information set at time t-1. The evidence Branch (1974), Lintner (1975), Fama and Schwert (1977), presents a negative instantaneous relationship between stock returns and both the anticipated and unanticipated parts of inflation rate.

There have been several explanations offered for the negative effect of unanticipated inflation rate on stock returns. Kessel and Alchian (1962) noted that unexpected inflation benefits net debtors and harm net creditors when contracts are written in nominal terms. However, the examination of this hypothesis is very difficult without any knowledge of the contractual obligation of firms. Another explanation is that there are distributive tax effects as a result of unanticipated inflation, Lintner (1975). The argument is that since depreciation and inventory expenses are based on historical costs rather than current replacement costs, unexpected inflation which affects all prices simultaneously increases revenues without an offsetting increase in depreciation and inventory expenses, thus increasing the real tax burden of the firm. In addition to the above arguments, unexpected increase in inflation could cause government policy makers to react by changing monetary or fiscal policy in order to counteract higher inflation. Such policy reactions, which can affect investments, are probably the basis of the hypothesis that unexpected inflation is bad for business. For example, if high unexpected inflation increases the probability of price controls, then if price controls distorts optimal investment plans they can have a negative effect on the value of firms, Schwert (1981). Finally, concerning the expected part of inflation, there has not been a satisfactory explanation for negative instantaneous relationship with the stock returns, opposite to the prediction of the Fisher hypothesis.

For the exchange rate variable it is argued that exchange rate risk may affect firms positions, especially when these firms are export or import oriented and they are involved in foreign markets in several ways. Exchange rate movements can greatly affect the value of firms' overseas assets or liabilities and cause fluctuations in firms' capital positions and profits; and consequently affect their stock prices. Some fluctuations in firms capital due to foreign exchange movements, can be offset somewhat by relative changes in the aggregate price levels. However, there is evidence that deviations from Purchasing Power Parity (PPP) in the short run are substantial and not necessarily self correcting, Adler and Dumas (1980). Fluctuations in the value of assets and liabilities that result from changes in exchange rates may expose firms to substantial risk, especially if firms are not properly hedged. While a variety of well known mechanisms exist for hedging, in order to avoid the exposure to exchange rate risk, these strategies may not be costless, and firms may choose to take some degree of exposure. Also, some firms, especially banks, may expose themselves to exchange rate risk to speculate on exchange rate movements in their trading room activities. The large value of foreign exchange trading may possibly generate large profits or losses, even from small movements in exchange rates.

Finally, there have been many explanations offered about the relationship of money supply and stock prices. Beginning with the early work of Sprinkel (1964), several studies have attempted to exploit statistically the reaction of the stock market to changes in the money supply. The stock market - money supply relationship has been widely tested because of the belief that money supply changes have important direct effects through portfolio changes, and indirect effects through their effect on real activity variables which are in turn postulated to the fundamental determinants of stock market prices.

Studies which used the monetary portfolio model (MP) developed by Friedman and others assumed that investors reach an equilibrium position in which they hold a number of assets including money in their portfolio. A monetary disturbance such as an unexpected increase or decrease in the growth rate of money supply, causes a disequilibrium in portfolios of assets by making actual money balances depart from desired money balances. The attempt by investors as a group to attain their desired money positions transmits the monetary change to the market at large. Investors respond to the wealth effect of increased money growth by exchanging money for a variety of assets like short and long term bonds, stocks, real estate, durable goods, capital goods and human capital. Hamburger and Kochin (1972)

argued that the return on corporate stock will be among the first and most strongly affected by changes in the money supply, since institutional money dealers and wealthy individuals who hold the bulk of the floating supply of corporate stock are among the first and most sensitive to changes in their money balances.

An alternative explanation for the response of stock market prices to unexpected-changes in the money supply, is based on investors expectations about the reaction of the monetary authorities to the surprise. This scenario is known as the "policy anticipation effect". In particular, an unexpected jump in money stock will lead market participants to believe that the aurhorities will have to tighten credit to offset the rise; the measures taken by the authorities will involve higher interest rates. This will lead to lower stock prices for two reasons. First, the discount rate will rise to reflect expectations of higher rates. Secondly, expected corporate cash flows will decline if market participants believe that an increase in rates depresses economic activity.

Finally, the money supply variable, as well as the other variables, can affect stock prices as a sunspot in the sense of an unjustified arbitrary belief. Camerer (1989), refers to the sunspot explanation of money supply: *"Traders often say that they know these announcements (money supply announcements) contain no information, but they expect them to affect prices, and their believe is self fulfilled"*.

3. The Models Employed

A very popular way to test for the existence of any temporal statistical relationship with predictive value between two time series is the Granger causality test, Granger (1969). Granger's tests for causality in the sense of precedence are based on the following statistical reasoning: if we consider two time series as Y_t and X_t, the series X_t fails to Granger cause Y_t, if in a regression of Y_t on lagged Y's and lagged X's the coefficients of the latter are zero.

Granger causality tests are usually performed on stationary data. Nevertheless, the first difference transformation, which is often used to attain stationarity filters out low frequency (long run) information. Cointegration reintroduces in a statisticaly acceptable way, the low frequency information. The basic idea of cointegration is that when two or more series move closely

together in the long run, even though the series themselves are trended, the difference between them is constant. We may regard the cointegrating series as defining a long run equilibrium relationship and the difference between them to be stationary. The term equilibrium in this case suggests a relationship which, on average, has been maintained by a set of variables for a long period (Hall and Hendry 1988).

Following Engle and Granger (1987), cointegration can be defined as follows: Consider two series X_t and Y_t, which are both non stationary, I~(1) processes. If there exists a linear combination of X and Y say,

$$z_t = X_t - \alpha Y_t \tag{2}$$

which is stationary, I~(0), we say that X and Y are cointegrated, where α is the cointegrating parameter.

If two variables are cointegrated then according to the Granger Representation Theorem, there must exist an Error Correction Representation of the following form:

$$\Delta x_t = -\hat{\rho}_1 z_{t-1} + \sum_{j=1}^{n} \alpha_j \Delta X_{t-1} + \sum_{j=1}^{n} \beta_j \Delta Y_{t-1} + \varepsilon_{1t} \tag{3}$$

$$\Delta Y_t = -\hat{\rho}_2 z_{t-1} + \sum_{j=1}^{n} \gamma_j \Delta Y_{t-1} + \sum_{j=1}^{n} \lambda_j \Delta X_{t-1} + \varepsilon_{2t} \tag{4}$$

where z_{t-1} is implicitly defined in (2) and $|\rho_1 + \rho_2|$ #0 and ε_{1t} and ε_{2t} are finite moving averages. Thus, changes in the variables Xt and Yt are partly driven by the previous value of Z_t.

Cointegrated variables in the bivariate case must possess temporal causality in the Granger sense, in at least one direction. For a pair of series to have an attainable equilibrium, there must be some causation between them to provide the necessary dynamics. It follows from this that since Z_{t-1} must occur in at least one of the Error Correction equations, it must improve the forecasting ability of at least on one of X_t or Y_t. MacDonald and Kearney (1987) point to the fact that vector autoregressive estimates which are derived from differenced data, the standard Granger causality test, are

misspecified in the case of cointegrated variables because the Error Correction Terms which appear in the Error Correction Models are excluded.

The cointegration analysis, suggested by Engle and Granger (1987), assumed that the cointegrating vector is unique. However, in the case of η variables we may have n-1 cointegrating vectors in the system. In that case a number of deficiencies may arise. The cointegration technique derived by Johansen (1988, 1991) and Johansen and Juselius (1990), is alternatively proposed. This Maximum Likelihood approach (M.L.), in comparison to the Granger - Engle OLS approach provides consistent ML estimates of the whole cointegrating matrix, and produces a maximum likelihood-ratio statistic for the maximum number of distinct equilibrium vectors in the matrix. Additionally, test statistics for cointegration in the Granger-Engle (G.E.) approach, like the Augmented Dikey-Fuller test on the residuals of the cointegrating regression, cannot be compared with critical values from known distributions, as the distribution is a function of the whole data generation process (which is of course unknown). The above advantage makes Johansen's approach preferable than the two step Granger-Engle approach.

4. Data and Results

In our investigation we have used as a depended variable the logarithmic change of the General Index of the Athens Stock Exchange adjusted for stock splits and dividends. As previously mentioned, the information set It-i with respect to which we test the efficient market hypothesis, includes the variables of money supply measured by M3, the inflation rate measured by the consumer price index (CPI), and the exchange rate of Greek Drachmae/US Dollar. All the explanatory variables were also transformed with the logarithmic form. The time period under investigation was from January 1984 to December 1995 on a monthly basis; that is a total of 132 observations.

The order of integration of a series (that is the number of times it must be differenced before attaining stationarity) may be ascertained by the application of a set of tests, commonly known as unit root tests. A number of tests are available for testing whether a series is stationary. We performed the Phillips Perron regressions in order to ensure white noise residuals in our regressions.

Table I presents the Phillips Perron statistics (PP) for the series under examination. It is clear from this table that the null hypothesis that any of

the series have unit roots cannot be rejected easily. This is confirmed by the PP statistics which test for unit roots in the first differenced series. In each case the null hypothesis is easily rejected. Together with the results in the level series, it strongly implies that each of our series is integrated of order one I~(1). Thus, the "Granger causality" tests have to be performed on the first logarithmic difference of the original series, and the results obtained from the "Granger causality" tests are presented in Table II. From the results in Table II it seems that the Efficient Market Hypothesis is statistically violated only in the case where the explanatory variable is the inflation rate, since the relevant F statistic indicates that the lagged values of the above explanatory variable can help to forecast the dependent variable i.e. the stock return.

In order to test whether the variables are cointegrated (i.e. they define a long run statistical equilibrium) we estimated the cointegrating regression, which includes all of the variables, by OLS, and tested whether the cointegrating residuals series Z_t as I~(0). Engle and Granger (1987), suggest a number of alternative tests for determining if Z_t is I~(0). We present the PP statistic on the residuals of the cointegrating regression, the DW statistics for cointegration, the statistical significance of the error correction term in the Error Correction Model and the statistics of the Johansen procedure. The results are presented in table IV.

The PP statistics lead us to reject the null hypothesis of no cointegration and the Johansen statistics indicate at least two cointegrating equations at 95% and one cointegrating equation at 99%. In the error correction model the significance of the error correction term also indicates that the null hypothesis of no cointegration must be rejected. At this point we must note that in the error correction model we also included a function of the variance as a proxy for risk. Engle (1987) argues that by including a function of the variance as an explanatory variable in a model where the depended variable is the stock return, it may resolve many empirical findings where variable which helped to predict returns when correlated with risk loose their significance when a function of the conditional variance is included as a repressor. In our case a GARCH (1,1) scheme seemed to be the appropriate specification for the GARCH — M function.

5. Conclusions and Policy Implications

The above statistical findings lead us to reject statistically the Efficient Market Hypothesis for the case of the Athens Stock Exchange. From the results in the error correction model it is very interesting to note the statistical significance of the lagged return. The statistical evidence suggests that monthly returns in the Athens Stock Exchange are positively correlated. The above finding can not be explained as a thin trading effect or as non synchronous trading effect because of the monthly time interval used in this study. On the contrary, someone can reasonably assume that either news is reflected with some delay on stock market prices or that the Greek stock market is influenced by psychological factors i.e. a period of price increase leads to optimism and further price increase, and a period of price decrease leads pessimism and further price decrease.

In addition to the above evidence of inefficiency, from the Granger causality tests and the error correction model results, there is statistical evidence that the lagged values of inflation rate have explanatory power in a model were the stock return is the depended variable. Although it is very difficult to explain the lag structure of a VAR model, someone can reasonably assume that the inflation rate can be related negatively to the stock market returns if a fall in the inflation rate may signal a possible fall in the interest rates and consequently on discount rates. Lower discount rates according to the classical stock valuation formula signifies a price increase, ceteris paribus. Of course the opposite may hold as well.

One may alternatively explain the above statistical finding as a portfolio adjustment result. A possible fall in interest rates as a result of a fall in the inflation rate may lead investors to buy corporate stocks in anticipation of better returns in comparison to fixed income securities like bonds. On the contrary, a rise in interest rates may lead investors to sell corporate stocks in order to buy new bond issues with higher interest rates.

Our statistical results indicate that investors in the Athens Stock Exchange reflect news on stock market prices with some delay and/or may be influenced by psychological factors like optimism and pessimism. In order for the A.S.E. to fulfil one of its important functions in the Greek economy, i.e. to value fairly corporate stocks and consequently to drive funds towards the best possible uses, the observed inefficiencies are needed to be eliminated. According to the Efficient Market Hypothesis it is assumed that information

is freely available to all market participants. For the Greek Stock Market this is not true, not so much as a result of cost barriers to information but as a result of readily access to information. It can be recommended at this point that the authorities of the A.S.E. may develop mechanisms to distribute official information to market participants. This policy may decrease or even eliminate the unpleasant effect of psychological effects on stock prices and also make stock prices to reflect the condition of the economy on the right time.

TABLE I

Unit root tests of the series

Variable	P.P. Statistic Levels	P.P. Statistic Difference Transformation
A.S.E. Index	-2.20	-7.27**
C.P.I.	-2.43	-11.17**
M3	-0.31	-22.11**
US$/GRDrs	-0.70	-7.87**

Double star denotes significance at 99% confidence interval

TABLE II

"Granger Causality" Results

Predictive Variable	F Statistic	L.M. Statistic	Causality Direction
C.P.I.	5.74**	0.75	C.P.I. "cause" A.S.E. Index
M3	1.77	0.97	No "causality"
US$/GRDRs	0.01	0.97	No "causality"

Double star denotes significance at 99% confidence interval

TABLE III

Cointegrating Regression Statistics

O.L.S. Cointegration Statistics		
R^2=0.68 C.R.D.W.=0.17		P.P. on residuals=-2.79**
M.L. Cointegration Statistics		
Hypothesised CE's		Likelihood Ratio
1		67.10**
2		38.58*

Single and double stars denote significance at *95%* and 99% confidence interval respectively.

TABLE IV

Error Correction Representation

Predictive Variable	Estimate	t Statistic
Constant	0.02	1.20
$\Delta index_{t-1}$	0.39	4.56*
ΔCPI_{t-1}	-0.69	-2.11*
ΔCPI_{t-4}	1.06	2.85*
E.C.T.$_{\cdot t-1}$	-0.05	-3.53*
GARCH-M(1,1)	-0.32	-1.47
GARCH-M(p,q)		
p	0.71	3.65*
q	0.23	2.63*

Single star denotes significance at 95% confidence interval
Regression Statistics: R^2=0.24 $Q_{(1)}$=1.92 $Q_{(6)}$=7.98 $ARCH_{(1)}$=0.02 $ARCH_{(6)}$=3.20

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