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# The Long-Run Relationship between Stock Indices and Economic Factors in the ASE: An Empirical Study between 1989 and 2006

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**ABSTRACT**

The present paper is focused on the examination of long-run relationships between specific stock indices and a number of economic factors in the Athens Stock Exchange (ASE) during the period between 1989 and 2006. After a theoretical and empirical review of unit root and cointegration analysis we present the methodology that is used so as to examine whether the series of the variables are cointegrated or not. The results of the tests indicated that for the whole period, as well as for specific subperiods, the indices seem to be related to specific groups of variables. These results verify in many cases prior economic hypotheses regarding the relationship between financial and macroeconomic variables. Investors can construct their portfolios by taking into consideration specific relationships between variables since there are factors that seem to have an explanatory power on the behavior of stocks leading to a possible inefficiency of the Greek market.

*JEL Classification:* *G12, G14*

*Keywords:* *ASE; Cointegration; Unit root; Market efficiency*

## I. INTRODUCTION

Some of the roles that a stock exchange can play in a country's economy are the raise of capital for businesses or the creation of investment opportunities for small investors. If these opportunities turn to be profitable, they might give the opportunity to investors for further investments. As a result, apart from the contribution of the stock exchange in the national economy, there is also a contribution to the investors separately.

The aim of the study is to investigate for the existence of factors that affect the behavior of stock returns in the ASE for the period between 1989 and 2006. Furthermore, the study examines whether these potential factors are correlated or present any similarities in their influence on stock returns. In order to achieve the objectives of the study specific models were employed, which are the unit root and cointegration models. By applying these models we proceed to an analysis of publicly available financial data in the ASE and macroeconomic data of the Greek economy.

The study examines several aspects that could offer new information regarding the way that the ASE functions. The Greek stock exchange is one of the capital markets which proved to be extremely attractive over the last ten years to international investors, as during the 90's it had started the transition to become a developed market. Investors and analysts have tried to benefit from possible abnormal returns as well as from the diversification of portfolio risk. The general reforms in the ASE from the late 80's and early 90's, that is capital market liberalization, automated trading system and a relative political stability (Chortareas et al., 2000) made the ASE a place of interest, so as to compare its evolution with that of other emerging or even developed markets. Although these markets are becoming the centre of several studies, they encounter problems that have to do mostly with data availability. This obstacle can lead to biased statistical results that cannot be easily overcome.

Several studies have been conducted in the ASE using different methodologies depending on the goal of each study, focusing mostly on the behavior of stocks, the efficiency of the market and the reaction to announcements or events (Karanikas, 2000; Niarchos and Alexakis, 2000). However, almost none of these studies have combined in such a way a selected number of macroeconomic and financial data with specific econometric models in order to come to some robust inferences regarding the behavior of stock returns in Greece.

Specifically, in the present study, we tried to combine different sets of financial as well as macroeconomic variables, based on economic theory and data availability. Although, there are studies that have used similar variables for different time periods, such as the inflation rate (Niarchos and Alexakis, 2000), in our study we have added variables which are not so usually employed in asset pricing studies, that is the retail sales index, and examined their possible long-run relationships with other variables. After we have completed the cointegration analysis we proceeded to a combination between cointegration and regression analysis, which is a procedure that is not usually visible in empirical studies (Maysami et al., 2004) for any stock market, although it is a relatively easy procedure and can give very interesting results regarding the direction of these relationships between the variables.

We should also mention that, in case some indices were unavailable for the whole period (1989−2006) under investigation, e.g. the industrial production index, the study is divided in specific sub-periods that could lead to interesting results without the need to subtract any variable from the analysis.

Moreover, there is a need nowadays to understand how many different economic factors work in order to understand their influence on securities. In this case the investors will be even more prepared to face new challenges while investing in specific securities, even in extreme cases, such as economic crises. In the case of the Greek Exchange it is very interesting for investors and academics to know how to react when there is a number of specific economic variables that behave separately and each one influence stocks in a different way. This is what this study tries to explain. This is the main reason that we explore the relationship between a number of stock market indices of the ASE and a number of domestic macroeconomic indices. The Greek market is one of those markets that during the last decades have substantially developed their financial structure. However, when it is compared to more developed markets, it is still characterised by lower levels of financial development and stock market transactions (Tsouma, 2009).

The study is organised as follows: Section II presents the literature review on unit root and cointegration analysis. Section III presents the methodology that is followed with the examination of the main models of the analysis. Furthermore, Section IV presents the data collection process and makes an introduction to the indices used in the tests. Section V presents the empirical results and, finally, Section VI concludes the study.

## II. LITERATURE REVIEW ON UNIT ROOT AND COINTEGRATION

If a time series is stationary, it is said to be integrated of order zero, or I(0). If it needs to be differenced once, in order to achieve stationarity, it is said to be integrated of order one, or I(1). An I(0) time series has no roots on or inside the unit root circle, but an I(1) or higher order integrated time series contain roots on or inside the unit circle. The most popular methods of unit root testing are: a) the Dickey-Fuller (DF) and the Augmented Dickey-Fuller (ADF) test (Dickey and Fuller, 1979; 1981), b) the Phillips-Perron (PP) (1988) test, which is an extension of the ADF test, and c) the Kwiatkowski *et al.* (1992) test.

Nelson and Plosser (1982) tested 14 macroeconomic time series for the US using the DF tests between 1860 and 1970. They analyzed the logarithms of all series, except from the interest rates that were examined in levels, and found empirical evidence which supported the existence of unit roots for the 13 of these series (except from unemployment). Alternatively, there were some studies that found contradictory results regarding the existence of unit roots in time series. Kwiatkowski et al. (1992) performed a test for the null hypothesis of stationarity against the alternative of a unit root and they could not reject the hypothesis of stationarity in the majority of the time series used by Nelson and Plosser (1982). Furthermore, other researches used the unit root tests but this time the main interest of the analysis was the alternative hypothesis of the existence of cointegration (Engle and Granger, 1987). Except from the residual-based approaches, there were studies based on likelihood ratio methods in vector autoregression in order to test for cointegration between the variables, like in the work of Johansen (1988; 1991) and Johansen and Juselius (1990).

Non-stationary I(1) time series are cointegrated if a certain linear combination of these time series is stationary. There are two main tests for the existence or not of cointegration among a set of time series: a) The Engle and Granger (1987) two-step method and the Johansen (1988; 1991) and Johansen and Juselius (1990) method. Muradoglu and Metin (1996) investigated the semi-strong form of the efficient market hypothesis in Turkey. The long-run relationship between stock prices and inflation was investigated and the results presented the inefficiency of the Turkish stock market as stock prices seemed to be forecasted. Choi et al. (1999) examined the interactions between stock markets and macroeconomic variables, and their results suggested that stock markets could help predict industrial production in the US, UK, Japan and Canada out of the G7. Aggarwal and Kyaw (2005) examined for integration and cointegration links between three equity markets before and after the 1993 North American Free Trade Agreement (NAFTA), based on daily, weekly, and monthly data. The cointegration results showed that the prices of stocks are cointegrated only for the post-NAFTA period. Finally, Syriopoulos (2006) examined developed and emerging Central European stock markets for possible dynamic links and the effects of time-varying volatilities. He found that there was one cointegration vector between the variables and the application of an asymmetric EGARCH model presented a time-varying volatility effect in these emerging markets.

## III. METHODOLOGY

The steps below are followed so as to employ unit root and cointegration analysis between a number of observed financial and macroeconomic time series based on the studies of Hondroyannis and Papapetrou (2001) and Maysami et al. (2004):

1) We examine the existence of a unit root in each one of the series that will be used in the analysis of cointegration.

2) If there is a unit root in the series, which means that the series is not stationary, we follow the Dickey-Fuller (1979; 1981), as well as the Phillips-Perron (1988) and the Kwiatkowski, Phillips, Schmidt and Shin (1992) procedure, in order to examine the levels of the series.

3) After the tests above, we apply again all the unit root tests in order to examine the first differences of the series − if the series are integrated of order 1 (I(1)).

4) If the test shows that the series are I(1), we proceed to cointegration analysis so as to examine if there is at least one linear combination between the series (the series are cointegrated).

5) If there is at least one linear combination between the series it means that there is at least one long-run relationship that connects the variables of the analysis.

Specifically, we investigate whether there is any relationship between the general market index and a number of macroeconomic variables during the period 1989−2006, and then we search for possible relationships between specific sectoral indices and a number of macroeconomic variables for the period between 1989 and 2005 (the last year of data availability for the sectoral indices). Finally, we examine if there is any relationship between the general market index and two different sets of variables - the set of variables also used for the whole period (1989−2006) and a set of new variables available only for the third period (2001−2006). The following sub-sections present the mathematical perspective of unit root and cointegration analysis.

## A. Unit Root Analysis

The presence of a unit root can be presented using a first-order autoregressive process:

$$y_t = l + k y_{t-1} + e_t, e_t \sim N(0, \sigma_e^2) \quad (1)$$

where $l$ is a constant of the equation, $k$ is the coefficient of the first difference of $y_t$ and $e_t$ is the error term which has a mean of zero and variance $\sigma_e^2$.

In this case the variance of $y_t$ is:

$$\mathrm{Var}(y_t) = \frac{1-k^n}{1-k}\sigma_e^2 \quad (2)$$

If $k \geq 1$, then there is no finite variance for $y_t$. If $k < 1$ the variance is $\sigma_e^2/(1-k)$.

It is verified that equation (1) has a unit root $r = 1/k$. When $y_t$ is non-stationary, it has a root on or inside the unit circle, which means that $r \geq 1$. While a stationary variable $y_t$ has a root $r < 1$, that means that it is out of the unit circle. As it was mentioned before, when someone tests for stationarity, he/she tests if there is a unit root in a time series.

### 1. The Dickey-Fuller/Augmented Dickey-Fuller Test

The Dickey-Fuller (DF) test (Dickey and Fuller, 1979; 1981) can be written as:

$$\Delta y_t = l + (k-1) y_{t-1} + e_t = l + p y_{t-1} + e_t \quad (3)$$

after the subtraction of $y_{t-1}$ from both sides of equation (1). In this test the null hypothesis says that there is a unit root in the time series, which means that $H_0 : p = 0$, while $H_1 : p < 0$, which is the alternative hypothesis and means that there is no unit root. Equation (3) gives the simplest case of a DF test where the residual is white noise. In fact, the residuals exhibit serial correlation most of the time and $\Delta y_t$ can be rewritten as:

$$\Delta y_t = l + p y_{t-1} + \sum_{\iota=1}^{c} f_i \Delta y_{t-i} + e_t \quad (4)$$

Equation (4) is the equation of the Augmented Dickey-Fuller (ADF) test. This is the improved version of the Dickey-Fuller test since it accommodates higher-order autoregressive processes in $e_t$.

## 2. The Phillips-Perron Test

The Phillips-Perron (PP) (1988) test is an extension of the ADF test. This test is more robust in the case of weak autocorrelation and heteroscedastic regression residuals than the ADF test. It is based on equation (4) and examines its component at zero frequency. The t-statistic of the PP test is:

$$t = \sqrt{\frac{r_0}{h_0}} t_p - \frac{(h_0 - r_0)}{2h_0\sigma}\sigma_p \tag{5}$$

where

$$h_0 = r_0 + 2\sum_{\tau=1}^{\nu}(1 - \frac{j}{T})r_j \tag{6}$$

is the variance of the $\nu -$ period differenced series $(y_t - y_{t-\nu})$, $r_j$ is the autocorrelation function at lag $j$, $t_p$ is the t-statistic of $p$, $\sigma_p$ is the standard error of $p$ and $\sigma$ is the standard error of the test regression. Finally, $r_0$ is the variance of the difference of one period $(\Delta y_t = y_t - y_{t-1})$.

## 3. The Kwiatkowski, Phillips, Schmidt and Shin Test

In the ADF test the null hypothesis supports the existence of a unit root in a time series. If there is strong evidence of stationarity near unit roots processes, then the ADF tests cannot give precise results and the model has a relative low power. Due to lack of power in the ADF test another stationarity test was applied. Particularly, the Kwiatkowski, Phillips, Schmidt and Shin (KPSS) (1992) test was used with the null hypothesis of the existence of stationarity against the alternative of a unit root. The KPSS test is based on the following equation:

$$y_t = \alpha + \delta_t + x_t + v_t, x_t = x_{t-1} + u_t \tag{7}$$

where $y_t =$ the sum of the deterministic trend, a random walk $x_t$ and a stationary error $v_t$, $u_t \sim (0, \sigma_u^2)$. According to equation (7) $v_t$ is assumed to be stationary and for the null hypothesis that $y_t$ is trend stationary, we simply require that $\sigma_u^2 = 0$.

## B. The Johansen Multi-variate Cointegration Test

Furthermore, in case there is a vector $y_t$ of first-order integrated variables which can be expressed by an unrestricted vector autoregressive (VAR) model, based on the studies of Johansen (1988; 1991) and Johansen and Juselius (1990), involving up to $k$ lags of $y_t$:

$$y_t = A_1 y_{t-1} + ... + A_k y_{t-k} + e_t \quad (8)$$

where $A_1,...,A_k =$ the matrices of the parameters of the model and $e_t =$ the vector of the residuals of the system that has a mean equal to zero, constant variance and its values are not serially correlated. The VAR model has been used in order to estimate dynamic relationships among jointly endogenous variables without imposing strong *a priori* restrictions - such as particular structural relationships. The VAR model is comprised of a system of equations where each variable in $y_t$ is regressed on the lagged values of itself and on the other variables of the system.

## IV. DATA COLLECTION

Monthly time series of specific stock market and macroeconomic indices were used for the empirical tests based on the studies of Dickey and Fuller (1979; 1981), Phillips and Perron (1988), Kwiatkowski et al. (1992) and Johansen (1988). The data was obtained from the ASE databanks and the National Statistical Service of Greece. In the following sub-sections we present the variables that were used in the analysis.

### A. General Stock Market Index and Sectoral Indices

As in prior studies for the application of the CAPM and the APT model (Chen et al., 1986; Chen and Jordan, 1993), we employ the general stock market index of the ASE so as to proceed to unit root and cointegration analysis. The monthly prices of the stock market index were obtained from the database of the ASE, along with the monthly prices of a number of sectoral indices (Maysami et al., 2004). These indices were chosen for the analysis because of data availability and their significance in the economy of Greece. Specifically, the indices cover the investment, industrial, insurance and banking sector of the Greek economy.

### B. USD/Euro and GBP/Euro Exchange Rates

As there is an increase in economic globalization, several businesses are affected by international activities. This means that the changes in the exchange rates may have an effect on the position of companies and industries globally. Furthermore, these effects of the exchange rates may lead to changes in the cash flows of companies, so it would be useful for the potential investors to use them in their portfolio evaluation. It is hypothesized that there is a positive relationship between exchange rates and stock prices. If the euro is expected to appreciate, the Greek market will attract new investments. This appreciation will cause an increase in the stock market level, meaning that the stock market returns will be positively correlated to the exchange rate changes (Mukherjee and Naka, 1995). In our study we used the USD/Euro exchange rate as well as the GBP/Euro exchange rate, so as to investigate whether they are related to the monthly prices of the Greek stock market index.

### C. Money Supply (M1)

A money supply index is employed for the tests based on the notion that the growth rate of money supply has an effect on a country's economy and on the expected stock returns. Specifically, an increase in the supply of money indicates excess liquidity available for buying securities, which leads to higher stock prices (Hamburger and Kochin, 1972). In our tests we use the M1 money supply index which is a measure of the money supply that is used by economists in order to quantify the amount of money in circulation because of its liquidity as it contains cash and assets that can quickly be converted to currency.

### D. Consumer Price Index (CPI)

The results of prior studies (Chen et al., 1986) showed that there is a negative relationship between inflation rate and stock prices. Based on the notion of a possible negative relationship we employ the CPI by hypothesizing that an increase in the rate of inflation is likely to lead to more tight policies, which increases the nominal risk-free rate and raises the discount rate which, consequently, leads to stock prices reduction. We should mention that the CPI is the index which has been edited appropriately in order to have as output the inflation rate for the tests, based on the studies of Chen *et al.* (1986) and Chen and Jordan (1993). Specifically, the monthly inflation rate was calculated as the change in the natural log of the Greek monthly CPI.

### E. Industrial Production

The industrial production index is used as a proxy for the level of real economic activity, which means that a rise in industrial production would signal economic growth. This was the hypothesis of prior studies (Fama, 1990) who investigated for a possible positive relationship between the industrial production and expected future cash flows. Based on this hypothesis we use the industrial production index in order to examine its possible long-run relationship with the stock indices of the analysis.

### F. Manufacture of Coke, Refined Petroleum Products and Nuclear Fuels

Finally, the index of Manufacture of Coke, Refined Petroleum Products and Nuclear Fuels comprised mostly by products that are constructed based on petroleum, was also used in the tests. We use the term "petroleum" not only for abbreviation purposes but due to the fact that the index is comprised mostly by refined petroleum derivatives. The index was previously used in the studies of Chen et al. (1986) and Chen and Jordan (1993). In our case we examine the hypothesis that the index is negatively related to stock prices as measured by the stock market indices.

### G. Interest Rate

The changes in short- and long-term government bond rates have an effect on the nominal risk-free rate and, consequently, on the discount rate (Mukherjee and Naka, 1995). In our study we assume that there might be a possible relationship between interest rates and stock prices as the interest rates influence the level of corporate profits which in turn influence the price that investors are willing to pay for the stock through expectations of higher future dividends payment. Because of the fact that several firms finance their capital equipments and inventories through borrowings, a reduction in the interest rates will reduce the costs of borrowing and thus serves as a motive for expansion, leading to a positive effect on future expected returns for the firm.

### H. Retail Price Index

Except for the variables mentioned above we have also included the retail price index, as it was used in prior studies (Clare and Thomas, 1994) and has been found to be a significant risk factor. The retail price index is used as a proxy for real consumption. Finally, we should mention that all the variables' prices were expressed in logarithms, so as to easily achieve stationarity of the data (Hondroyannis and Papapetrou, 2001; Maysami et al., 2004).

## V. EMPIRICAL RESULTS

Table 1 presents the unit root test results of all the variables used in the period between 1989 and 2006 in their levels as well as in their first differences. The first four rows of Table 1 present the variables in their levels in logarithmic form, while the following four rows present the same variables in their first differences. Next to the name of each variable the respective ADF, PP and KPSS test statistics are presented by applying the models without a constant and a trend, then only with a constant and, finally, both with a constant and a trend. The significance of each model is presented in bold numbers. The results show that during the whole period (1989−2006) the statistics of ADF, PP and KPSS verify in most cases the nonstationarity of the variables in their levels. More specifically, the ADF and PP unit root tests show that the null hypothesis of non-stationarity (unit root) based on the critical values of MacKinnon (1991) is accepted in most cases. Moreover, the results of the KPSS tests show that the null hypothesis of level and trend stationarity is rejected for the variables based on the critical values of Kwiatkowski *et al.* (1992). The results of our tests are similar with those in the work of Hondroyannis and Papapetrou (2001) where macroeconomic variables were employed for a different time period so as to examine possible relationships in the ASE. The unit root results for the sectoral indices as well as the results of the variables that were available only during the period between 2001 and 2006 are similar to those in Table 1 and available upon request from the authors.

After we come to the conclusion that the series are I(1) based on the ADF, PP and KPSS test statistics, we proceed to the examination of possible long-run relationships between the variables. The cointegration procedure of Johansen (1988; 1991) was employed in our tests, instead of the two-step test of Engle and Granger (1987), as it yields more efficient estimators of cointegrating vectors (Niarchos and Alexakis, 2000; Maysami et al., 2004). Johansen's method allows testing the cointegration between variables in a whole system of equations in one step, without requiring normalizing a specific variable. Consequently, we can avoid carrying over the errors from the first to the second step (as in the case of the Engle-Granger (1987) test).

**Table 1**
Unit root tests of the initial variables (1989-2006)

| | ADF | | | PP | | | KPSS | |
|---|---|---|---|---|---|---|---|---|
| Variables | None | Const | const/trend | None | Const | const/trend | Const | const/trend |
| LRMI | 1.327 | -2.147 | -2.717 | 1.599 | -1.987 | -2.339 | **1.470**** | **0.139***** |
| LCPI | 0.089 | **-4.707**** | **-5.751**** | -5.101 | **-10.070**** | **-3.730*** | **1.714**** | **0.440**** |
| LPS | 1.691 | -1.386 | **-3.541*** | 1.369 | -1.467 | **-3.500*** | **1.715**** | 0.066 |
| L3MTBR | -1.559 | -0.417 | -1.995 | -1.660 | -0.374 | -1.943 | **1.700**** | **0.307**** |
| DLRMI | **-9.754**** | **-9.906**** | **-9.925**** | **-9.644**** | **-9.700**** | **-9.679**** | 0.142 | 0.094 |
| DLCPI | **-1.749***** | -1.213 | -1.570 | **-10.392**** | **-14.936**** | **-14.066**** | **1.072**** | 0.171 |
| DLPS | **-12.371**** | **-12.566**** | **-12.544**** | **-13.247**** | **-13.349**** | **-13.323**** | 0.034 | 0.029 |
| DL3MTBR | **-15.752**** | **-15.902**** | **-15.877**** | **-15.713**** | **-15.873**** | **-15.869**** | 0.209 | 0.181 |

Notes: * Indicates significance at the 5 per cent level.
** Indicates significance at the 1 per cent level.
*** Indicates significance at the 10 per cent level.

Tables 2 to 4 present the results of cointegration analysis between specific sets of variables. Specifically, Table 2 shows that between the general share market index and the macro variables used for the whole period (1989−2006) there is one cointegrating vector as the p-value is less than 0.05 and rejects the null hypothesis of no cointegration. As there are two statistics in Johansen's procedure that test for possible cointegrating vectors (the maximum eigenvalue and the trace statistic), in case there are differences in their results, the trace statistic is preferred. The reason is that it shows more robustness to skewness and kurtosis in the residuals (Cheung and Lai, 1993). As there is at least one cointegrating vector in each set of variables we proceed to examine this relationship. As far as the first set of variables is concerned (Table 2), the normalized cointegrating coefficients for the general market index during the whole period (1989−2006) are:

$$Y_t = (LRMI_t, LCPI_t, L3MTBR_t, LPS_t)$$
$$b = (1.000, 14.3326, -0.7506, -7.2681)$$

In order to investigate whether the existence of one cointegrating vector in the set can lead to more solid conclusions regarding the relationship between the variables, we express the set in the form of a linear regression model (the t-statistics are presented below the equation):

$$\underset{}{LRMI_t} = -\underset{(-8.600)}{14.3326LCPI_t} + \underset{(+1.307)}{0.7506L3MTBR_t} + \underset{(+3.385)}{7.2681LPS_t} \quad (9)$$

It is evident from the results of equation (9) that there is a negative and significant relationship between the general stock market index and the consumer price index, which is in agreement with the hypothesis of Nelson (1976) and Chen *et al.* (1986). The petroleum series seems to have a positive relationship with the market index, while it is interesting to mention that the interest rate also shows a positive relationship with the stock market index, a result that contradicts our hypothesis but is in agreement with prior studies (Mukherjee and Naka, 1995). A reason might be that a short-term interest rate (3-month) is not a good proxy for the risk-free component used in valuation models. A long-term rate (1-year) might prove to be a better proxy.

Table 3 shows that there are two cointegrating vectors between the sectoral banking index, the consumer price index, 3-month treasury bill rate and petroleum series. Furthermore, the results of Table 4 show that for the sectoral insurance index and the same macrovariables there is one cointegrating vector as in the case of the general market index (Table 2). Moreover, the results for the sectoral investment index and the industrial index also verify the existence of cointegrating vectors. The respective tables with the results are available upon request from the authors.

As far as the banking index is concerned, the normalized cointegrating coefficients during the period (1989−2005) are:

$$Y_t = (LBSI_t, LCPI_t, L3MTBR_t, LPS_t)$$
$$b = (1.000, 14.70114, -0.934294, -9.296012)$$

The above relationship with the normalized coefficients can be re-expressed as:

$$LBSI_t = -14.70114LCPI_t + 0.934294L3MTBR_t + 9.296012LPS_t \quad (10)$$
$$(-8.221) \quad (+1.575) \quad (+3.463)$$

The results show that the banking sector has negative relationship with the consumer price index and a positive relationship with the interest rate and petroleum series. Moreover, the results of the sectoral insurance index and the macro variables are:

$$Y_t = (LISI_t, LCPI_t, L3MTBR_t, LPS_t)$$
$$b = (1.000, 30.43464, -1.359545, -12.47712)$$

which can be expressed as:

$$LISI_t = -30.43464LCPI_t + 1.359545L3MTBR_t + 12.47712LPS_t \quad (11)$$
$$(-8.435) \quad (+1.149) \quad (+2.395)$$

The results for the insurance index are same to those in the previous cases. Moreover, the results of the sectoral investment index regarding the normalized coefficients are the following:

$$Y_t = (LINSI_t, LCPI_t, L3MTBR_t, LPS_t)$$
$$b = (1.000, 16.01136, -0.832926, -8.592847)$$

also expressed as:

$$LINSI_t = -16.01136LCPI_t + 0.832926L3MTBR_t + 8.592847LPS_t \quad (12)$$
$$(-8.714) \quad (+1.370) \quad (+3.153)$$

Finally, as far as the sectoral industrial index is concerned, the coefficients of the relationship are the following:

$$Y_t = (LINDSI_t, LCPI_t, L3MTBR_t, LPS_t)$$
$$b = (1.000, 10.23537, -0.528742, -4{,}697293)$$

which can be expressed as:

$$LINDSI_t = -10.23537LCPI_t + 0.528742L3MTBR_t + 4.697293LPS_t \quad (13)$$
$$(-7.875) \quad (+1.220) \quad (+2.412)$$

The main conclusion of equations (9) to (13) is that all the market indices present a negative relationship with the consumer price index (Chen et al., 1986; Niarchos and Alexakis, 2000), and a positive relationship with the interest rate (Mukherjee and Naka, 1995) and the petroleum series.

Finally, we proceed to the examination of the relationship between the general stock market index and two different sets of variables for the period between 2001 and

2006. This time period was chosen because for most of the variables their data were available only during this period. Specifically, the results between the general market index and the first set of variables for the period between 2001−2006 are:

$$Y_t = (LRMI_t, LCPI_t, LIP_t, LPS_t)$$
$$b = (1.000, 12.4621, -31.9698, -3.649762)$$

and re-expressed as a linear regression model in the following form:

$$\underset{}{LRMI_t} = \underset{(-1.774)}{-12.4621LCPI_t} + \underset{(+5.495)}{31.9698LIP_t} + \underset{(+1.697)}{3.649762LPS_t} \tag{14}$$

Once more there is a negative relationship between the market index and the consumer price index, although in this case the relationship is insignificant, and a positive relationship with the petroleum series index. An interesting result at this point is that the stock market index shows a positive and significant relationship with the industrial production index. This result verifies that a raise in industrial production can signal economic growth and lead to an increase in expected future cash flows (Fama, 1990). The results between the general market index and the second set of variables are:

$$Y_t = (LRMI_t, L3MTBR_t, LLM1_t, LRPI_t, LGBPEEXR_t, LUSDEEXR_t)$$
$$b = (1.000, -0.341028, 0.780099, -1.81824, -5.115774, 0.29476)$$

and re-expressed as:

$$\begin{aligned} LRMI_t = {} & \underset{(+1.133)}{0.341028L3MTBR_t} - \underset{(-1.196)}{0.780099LM1_t} + \underset{(+2.347)}{1.81824LRPI_t} + \\ & + \underset{(+2.136)}{5.115774LGBPEEXR_t} - \underset{(-0.282)}{0.29476LUSDEEXR_t} \end{aligned} \tag{15}$$

Equation (15) shows that the (short-term) interest rate has a positive relationship with the general market index (Mukherjee and Naka, 1995) and that the index of money supply (M1) shows a negative relationship (although insignificant) with the general market index which is in agreement with Fama (1981) who argued that an increase in money supply would lead to inflation and to the reduction of stock prices. Moreover, the general market index presents a positive relationship with the retail price index, which has been proved to be a significant risk factor (Clare and Thomas, 1994). The GBP/Euro exchange rate presents a different relationship compared to the USD/Euro exchange rate. Specifically, the USD/Euro exchange rate shows that if the USD depreciates compared to euro, it will lead to new domestic investments and to an increase in stock prices (although this relationship is insignificant). Alternatively, in the case of the GBP/Euro exchange rate, if the GBP appreciates compared to euro, this change will decrease the stock market level, leading to a negative and significant correlation between stock prices and exchange rates (Mukherjee and Naka, 1995).

**Table 2**
Johansen's cointegration test on the general market index, 3-month Treasury bill rate, consumer price index and petroleum series index (1989–2006)

Maximum Eigenvalue Test

| Null | Maximum Eigenvalue Statistic | Critical Values (at 5%) | Prob. |
|---|---|---|---|
| R = 0 * | 126.7211 | 27.58434 | **0.0000** |
| R ≤ 1 | 14.44813 | 21.13162 | 0.3294 |
| R ≤ 2 | 5.481329 | 14.2646 | 0.6802 |
| R ≤ 3 | 1.967995 | 3.841466 | 0.1607 |

Trace Test

| Null | Trace Statistic | Critical Values (at 5%) | Prob. |
|---|---|---|---|
| R = 0 * | 148.6185 | 47.85613 | **0.0000** |
| R ≤ 1 | 21.89745 | 29.79707 | 0.3042 |
| R ≤ 2 | 7.449324 | 15.49471 | 0.526 |
| R ≤ 3 | 1.967995 | 3.841466 | 0.1607 |

Note: *Indicates significance at the 5 per cent level.

**Table 3**
Johansen's cointegration test on the sectoral banking index, 3-month Treasury bill rate, consumer price index and petroleum series index (1989–2005)

Maximum Eigenvalue Test

| Null | Maximum Eigenvalue Statistic | Critical Values (at 5%) | Prob. |
|---|---|---|---|
| R = 0 * | 121.6452 | 27.5843 | **0.0000** |
| R ≤ 1 * | 25.17394 | 21.13162 | **0.0127** |
| R ≤ 2 | 4.427773 | 14.2646 | 0.8117 |
| R ≤ 3 | 0.210575 | 3.841466 | 0.6463 |

*Note:* *Indicates significance at the 5 per cent level.

**Table 3 (Continued)**

Trace Statistic

| Null | Trace Statistic | Critical Values (at 5%) | Prob. |
|---|---|---|---|
| R = 0 * | 151.4575 | 47.85613 | **0.0000** |
| R ≤ 1* | 29.81229 | 29.79707 | **0.0498** |
| R ≤ 2 | 4.638347 | 15.49471 | 0.846 |
| R ≤ 3 | 0.210575 | 3.841466 | 0.6463 |

*Note:* *Indicates significance at the 5 per cent level.

**Table 4**
Johansen's cointegration test on the sectoral insurance index, 3-month Treasury bill rate, consumer price index and petroleum series index (1989–2005)

Maximum Eigenvalue

| Null | Maximum Eigenvalue Statistic | Critical Values (at 5%) | Prob. |
|---|---|---|---|
| R = 0 * | 118.2682 | 27.58434 | **0.0000** |
| R ≤ 1 | 17.70641 | 21.13162 | 0.1412 |
| R ≤ 2 | 4.99791 | 14.2646 | 0.7421 |
| R ≤ 3 | 0.135547 | 3.841466 | 0.7127 |

Trace Statistic

| Null | Trace Statistic | Critical Values (at 5%) | Prob. |
|---|---|---|---|
| R = 0 * | 141.1081 | 47.85613 | **0.0000** |
| R ≤ 1 | 22.83986 | 29.79707 | 0.254 |
| R ≤ 2 | 5.133457 | 15.49471 | 0.7945 |
| R ≤ 3 | 0.135547 | 3.841466 | 0.7127 |

*Note:* *Indicates significance at the 5 per cent level.

## VI. CONCLUSIONS

The present study examines if there are specific economic factors that could offer further information on the way that the ASE functions. As mentioned in the introduction, the ASE is a market which proved to be attractive to international investors, as during the 90's it had started the transition so as to become a developed market (Chortareas et al., 2000). In 2001, Morgan Stanley, which is an investment banking and global financial services corporation headquartered in New York City, upgraded the ASE giving it the status of a developed market (Argyropoulos, 2006). But it is also a fact that, so far, most empirical studies have treated the Greek market as an emerging one, mostly because of data availability, as contemporary data are more difficult to be gathered. We should also mention that the period examined extends from January 1989 to December 2006, which could be characterised as a large period under examination (for the ASE standards), as it includes periods of economic and social changes in Greece that is reforms in the ASE, several elections and the Olympic Games of 2004 held in the city of Athens.

The inability of classic models, such as the Capital Asset pricing Model (CAPM), and the possible economic relationships between the variables led us to the conclusion that the Greek market seems to be inefficient as there are variables, like the stock market indices, that depend on the past values of other variables, based on the theory of cointegration analysis. Although Euro was introduced in 2001 in the Greek market, the empirical results seemed to be unaffected by this monetary change, which might be a result of the existence of other factors that influence the decision of investors. These factors could be psychological, which means that they may be related to the theory of behavioral finance (Fama, 1998). Moreover, the development of behavioral models as well as a combination between financial models might lead investors and analysts to even more accurate inferences. The addition of the psychological factor of each investor (Niarchos and Alexakis, 2000) to the list of all the factors presented in this study could show that the optimal market portfolio (based on the theory of the CAPM) cannot explain stocks by itself.

Many brokerage firms, financial institutions, and financial consulting firms can develop their own model to aid their investment decision-making process. These models have become increasingly popular because they allow risk to be more tightly controlled and they allow the investor to be protected against specific types of risk to which he or she is more sensitive. The findings of this study, which indicate that there are variables others than beta that can explain the cross-section of average stock returns, suggest that cointegration models can be broadly applied in the explanation of stock returns behavior, especially when the variables can be determined *a priori* based on a more theoretical context.

Moreover, a useful tool for any financial institution would be to understand the direction of the relationship between different groups of indices. Specifically, it has been shown in our work that the short-term interest rates are positively associated with the market indices. It is argued that, in contrast to the short-term interest rate, the long-term one exhibit a negative influence on the indices (Maysami et al., 2004). This might be a result of the negative influence of the inflation on the market indices. In case that a rise in inflation leads to a rise in the interest rates the investors will want to sell their stocks.

The variables were grouped in order to examine for possible long-run relationships, as well as the direction of these relationships. In most cases the results were in agreement with those of prior studies (Niarchos and Alexakis, 2000; Maysami et al., 2004), which indicated that the inflation rate is negatively related to the market indices, the (short-term) interest rate is positively related to market indices (although, based on previous studies the results are not the same for long-term rates) and the industrial production index is also positively related to the same indices. Moreover, the results justify that the (weak-form) market efficiency may be rejected and that investors should keep in mind that the examination of different factors could lead to better and more profitable decisions.

The empirical results of all the groups of variables showed that there is at least one cointegrating vector, which proves that the variables are linearly related on the long-run. Moreover, we expressed the groups of variables in the form of a linear regression model so as to examine the sign of each relationship based on specific hypotheses presented in section 5. The developed regression model had as a dependent variable the stock market index and the results were partially similar to prior studies. For example, in the case of the consumer price index, which is generally used in the calculation of the inflation rate, it seemed to be negatively related to all the market indices, verifying the notion that as inflation increases its impact is negative on stock prices (Chen et al., 1986). A possible reason for this relationship could be that an increase in the inflation rate causes government policy makers to react by changing their monetary policy. These reactions that can affect investments are the basis of the notion that inflation is generally harmful for business (Niarchos and Alexakis, 2000). Furthermore, as far as other variables are concerned, the results regarding the relationship between industrial production and stock market indices were in agreement with prior studies (Fama, 1990), showing that a raise in industrial production can lead to economic growth and to an increase of stock prices. Moreover, the relationship between the petroleum products index and stock market indices was positive, a result that contradicts our hypothesis that is as energy prices raise the production and input costs will increase, decreasing gross profits and cash flows.

The findings presented above might have important applications for investors' portfolio formation and performance evaluation, as the majority care about long-term security returns. By adding the fact that there is not a solid theoretical background on these relationships, as most of them are results of statistical analysis, we tried to employ an adequate number of variables so as to come to some inferences regarding the way that the ASE functions and to present the parameters that investors should take into consideration during their investment decisions.

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