A study on the long-run benefits of diversification in the stock markets of Greece, the UK and the US

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Abstract

This paper examines the existence of long-run benefits of the international diversification in the equity markets of the US, Greece, UK. The study which spans 11 years uses monthly data based on closing values of the general indices of *Dow & Jones Industrial Average*, *FT All Share* and *Athens General Index*. The examined period is based on a transitive stage of adaptation in the European equity markets after the end of 1999. The objective of this study is to present and analyze the long-run relations before (1994-1999) and after the stage of advancement and the institutional changes (2000-2005). For the analysis, the method of *Engle & Granger* is basically used, while in the cases of marginal results, the *Johansen* approach seems to be essential.

Keywords: *Unit root tests; Cointegration; Long-run benefits*

JEL classifications: *G11, G15*

I. INTRODUCTION

The aim of the present analysis is the outcome of results that are related to long-run benefits of diversification in the international stock markets of the USA, the UK and Greece. This particular survey will try to interpret the international relations between the stock markets above, from the aspect of an investor, who will dispose a series of investment choices both in each of the referred markets as well as to all three stock markets simultaneously.

The analysis uses the theory of cointegration, which has become an object of systematic study for the determination of the existence of long-run benefits of the international diversification. This particular work basically follows the method of

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Engle & Granger (1987), while in the cases in which marginal results are presented the method of *Johansen* is also used (1988).

Previous studies, defined by the method of cointegration, examined long-run bonds between the international indices and possible profits in the portfolio. The results of these studies could not be compared with the findings of this particular analysis for the simple reason of the chronological difference of the results[2].

The study which has 11 years duration, uses monthly data from the beginning of 1994 till the end of 2005 in two equally divided time-periods (’94-’99 and ’00-’05)of the initial period. On the one hand, the selection of monthly data in combination with the separation of the time-period regularizes the distribution by excluding possible individual incidents. On the other hand, they are able to make the examined sample more representative by specifying the results of the analysis.

The separation of the examined period has as a focal point a series of institutional changes which tend to be established in the second period. The first half of the period which is carefully examined presents the international stock markets as they follow a process of an increasing stock-exchanging fluidity, while the short-run profit-targeting prevail in the investment environment. This phenomenon becomes more obvious in the Greek stock market. In contrast, in the second half, the European stock markets are presented to follow a descending route, which is not shown to be equivalent to those of the USA.

The particular descending route of the European stock markets, which was also continued after ’99 lead the European Union to the creation of institutional regulations which have as a final aim, the renovation, the establishment of the equilibrium to the European stock markets and furthermore, the avoidance of cases that are harmful for the long-run profits of investment in an international portfolio. Even though the findings of the analysis seem to present in many cases extreme behaviour, they could not be characterized in any case as expected. In the first subperiod as in the second one, the interdependence of the indices, by examining all three indices simultaneously, is quite important so that it will be able to influence the long-run

[2] The period of examination does not coincide chronologically with any other corresponding work. Most recent constitutes the research of Chacg, T. and Caudill B. P. (2004), for the long-term profits of international diversification between the stock markets of Japan and the USA.

benefits of international diversification in terms of risk-reduction. While in the case of the examination of the interdependence of two indices, only in a few cases results in the existence of cointegration.

II. DATA

The study examines monthly data of the international stock-exchange indices of the markets of US (*Dow & Jones Industrial Average*), of the UK (*FT All Share*) and Greece (*Athens General Index*) expressed in natural logarithms. The elements which have been received are based on the closing-prices of the indices below and on the existing local currency. The period under-examination extends from Jan- ’94 till Dec-’05 in a sample which is constituted of 144 observations. The sample is divided in two equal in amount sizes which consists of 72 obs. The first period takes values from Jan-’04 till Dec-’99, while the second half from Jan-’00 till Dec- ’05. Additionally, the survey is extended also in the study of the period as a whole.

The selection of monthly data seems to be better related to the daily values since individual incidents can be excluded and on the real behaviour of the market can be presented. What is more, the analysis of the data on a daily basis could create faults in measurement of the variables. These faults might be related either to a difference in closing times of indices or to the lack of data because of unexpected and non-daily incidents (bank holidays).Finally, endogenous and exogenous incidents of the economy have the ability to influence the returns of the portfolio on a daily basis, which as time goes by, become extinguished and as a result the economy is restored to its naturals levels.

III. UNIT ROOT TESTS

At this point, it is essential to use the *Dickey & Fuller* (1979) method, which examines the existence of unit roots I(1). The particular method has the possibility to give results with a specific statistical control T_{τ}. The existence of a unit root in a wide time spectrum for a selection of data is responsible for the creation of what is called “memory” and is shown by the time-series. The memory has the ability to record and registrate the incidents (crash, shock), which can also re-establish in long-run or short-run cases.

It is essential to carry out the examination of integration is essential to be carried out, before the control for cointegration, in each one individually. For the analysis, Augmented *Dickey-Fuller* (ADF) is used in three time-periods as they are presented in tables (1), (2) and (3). According to this control it is examined the model below:

$$\Delta X_t = \beta_0 + \beta_1 X_t + \beta_2 X_{t-1} + u_t \quad (1)$$

where Δ depicts the first difference of variable *X*, *Xt* depicts the value of a logarithm of an index while taking lags, t is trend by receiving values 1, 2, 3.., *T*, while u_t represents the error-term on which a systematic control should be carried out for the proof of stationarity or not.

Table 1. *Unit Root Tests (Period 1994-1999)*

Country	*Critical Value*	T_τ	*Lags*
USA			
Levels	-2,9035	*-0,4112*	2
USA			
Differences	-2,9042	*-5,5027*	2
UK			
Levels	-2,9035	*0,0186*	2
UK			
Differences	-2,9042	*-5,1812*	2
GR			
Levels	-2,9035	*0,8158*	2
GR			
Differences	-2,9042	*-4,5715*	2

Table 2. *Unit Root Tests (Period 2000-2005)*

Country	*Critical Value*	T_τ	*Lags*
USA			
Levels	-2,9035	*-1,7830*	2
USA			
Differences	-5,0912	*-5,0912*	2
UK			
Levels	-2,9035	*-1,6225*	2
UK			
Differences	-4,3485	*-4,3485*	2
GR			
Levels	-2,9035	*-1,9670*	2
GR			
Differences	-4,0252	*-4,0852*	2

Table 3. *Unit Root Tests (Period 1994-2005)*

Country	*Critical Value*	T_τ	*Lags*
USA			
Levels	-2,8822	*-2,5104*	4
USA			
Differences	-2,8824	*-5,6479*	4
UK			
Levels	-2,8822	*-1,9297*	4
UK			
Differences	-2,8824	*-5,1222*	4
GR			
Levels	-2,8822	*-1,4413*	4
GR			
Differences	-2,8824	*-5,7958*	4

If the absolute value of the T_τ is lower than the critical value, then the series have nonstationarity in levels. Moreover, if the T_τ statistic for the series in the first differences is higher than the critical value, then the original series have stationarity in first differences, in a significance level of 5%.

IV.COINTEGRATION TESTS

The completion and interpretation of the integrated stock markets which have already been mentioned leads the study to the next level of analysis. In the first step, the method of *Engle & Granger* is used and it will constitute the basic axis of understanding and methodology. Even though in the cases of determination and interpretation of marginal results the method of *Johansen* is used in order to verify their correctness.

According to the *Engle & Granger* method the under-estimation model in the case of studying two variables, is defined from the equation (3) which is described below and is generalised in the long-run period:

$$Y_t = \beta_0 + \beta_1 \mathrm{X}_t + \varepsilon_t \quad (3)$$

Where ε_t symbolizes the time series of the residuals, while Y_t and X_t symbolizes the general indices of the markets which are under examination. The reception of the residuals as an estimation of disequilibrium and the implementation of the method which tests the existence of unit roots leads to understand whether the residuals are stationary or not. The implementation for the control of unit roots is carried out by the following equation:

$$\Delta\hat{\varepsilon}_t = \gamma_0 + \gamma_1 \hat{\varepsilon}_{t-1} + u_t \quad (4)$$

The addition of one more index in equation (3), for instance Wt leads to the following form:

$$Y_t = \beta_0 + \beta_1 \mathrm{X}_t + \beta_2 W_t + \varepsilon_t \quad (6)$$

In equation (3) the basic methodology of Engle & Granger has remained the same except from reversing the dependent and independent variable.

The results of the analysis can be shown in tables (4), (5), (6) categorized in each different period. According to the first table which follows, the existence of cointegration does not emerge in the case of interdependence between two stock markets. An exception is the long-run relation between the stock markets of USA & Greece with the part existence of cointegration during the conducting of the first control test. After the end of the second test the results come in opposition and are not suitable for the conducting and the correct interpretation for the long-run benefits of the international diversification.

The examination of a portfolio which consists of three markets of stocks can give specific evidence for the long-term benefits in the first subperiod defines the long-run investment scene. The non-existence of profits from diversifying can also be understood from the investing choices of each period, defined by the short-run wish for profit-collection.

In the same way, in the second subperiod the implementation of *Engle & Granger* method by taking equities of all three stock markets simultaneously, presents marginal results. By following faithfully the same method, the findings for non-stationarity of stock markets is marginal. Furthermore, and the repetition of this process by reversing the dependent and independent variables leads to similar marginal results. Finally the examination of the whole period presents the markets moving independently in the long-run. The selection and investment in a long-run portfolio for the period from 1994 till 2005 could bring long-run profits in terms of reducing the risk of an investment.

Table 4. *Cointegration Analysis (Engle-Granger Method), (Period 1994-1999)*

Countries	*Critical Value*	*ADF test*	*Lags*
USA - UK	-2,912	-2,411	2
UK - USA	-2,912	-2,010	2
USA - GR	-2,912	-2,955	2
GR - USA	-2,912	-2,752	2
UK - GR	-2,912	-2,685	2
GR - UK	-2,912	-2,566	2
USA - GR - UK	-2,912	-3,623	2
GR - USA - UK	-2,912	-3,893	2
UK - USA - GR	-2,912	-3,291	2

Table 5. *Cointegration Analysis (Engle-Granger Method), (Period 2000-2005)*

Countries	*Critical Value*	*ADF test*	*Lags*
USA - UK	-2,904	-2,793	2
UK - USA	-2,904	-2,954	2
USA - GR	-2,904	-1,747	2
GR - USA	-2,904	-1,534	2
UK - GR	-2,904	-2,195	2
GR - UK	-2,904	-2,490	2
USA - GR - UK	-2,904	-2,375	2
GR - USA - UK	-2,904	-1,774	2
UK - USA - GR	-2,904	-3,191	2

Table 6. *Cointegration Analysis (Engle-Granger Method), (Period 1994-2005)*

Countries	*Critical Value*	*ADF test*	*Lags*
USA - UK	-2,882	-1,172	4
UK - USA	-2,882	-1,165	4
USA - GR	-2,882	-2,423	4
GR - USA	-2,882	-1,938	4
UK - GR	-2,882	-1,958	4
GR - UK	-2,882	-1,630	4
USA - GR - UK	-2,891	-2,060	4
GR - USA - UK	-2,891	-1,592	4
UK - USA - GR	-2,891	-2,331	4

If the computed value of ADF test in absolute numbers is lower than the critical value results in the acceptance of null hypothesis of no cointegration. For the proof of cointegration, the computed value of ADF test in absolute numbers should be higher than the critical value in both cases of reversing the dependent and independent variables in the equation.

The weakness of interpreting the marginal results that emerge from the implementation of *Engle & Granger* method and are presented in tables (4) & (5) require further analysis. In this point, it is essential to apply an additional method of testing for cointegration. This test is conducted according to the method of *Johansen*. The model which is under-estimation as it is presented in equation (7) constitutes a system of autoregressive representation (VAR).

$$X_t = \beta_0 + \beta_1 X_{t-1} + \beta_2 X_{t-2} + \ldots + \beta_n X_{t-n} + \varepsilon_t$$

Where X_t shows the *I(1)* variables, β_0 a vector of constant term, β_1, β_2,…, β_n are the matrices of coefficients of each variable and take (n) lags, while ε_t is the error-term. The acceptance or not of the H_o hypothesis, for the existence of no cointegration, is tested by two statistics, which are developed by *Johansen*, namely the trace statistic and the max-L statistic. These particular values lead us to discover the number of cointegrating vectors and a possible existence of cointegration.

$$Trace = T\sum_{i=r+1}^{p} \ln(1-\lambda_i) \quad (8)$$

$$Max-L = T\ln(1-\lambda_{r+1}) \quad (9)$$

In the equations (8), (9) above, T denotes the number of observations, r shows the cointegrating vector, the acceptance of H_o hypothesis results when ($r=0$), while λ_1, λ_2,..., λ_p are the correlations between X_{t-p} and ΔX_t. The results from the implementation of the methodology are extensively presented in tables (7), (8) and (9). According to the first table the acceptance of H_o hypothesis indicates that the equity-markets of US and Greece are independent in the long-run. The investment in a portfolio which contains equities of these particular markets could give positive long-run outputs.

Furthermore, in the cases of marginal results tables (8) and (9) for the second sub period, the US and the UK stock markets have no long-run interdependence ($r = 0$). The findings for no cointegration in this case are not differentiated from the basic analysis based on the *Engle & Granger* method. In contrast, the results of long-run investment in the three markets simultaneously are against the basic analysis. In this case, Trace and max-L statistic as well, are higher than the critical value.

Πίνακας 7. *Cointegration Analysis (Johansen Method), (1994-1999)*

Hypotheses	*Country*	*Trace*	*Critical*
Ho H1	*GR - USA*	*Test*	*Value*
r = 0 r ≥ 1	–	6,426	15,410
r ≤ 1 r ≥ 2	–	0,010	3,760

Hypotheses	*Country*	*Max-L*	*Critical*
Ho H1	*GR - USA*	*Test*	*Value*
r = 0 r = 1	–	6,406	14,070
r ≤ 1 r = 2	–	0,019	3,760

Πίνακας 8. *Cointegration Analysis (Johansen Method), (2000-2005)*

Hypotheses	*Country*	*Trace*	*Critical*
Ho H1	*UK - USA*	*Test*	*Value*
r = 0 r ≥ 1	–	4,998	12,530
r ≤ 1 r ≥ 2	–	0,225	3,840

Hypotheses	*Country*	*Max-L*	*Critical*
Ho H1	*UK - USA*	*Test*	*Value*
r = 0 r = 1	–	4,773	11,440
r ≤ 1 r = 2	–	0,225	3,840

Πίνακας 9. *Cointegration Analysis (Johansen Method), (2000-2005*)

Hypotheses	*Country*	*Trace*	*Critical*
Ho H1	*GR - UK - USA*	*Test*	*Value*
r = 0 r ≥ 1	–	31,102	24,310
r ≤ 1 r ≥ 2	–	9,983	12,530
r ≤ 2 r ≥ 3	–	0,105	3,840

Hypotheses	*Country*	*Max-L*	*Critical*
Ho H1	*GR - UK - USA*	*Test*	*Value*
r = 0 r = 1	–	21,118	17,890
r ≤ 1 r = 2	–	9,878	11,440
r ≤ 2 r = 3	–	0,105	3,84

If *r = 0*, then the null hypothesis of no cointegration becomes acceptable. If r =1, then there is one cointegrating vector. If the computed statistic is below the critical value (5% significance level), then we cannot reject the null hypothesis of no cointegration. (i.e. Ho: r=0)

V.Conclusion

The findings of this research on the long-run benefits that have resulted from two methodologies of testing for cointegration, presents the equity markets of the US, Greece and the UK without any interdependence in the cases of international diversifications of a portfolio which contains equities from two different stock markets.

In contrast, when a portfolio of all three stock markets exists , the cointegration during 1994-1999 and 2000-2005 as well can influence the long-run profits in terms of risk-reduction.

The conclusion is that there are no significant changes in the European stock markets before and after the year 1999 and the institutional changes haven't brought the desired results at least not in terms of the long-run benefits of the international diversification of the stocks.

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