Short and Long-Term Links Among Turkish and European Stock Markets: Portugal, Italy, Greece, Spain and Ireland*

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ABSTRACT

Portugal, Italy, Greece, Spain and Ireland are the European countries having similar economic environments. Since the European sovereign debt crisis, they have been referred to as a group of European economies facing particular financial crisis. This study, first, tests the interdependence of these countries' stock markets and Turkey in a period covering both global financial crises and European sovereign debt crisis. Secondly, it uses GARCH(1,1), IGARCH(1,1) and EGARCH(1,1) models to examine the index return volatilities. Thirdly, it applies a gravity model to determine the effects of variables such as the distance between stock markets and the size of markets on the correlation coefficient between returns. Using data from March 2005 to December 2011, we examine the stock market indexes of Portugal, Italy, Greece, Spain, Ireland and Turkey. The index level series are non-stationary and hence we employ co-integration analysis to model the interdependencies. The results of the co-integration tests indicate that there is no long-run relationship between the stock markets. There is only one co-integrating vector which appears to explain the dependencies in prices between Greece and Turkey. Our results suggest that there is a potential for diversifying risk as they are not integrated. We find strong evidence of time-varying volatility and volatilities show high persistence. The results of gravity model indicate that the distance between stock markets and the size of markets have significant effects on the correlation of returns between Turkish stock market and the other countries while neighborhood does not.

Keywords: *Co-integration, correlation, volatility, gravity model*
Jel Classification: G11, G12, G15

Türk Ve Avrupa Hisse Senedi Borsaları Arasındakı Kısa Ve Uzun Dönemli İlişkiler : Portekiz, İtalya, Yunanistan, İspanya Ve İrlanda

ÖZET

Portekiz, İtalya, Yunanistan, İspanya ve İrlanda Avrupa'nın benzer ekonomik yapılara sahip ülkeleridir. Avrupa'da ortaya çıkan borç kriziyle birlikte bu ülkeler finansal kriz karşısında benzer problemleri yaşayan Avrupa ülkeleri grubu olarak anılmaktadırlar. Bu çalışma, öncelikle, global finansal kriz ve Avrupa borç krizini kapsayan dönemde ilgili ülkelerin borsaları ile Türkiye arasındaki karşılıklı bağımlılığı test eder. İkinci olarak, GARCH(1,1), IGARCH(1,1) ve EGARCH(1,1) modellerini kullanarak endeks getiri oynaklıklarını analiz eder. Üçüncü olarak, borsalar arası coğrafi mesafeler ve piyasa büyüklükleri gibi değişkenlerin borsa getirilerinin korelasyonları üzerindeki etkilerini analiz etmek için gravity model uygular. Analiz verisi olarak Portekiz, İtalya, Yunanistan, İspanya, İrlanda ve Türkiye'nin Mart 2005 - Aralık 2011 tarihleri arasındaki hisse senedi borsa endeks verileri kullanılmıştır. Endeks serileri durağan değildir ve bu nedenle karşılıklı bağımlılığı analiz etmek için eşbütünleşme modelleri uygulanmıştır. Analiz sonuçları bu ülkelerin borsaları arasında uzun dönem ilişkisinin olmadığına işaret etmiştir. Sadece Yunanistan ve Türkiye borsaları arasında bağımlılıkları açıklayan bir eşbütünleşme vektörü bulunmuştur. Analiz sonuçları borsalar arasında eşbütünleşme olmadığı için portföy riskinin çeşitlendirilmesi için potansiyel bulunduğunu göstermiştir. Borsaların oynaklığı yüksektir ve etkisi kalıcıdır. Gravity modelin sonuçlarına göre borsalar arası mesafe ve piyasa büyüklükleri, Türkiye ve diğer ülkelerin borsa getirilerinin korelasyonları üzerinde anlamlı etkilere sahiptir ancak ortak sınırın olması bir etkiye sahip değildir.

Anahtar Kelimeler: *Eşbütünleşme, korelasyon, oynaklık, gravity model*
JEL Sınıflandırması*:* G11, G12, G15

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1. INTRODUCTION

There are multiple studies analyzing stock market integration around the world most of which analyze stock markets among developed markets and between developed markets and relatively well-established emerging markets in Latin America and Asia. Nevertheless, integration of the Turkish stock market with the European Union stock markets especially after the global financial crisis and European sovereign debt crisis has been rather understudied.

A variety of Western economies such as Greece, Ireland, Italy Spain and Portugal have been under the threat of a sovereign debt crisis which has been affecting the global economy by spreading rapidly across the Euro region. The current crisis has been the inevitable result of some European governments' incompetence in managing their debt whereas the 2008-09 global crisis was due to the insolvency of US financial institutions. The excessive expenditure by the government in addition to low growth in Greece has yielded an unsustainable debt burden which, in turn, created a potential domino effect threatening the whole Euro region and the global economy.

Turkish economy was affected by the global financial crisis as a result of the decay in financing conditions, waning foreign trade and unstable confidence which yielded shrinkage in economic activity and high unemployment in 2009. However, Turkey's recovery was boosted thanks to the improvements in financial sector and public debt dynamics completed after the 2001 crisis. In 2011, the strong economic recovery was achieved. Furthermore, international rating agencies upgraded the sovereign credit ratings during the period between December 2009 and February 2010.

The aim of this study is to examine whether the Turkish stock market is integrated with Portugal, Italy, Greece, Spain and Ireland stock markets. If Turkish stock market is not integrated with these countries' stock markets, we conclude that there is the potential for diversifying risk for the European Union investors in the Turkish stock market. The study contributes to the literature as it will have important implications for individual investors, portfolio managers, and financial managers of corporations willing to invest in the Turkish stock market.

Researchers in their works use various methodologies in analyzing integration of stock markets. In this study, we use Engle-Granger Co-integration Test, Granger Causality Test, Johansen Co-integration Test and Vector Autoregressive Model (VAR) and Variance Decomposition methodologies in order to examine integration between stock markets. We observe that there is no co-integration in these markets. The stock markets of these countries do not exhibit long-run co-movements which can allow the benefits of international diversification.

In this study, we also characterize the dynamics of stock returns and conditional volatility in stock exchanges. We examine whether stock returns volatility changes over time. The generalized autoregressive conditionally heteroskedastic (GARCH), integrated-GARCH (IGARCH) and the exponential generalized autoregressive conditionally heteroskedastic (EGARCH) models are used to obtain appropriate series of conditional variances that can be used as expected volatility estimates. We find strong evidence of time-varying volatility. Additionally, we observe that volatility shows high persistence.

In addition to analyses mentioned above, we constructed a gravity model to estimate the effects of variables such as the distance between stock markets and the size of markets on the correlation coefficient between returns. Since we focused on the relationship between the Turkish stock market and the stock markets of Portugal, Italy, Ireland, Greece and Spain, we restricted our research and all other mutual relationships among countries were hence omitted. We applied a feasible Generalized Least Squares specification to estimate the gravity model. Our results suggest that the distance between countries and size of the markets have significant effects with expected signs on stock market correlations while neighborhood does not. In order to test the effect of crisis on correlation then we add a dummy variable which takes the value of one during 2007- 2011 period into the gravity model. The model results suggest that the crisis has a significant and positive effect on correlation.

The remainder of this paper continues as follows. First, we employ the most recent data, which will allow us to study the effects of global financial crisis and European sovereign debt crisis on the integration of stock markets. In addition, we also examine the stock market volatilities. Second, we explore stock diversification opportunities in Turkey as an emerging market. Third, we employ a gravity model to explain the cross-sectional properties of stock market correlations of Turkey with the other countries under study. Section two presents a brief review of literature, whereas section three provides information about data, the methodologies we used and our results. Part four is the conclusion.

2. LITERATURE

In Table 1, the stock markets of Portugal, Italy, Greece, Spain, Ireland and Turkey are compared under the headings; listed domestic companies, market capitalization of listed companies and stocks traded turnover ratio.

Table 1: Statistics for the Stock Exchanges

	Listed Domestic Companies, Total	Market Capitalization of listed Companies (current US$)	Stocks traded, Turnover ratio (%)
Portugal	46	61.68*	50.3
Italy	287	431.47*	236.8
Ireland	48	35.36*	45.3
Greece	275	33.64*	46.5
Spain	3241	1030.95*	128.9
Turkey	362	201.81*	162.7

*Billion

Source: The World Bank, http://data.worldbank.org/indicator, (05.12.2012)

Market capitalization is one of the most important indicators in conducting comparisons in inter-stock exchanges. As in Table 1, the stock exchange having the highest market capitalization out of six stock exchanges is Spain, which is followed by Italy and Turkey. In the literature, turnover ratio, measured by trading volume divided by market value of outstanding stocks, is used as an alternative measure of liquidity in the stock market. Table 1 display that Italy has the highest turnover, followed by Turkey and Spain. One of the most important criteria indicating level of development of stock exchanges is the number of corporations quoted in the stock exchange. As can be observed on Table 1, total 3,241 corporations were quoted in Spain by the end of 2011, while 362 corporations were quoted in Turkey and 287 in Italy in the same year.

A literature review on possible relationships and interactions amongst integrated stock markets shows that the GARCH family models and VAR models are valid to identify this phenomenon. In addition to these models, Granger causality tests and Co-integration tests could be applied adequately to clarify the causal relations and co-movements both in short-run and long-run.

Worthington and Higgs (2004) examine the transmissions of equity market returns and volatility among nine major Asian markets during the period from 1988 to 2000. They also investigate the differences between the emerging markets and the developed ones. Hong Kong, Japan and Singapore are regarded as the developed markets whereas Indonesia, Korea, Malaysia, the Philippines, Taiwan and Thailand are regarded as the emerging markets in the analysis. A multivariate GARCH model is employed to determine the origin and magnitude of spillovers. It is concluded that even though the mean spillovers from developed to the emerging are not homogenous across the emerging markets, all Asian markets are highly integrated. However, the own-volatility spillovers are higher than cross-volatility spillovers for all markets, but more prominently emphasized for emerging markets. This finding implies that in regard to Asian markets the changes in volatility in emerging markets are relatively more significant than those in developed markets.

PIIGS is an acronym referring to the economies of Portugal, Italy, Greece and Spain and Ireland. Tamakoshi and Hamori (2011) investigated the causal relationships between the transmission of stock indexes among the PIIGS, Germany and UK before and during European sovereign debt crisis. In this paper, authors used the lag-augmented VAR (LA-VAR) methodology on two different data sets consisting of daily returns of stock market indexes from seven members of European Union. First data set includes a sample period from February 2007 to November 2009 referred to as the period before crisis, while the second includes from May 2009 to June 2011 referred to as the crisis period. Authors concluded that Portugal and Ireland Granger-caused multiple other countries, including Germany while Germany had a reverse causal effect only on Ireland. Although these causal relationships are valid before and during the sovereign debt crisis which has originated in Greece, they are mostly diminished during the crisis. Likewise, the co-movements among stock exchanges of PIIGS countries decreased gradually all along the crisis.

Kizys and Pierdzioch (2011) investigated potential causal linkages of the news to speculative bubbles in the Greek equity market and the equity markets of Portugal, Ireland, Italy and Spain by employing VAR model and Granger non-causality test for a sample period from January 1999 to April 2011. The authors defined speculative bubbles as the equity market prices stochastically deviating from their fundamentals-based values. The main finding of this research is that news to speculative bubbles in the Greek equity market caused movements in the equity markets of the other countries, but there is no strong evidence of a reversed causality.

Gklezakou and Mylonakis (2009) examined the correlation and causal relationship among the emerging stock markets of the South Eastern Europe before and during the current economic crisis. Romania, Bulgaria, Croatia, Slovenia and Turkey were included in the analysis as emerging markets. In regard to previous research which suggests that the interdependence is mainly originated from the dominant markets, authors also added Germany as the leading European stock market and Greece because of its dominant role in the area. The logarithmic daily closing prices of indexes of included stock markets were divided into two sub-periods extending from November 2000 to July 2007 and from July 2007 to February 2009. Based on the unidirectional influences from Germany to all of the other countries which are verified in their research, authors supported the extant literature that Germany is a leading stock market. Similarly, it is found that Greece has dominant influences on most of the developing markets. Although the causality among the emerging markets is low and indistinct, it can be argued that the Bulgarian and the Turkish markets are relatively stronger, since they are affected only by the Greek and the German markets. It is also concluded that the weak relations among the markets during normal economic activity are strengthened by conditions under the economic crisis.

Benli et al. (2012) investigated the existence of common stochastic trends between European Union member countries (Austria, Belgium, Denmark, England, Finland, France, Germany, Greece, Holland, Ireland, Italy, Portugal, Spain and Sweden) and Turkey by using the Johansen (1989) and Johansen and Juselius (1990) methodology. The sample set includes data from January 1988 to August 2008. In the analysis, these fourteen EU member countries were divided into four sub-groups and the relations of each group with Turkey in terms of stock price indexes were investigated separately. It is concluded that there is strong evidence for the existence of common stochastic trends except for a few cases.

Ergun and Nor (2009) examined external linkages of Turkish Stock Market with twenty-seven EU member countries, five non-EU member European countries, the US, and Japan by considering the role of EU accession period. Their research includes both the daily and monthly data from stock market indexes from 1988- 2008 period. They used the Johansen's multivariate co-integration test and the recursive co-integration approach of Hansen and Johansen (1992) to identify the interactions among the stock markets. The main finding of this paper is that there were significant linkages between Turkey and developing EU member countries that became member after 2004, but only until they joined EU. Moreover, the linkages between Turkey and the developed EU countries were found to be significant and influenced by the breakthrough points which indicate the unionization.

İbicioğlu and Kapusuzoğlu (2011) investigated the causal interactions and long-run relationships of Turkish stock market with the stock markets of EU member Mediterranean countries by using the Granger causality tests, Vector Error Correction Model (VECM), Johansen co-integration test and variance decomposition techniques. Their research includes daily data from Turkey and six EU member Mediterranean countries including France, Spain, Italy, Greece, Malta and Croatia for the period of July 2002- March 2010. Authors concluded that the stock markets of all included countries are related in the long- run. Besides, the stock market of France is found significantly dominant and Turkish stock market is not Granger-caused by any other market.

Gravity modeling approach has been frequently used to explain the trade patterns among countries. Recent studies also suggest that gravity models can be used to explain cross-country stock market correlations adequately. Huang et al. (2006) used a gravity modeling approach to explain the stock market correlations in emerging markets for 20 countries. Their analysis includes the explanatory variables such as distance between countries, market size, legal system, language and border. It is found in this research that the physical distance, market size and legal system similarities have significant effects on stock market correlations. Flavin et al. (2001) employed a gravity model by using 1999 national stock market data for 27 countries to explain stock market correlations. They found that geographical variables with overlapping opening hours and neighborhood have significant effects on stock market correlation. Even though the distance variable was found to be insignificant, the authors suggest that this result does not imply invalidity of the gravity model.

3. METHODOLOGY

The actual time period under study ranges from March 2005 to December 2011. FTSEMIB Index for Italy, PSI20 Index for Portugal, FTASE Index for Greece, XU030 for Turkey, ISEQ20P Index for Ireland and IBEX Index for Spain were used as the blue chip stock market indexes for the analysis. This paper examines the interdependence of the stock markets among Portugal, Italy, Ireland, Greece, Spain and Turkey through a few different perspectives. First, we applied the granger causality test to determine the mutual causal relations in addition to Engle-Granger co-integration test and Johansen co-integration test in order to detect the co-movements in the long run. Second, GARCH (1,1), IGARCH (1,1) and EGARCH (1,1) models were used to examine whether stock returns volatility changes over time. Finally, we constructed a gravity model to estimate the effects of variables such as the distance between stock markets and the size of markets on the correlation coefficient between returns. Since we focused on the relationship between the Turkish stock market and the stock markets of Portugal, Italy, Ireland, Greece and Spain, we restricted our research and all other mutual relationships among countries were omitted.

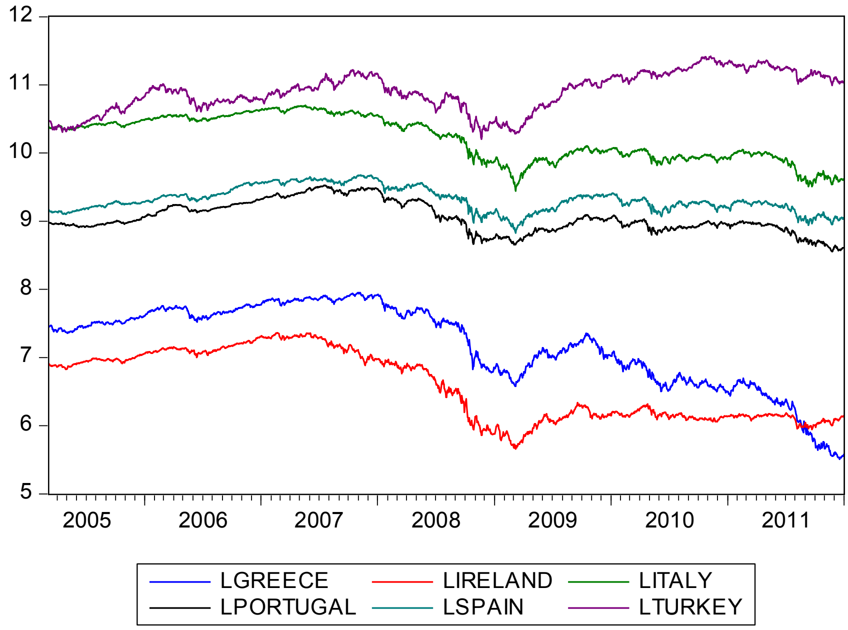
Descriptive Statistics

Table 2 reports the descriptive statistics for the log of daily closing prices for the entire study period and clearly displays that distributions are not normal. Greece, Italy and Turkey have negative skewness, which means the left tail is longer, and the mass of the distribution is concentrated on the right of the figure. Additionally, they have relatively few low values. A high kurtosis portrays a chart with fat tails and a low, even distribution, whereas a low kurtosis portrays a chart with skinny tails and a distribution concentrated toward the mean. Moreover, the table also indicates that Italy and Ireland have low kurtosis values compared to others.

Table 2. Descriptive Statistics for Log of Daily Closing Prices

	Greece	Ireland	Italy	Portugal	Spain	Turkey
Mean	7.190	6.582	10.207	9.051	9.315	10.904
Median	7.404	6.528	10.257	8.990	9.293	10.930
Maximum	7.951	7.362	10.700	9.525	9.676	11.421
Minimum	5.508	5.658	9.443	8.553	8.827	10.205
Std. Dev.	0.598	0.500	0.327	0.230	0.181	0.283
Skewness	-0.793	0.051	-0.203	0.282	0.119	-0.371
Kurtosis	2.868	1.372	1.727	2.269	2.284	2.280
Jarque-Bera	187.947	197.257	132.338	63.328	42.205	79.397
Observations	1780	1780	1780	1780	1780	1780

Figure 1: Graphs for Log of Daily Closing Prices



Augmented Dickey-Fuller (ADF) Test

Most of the financial time series are non- stationary. However, it is important to obtain stationarity to avoid the spurious regression problem. Moreover, transforming non-stationary time series to achieve the stationarity is a precondition for some time series analysis such as co-integration. Unit root tests such as ADF, PP and KPSS are used to detect the existence of unit roots (Gujarati 2003:820).

The most commonly used test to examine the existence of a unit root is the Dickey-Fuller test. The Augmented Dickey-Fuller (ADF) test includes additional lagged difference terms to avoid the auto-correlated error term while the original series follows an AR(p) process. The ADF unit root test is based on the following regression:

$$\Delta Y_t = \beta_1 + \beta_2 t + \delta Y_{t-1} + \sum_{i=1}^{m} \alpha_i \Delta Y_{t-i} + \varepsilon_t \quad (1)$$

We refer to the Augmented-Dickey Fuller (ADF) test to see whether or not the log of daily price series is stationary. Table 3 displays the ADF test results. First, we fail to reject the null hypothesis containing the unit root in each variable case. However, once we take the first difference, we reject the null hypothesis at one percent level and conclude that all the series are stationary and integrated in the same order, namely I (1).

Table 3: ADF Test Results

	ADF (level)		ADF (1st diff.)	
	t-Statistic	*Prob.*	*t-Statistic*	*Prob.*
Greece	1.629	(0.999)	-40.788	(0.000)***
Ireland	-0.654	(0.855)	-40.472	(0.000)***
Italy	-0.352	(0.914)	-42.039	(0.000)***
Portugal	-0.410	(0.905)	-40.142	(0.000)***
Spain	-1.660	(0.451)	-41.853	(0.000)***
Turkey	-1.836	(0.363)	-40.631	(0.000)***

Note: - Price series are in the log form. ADF is with intercept. ***, ** and * indicate the level of significance at the 1 percent, 5 percent and 10 percent level, respectively.

Engle-Granger Co-integration Test

Two variables will be co-integrated if they have a long-term, or equilibrium, relationship. Testing for co-integration is undertaken once it is found that each series contains one unit root. The concept of co-integration developed by Engle and Granger (1987) is that some linear combination of two or more series is stationary even when each of the series individually is non-stationary. First, the two non-stationary time series Y_{1t} and Y_{2t} are regressed on each other to obtain the residuals from ordinary least squares (OLS) regression:

$$Y_{2t} = \alpha + \beta Y_{1t} + \varepsilon_t \qquad (2)$$

Second, these residuals ε_t are tested for unit root characteristics by employing the ADF test. The two time series are said to be co-integrated if they are integrated of the same order and the residuals from the OLS regression are stationary in levels and integrated of the order zero, respectively.

Table 4: Results for Bivariate Co-integration

	Unit Root Tests in Regression Residuals ADF	
	t-Statistic	*Prob.*
Greece/Turkey	0.483	(0.986)
Turkey/Greece	-1.982	(0.294)
Ireland/Turkey	-0.797	(0.819)
Turkey/Ireland	-1.882	(0.340)
Italy/Turkey	-0.607	(0.866)
Turkey/Italy	-1.926	(0.320)
Portugal/Turkey	-0.182	(0.938)
Turkey/Portugal	-1.718	(0.421)
Spain/Turkey	-1.393	(0.586)
Turkey/Spain	-1.547	(0.509)

Notes: Price series are in the log form. ADF is level with intercept. ***, ** and * indicate the level of significance at the 1 percent, 5 percent and 10 percent level, respectively.

Table 4 summarizes the unit root tests for the co-integrated Portugal, Italy, Greece, Spain and Ireland stock market indexes for Turkey. The null hypothesis of a unit root is not rejected by the ADF test. Turkey does not share a common stochastic trend with these countries and is said not to be co-integrated.

Granger Causality Test

The Granger (1969) approach questions whether X causes Y by regressing lagged values of X and Y on Y. If adding lagged values significantly improves the prediction of Y, then it can be said that X (Granger) causes Y. A similar definition applies if Y (Granger) causes X (Gujarati 2003: 697). The Granger causality test is based on the following regression:

$$y_t = \alpha_0 + \alpha_1 y_{t-1} + \cdots + \alpha_l y_{t-l} + \beta_1 x_{t-1} + \cdots + \beta_l x_{-l} + \epsilon_t \quad (3)$$

$$x_t = \alpha_0 + \alpha_1 x_{t-1} + \cdots + \alpha_l x_{t-l} + \beta_1 y_{t-1} + \cdots + \beta_l y_{-l} + u_t \quad (4)$$

Table 5: Granger causality test results

Null Hypothesis	F-statistic	Probability
TURKEY does not Granger Cause GREECE	3.666	0.025**
GREECE does not Granger Cause TURKEY	0.231	0.793
TURKEY does not Granger Cause IRELAND	0.213	0.808
IRELAND does not Granger Cause TURKEY	0.514	0.597
TURKEY does not Granger Cause ITALY	0.897	0.407
ITALY does not Granger Cause TURKEY	1.869	0.154
TURKEY does not Granger Cause PORTUGAL	0.527	0.590
PORTUGAL does not Granger Cause TURKEY	0.159	0.852
TURKEY does not Granger Cause SPAIN	2.546	0.078*
SPAIN does not Granger Cause TURKEY	3.378	0.034**

Notes: - Price series are in the log form. ***, ** and * indicate the level of significance at the 1 percent, 5 percent and 10 percent level, respectively.

Table 5 indicates the results from pairwise Granger Causality Tests for the log of daily price series. We reject the null hypothesis of no Granger causality in 3 cases. We find unidirectional result from Turkey to Greece, where as there is a bidirectional (feedback) result between Turkey and Spain. Since there is Granger causality among stock market indices, there is a strong correlation between the current and the past values. Granger causality result supports the idea that knowing the current prices improves the forecast ability of stock prices.

Johansen Co-integration Test

Although extremely simple and appealing for empirical applications, bi-variate co-integration analysis suffers from several drawbacks, among which we may mention the impossibility of identifying more than one co-integrated variables among a k-dimensional set of variables with k>2. Our interest is to uncover the co-movement of six stock markets. For this reason, we follow the multivariate test for co-integration advocated by Johansen and

Juselius (1990). Johansen and Juselius et al. (1990) developed the multivariate approach, which begins with defining a VAR order of p:

$$y_t = A_1 y_{t-1} + \cdots + A_p y_{t-p} + Bx_t + \epsilon_t \qquad (5)$$

Where yt is a k -vector of non-stationary I (1) variables, xt is a d-vector of deterministic variables, and et is a vector of innovations. We may rewrite this VAR as,

$$\Delta y_t = \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + Bx_t + \epsilon_t \qquad (6)$$

where:

$$\Pi = \sum_{i=1}^{p} A_i - I \qquad (7)$$

$$\Gamma_i = - \sum_{j=i+1}^{p} A_j \qquad (8)$$

Granger's representation theorem asserts that if the coefficient matrix π has reduced rank r < k, then there exist k x r matrices α and β each with rank r such that π = α β and β y_t is I(0). r is the number of co-integrating relations (the co-integrating rank) and each column of β is the co-integrating vector. The elements of α are known as the adjustment parameters in the VEC model. Johansen's method is to estimate the π matrix from an unrestricted VAR and to test whether we can reject the restrictions implied by the reduced rank of π.

Table 6: Multivariate co-integration results (Johansen Test) between Turkey and Greece

Hypothesized No. of CE	Eigenvalue	Trace Statistics (λ)	Critical Value 0.05	Prob
None*	0.0080	14.889	12.320	0.0182
At most 1	0.0003	0.599	4.129	0.500

Notes: Price series are in the log form. * denotes rejection of the hypothesis of no co-integration at the 5% level. Trace test indicates no co-integration at the 0.05 level.

The results of the co-integration tests indicate that there is not long-run relationship between the stock markets. Moreover, they do not share the same stochastic trend, and a long run relationship does not exist. However, it should be noted that long-run relationship exists only between Turkey and Greece stock markets. Table 6 exhibits the results from Johansen co-integration test for long-run relationship between Turkey and Greece.

Vector Autoregressive Model (VAR) and Variance Decomposition

Vector Autoregressive Model (VAR) is an econometrics tool that shows the dynamic interrelationship between stationary variables. There are two techniques of VAR employed in order to show the statistically significant impacts of each variables on the future values, for example, whether the changes of a variable have a positive or negative effect on other variables in the system, namely the VAR's impulse responses and variance decompositions. In determining both techniques, ordering of the variables plays a very important role.

Impulse responses show how the shocks to any single variable affect the dependent variable in the VAR. Another way to explain the effects of the shocks is to analyze the variance decompositions. Variance decompositions analysis is slightly different from impulse responses in terms of how the shocks are applied. It records the effect on the dependent variable due to its own shocks against shocks to other variables in the system. Moreover, variance decompositions analysis focuses not only on the movement of the dependent variable, but also on the forecast error variance produced by the shocks which help to identify the sources of the volatility.

Table 1 in the appendix presents the results of variance decomposition for Turkey. As we can expect, Turkey is independent on the five stock markets and Turkey stock markets explain 99.5 percent of the variance of itself.

Volatility Index Measurement

In this study, we characterize the dynamics of stock returns and conditional volatility for stock markets of Portugal, Italy, Greece, Spain, Ireland and Turkey. We examine whether stock return volatility changes over time.

The return is calculated as first differences in natural logarithms according to the following expression:

$$Rt = \ln\left(\frac{Pt}{Pt - 1}\right) \tag{9}$$

Table 7 gives the descriptive statistics for daily stock market returns for the entire period. As it can be noticed from Table 7, all series except Greece and Spain exhibit negative skewness, which indicates that the series have an asymmetric distribution with a longer left tail. Every variable has a relatively high kurtosis compared to the normal value, which is three and very high Jarcque-Bera test statistics which strongly suggests a rejection of normality. All the countries except Turkey have negative returns. Meanwhile, the volatility of the returns in terms of standard deviation is the highest for Greece and the lowest for Portugal.

Table 7: Descriptive Statistics of Daily Returns

	Greece	Ireland	Italy	Portugal	Spain	Turkey
Mean	-0.001055	-0.000425	-0.000427	-0.000207	-6.09E-05	0.000313
Median	0.000000	0.000000	0.000336	0.000120	0.000369	0.000000
Maximum	0.163741	0.108228	0.108742	0.101959	0.134836	0.127255
Minimum	-0.097963	-0.149554	-0.085991	-0.103792	-0.095859	-0.097398
Std. Dev.	0.021124	0.018120	0.016276	0.012783	0.015859	0.019898
Skewness	0.243612	-0.515446	-0.056279	-0.081800	0.175572	-0.060197
Kurtosis	7.734312	10.15654	8.979903	12.65846	10.73161	5.741694
Jarque-Bera	1679.013	3875.168	2651.593	6916.790	4440.169	558.2637
Observations	1779	1779	1779	1779	1779	1779

Table 8: Correlation of Daily Returns

	Greece	Ireland	Italy	Portugal	Spain	Turkey
Greece	1.00	0.51	0.57	0.57	0.57	0.47
Ireland	0.51	1.00	0.67	0.62	0.69	0.48
Italy	0.57	0.67	1.00	0.77	0.90	0.53
Portugal	0.57	0.62	0.77	1.00	0.79	0.51
Spain	0.57	0.69	0.90	0.79	1.00	0.54
Turkey	0.47	0.48	0.53	0.51	0.54	1.00

Figure 2: Rolling Correlations for Returns (30 days windows)

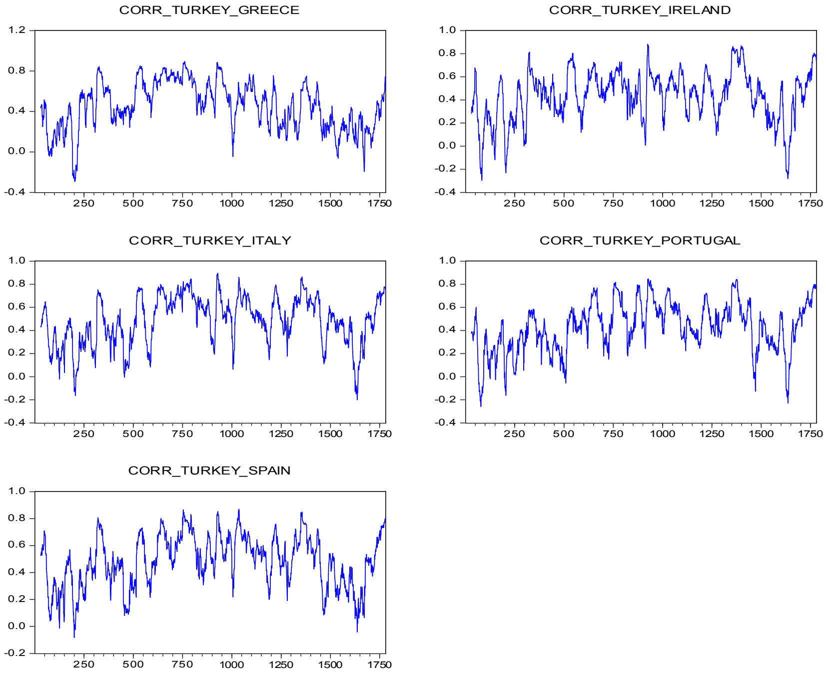
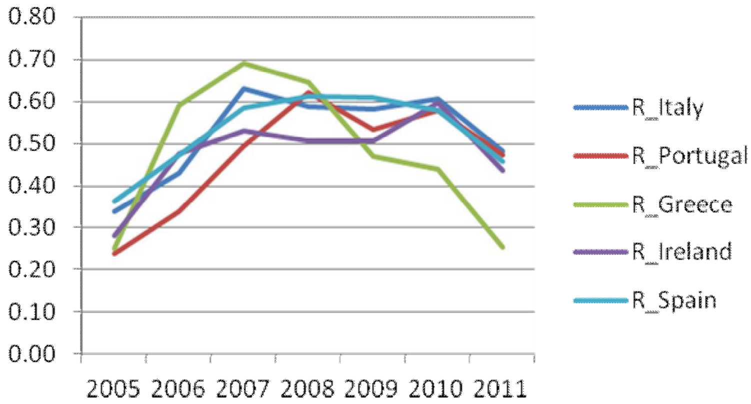


Figure 3: Time Varying Pairwise Correlations between Turkey and Selected Countries



The correlation coefficients for daily return series are displayed on Table 8. A low return correlation coefficient among markets is considered as a sign of potential diversification benefits, and an opportunity for portfolio risk reduction. When we look at the correlation results, we find that the highest dependencies exist between markets which are strongly connected both geographically and economically. Additionally, Turkey has lower coefficients compared to other countries.

Figure 3 shows that time varying pair-wise correlations between Turkey and selected countries have increased during global crisis period and decreased gradually after 2009. This decline is the highest for Greece.

The GARCH Model

GARCH model is expressed as the extended version of ARCH model and developed by Bollerslev (1986). In addition to the delayed values of the conditional variance of error term, it is the volatility model dependent on its own delayed values. GARCH (p, q) model, in addition to the conditional mean equation, consists of the conditional variance equation

$$R_t = \mu + \varepsilon_t \quad (11)$$

$$\sigma_t^2 = \omega + \sum_{i=1}^{q} \alpha_i \varepsilon_{t-i}^2 + \sum_{j=1}^{p} \beta_j \sigma_{t-j}^2 \quad (12)$$

In the GARCH models, $\alpha + \beta < 1$ is the prerequisite. Otherwise, the stability cannot be achieved. In this equation, the closer you approach to the 0 value the resistance of shock decreases, the closer you approach to 1 value resistance of shock increases. It is proven with the previous studies that GARCH group of models is more appropriate for modeling of financial time series models.

This study, initially, investigated the ARCH effect for the index daily returns series for each of the countries. After testing the presence of ARCH effect, it modeled the index return volatilities by using GARCH (1, 1) model.

Table 9 contains parameter estimates for GARCH (1, 1) model. At first glance, the results are consistent with those of other empirical works on time-varying volatility. First, the GARCH parameterization is statistically significant. Second, most of the estimated β coefficients in the conditional variance equation are considerably larger than the α coefficients, which implies that large market surprises induce relatively small revisions in the future volatility. Finally, the persistence of the conditional variance process, measure by α + β, is high and often close to 1, which suggests that current information is also relevant in predicting future volatility at a long horizon. For Greece, Ireland and Portugal, estimated coefficients α + β are slightly greater than 1. So, we employ the model known as integrated GARCH or IGARCH to estimate the return volatilities. This implies persistence in the forecast of the conditional variance over all future horizons and also suggests an infinite variance for the unconditional distribution.

Table 9: GARCH Models

Greece			**Ireland**		
Return Equation	Coefficient	p-value	Return Equation	Coefficient	p-value
μ	0.000735	0.0338**	μ	0.000577	0.0345**
AR(1)	0.048089	0.0387**	AR(1)	0.043089	0.0988*
Variance Equation			Variance Equation		
ω	1.60E-06	0.0062***	ω	1.35E-06	0.0049***
α	0.095591	0.0000***	α	0.101095	0.0000***
β	0.907330	0.0000***	β	0.900002	0.0000***
Italy			**Portugal**		
Return Equation	Coefficient	p-value	Return Equation	Coefficient	p-value
μ	0.000322	0.1913	μ	0.000803	0.0001***
			AR(1)	0.058699	0.0127**
AR(1)	-0.032950	0.2103	AR(13)	0.027969	0.2264
Variance Equation			Variance Equation		
ω	1.99E-06	0.0000***	ω	1.55E-06	0.0000***
α	0.115366	0.0000***	α	0.163185	0.0000***
β	0.881495	0.0000***	β	0.840885	0.0000***
Spain			**Turkey**		
Return Equation	Coefficient	p-value	Return Equation	Coefficient	p-value
μ	0.000690	0.0070***	μ	0.001177	0.0094***
AR(1)	-0.005984	0.8147	AR(1)	0.026528	0.2925
Variance Equation			Variance Equation		
ω	2.89E-06	0.0000***	ω	1.53E-05	0.0000***
α	0.128637	0.0000***	α	0.094598	0.0000***
β	0.865859	0.0000***	β	0.866388	0.0000***

Note: ***, ** and * indicate the level of significance at the 1 percent, 5 percent and 10 percent level, respectively.

The EGARCH Model

An important restriction of GARCH model is about the symmetric response of volatility to positive and negative shocks. However, it can be observed that "bad" news or a negative shock to financial time series has larger effects on volatility than "good" news or a positive shock does. The tendency of such a negative correlation between volatility and returns is often called the leverage effect. A model that allows for this asymmetric effect of shocks is the exponential-GARCH (EGARCH) model. Nelson (1991) proposed a specification that does not require the non-negativity of model parameters, which is another advantage over the standard GARCH model (Enders 2004:141-143, Brooks 2008:404-406).

The specification of the conditional variance equation can be expressed by

$$\log(\sigma_t^2) = \omega + \sum_{j=1}^{p} \beta_j \log(\sigma_{t-j}^2) + \sum_{i=1}^{q} \alpha_i \frac{|\varepsilon_{t-i}|}{\sqrt{\sigma_{t-i}^2}} + \sum_{i=1}^{q} \gamma_i \frac{\varepsilon_{t-i}}{\sqrt{\sigma_{t-i}^2}} \tag{13}$$

Table 10: EGARCH Models

Greece			**Ireland**		
Return Equation	Coefficient	p-value	Return Equation	Coefficient	p-value
μ	0.000260	0.4531	μ	0.000276	0.3191
AR(1)	0.062711	0.0089***	AR(1)	0.043027	0.0892*
Variance Equation			Variance Equation		
ω	-0.214917	0.0000***	ω	-0.210199	0.0000***
α	0.151008	0.0000***	α	0.153211	0.0000***
β	0.987952	0.0000***	β	0.989298	0.0000***
γ	-0.075384	0.0000***	γ	-0.074765	0.0000***
Italy			**Portugal**		
Return Equation	Coefficient	p-value	Return Equation	Coefficient	p-value
μ	-0.000164	0.4985	μ	0.000468	0.0115**
AR(1)	-0.015558	0.5466	AR(1)	0.070106	0.0038***
Variance Equation			Variance Equation		
ω	-0.257667	0.0000***	ω	-0.458081	0.0000***
α	0.136730	0.0000***	α	0.234688	0.0000***
β	0.982613	0.0000***	β	0.970081	0.0000***
γ	-0.111077	0.0000***	γ	-0.113405	0.0000***
Spain			**Turkey**		
Return Equation	Coefficient	p-value	Return Equation	Coefficient	p-value
μ	6.88E-05	0.7914	μ	0.001013	0.0210**
AR(1)	0.016376	0.5142	AR(1)	0.040958	0.0919*
Variance Equation			Variance Equation		
ω	-0.279495	0.0000***	ω	-0.512377	0.0000***
α	0.123798	0.0000***	α	0.155240	0.0000***
β	0.978927	0.0000***	β	0.950897	0.0000***
γ	-0.135747	0.0000***	γ	-0.083086	0.0000***

- Note: ***, ** and * indicate the level of significance at the 1 percent, 5 percent and 10 percent level, respectively.

We employ EGARCH model to estimate the return volatilities. The results of the EGARCH model are reported in Table 10. The leverage factor γ is negative for all index returns which means the effect of a negative shock has greater effects on the log of the conditional variance than does a positive shock of the same magnitude.

The IGARCH Model

In most of the financial series, the conditional variance is persistent and changing while the unconditional variance is constant over time only if the sum of the estimated coefficients α_1 and β_1 is less than unity. However, when using a GARCH (1, 1) model to estimate a long-time series, $\alpha_1 + \beta_1$ can be found equal or slightly greater than unity. In case of non-stationarity in variance, $\alpha_1 + \beta_1$ would be greater than unity which means the unconditional variance (ε_1t) can not be defined (Eq.14).

$$var(\varepsilon_t) = \frac{\alpha_0}{1 - (\alpha_1 + \beta_1)} \quad (14)$$

Nelson (1990) proposed a restriction over the sum of α_1 and β_1, which forces the conditional variance to act like a unit-root process by constraining $\alpha_1 + \beta_1$ equal to 1. This type of GARCH model is known as the integrated-GARCH (IGARCH). If this is the case, the k step ahead forecast of the conditional variance is

$$E_t \sigma^2_{t+k} = k\alpha_0 + \sigma^2_t \quad (15)$$

Therefore, the forecast of the conditional variance of the next period is the current value of the conditional variance (except the term α_0) and the unconditional variance forecast will tend to be infinite as the forecast horizon increases. Assuming the constraint over the $\alpha_1 + \beta_1$ and $\sigma^2_{t-1} = L\sigma^2_t$ together, the conditional variance can be expressed by

$$\sigma^2_t = \frac{\alpha_0}{1 - \beta_1} + (1 - \beta_1)\sum_{i=0}^{\infty} \beta_1^i \varepsilon^2_{t-1-i} \quad (16)$$

This expression implies that the conditional variance is a geometrically decaying function of the current and past realizations of the ε^2_t. Hence, it can be expected that past shocks do not dissipate but persist for long periods of time (Enders 2004: 140-141).

Table 11: IGARCH Models

Greece			Ireland		
Return Equation	Coefficient	p-value	Return Equation	Coefficient	p-value
μ	0.000670	0.0134**	μ	0.000546	0.0139**
AR(1)	0.047267	0.0180**	AR(1)	0.044242	0.0510*
Variance Equation			Variance Equation		
α	0.073931	0.0000***	α	0.075324	0.0000***
β	0.926069	0.0000***	β	0.924676	0.0000***
Italy			**Portugal**		
Return Equation	Coefficient	p-value	Return Equation	Coefficient	p-value
μ	0.000195	0.2676	μ	0.000889	0.0000***
			AR(1)	0.071116	0.0001***
AR(1)	-0.031845	0.1513	AR(13)	0.028609	0.1777
Variance Equation			Variance Equation		
α	0.083152	0.0000***	α	0.103331	0.0000***
β	0.916848	0.0000***	β	0.896669	0.0000***
Spain			**Turkey**		
Return Equation	Coefficient	p-value	Return Equation	Coefficient	p-value
μ	0.000567	0.0027***	μ	0.001066	0.0059***
AR(1)	-0.004607	0.8265	AR(1)	0.030174	0.1588
Variance Equation			Variance Equation		
α	0.080399	0.0000***	α	0.059899	0.0000***
β	0.919601	0.0000***	β	0.940101	0.0000***

Note: ***, ** and * indicate the level of significance at the 1 percent, 5 percent and 10 percent level, respectively.

If the sum of the parameters of the lag polynomials α + β equals to or is slightly greater than 1 in the GARCH(1,1) process (the model is known as integrated GARCH, or IGARCH) which implies persistence in the forecast of the conditional variance over all future horizons and implies an infinite variance for the unconditional distribution.

Gravity Model

Gravity model approach can be used to explain the effects of cross-sectional properties on the stock market correlation among countries. For this purpose, we conducted a gravity model which consists of explanatory variables of the distance between countries, the economic size of both markets, and a dummy variable for common border while the dependent variable is the mutual correlation between Turkish stock market and the stock markets of other countries.

$$Corr_{ijt} = \beta_0 + \beta_1(Distance)_{ij} + \beta_2[[(Size)]_{it} * (Size)_{jt}] + \beta_3(Border)_{ij} + \varepsilon_{ij} \quad (17)$$

where,

$Corr_{ijt}$ are mutual stock market return correlations between countries in year t. It is transformed into z'=[ln(1+r) - ln(1-r)], proposed by Fisher (1915) to overcome the non-normal distribution of Pearson's correlation.

$(Distance)_{ij}$ is the geographical distance between the cities where the stock market centers are located.

$[(Size)]_{it} * (Size)_{jt}]$ is generated by multiplying the market capitalization of two countries and represents the market size between two countries.

$(Border)_{ij}$ is the dummy variable represents the neighborhood effect arising from sharing a common border. It takes the value of one if two countries have a common border.

ε_{ij} is a stochastic error term.

Considering the individual effects of included explanatory variables on stock market correlations, it is expected that market size and common border have positive effects which strengthen the correlation while distance has negative effects.

We employed the panel data which consist of five cross-section units and seven periods to estimate the gravity model. First, we estimated the unweighted model using Ordinary Least Squares (OLS) estimator and checked the assumptions for the validity of the model. Since we observed heteroscedastic and correlated errors, we applied a feasible Generalized Least Squares (GLS) specification correcting the heteroscedasticity and contemporaneous correlation by using cross-section SUR weights.

The estimated coefficients of the model were found statistically significant with expected signs except for the common border variable. The results are presented on Table 12.

Table 12: Model 1 results

	Weighted Model (feasible GLS)	
	Coefficient	***Prob.***
Constant	1.135349	0.0000***
Distance	-4.28E-05	0.0362**
Market Size	-5.97E-07	0.0006***
Border	-0.046789	0.7301
R-square	0.544506	
Adj. R-square	0.500426	
F-statistic	12.35266	0.000017***
Durbin-Watson statistic	2.111528	

Note: The parentheses are the p-values. *** and ** indicate the level of significance at the 1 percent and 5 percent level, respectively.

In order to detect the effect of the crisis then we add a dummy variable which takes the value of zero for the years 2005 and 2006 and, the value of one for the rest, into the model (Model 1). Our second model which includes the crisis variable is as follows:

$$Corr_{ijt} = \beta_0 + \beta_1 (Distance)_{ij} + \beta_2 [[(Size)]_{it} * (Size)_{jt}] + \beta_3 (Border)_{ij} + \beta_3 (Crisis)_{ij} + \varepsilon_{ij} \quad (18)$$

where, $(Crisis)_{ij}$, is the dummy variable that represents the effect of crisis. It takes the value of one for period of 2007- 2011. The results of Model 2 is presented at Table 13.

Table 13: Model 2 results

	Weighted Model (feasible GLS)	
	Coefficient	***Prob.***
Constant	0.871665	0.0000***
Distance	-5.08E-05	0.0162**
Market Size	4.74E-07	0.0028***
Border	-0.093738	0.4847
Crisis	0.449830	0.0000***
R-square	0.646679	
Adj. R-square	0.599569	
F-statistic	13.72713	0.000002***
Durbin-Watson statistic	2.179960	

Note: The parentheses are the p-values. *** and ** indicate the level of significance at the 1 percent and 5 percent level, respectively.

The coefficient of the crisis dummy variable is significant and positive. This result implies, during the crisis period the correlation with Turkey and the European countries tend to increase.

4. CONCLUSION

In this paper, we, initially, apply a correlation analysis. When we look at the correlation results, we observe that the highest dependencies exist between markets strongly connected both geographically and economically. Turkey has lower coefficients compared to other countries.

The individual stochastic structure of daily stock market indexes over the period of March 2005 - December 2011 is investigated. The individual stochastic investigation is conducted by means of the ADF test. Results from the tests indicate that all series are non-stationary in levels. Also, presence of a unit root implies that shocks to stock prices are permanent. Consequently, stock prices may not be predictable. Tests are also conducted to examine the common stochastic trends in a system of these stock prices. The Johansen procedure of co-integration test is applied to test multivariate relationships among the stock prices, as a result of which no co-integration is detected in these markets. There is only one co-integrating vector which appears to explain the dependencies in prices between Greece and Turkey. Therefore, the stock markets of these countries do not exhibit long-run co-movements which can allow for the benefits of international diversification. Moreover, we find strong evidence of time-varying volatility. Furthermore, volatility shows high persistence.

In addition to analyses mentioned above, we constructed a gravity model to estimate the effects of variables such as the distance between stock markets and the size of markets on the correlation coefficient between returns. Since we focused on the relationship between the Turkish stock market and the stock markets of Portugal, Italy, Ireland, Greece and Spain, we restricted our research and all other mutual relationships among countries were excluded. We applied a feasible Generalized Least Squares specification to estimate the gravity model. As a conclusion, our results suggest that the distance between countries and size of the markets have significant effects with expected signs on stock market correlations while neighborhood does not. In order to test the effect of crisis on correlation a dummy variable which takes the value of one during 2007- 2011 period is added into the gravity model. The model results suggest that the crisis has a significant and positive effect on correlation.

The findings of this study have important implications for practitioners and academics. For practitioners, it affects designing trading strategies, drawing investment decisions, risk management. For academics, it has implications for asset pricing and performance evaluation.

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Appendix I.

Table 1: Variance Decomposition For Turkey

Variance Decomposition of LTURKEY:							
Period	S.E.	LTURKEY	LGREECE	LIRELAND	LITALY	LPORTUGAL	LSPAIN
1	0.019849	100.0000	0.000000	0.000000	0.000000	0.000000	0.000000
2	0.028582	99.68382	0.000524	0.015036	0.056995	0.053635	0.189992
3	0.035056	99.58550	0.000909	0.017007	0.055949	0.083995	0.256635
4	0.040448	99.55915	0.000923	0.017134	0.045935	0.095132	0.281730
5	0.045157	99.55571	0.000844	0.016638	0.036981	0.098198	0.291634
6	0.049379	99.55971	0.000742	0.015881	0.031757	0.097508	0.294406
7	0.053231	99.56502	0.000645	0.015022	0.031100	0.094889	0.293329
8	0.056789	99.56883	0.000567	0.014138	0.035199	0.091243	0.290021
9	0.060107	99.56981	0.000515	0.013268	0.043972	0.087069	0.285367
10	0.063223	99.56730	0.000495	0.012434	0.057214	0.082663	0.279895

Table 2: Market Capitilization of Countries

Iarket Capitilization of Listed Companies (US$)							
	2005	***2006***	***2007***	***2008***	***2009***	***2010***	***2011***
Portugal	66.98	104.2	132.25	68.713	98.64	81.99	61.68
Ireland	114.13	163.35	144.02	49.4	63.29	86.61	107.24
Italy	798.16	1,026.63	1,072.69	520.85	317.31	318.14	431.47
Greece	145.01	208.28	264.94	90.39	54.71	72.63	33.64
Spain	960.02	1,323.08	1,800.09	946.11	1,29722	1,171.61	1,030.95
Turkey	161.53	162.39	286.57	117.92	225.73	306.66	201.81