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European Equity Markets and Currency Markets Interlinkages

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Abstract

This thesis examines the relationship between exchange rates and stock prices in a number of European countries. We focus our attention in three different regions of Europe that are: four Eastern European markets, Czech Republic, Hungary, Poland and Slovakia, four South European Countries: Greece, Italy, Portugal and Spain and one West European Country: Ireland, using daily data we analyze the relationship between these two financial markets from 1996 to 2006. Both the long-run and the short-run association between these variables are analyzed. We employed the Engle and Granger two step and Johansen cointegration techniques, Vector Error Correction Modeling Technique and the standard Granger causality tests to examine the relationship between these two financial variables. We employ a bivariate a trivariate econometric techniques in order to provide and in depth analyses of the interlinkanges between these two financial variables. We also investigate the nature of volatility spillovers between stock returns and a number of exchange rates; we divide our sample period into a number of sub periods that will analyze the behavior of our variables before and post introduction of the Euro, using EGARCH modeling. Our findings show that exchange rates and stock prices seem to be independent. Overall there is no evidence of these two variables moving together either in the long-run or in the short-run. We found a unidirectional causality relationship running from stock prices to exchange rates in some of the countries introduced in our analysis. With regard to the volatility analysis there is some commonality regarding to the behaviour of the variables, it seems to exist a unidirectional spillover effect between the markets, which is found from the stock returns equation to the exchange rates equation. The lack of significant spillovers from exchange rate changes to stock returns found here for some countries across a number of exchange rates is consistent with existing research in this area.

1. Introduction

In the last decade, there have been important and continuous changes in the world's financial markets. These changes have affected emerging and developed economies, especially in terms of eliminating restrictions with regard to capital movements. Technological advances also have allowed individual and institutional investors to trade world wide on a twenty-four hours basis in many assets and markets. The liberalization of capital markets and these technological advances suggest that markets have become more integrated over the time. If markets experience an increase in their level of integration, events in one market can immediately affect other equity markets, and can impact directly on the benefits that investors derive from diversifying their portfolios internationally. These benefits will be eradicated in the long-term and investors with long horizons may not benefit from their portfolio (Garret and Spyrou (1999), Garret, Hyde and Varas (2004)).

Our study differs in a number of aspects from previous studies in the existing literature: First, our data sample covers longer and more up to date sample from 1996 to 2006, than existing studies. We research in this area the interlinkages between of equity markets and currency markets in Europe. We analyse the relationship between these two financial markets for four Eastern European Countries, Hungary, Czech Republic, Poland and Slovakia, Ireland and four South European countries, Greece, Italy Portugal and Spain. The analysis that is presented in this thesis has been developed in order to provide empirical evidence of the relationship between equity markets and currency markets, improve our understanding of the relationships between these two financial markets, we employ three different methodologies in order to conduct an in depth analysis of the relationships between these two financial markets. As a first step we will perform a pair wise study that involves the use of time series econometric techniques to test for cointegration between these financial markets we also apply the general technique of Granger Causality plus a Bivariate Causality test. The application of these two different types of causality tests will facilitate a comparison of the results from both methodologies in order to establish how sensitive the results are to different causality tests. Secondly we perform a Trivariate Causality test, where we decide to include a proxy variable to take into account the international effect of some of the major financial markets in the relationship between our variables, with the objective of providing more evidence of the existence of causality relationships between equity markets and exchange rates. Finally, we conclude our analysis by employing EGARCH modelling in order to analyse volatility spillovers between these two financial markets. This thesis will be the first attempt to analyse the relationships between these two variables in such a comprehensive way for the countries, included in our analysis.

The remainder of the thesis is organized as follows: In Chapter II, we present the Bivariate analysis investigating equity markets and currency markets interlinkages. In Chapter III, we present the Trivariate analysis developed for these two financial markets. In Chapter IV we present the EGARCH analysis and in Chapter V we summarize the main findings and draw some conclusions from the research.

2. Literature Review

The present section will present the major studies that have been performed until today analysing the relationship between stock prices and foreign exchange rates, analysis that are of interest to economists because these two variables play crucial roles in influencing the development of a country's economy. In an open economy the expectation of relative currency values influence the levels of domestic and foreign interest rates, which in turn affect the present value of a firm's asset. Therefore, exchange rates play a considerable role in the movements of stock prices, especially for international hold of financial assets (Nieh and Lee, 2001).

Chowdhury (2004) analyses the relationship between exchange rates and stock prices for four East Asian countries (Indonesia, Malaysia, Philippines and Thailand) and the effect of the financial crisis in East Asian countries on stock prices indices. Using monthly data on the bilateral nominal exchange rates of the four countries, against US dollar and the Jakarta Composite for Indonesia, the KLSE Composite for Malaysia, the PSE Composite for Philippines and the SEI for Thailand stock price indices. For the period January 1990 to January 2003. Given that there exists a distinct structural break in July/August 1997 due to the occurrence of currency crisis in East Asian countries, he applied a cointegration test for the entire period between 1990-2003, as well separately for 1990 to June 1997 between July 1997 and 2003, to investigate the effect of currency crisis on the stock prices before and after the crisis. The results indicate that exchange rates and stock prices are cointegrated over the entire period only for Thailand, but cointegrated for all the countries during the pre currency crisis period and post-currency crisis period for all the countries except Indonesia. Using ECM and standard Granger Causality tests, he found bidirectional causality for Indonesia and Malaysia and no causality for Philippines and Thailand over the entire period between these two financial variables. The analysis also showed that exchange rates Granger caused stock prices in Indonesia and stock prices led currency market in Thailand during and after the currency crisis period, and bi-directional causality was detected for Malaysia and Philippines for both the pre-crisis and post-crisis periods.

Smyth and Nandha(2003) investigated the interaction between exchange rates and stock prices for four South Asian countries (Bangladesh, India, Pakistan and Sri Lanka) using daily data over the period 1995 to 2001. Both the Engle and Granger two step and Johansen cointegration methods were used and the results indicated that there was no long-run equilibrium relationship between these two financial variables in any of the four countries. Granger causality test indicated that there is uni-directional causality running from exchange rates to stock prices in India and Sri Lanka, but in Bangladesh and Pakistan exchange rates and stock prices were independent. The conclusion they draw from their results is that changes in exchanges rate influence firms' exports and ultimately affect stock prices in these countries.

Griffin and Stulz (2001) examined the importance of exchange rate movements and industry competition for stock returns. They study the stock price impact of competition between similar industries located in different countries, using a unique dataset of industry indices from the United States, Canada, United Kingdom, France, Germany and Japan from 1975 to 1997. Their results showed that the impact of exchange rate shocks are trivial in explaining the relative performance of US industries, even in the countries where international trade is much more important than in the US; Industry effects were more important than exchange rate effects. They concluded that exchange rate shocks have almost a negligible impact on the value of industries across the world.

Nieh and Lee (2001) found no long-run significant relationship between stock prices and exchange rates in the G-7 countries (Canada, France, Germany, Italy, Japan, UK and the US); they studied the dynamic relationships between the stock prices and exchange rates for each G-7 country. By assuming that capital markets react fully and instantaneously to changes in a country's currency, Bodnar and Gautry (1993), Barton and Bodnar (1994) and Choi (1995) have encountered limited success in identifying a significant correlation between stock prices and currency fluctuations. Choi (1995) covered the period from October 1, 1993 to February 15, 1996 of daily closing stock market indices and foreign exchange rates for the G7 countries (Canada, France, Italy, Japan, UK and the US). The methodology used consisted on the Engle-Granger (EG) two step and the Johansen cointegration test as well as the Vector Error Correction Model (VECM). The study rejected the existence of a significant relationship between stock prices and exchange rates. The study concludes that these two financial variables do not have predictive capabilities for more than two consecutive trading days. He found different results among G-7 countries which might be due to deeper causes, not merely from the observed financial factors. The results might be influence by each country's differences in economic development, government policy, and the differences in the degree of internationalization and liberalization, the degree of the capital control from country to country.

Abdalla and Murinde (1997) investigated the interactions between exchange rates and stock prices in the emerging financial markets of India, Korea, Pakistan and the Philippines. The data set consists of monthly observation for 1985:01 to 1994:07. To analyse the relationship between these two variables they used the two step Engle and Granger procedure and the Granger causality test. Their findings showed that exchange rates Granger cause stock prices in Korea, Pakistan and India, whereas stock prices Granger cause exchange rates in the Philippines. Their evidence on the causal influence of exchange rates on stock prices is strong and also consistent with some earlier research based on developed economies.

Ayayi and Mougoue (1996): they examined whether stock prices and exchange rates are related to each other or not. The data used in the analysis consisted in the major stock prices indices of these countries (KSE100 index for Pakistan, BSE 200 for India, CSE Sensitive Index for Sri-Lanka and DSE All Share Price Index for Bangladesh) and the exchange rates between the currencies of theses countries and the US dollar. The study used monthly data for four South Asian countries: Pakistan, India, Bangladesh and Sri-Lanka for the period January 1994 to December 2000. They employed cointegartion and vector error correction modelling technique and standard Granger causality test to examine the long-run and short-run association between stock prices and exchange rates. Their results showed no short-run association between stock prices and exchange rates for all four countries. There was also no long-run relationship between stock prices and exchange rates for Pakistan and India. However, they found that for Bangladesh and Sri-Lanka there appears to be bidirectional causality between these two financial variables.

Bailey and Chung (1995) studied the importance of exchange rate fluctuations and political risk for stock prices. They explored the impact of exposure to exchange rate fluctuations and political risk factors, and measured the extent to which exposure to these factors explained cross-sections of returns on individual securities and industry portfolios. The sample covered the period from January 1986 to June 1994.They found no evidence of unconditional equity market premiums for the currency and political risks reflected in the variables that they selected. They found some evidence consistent with time-varying equity market premiums for exposure to changes in the free market dollar premium and Mexican sovereign default risk. There were significant associations between expected equity market premiums for these risks and related premiums from the currency and sovereign debt markets. They found no evidence of either unconditional or conditional risk premiums for exposure to changes in the official exchange rate.

Mukhejee and Naka (1995) examined the relationship between stock price and some key macroeconomic variables in India for the period 1991-1995 using monthly time series data. The study used the Granger causality test procedure developed by Toda and Yamamoto (1995). The data set are from RBI weekly and monthly bulletins. The empirical results showed that the exchange rate does not Granger causes stock prices and that stock prices do not Granger causes the exchange rates.

Jorion (1991) examined the pricing of exchange rate risk in the US stock market using two factor and multifactor arbitrage pricing models between January 1971, which was the year when exchange rates started to float, and December 1987. The paper investigated the problem of empirically measuring whether currency exposure commands a risk premium in the stock market using a sample of value weighted industry portfolios. Jorion found that US industries display significant cross-sectional differences in their exposure to movements in the dollar, and there was little evidence that US investors require compensation for bearing exchange risk. He also found that the relation between stock returns and the value of the dollar differs systematically across industries.

Solnik (1987), analyzed stocks returns to test the relation between exchange rates and economic activity. The data consisted of monthly and quarterly observations for the period of July 1973 to December 1983. Eight countries were analysed: Canada, France, Germany, Japan, The Netherlands, Switzerland, UK and USA, that represented over 90 per cent of the market capitalization. He found a weak positive relationship between real stock-return differentials and changes in the real exchange rate. This result would support the idea that anticipated real growth in GDP has a positive influence on the exchange rate. However, the relation is fairly weak, might be caused by the fact that stock returns are a poor proxy for real economic growth.

Bahmani-Oskooee and Sohrabian (1992) analysed if whether changes in stock prices could be a cause of change in exchange rates and vice versa, using the Granger causality test and cointegration analysis for the period July 1973 - December 1988. The results showed that there was a bidirectional causal relationship between the stock prices measured by S&P500 index and effective exchange rate of the dollar at least in the short-run. Using the cointegration approach, the authors were unable to establish any long-run relationship between the two variables.

As the literature review has shown there are many empirical studies which have analysed the linkages between exchange rates and stock prices, focusing on the emerging markets and in the main financial markets in the world. The purpose of this thesis will be to add to the existing literature evidence on the relationship between stock prices and exchange rates.

This research represents a significant contribution to the existing empirical evidence in this area.

3. Data and Methodology

3.1 Bivariate Analysis

This section sets out details of the data and methodology used to analyse the relation between the exchange rates and stock prices for 4 Eastern European markets, the Czech Republic, Hungary, Poland and Slovakia, four South European markets, Greece, Italy, Portugal and Spain and Ireland for the period 1996-2006. The data set consists of daily (5days) closing stock market indices and foreign exchange rates giving a total of 2766 observations for each series. For the Exchange Rates we used a number of exchange rates in order to provide comprehensive analysis of the relationship between the equity markets and the money markets; that is we used data for: Czech Koruna, Hungarian Forint, Polish Zloty, Slovak Koruna, Irish Pound, Lira, Drachma, Escudo and Peseta, against the US$, UK£, Swiss Franc (CHF), Japanese ¥ and European €, this gives a total of 14 bilateral exchange rates that we will use for the different countries of the analysis. For the stock prices; the Prague SE PX, Budapest BUX, WARSAW General Index, Slovakia SAX 16, FTSE/ATX 20, ISEQ, MIB 30, PSI 20 and IBEX 35 were used. The time period covered facilitates a comparison of the relationship between currency depreciation and stock returns before and after the introduction of the Euro. In addition to this, it will allow us to examine the extent of differences in the relationship between the stock market and the Exchange Rates between these countries.

The methodology that will be used for this analysis involves the use of time series techniques including, testing for unit roots using Dickey-Fuller (DF) and Augmented Dickey-Fuller (ADF) tests (1979); testing for serial correlation of errors, using the Lagrange Multiplier (LMF test); testing for cointegration, using the Engle-Granger procedure (1987) and Johansen Cointegration Test (1992); the Granger causality test (1981) is used to investigate the causal relationship between stock prices and exchange rates in the various markets. In addition to the Granger Causality Test we also apply a bivariate causality test, following the methodology used by Abdalla and Murinde (1997) for comparative purposes.

As an initial step in the cointegration test, we perform a stationarity test on each of the relevant variables that are included in our analysis to ensure that the results from the analysis are not spurious. For this particular issue, the stationarity test procedure developed by Dickey and Fuller (1979) will be used. This technique considers three different regression equations that can be implemented to test for the presence of unit root:

$\Delta Y_t = \gamma Y_{t-1} + \varepsilon_t$ Pure random model. (3.1.1)

$\Delta Y_t = a_0 + \gamma Y_{t-1} + \varepsilon_t$ Model that add an intercept and drift term. (3.1.2)

$\Delta Y_t = a_0 + \gamma Y_{t-1} + a_{2t} + \varepsilon_t$ Model that adds an intercept and linear time trend. (3.1.3)

The Augmented Dickey-Fuller test (ADF) procedure can be used to test for stationarity in the presence of serial correlation and the model that will be used in this case is:

$$\Delta Y_t = \alpha + \gamma Y_{t-1} + \sum_{i=2}^{p} \Delta Y_{t-i+1} + \varepsilon_t \quad (3.1.4)$$

After applying these equations, the Lagrange Multiplier (LMF) test, will be implemented to test for the existence of serial correlation in the error term. This test will allow us to verify that our residuals are white noise. We use the Lagrange Multiplier test as this test is valid in the presence of lagged dependent variables and also tests for higher order autocorrelation.

$$Y_t = \beta_0 + \beta_1 X_{1t} + ... + \beta_k X_{kt} + \mu_t ; \quad (3.1.5)$$

$$\text{with } \mu_t = \rho_1 \mu_{t-1} + ... + \rho_p \mu_{t-p} + \varepsilon_t \quad (3.1.6)$$

$$\hat{\mu}_t = Y_t - \hat{\beta}_0 - \hat{\beta}_1 X_{1t} - ... - \hat{\beta}_k X_{kt} \quad (3.1.7)$$

After applying these equations and establishing whether our series are stationary, we proceed and perform the cointegration test on our variables. The methodology to determine if the variables are cointegrated will involve the use of Engle and Granger (1987) technique, which will identify the long run relationships between stock prices and exchange rates in each market. For this purpose, we estimate the long-run equilibrium relationship in the form:

$$Y_t = \beta_0 + \beta_1 X_t + \varepsilon_t \quad (3.1.8)$$

Following this we check for the existence of serial correlation in the residuals, using the Lagrange Multiplier test. If we find that there is serial correlation on the errors, we will need to estimate the following model adding sufficient lags until we get rid of serial correlation:

$$\hat{Y}_t = a_1 \hat{Y}_{t-1} + \sum_{i=1}^{k} \beta_i \Delta \hat{Y}_{t-i} + \varepsilon_t \quad (3.1.9)$$

We also use the Johansen Cointegration Test to investigate the long-run relationship between stock prices and exchange rates, Enders (2004) notes that given that results of this test can be quite sensitive to the lag length, the most common procedure is to estimate a Vector Autoregression model using the undifferenced data in order to determine the lag length for the Johansen test. We will first estimate the lag selection tests up 20 lags. In terms of choosing between the various lag length selection criterion we follow Johansen et al (2000) who notes that when different information criteria suggests different lag length, it is common practice to prefer the Hannan Quinn criterion. After performing our VAR models for the Johansen test it is necessary to ensure that there is no serial correlation in the lag length selected from our VAR model. Therefore we will implement the Lagrange Multiplier (LM) test for serial correlation up to the number of lags that our VAR indicates. We will also test for normality on the errors using Cholesky, Doornik and Urzua versions of the Jarque Bera test for normality on the errors, and finally we will also test for the absence of heteroskedasticity. When we have verified that our errors are not serial correlated, normal and homokedastic we will be able to proceed and conduct the Johansen Cointegration Test. There are 5 possible models to choose from the Johansen test. Harris and Solis (2003) note that model 1 i.e.: with no deterministic components in the data is unlikely to occur in practice, as generally an intercept is needed to take into account the units of measurement of the variables. They also note that model 5 with quadratic trends, is economically hard to justify. This leaves a choice between models 2 to 4. Johansen (1992) suggests choosing the appropriate model according to the Pantula principle; all three models are estimated and the results are presented for each. The test procedure involves moving through each model for the null hypothesis of r=0 (no cointegrating relationship between the variables), then r=1, etc and picking the model where we fail to reject the null hypothesis for the first time. After we have run our cointegration analysis we will be interested in studying the causality relationship between the stock prices and exchange rates.

The basic idea of the Granger causality test is that a variable X (Koop, 2004) Granger causes Y, if past values of X can help to explain Y. One important thing to bear in mind is that if Granger causality holds, this does not guarantee that the inverse will hold, that is that X causes Y. Nevertheless, if past values of X have explanatory power for current values of Y, it at least suggests that X might be causing Y.

Our initial model for the causality test will be:

$$1.\quad Y_t = \alpha_0 + \beta_1 Y_{t-1} + \beta_2 X_{t-1} + \varepsilon_{yt} \quad (3.1.10)$$

This simple regression model will allow us to interpret the causality relationship between the countries. The regression model implies that last periods values of X have explanatory power for the current value of Y. Our coefficient β_2 is the coefficient measuring the influence of X_{t-1} on Yt. If β_2=0, this means that past values of X have no effect on Y and there in no way that X could Granger cause Y. In other words, past values of X have no explanatory power for Y beyond that provided by past values for Y.

If β_2 is statistically significant we can conclude that X Granger causes Y.

$$\left.\begin{array}{l} H_0 : \beta_2 = 0 \\ Ha : \beta_2 \neq 0 \end{array}\right\}$$

If we fail to reject the null hypothesis, this means that Granger causality does not occur.

An important factor to take into account in our causality analysis is that we would be able to find that Y Granger causes X, but also X Granger causes Y or not. In terms of our analysis, this means that it will be possible to find that stock prices may cause exchange rates but that does not mean that the opposite should occur. Thus it is possible that either a bidirectional causal relationship or a unidirectional one can occur.

$$Y_t = \alpha_0 + \beta_1 Y_{t-1} + \beta_2 X_{t-1} + \varepsilon_{yt} \qquad (3.1.11)$$

$$Y_t = \sum_{i=1}^{n} \alpha_b Y_{i=1} + \sum_{i=1}^{n} \beta_{i=1} X_{i=1} + \upsilon_T \quad (3.1.12)$$

$$X_t = \sum_{i=1}^{n} \lambda_i X_{i=1} + \sum_{j=1}^{n} \gamma_j Y_{t-1} + \upsilon_T \quad (3.1.13)$$

$$\left.\begin{array}{l} H_0 : \sum_{i=1}^{n} \beta_I \neq 0 \\ Ha : \sum_{i=1}^{n} \beta_I = 0 \end{array}\right\} \text{ Hypothesis when X causes Y} \qquad \left.\begin{array}{l} H_0 : \sum_{j=1}^{n} \gamma_I \neq 0 \\ Ha : \sum_{j=1}^{n} \gamma_I = 0 \end{array}\right\} \text{ When Y causes X}$$

Following the methodology of Engle and Granger (1987), if we find that two variables are cointegrated, it will be necessary to estimate an error correction mechanism.The ECM allows us to examine short run behaviour between the various equity markets. To perform our ECM we follow the methodology set out in the Granger Representation Theorem (1981). This states that if Y and X are cointegrated, their relationship can be expressed as an ECM. Thus for the stock prices and exchange rates which we find are cointegrated we construct the error correction mechanism that will allow us to assess the validity of the model that we are using. With this purpose we will estimate our ECM through the following equation:

$$\Delta Y_t = \beta_0 + \lambda e_{1,t-1} + \beta_1 \Delta Y_{t-1} + \beta_2 \Delta X_{t-1} + \varepsilon_{yt} \quad (3.1.14)$$

If we find that our variables are cointegrated the ECM will be formulated as follows:

$$\Delta Y_t = \beta_0 + \lambda e_{1,t-1} + \beta_1 \Delta Y_{t-1} + \beta_2 \Delta X_{t-1} + \varepsilon_{yt} \quad (3.1.15)$$

$$e_{t-1} = Y_{t-1} - \alpha_0 - \beta_1 X_{t-1} \quad (3.1.16)$$

$\lambda < 0$ Hypothesis to test in our ECM

Where e_{t-1} are the residuals from the cointegrating regression. One interesting consequence (Koop, 2004) of the Granger Representation Theorem is worth noting is that; if X and Y are cointegrated, then it is expected that some form of Granger causality must occur. That is, either X must Granger cause, or Y must Granger cause X, or both. If two variables are found to be cointegrated an error correction term must be included in the causality model as an explanatory variable, otherwise as Granger (1981) notes a causality test between two cointegrated variables may produce misleading results.

As the standard Granger causality test is sensitive to the lag length selection, we perform a bivariate causality test for comparative purposes following Abdalla and Murinde (1997). On the basis of the result for the unit roots and cointegration test we apply the standard Granger Causality test to our variables. This will involve the estimation of the following BVAR model:

$$EX_t = \sum_{i=1}^{n} \alpha_b \Delta EX_{i=1} + \sum_{i=1}^{n} \beta_{i=1} \Delta PI_{i=1} + \upsilon_T \qquad (3.1.17)$$

$$PI_t = \sum_{i=1}^{n} \lambda_i \Delta PI_{i=1} + \sum_{j=1}^{n} \gamma_j \Delta EX_{t-1} + \upsilon_T \qquad (3.1.18)$$

The lag length in Equation 1 and 2 will be selected using a two stage procedure. In the first stage we will run the following regressions:

$$\Delta EX_t = a_1 + \sum_{i=1}^{20} f_i \Delta EX_{t-i} + \varepsilon_{1t} \qquad (3.1.19)$$

$$\Delta PI_t = a_2 + \sum_{i=1}^{20} f_i \Delta PI_{t-i} + \varepsilon_{2t} \qquad (3.1.20)$$

The lag length for equation 2.19 and 2.20 will be selected in order to minimize the AIC. In the second stage, Equation 2.17 and 2.18 will be estimated fixing the number of lags on ΔEX (exchange rates in first differences, in equation 2.17) and ΔPI (stock prices in first differences, in equation 2.18) at the optimal level determined in stage 1 and then varying the number of lags on the independent variables form 1 to 20 so as to minimize the AIC. The results of this equation will be subjected to diagnostic testing for heteroskedasticity and serial correlation to ensure that our results are reliable. The statistics results obtained from this test come from the implementation of the F-test.

This model will be modified if we find that our variables are cointegrated by adding the error correction term from the cointegrating regression lagged for one period, representing the error correction mechanism (ECM).

To summarise the main points of the methodology set out above, we begin by performing Dickey Fuller, or Augmented Dickey Fuller tests where serial correlation is present, in order to ensure that the variables included in the analysis are stationary and that the results from the cointegration and causality analyses are not spurious. We follow this with the Engle Granger cointegration methodology, which allows us to test for a long run relationship between stock prices and exchange rates. We also use the Johansen cointegration test in order to verify our results. Following this, we conduct Granger causality tests for our variables to establish whether movements in stock prices have an impact on movements in exchange rates, and apply Akaike's information criteria to ensure that the lag length specified in the causality tests is optimal. Where we find that our variables are cointegrated, we included the errors from the cointegrating regression in the Granger causality tests in the form of an error correction mechanism (ECM) to examine whether there may also be a short run relationship between the variables.

3.2 Trivariate Analysis

After we have run our bivariate cointegration analysis we proceed and investigate the possible causal relationships between stock prices and exchange rates in each country. Normally a bivariate model is selected in terms of analyzing the relationship between stock prices and exchange rates, as illustrate below.

$$EX_t = \beta_0 + \beta_1 PI_t + \varepsilon_t \qquad (3.2.1)$$

where EX is the exchange rate and PI is the stock price index. Economic theory supports the existence of a long-run relationship in the above system. Such a relationship derives from the connection of both the exchange rate and equity prices with the level of general economic activity, as demonstrated by Philaktis and Ravazzolo (1999). In addition, empirical studies have demonstrated that a significant relationship has been found in a number of countries (Quiao, 1996; Bahmani-Oskooee and Domac 1997). Moreover, where cointegration has not been demonstrated, this may not be because of its absence but actually because of the omission of one or more important variables (Grambovas, 2003). Therefore, we have decided to include another variable to capture the possibility that changes in international stock markets can lead to changes in the relevant domestic stock exchange due to issues of international investor sentiment. In our case to proxy the international environment we introduce three different variables; the German, UK and US stock markets in order to analyze three different scenarios. The trivariate case can be described as:

$$EX_t = \beta_0 + \beta_1 PI_t + \beta_2 GEI_t + \varepsilon_t \qquad (3.2.2)$$

$$EX_t = \beta_0 + \beta_1 PI_t + \beta_2 UKI_t + \varepsilon_t \qquad (3.2.3)$$

$$EX_t = \beta_0 + \beta_1 PI_t + \beta_2 USI_t + \varepsilon_t \qquad (3.2.4)$$

$$PI_t = \beta_0 + \beta_1 EX_t + \beta_2 GEI_t + \varepsilon_t \qquad (3.2.5)$$

$$PI_t = \beta_0 + \beta_1 EX_t + \beta_2 UKI_t + \varepsilon_t \qquad (3.2.6)$$

$$PI_t = \beta_0 + \beta_1 EX_t + \beta_2 USI_t + \varepsilon_t \qquad (3.2.7)$$

Where GEI is the DAX XETRA Index, UKI the FTSE 100 Index and USI the Dow Jones Industrial Index

After we have implemented the basic battery of econometric techniques (Dickey & Fuller Test, LMF, Engle & Granger Test) to establish whether equity markets move together in the long term, we also want to analyze whether there is any causal relationships between the various markets. Thus we proceed and implement a causality test between the markets. A critical issue in the Granger causality tests is to establish the optimal number of lags for the variables included in the regression. We use both the Akaike Information Criterion and the Hannan Quinn criterion to specify the optimal number of lags for the Granger causality test.

The basic idea of the Granger causality test is that a variable X (Koop, 2004) Granger causes Y, if past values of X can help to explain Y. One important thing to bear in mind is that if Granger causality holds, this does not guarantee that the inverse will hold, that is that X causes Y. Nevertheless, if past values of X have explanatory power for current values of Y, it at least suggests that X might be causing Y.

Our initial model for causality test will be:

$$Y_t = \alpha_0 + \beta_1 Y_{t-1} + \beta_2 X_{t-1} + \beta_3 Z_{t-1} + \varepsilon_{yt} \qquad (3.2.8)$$

$$EX_t = \alpha_0 + \beta_1 EX_{t-1} + \beta_2 PI_{t-1} + GEI_{t-1} + \varepsilon_{yt} \qquad (3.2.9)$$

$$PI_t = \alpha_0 + \beta_1 PI_{t-1} + \beta_2 EX_{t-1} + GEI_{t-1} + \varepsilon_{yt} \quad (3.2.10)$$

$$EX_t = \alpha_0 + \beta_1 EX_{t-1} + \beta_2 PI_{t-1} + UKI_{t-1} + \varepsilon_{yt} \quad (3.2.11)$$

$$PI_t = \alpha_0 + \beta_1 PI_{t-1} + \beta_2 EX_{t-1} + UKI_{t-1} + \varepsilon_{yt} \quad (3.2.12)$$

$$EX_t = \alpha_0 + \beta_1 EX_{t-1} + \beta_2 PI_{t-1} + USI_{t-1} + \varepsilon_{yt} \quad (3.2.13)$$

$$PI_t = \alpha_0 + \beta_1 PI_{t-1} + \beta_2 EX_{t-1} + USI_{t-1} + \varepsilon_{yt} \quad (3.2.14)$$

This model will allow us to interpret the causality relationship between the countries. The regression model implies that last periods values of X have explanatory power for the current value of Y. Our coefficient β_2 is the coefficient measuring the influence of X_{t-1} on Yt. If β_2 =0, this means that past values of X have no effect on Y and there in no way that X could Granger cause Y. In other words, past values of X have no explanatory power for Y beyond that provided by past values for Y.

If β_2 is statistically significant (e.g.: p-value < 0.05) we will conclude that X Granger causes Y. Therefore, if our contrast hypothesis tests conduct us to accept our null we will conclude that Granger causality does not occur.

$$\left.\begin{array}{l} H_0 : \beta_2 = 0 \\ Ha : \beta_2 \neq 0 \end{array}\right\}$$ If we accept our null, this means that Granger causality does not occur.

An important factor to take into account in our causality analysis is that we would be able to find that Y Granger causes X, but also X Granger causes Y or not. In terms of our analysis, this means that it will be possible to find that stock prices may cause exchange rates but that does not means that the opposite effect should occur.

If we find that two variables are cointegrated, it will be necessary to estimate an error correction mechanism including a variant (ECM). The ECM allows us to examine short run behaviour between the various equity markets. To perform our ECM we follow the methodology set out in the Granger Representation Theorem (1981). This states that if Y and X are cointegrated, their relationship can be expressed as an ECM. Thus for the equity markets which we find are cointegrated we will construct the error correction mechanism through the following equation:

$$\Delta Y_t = \beta_0 + \lambda e_{1,t-1} + \beta_1 \Delta Y_{t-1} + \beta_2 \Delta X_{t-1} + \beta_3 Z_{t-1} + \varepsilon_{yt} \qquad (3.2.15)$$

If we find that our variables are cointegrated and the residuals are stationary our ECM will be formulated as follows:

$$\Delta Y_t = \beta_0 + \lambda e_{1,t-1} + \beta_1 \Delta Y_{t-1} + \beta_2 \Delta X_{t-1} + \beta_3 Z_{t-1} + \varepsilon_{yt} \qquad (3.2.16)$$

$$e_{t-1} = Y_{t-1} - \alpha_0 - \beta_2 X_{t-1} - \beta_3 Z_{t-1} \qquad (3.2.17)$$

$\lambda < 0$ Hypothesis to test in our ECM

Where e_{t-1} are the residuals from the cointegrating regression in which the DF test has been performed. One interesting consequence (Koop, 2004) of the Granger Representation Theorem is worth noting is: If X and Y are cointegrated then is expected that some form of Granger causality must occur. That is, either X must Granger causes Y or Y must Granger cause X or both. If two variables are found to be cointegrated and error correction term must be included in the causality model as an explanatory variable, if we do not do this, and following Granger (1981) methodology a causality test between two cointegrated variables may produce misleading results.

To summarise the main points of the methodology set out above, we begin by performing Dickey Fuller, or Augmented Dickey Fuller tests where serial correlation is present, in order to ensure that the variables included in the analysis are stationary and that the results from the cointegration and causality analyses are not spurious. We follow this with the Johansen cointegration test. Following this, we conduct Granger causality tests for our variables to establish whether movement in stock prices have an impact on movements in exchange rates, and apply Akaike's information criteria to ensure that the lag length specified in the causality tests is optimal. Where we find that our variables are cointegrated, we included the errors from the cointegrating regression in the Granger causality tests in the form of an error correction mechanism (ECM) to examine whether there may also be a short run relationship between the variables.

3.3 Volatility Analysis

The analysis will be conducted with the purpose of investigating volatility spillovers between stock returns and exchange rate changes for nine European Markets: 4 Eastern European Markets (Czech Republic, Hungary, Poland and Slovakia), four South European Markets (Greece, Italy, Portugal and Spain) and one West European Markets (Ireland) for the period 1996-2006. The data set consists of daily (5days) closed stock market indices and foreign exchange rates with a total of 2766 observations for each series. On the Exchange Rates we used the domestic exchange rates plus and additional exchanges rates in order to provide an in depth analysis of the relationships between the equity markets and the money markets, (Czech Koruna, Hungarian Forint, Polish Zloty, Slovak Koruna, Irish Pound, Lira, Drachma, Escudo and Peseta, against the US$, UK£, Swiss Franc (CHF), Japanese ¥ and European €, and Stock Prices (Prague SE PX, Budapest BUX, WARSAW General Index, Slovakia SAX 16, FTSE/ATX 20, ISEQ, MIB 30, PSI 20 and IBEX 35) for each country. All data are taken from DataStream, and the Federal Reserve Statistic Release. Following Kanas (2000) we use continuously compounded stock returns and exchange rate changes calculated as the first differences of the natural log. That is, S= Stock Prices; $S_t = \ln\left(P_t^s\right) - \ln\left(P_{t-1}^s\right)$ and E= Exchange Rates; $E_t = \ln\left(P_t^e\right) - \ln\left(P_{t-1}^e\right)$.

As an initial step we perform a stationarity test on each of the relevant variables that are included in our analysis to ensure that the results from the analysis are not spurious. We apply the Dickey Fuller (DF) test, or Augmented Dickey-Fuller test (ADF) procedure if serial correlation is present. We also apply the Lagrange Multiplier (LMF) test, to ensure that a sufficient number of lags have been added in the ADF test to ensure that there is no serial correlation present and the results of the ADF test are valid. The LMF test is applied given that it is valid in the presence of lagged dependent variables as well as having the advantage of testing for first and higher orders of serial correlation. We then proceed and perform a cointegration test on our variables using the Johansen Cointegration test to investigate the long-run relationship between Stock Prices and Exchange Rates. As Enders (2004) notes given that the results of the test can be quite sensitive to the lag length, the most common procedure is to estimate a Vector Autoregression (VAR) model on the undifferenced data in order to determine the lag length for the Johansen test. We estimate the lag selection tests up 20 lags. In terms of choosing between the various lag length selection criteria we follow Johansen *et al* .(2000) who suggest that when different information criteria suggest different lag lengths, it is common practice to prefer Hannan-Quinn (HQ) criteria. Again, we ensure that the lag length selected for the VAR model is free from serial after performing by applying the LMF test to test for serial correlation up to the number of lags in the VAR model. There are five possible models to choose from for the Johansen test as follows:

$$H_2\,(r) \;:\; \Pi y_{t-1} + B\,x_t = \alpha B'\,y_{t-1} \qquad (3.3.1)$$

$$H^*_1\,(r) : \Pi y_{t-1} + B\,x_t = \alpha\,(B'y_{t-1} + p_0) \qquad (3.3.2)$$

$$H_1\,(r) \;:\; \Pi y_{t-1} + B\,x_t = \alpha\,(B'y_{\,t-1} + p_0) + \alpha_\perp \gamma_0 \qquad (3.3.3)$$

$$H^*\,(r) \;:\; \Pi y_{t-1} + B\,x_t = \alpha\,(B'y_{t-1} + p_0 + p_1\,t) + \alpha_\perp \gamma_0 \qquad (3.3.4)$$

$$H\,(r) \;:\; \Pi \mathrm{y}_{t-1} + B\,x_t = \alpha\,(B'y_{t-1} + p_0 + p_1\,t) + \alpha_\perp (\gamma_0 + \gamma_1\,t) \qquad (3.3.5)$$

Equation 1 has no deterministic trends in the level data and no intercepts in the cointegrating equations. Equation 2 has no deterministic trends in the level data and the cointegrating equations have intercepts. Equation 3 has linear trends in the level data but the cointegrating equations only have intercepts. Equation 4 has linear trends in both the level data and the cointegrating equations, and equation 5 has quadratic trends in the level data and linear trends in the cointegrating equations. Harris and Sollis (2003) note that model 1 i.e. with no deterministic components in the data or cointegration relations, is unlikely to occur in practice, as generally an intercept is needed to take account of the units of measurement of the variables; they also note that model 5 with quadratic trends, is economically hard to justify, as if the variables are entered in logs, as they are in our model, as this would imply an every increasing or decreasing rate of change. This leaves a choice between models 2-4. Johansen (1992) suggests choosing the appropriate model according to the Pantula principle; all three models are estimated; the Pantula principle involves moving through each model for the null hypothesis of *r=0,* then *r=1* etc., and picking the model where the null hypothesis is rejected for the first time. Chang and Caudill (2005) note that the $\square_{trace}$ test statistic is more robustness to both skewness and excess kurtosis than the $\square_{max}$ test statistic; for comparative purposes, we show both the results of the $\square_{trace}$ and the $\square_{max}$ test statistics.

We then proceed with our volatility analysis and apply a bivariate extension of the EGARCH (*p,q*) model in order to examine whether the volatility of stock returns affects and is affected by the volatility of exchange rate changes within each economy. The EGARCH specification (Nelson, 1991) is used in order to test whether the volatility spillover effects are asymmetric. For example, an asymmetric spillover from stock returns to exchange rate changes would suggest that the effect of “bad” stock market news on the exchange rate change is greater than the effect of “good” news. The model is specified as follows:

$$S_t = a_{s,0} + \sum_{i=1}^{r} a_{s,i} S_{t-i} + \sum_{i=1}^{r} a_{e,i} E_{t-i} + \beta_s \lambda_{s,t-1} + e_{S,t} \qquad (3.3.6)$$

$$E_t = a_{E,0} + \sum_{i=1}^{r} a_{E,i} E_{t-i} + \sum_{i=1}^{r} a_{S,i} S_{t-i} + \beta_E \lambda_{E,t-1} + e_{E,t} \qquad (3.3.7)$$

$$e_{S,t} / \Omega_{t-1} \approx N(0, \sigma^2_{S,t})$$

$$e_{E,t} / \Omega_{t-1} \approx N(0, \sigma^2_{E,t})$$

The conditional variances of stock returns and exchange rates changes are specified as follows:

$$\sigma^2_{S,t} = \exp\left\{ c_{S,0} + \sum_{j=1}^{ps} b_{S,j} \log(\sigma^2_{S,t-j}) + \delta_{S,S} \left[\left(|z_{S,t-1}| - E|z_{S,t-1}| + \theta_{S,Sz_{s,T-1}} \right) + \delta_{S,E} \left[\left(|z_{E,t-1}| - E|z_{E,t-1}| + \theta_{S,EzE,t-1} \right) \right] \right] \right. \qquad (3.3.8)$$

$$\sigma^2_{E,t} = \exp\left\{ c_{E,0} + \sum_{j=1}^{ps} b_{E,j} \log(\sigma^2_{E,t-j}) + \delta_{E,E} \left[\left(|z_{E,t-1}| - E|z_{E,t-1}| + \theta_{E,Ez_{s,T-1}} \right) + \delta_{E,S} \left[\left(|z_{S,t-1}| - E|z_{S,t-1}| + \theta_{E,SzE,t-1} \right) \right] \right] \right. \qquad (3.3.9)$$

$$\sigma_{S,E,T} = \rho_{S,E} \sigma_{S,t} \sigma_{E,t}$$

We summarise each of the relevant terms in equations (3.3.6-3.3.9) in Table 1.

Table 1 Description of Parameters Equations (3.3.6)-(3.3.9)

	Stock Returns	Exchange Rate Returns
Error correction terms (lagged residuals from the cointegrating regression of S_t, E_t)	$\lambda_{S,t-1}$	$\lambda_{E,t-1}$
Stochastic error terms	$e_{S,t}$	$e_{E,t}$
Information set at time *t-1*	Ω_{t-1}	Ω_{t-1}
Conditional (time varying) variances	$\sigma^2_{S,t}$	$\sigma^2_{E,t}$
Standardised residuals assumed to be normally distributed with 0 mean and variances of $\sigma^2_{S,t}, \sigma^2_{E,t}$	$z_{S,t} = e_{S,t} / \sigma_{S,t}$ $e_{S,t} / \Omega_{t-1} \sim \text{N}(0,\ \sigma^2_{S,t})$	$z_{E,t} = e_{E,t} / \sigma_{E,t}$ $e_{E,t} / \Omega_{t-1} \sim \text{N}(0,\ \sigma^2_{E,t})$
Persistence of Volatility	$\sum_{j=1}^{ps} b_{S,j}$	$\sum_{j=1}^{pE} b_{E,j}$
ARCH effect where the parameters $\theta_{S,S}, \theta_{E,E}$ allow this effect to be asymmetric	$\left[\left\|z_{S,t}\right\| - E\left\|z_{S,t}\right\| + \theta_{S,S} z_{S,t}\right]$	$\left[\left\|z_{E,t}\right\| - E\left\|z_{E,t}\right\| + \theta_{E,E} z_{E,t}\right]$
Volatility Spillover	$\delta_{S,E}\left[\left\|z_{E,t-1}\right\| - E\left\|z_{E,t-1}\right\| + \theta_{S,E} z_{E,t-1}\right]$	$\delta_{E,S}\left[\left\|z_{S,t-1}\right\| - E\left\|z_{S,t-1}\right\| + \theta_{E,S} z_{SSt-1}\right]$
Measures of spillovers	$\delta_{S,E}$	$\delta_{E,S}$
Asymmetry of Spillovers	[1] $\theta_{S,E}$	$\theta_{E,S}$
Correlation Coefficient for Standardised Residuals	$\rho_{S,E}$	$\rho_{E,S}$

The lag truncation length p in the EGARCH model is determined using the Likelihood Ratio (LR) test on alternative specifications. Hamilton (1994) defines the LR test as follows: $2\left[L(\hat{\theta}) - L(\tilde{\theta})\right] \approx \chi^2(m)$, where $L(\hat{\theta})$ denotes the value of the log likelihood function at the unrestricted estimate and $L(\tilde{\theta})$ denotes the value of the log likelihood function of the restricted estimate. Bollerslev-Woolridge robust *t*-statistics are derived to take into account possible non-normality of the residuals.

Given that our sample period includes the Asian financial crises, in addition to examining volatility spillovers between stock returns and exchange rates for the entire period, we also split our sample in order to compare the effect of volatility spillovers during and after the crises. Wu (2005) notes that the financial crisis was triggered by Thailand's request for assistance from the IMF on 2 July 1997 and that most countries

[1] $\theta_{S,E} < 0$, $\theta_{S,E} < 0$, implies that negative exchange rate shocks increase the volatility of stock returns more than positive shocks

had recovered from the crises by late 1998. Thus our split samples comprise the crises period of 2 July 1997 to31 December 1998 and the post crises period of 1 January 1999-7 July 2006.[2]

4. Empirical Results

4.1 Bivariate Resutls[3]

Our individual pair wise analysis does not identify any country where exchange rates and stock prices are found to be cointegrated. As we do a comparison with the results of the Johansen cointegration technique, we found that our results are consistent. We confirm the non existence of cointegration relationship in almost all the cases. We expected that at least the results of the test will confirm the existence of cointegration but surprisingly this did not happen, instead of that we got a contradictory result. Therefore, it is possible to conclude the no existence of cointegrating relationship between stock returns and exchange rates in any of our countries. In terms of our Granger Causality test our results are also consistent, there are just few exceptions where we found mixed results, but in most of the cases the results show the no existence of causality relationship between these two variables. In terms of our priori expectations our results are quite surprising, we were expecting to confirm the existence of a cointegrating relationship plus causality relationships between our variables, but our findings showed that exchange rates and stock prices seems to be independent. There is no evidence of these two variables moving together neither in the long-run nor in the short-run. Although the causality results are supporting our analysis as our methodologies are given consistent results.

Our causality test is showing a unidirectional causality relationship from stock prices to exchange rates in most of the cases; few times we found causality relationships running from exchange rates to stock prices.

Overall, the findings of our paper are consistent with the results that Nieh and Lee (2001) got from their analysis they did not find significant evidences for the

[2] Wu (2005) examines the extent of volatility spillover before and after the crises but our results differ from his in that he defines the crises period from 2 July 1997 to 30 September 1998 and his sample for the post crises period runs from 1 October 1998 to 31 December 2000; thus our post crises sample is considerably longer and more up to date.

[3] See Appendix 3.1 for selected results. Tables have been reduced to a minor sample to provide an idea of some of the results. The whole analysis is available upon request.

relationship between stock prices and exchange rates. They pointed out that most investors believe that both stock prices and exchange rates can serve as instruments to predict the future of each other. However their ambiguous findings question this belief. In our particular case we found that our results are consistent with their conclusions, we did not find strong evidences of the existence of relationship between these variables.

Smyth and Nandha (2003) also examined the relationship between exchange rates and stock prices in four Asian countries (Bangladesh, India, Pakistan and Sri Lanka) their findings are that there is no long-run equilibrium relationship between these two financial variables in any of the four countries results that were obtained from the Engle and Granger two steps and the Johansen cointegration test. As Nieh and Lee (2001) findings are inconsistent with most of the previous studies where the analysis has shown the existence of relationship between the variables. Our findings supports the results of Bahamani-Oskooee and Sohrabian (1992), Nieh and Lee (2001) and Smyth and Nandha (2003).

4.2 Trivariate Results[4]

The results from our cointegration tests indicated that in most of the cases the null hypothesis of no cointegration could not be rejected indicating that there is no long run relationship between exchange rates and stock markets; there are few exceptions in the case of the markets that were analysed, therefore in that cases and error correction mechanism was included in the model in order to investigate the short-run relationship in those markets. Our findings are thus consistent with the results of Smyth and Nandha (2003), Nieh and Lee (2001) and Bahamani-Oskooee and Sohrabian (1992), who did not find any significant evidence of a long run relationship between stock prices and exchange rates. While Grambovas (2003), found evidence of a cointegrating relationship between the Hungarian and German stock markets as well as between the Czech Republic market and the German market; the fact that our results here differ can partly be explained by the different period of analysis. Given that his analysis focused on the 1994-2000 period, our results indicate that for the 1999-2006 period, the influence of the German market on stock markets in Hungary and the Czech Republic appears to have declined.

[4] See appendix 3.2 for some results. The whole analysis is available upon request.

The results from the causality tests indicate that for normally movements in the exchange rate causes movements in stock prices; thus causality is unidirectional with no evidence of bidirectional causality between exchange rates and stock markets in most of the countries and cases of analysis. Furthermore, what happens on international stock markets can also affect domestic stock market and exchange rate movements, as reflected in the significant causal relationship from the UK stock market to most of the European markets, there are also evidence of influence from the US stock market in the European markets, the effect from the German market in less evident. The lack of international stock market influence on the European stock exchanges indicates that these markets are not as integrated with world financial markets as the big European stock markets. The results indicate that for example, a fall in the US stock market would have a negative effect on the Czech and Polish stock markets, which in turn would cause a capital outflow which would create depreciation pressures for the Czech and Polish exchange rates; conversely, a boom in the US stock market would have a positive effect on Czech or Polish stock markets and would lead to increased demand for the currencies and so appreciation of the exchange rate. Awareness of these linkages is likely to provide important information for more effective policy formulation on exchange rate issues, as well as for fund managers in terms of devising more effective portfolio hedging and diversification strategies.

4.3 Volatility Results[5]

Relationships between equity returns and exchange rates are of particular interest for academics and practitioners due to the fact that these two variables play a crucial role in portfolio and risk management. Equity returns and exchange rate movements may be used to hedge portfolios against currency movements, where risk management will have to take into consideration the linkages between these to markets in order to design the appropriate strategies.

This section set out to examine the volatility linkages between stock returns and exchange rates in three European markets. While there is a significant body of evidence which investigates the relationship between the first moments of exchange rates and stock returns, the evidence on volatility linkages between the two markets is scarce and has generally been confined to investigation of the relationship for developed

[5] See appendix 3.3 for a sample of results.

country markets. Thus our analysis make a clear contribution in providing more up to date information of the volatility linkages between stock prices and exchange rates which serves as a basis for increasing our understanding of the nature of integration of stock and exchange rate markets in the countries we have examined.

We examined two main periods, before the introduction of the Euro 1996-1998 and after the introduction of the single currency 1999-2006, as well as splitting our sample to compare and contrast the volatility linkages between the two markets during the first years of the introduction of the Euro (1999-2001) and after the currency have been physically introduced in the market (2002-2006). Our findings show evidences of unidirectional volatility spillovers, the coefficients for spillovers effects from stock returns to exchange rates appear to be significant in almost all the cases for the four period of analysis, but there are few exceptions with regard to the mentioned results, when we analysed the relationship for the period of time previous the introduction of the Euro we found that there are no evidences of volatility spillovers effects in the case of any financial markets, similar results were found in the case of some sub samples, where we found that for the sample period 1999-2001 the coefficients are insignificant in the case of Italy from stock returns to exchange rates when we analyse Euro/CHF, Euro/Yen, and Euro/Pound, being the coefficient Euro/Dollar significant. In the analysis for the sample period 2002-2006 we found that in this case the coefficients are not significant in the case of Portugal, while Italy and Spain show evidence of existence of volatility spillovers from stock returns to exchange rates.

Volatility spillovers from exchange rates to stock returns appears as not significant in almost all the cases, there are just a couple of exceptions, for 1999-2001 in the case of Euro/CHF where the coefficients are significant for Portugal and Spain, situation that could be explained for the reaction of the markets during the initial time period of the introduction of the Euro, and where the markets are adapting the systems to the single currency. Surprisingly these happen just in relation to the Euro/CHF in the rest of the cases there are no evidence of existence of spillovers effects from the exchange rates to the stock prices.

The evidence shows that movements of stock prices will affect future exchange rates movements while changes in exchange rates have less direct impact on future changes of stock prices. Overall our results found a unidirectional volatility spillovers from stock returns to exchange rates, results that are consistent with the finding of Kanas (2000), where he found evidence of volatility spillovers from stock returns to exchange rates and insignificant volatility spillovers from exchange rates to stock returns, Yang and Doong (2004) found evidence of volatility spillovers from stock returns to exchange rates but no evidences of vice versa relationship.

As we pointed out in the introduction of this analysis the empirical research examining volatility transmission and spillover effects provides mixed results, there are no enough research analysing the relationship between these two variables, therefore there is need of more research analysing this issue.

5. Conclusions

The objective of this thesis is to provide empirical evidence of the relationship between equity markets and money markets in nine European countries. With the purpose of a better understanding of the behaviour of these variables we decide to divide the analysis in three main geographical areas that are: four Eastern European countries (Czech Republic, Hungary, Poland and Slovakia), four South European countries (Greece, Italy, Portugal and Spain), and one West European country (Ireland). Each country was analysed in an individual basis and also located in the group of interest with the objective to find out any coincidences or divergences in our study. The analysis was conducted for each country performing three different methodologies, first we perform a Bivariate analysis where stock prices and exchange rates where analysed, then we proceed with a Trivariate analysis that introduce the international environment as a proxy in our modelling in order to find out which are the influence of the most important international markets in the European markets, and also which are the effects on the variables. Finally our analysis concludes performing an EGARCH model that will allow analysing volatility spillovers between these markets. The most important characteristic of our analysis is that we have include in our study European countries that have not been analysed in this field before, also we include a wide range of exchange rates for each country, analysis that have not been done until now. Therefore, the present thesis is providing valuable information with regard to the interlinkages between stock prices and exchange rates.

The main findings from our bivariate analysis show that the individual pair wise analysis does not identify any country where exchange rates and stock prices are found to be cointegrated. As we do a comparison with the results of the Johansen cointegration technique, we found that our results are consistent. We confirm the non existence of cointegration relationship in almost all the cases. We expected that at least the results of the test will confirm the existence of cointegration but surprisingly this did not happen, instead of that we got a contradictory result. Therefore, it is possible to conclude the no existence of cointegrating relationship between stock returns and exchange rates in any of our countries. In terms of our Granger Causality test our results are also consistent, there are just few exceptions where we found mixed results, but in most of the cases the results show the no existence of causality relationship between these two variables. In terms of our priori expectations our results are quite surprising, we were expecting to confirm the existence of a cointegrating relationship plus causality relationships between our variables, but our findings showed that exchange rates and stock prices seems to be independent. There is no evidence of these two variables moving together neither in the long-run nor in the short-run. Although the causality results are supporting our analysis as our methodologies are given consistent results.

Our causality test is showing a unidirectional causality relationship from stock prices to exchange rates in most of the cases; few times we found causality relationships running from exchange rates to stock prices.

Overall, the findings from our bivariate analysis are consistent with the results that Nieh and Lee (2001) got from their analysis they did not find significant evidences for the relationship between stock prices and exchange rates. They pointed out that most investors believe that both stock prices and exchange rates can serve as instruments to predict the future of each other. However their ambiguous findings question this belief. In our particular case we found that our results are consistent with their conclusions, we did not find strong evidences of the existence of relationship between these variables.

Smyth and Nandha (2003) also examined the relationship between exchange rates and stock prices in four Asian countries (Bangladesh, India, Pakistan and Sri Lanka) their findings are that there is no long-run equilibrium relationship between these two financial variables in any of the four countries results that were obtained from the Engle and Granger two steps and the Johansen cointegration test. As Nieh and Lee (2001) findings are inconsistent with most of the previous studies where the analysis has shown the existence of relationship between the variables. Our findings supports the results of Bahamani-Oskooee and Sohrabian (1992), Nieh and Lee (2001) and Smyth and Nandha (2003).

The trivariate analysis results show consistency with the Bivariate analysis, from our cointegration tests indicated that in most of the cases the null hypothesis of no cointegration could not be rejected indicating that there is no long run relationship between exchange rates and stock markets; there are few exceptions in the case of the markets that were analysed, therefore in that cases and error correction mechanism was included in the model in order to investigate the short-run relationship in those markets. Our findings are thus consistent with the results of Smyth and Nandha (2003), Nieh and Lee (2001) and Bahamani-Oskooee and Sohrabian (1992), who did not find any significant evidence of a long run relationship between stock prices and exchange rates. While Grambovas (2003), found evidence of a cointegrating relationship between the Hungarian and German stock markets as well as between the Czech Republic market and the German market; the fact that our results here differ can partly be explained by the different period of analysis. Given that his analysis focused on the 1994-2000 period, our results indicate that for the 1999-2006 period, the influence of the German market on stock markets in Hungary and the Czech Republic appears to have declined.

The results from the causality tests indicate that for normally movements in the exchange rate causes movements in stock prices; thus causality is unidirectional with very little evidence of bidirectional causality between exchange rates and stock markets in most of the countries and cases of analysis. Furthermore, what happens on international stock markets can also affect domestic stock market and exchange rate movements, as reflected in the significant causal relationship from the UK and US stock market to most of the European markets, the effect from the German market in less evident. The lack of international stock market influence on the European stock exchanges indicates that these markets are not as integrated with world financial markets as the big European stock markets. Awareness of these linkages is likely to provide important information for more effective policy formulation on exchange rate issues, as well as for fund managers in terms of devising more effective portfolio hedging and diversification strategies.

Finally we examined the volatility linkages between stock returns and exchange rates in our nine European markets. While there is a significant body of evidence which investigates the relationship between the first moments of exchange rates and stock returns, the evidence on volatility linkages between the two markets is scarce and has generally been confined to investigation of the relationship for developed country markets. Thus our analysis make a clear contribution in providing more up to date information of the volatility linkages between stock prices and exchange rates which serves as a basis for increasing our understanding of the nature of integration of stock and exchange rate markets in the countries we have examined.

We examined two main periods, before the introduction of the Euro 1996-1998 and after the introduction of the single currency 1999-2006, as well as splitting our sample to compare and contrast the volatility linkages between the two markets during the first years of the introduction of the Euro (1999-2001) and after the currency have been physically introduced in the market (2002-2006). Our findings show evidences of unidirectional volatility spillovers, the coefficients for spillovers effects from stock returns to exchange rates appear to be significant in almost all the cases for the four period of analysis, but there are few exceptions with regard to the mentioned results, when we analysed the relationship for the period of time previous the introduction of the Euro we found that there are no evidences of volatility spillovers effects in the case of any financial markets, similar results were found in the case of some sub samples, where we found that for the sample period 1999-2001 the coefficients are insignificant in most of the cases.

Volatility spillovers from exchange rates to stock returns appear as not significant in almost all the cases. The evidence shows that movements of stock prices will affect future exchange rates movements while changes in exchange rates have less direct impact on future changes of stock prices. Overall our results found a unidirectional volatility spillovers from stock returns to exchange rates, results that are consistent with the finding of Kanas (2000), where he found evidence of volatility spillovers from stock returns to exchange rates and insignificant volatility spillovers from exchange rates to stock returns, Yang and Doong (2004) found evidence of volatility spillovers from stock returns to exchange rates but no evidences of vice versa relationship. As we pointed out in the introduction of this analysis the empirical research examining volatility transmission and spillover effects provides mixed results, there are no enough research analysing the relationship between these two variables, therefore there is need of more research analysing this issue. Relationships between equity returns and exchange rates are of particular interest for academics and practitioners due to the fact that these two variables play a crucial role in portfolio and risk management. Equity returns and exchange rate movements may be used to hedge portfolios against currency movements, where risk management will have to take into consideration the linkages between these to markets in order to design the appropriate strategies.

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Appendix 3.1

TABLE 3.1.1.: GRANGER CAUSALITY TEST

TYPE OF TEST		AIC			HQ		
Countries	**Variables**	**No. of lags**	**F-stat**	**p-value**	**No. of lags**	**F-stat**	**p-value**
Czech Republic	DCZI $\Rightarrow$ DCZE	4	2.6616	0.0312	2	3.6440	0.0263
	DCZE $\Rightarrow$ DCZI		1.6261	0.1650		0.1947	0.8231
Hungary	DHGI $\Rightarrow$ DHGE	2	0.2638	0.7682	1	0.5502	0.4583
	DHGE $\Rightarrow$ DHGI		0.1382	0.8710		0.2842	0.5940
Poland	DPOI $\Rightarrow$ DPOE	8	3.8423	0.0002*	2	6.7548	0.0012*
	DPOE $\Rightarrow$ DPOI		1.0704	0.3810		0.7665	0.4648
Slovakia	DSLI $\Rightarrow$ DSLE	6	0.1608	0.9869	3	0.1945	0.9002
	DSLE $\Rightarrow$ DSLI		0.2380	0.9641		0.2645	0.8510

*Reject the null hypothesis. Ho: Y does not cause X. In our case the Stock Prices cause the Exchange Rates or Vice versa, at 1% significance level**,** D: variables in first differences, DCZI: Czech Republic Stock Prices, DCZE: Czech Republic Exchange Rates, DHGI: Hungary Stock Prices, DHGE: Hungary Exchange Rate, DPOI: Poland Stock Prices, DPOE: Poland Exchange Rate, DSLI: Slovakia Stock Prices, DSLE: Slovakia Exchange Rate.

TABLE 3.1.2: BIVARIATE MODEL FOR GRANGER CAUSALITY TEST

TYPE OF TEST		GRANGER CAUSALITY TEST				
Countries	**Variables**	**No. of lags**	**F-stat**	**1% CV**	**5% CV**	**10% CV**
Czech Republic	DCZI $\Rightarrow$ DCZE	(1,5)	2.0894	2.811	2.103	1.777
	DCZE $\Rightarrow$ DCZI	(11,6)	2.6543*	1.863	1.561	1.414
Hungary	DHGI $\Rightarrow$ DHGE	(19,19)	0.7861	2.811	2.103	1.777
	DHGE $\Rightarrow$ DHGI	(2,5)	0.8564	1.974	1.6208	1.46
Poland	DPOI $\Rightarrow$ DPOE	(18,16)	1.1024	1.62	1.411	1.307
	DPOE $\Rightarrow$ DPOI	(4,1)	8.84*	2.648	2.014	1.719
Slovakia	DSLI $\Rightarrow$ DSLE	(1,5)	1.2004	2.811	2.103	1.777
	DSLE $\Rightarrow$ DSLI	(1,20)	0.4921	1.863	1.561	1.414

*Reject the null hypothesis. Ho: Y does not cause X. In our case the Stock Prices cause the Exchange Rates or Vice versa, at 1% significance level, D: variables in first differences, DCZI: Czech Republic Stock Prices, DCZE: Czech Republic Exchange Rates, DHGI: Hungary Stock Prices, DHGE: Hungary Exchange Rate, DPOI: Poland Stock Prices, DPOE: Poland Exchange Rate, DSLI: Slovakia Stock Prices, DSLE: Slovakia Exchange Rate.

TABLE 3.1.3: ENGLE & GRANGER COINTEGRATION TEST (Results of the model including a Constant)

TYPE OF TEST	ENGLE & GRANGER COINTEGRATION TEST					
Countries	**Variables**	**t-statistic**	**p-value**	***1% CV**	****5% CV**	*****10% CV**
Greece 1999-2000	FTSE/ATX 20 to Drachma/CHF	-3.64*	0.01	-3.44	-2.87	-2.57
	Drachma/CHF to FTSE/ATX 20	-3.34	0.01	-3.44	-2.87	-2.57
	FTSE/ATX 20 to Drachma/¥	-2.22	0.20	-3.44	-2.87	-2.57
	Drachma/¥ to FTSE/ATX 20	-1.62	0.47	-3.44	-2.87	-2.57
	FTSE/ATX 20 to Drachma/£	-2.78	0.06	-3.44	-2.87	-2.57
	Drachma/£ to FTSE/ATX 20	-2.37	0.15	-3.44	-2.87	-2.57
	FTSE/ATX 20 to Drachma/$	-2.59	0.10	-3.44	-2.87	-2.57
	Drachma/$ to FTSE/ATX 20	-2.31	0.17	-3.44	-2.87	-2.57
	FTSE/ATX 20 to Drachma/€	-2.59	0.10	-3.44	-2.87	-2.57
	Drachma/€ to FTSE/ATX 20	-2.31	0.17	-3.44	-2.87	-2.57
Greece 2001	FTSE/ATX 20 to €/CHF	-2.94	0.04	-3.46	-2.87	-2.57
	€/CHF to FTSE/ATX 20	-2.72	0.07	-3.46	-2.87	-2.57
	FTSE/ATX 20 to €/¥	-1.64	0.46	-3.46	-2.87	-2.57
	€/¥ to FTSE/ATX 20	-2.13	0.23	-3.46	-2.87	-2.57
	FTSE/ATX 20 to €/£	-1.66	0.45	-3.46	-2.87	-2.57
	€/£ to FTSE/ATX 20	-2.71	0.07	-3.46	-2.87	-2.57
	FTSE/ATX 20 to €/$	-1.44	0.56	-3.46	-2.87	-2.57
	€/$ to FTSE/ATX 20	-2.16	0.22	-3.46	-2.87	-2.57
Greece 2002-2006	FTSE/ATX 20 to €/CHF	-1.48	0.54	-3.44	-2.86	-2.57
	€/CHF to FTSE/ATX 20	-2.13	0.23	-3.44	-2.86	-2.57
	FTSE/ATX 20 to €/¥	-2.05	0.26	-3.44	-2.86	-2.57
	€/¥ to FTSE/ATX 20	-2.51	0.11	-3.44	-2.86	-2.57
	FTSE/ATX 20 to €/£	0.36	0.98	-3.44	-2.86	-2.57
	€/£ to FTSE/ATX 20	-2.61	0.09	-3.44	-2.86	-2.57
	FTSE/ATX 20 to €/$	-0.83	0.81	-3.44	-2.86	-2.57
	€/$ to FTSE/ATX 20	-2.52	0.11	-3.44	-2.86	-2.57

*1% significance level

TABLE 3.1.4: GRANGER CAUSALITY TEST

TYPE OF TEST	AIC			HQ		
Greece	**No. of lags**	**F-stat**	**p-value**	**No. of lags**	**F-stat**	**p-value**
Greece 1999-2000						
DCHF does not Granger Cause DGR	2	n/a	n/a	2	0.0257	0.9746
DGR does not Granger Cause DCHF		n/a	n/a		0.4785	0.6200
DJP does not Granger Cause DGR	2	n/a	n/a	2	1.7309	0.1782
DGR does not Granger Cause DJP		n/a	n/a		0.6741	0.5101
DUK does not Granger Cause DGR	2	n/a	n/a	2	0.1472	0.8632
DGR does not Granger Cause DUK		n/a	n/a		0.0054	0.9947
DUS does not Granger Cause DGR	2	n/a	n/a	2	0.4627	0.6299
DGR does not Granger Cause DUS		n/a	n/a		0.2545	0.7754
DEUR does not Granger Cause DGR	2	n/a	n/a	2	0.9287	0.3958
DGR does not Granger Cause DEUR		n/a	n/a		1.5082	0.2224
Greece 2001						
DCHF does not Granger Cause DGR	1	n/a	n/a	1	0.0355	0.8507
DGR does not Granger Cause DCHF		n/a	n/a		6.7039	0.0102*
DJP does not Granger Cause DGR	1	n/a	n/a	1	2.5241	0.1134
DGR does not Granger Cause DJP		n/a	n/a		0.0506	0.8222
DUK does not Granger Cause DGR	1	n/a	n/a	1	0.5257	0.4691
DGR does not Granger Cause DUK		n/a	n/a		0.0271	0.8694
DUS does not Granger Cause DGR	1	n/a	n/a	1	1.7324	0.1893
DGR does not Granger Cause DUS		n/a	n/a		0.5736	0.4496
Greece 2002						
DCHF does not Granger Cause DGR	2	n/a	n/a	2	0.2736	0.7607
DGR does not Granger Cause DCHF		n/a	n/a		16.7119	0.0000*
DJP does not Granger Cause DGR	2	0.3324	0.5644	1	1.0574	0.3477
DGR does not Granger Cause DJP		5.1223	0.0238*		3.0160	0.0494*
DUK does not Granger Cause DGR	1	n/a	n/a	1	0.3515	0.5534
DGR does not Granger Cause DUK		n/a	n/a		1.4268	0.2325
DUS does not Granger Cause DGR	2	0.2158	0.8060	1	0.4724	0.4920
DGR does not Granger Cause DUS		2.2612	0.1047		3.3704	0.0666*

*Reject the null hypothesis. Ho: Y does not cause X. In our case the Stock Prices cause the Exchange Rates or Vice versa.

TABLE 3.1.5: BIVARIATE MODEL FOR GRANGER CAUSALITY TEST

TYPE OF TEST	GRANGER CAUSALITY TEST				
Greece	No. of lags	F-stat	1% CV	5% CV	10% CV
Greece 1999-2000					
DCHF does not Granger Cause DGR	(20,20)	0.97	1.88	1.57	1.42
DGR does not Granger Cause DCHF	(20,20)	0.67	1.88	1.57	1.42
DJP does not Granger Cause DGR	(5,2)	0.77	3.02	2.21	1.85
DGR does not Granger Cause DJP	(20,20)	1.15	1.88	1.57	1.42
DUK does not Granger Cause DGR	(20,20)	0.55	1.88	1.57	1.42
DGR does not Granger Cause DUK	(20,18)	0.72	1.88	1.57	1.42
DUS does not Granger Cause DGR	(20,20)	0.61	1.88	1.57	1.42
DGR does not Granger Cause DUS	(20,18)	0.90	1.88	1.57	1.42
DEUR does not Granger Cause DGR	(20,18)	0.91	1.88	1.57	1.42
DGR does not Granger Cause DEUR	(20,11)	1.07	2.25	1.79	1.75
Greece 2001					
DCHF does not Granger Cause DGR	(9,2)	0.66	4.61	3.00	2.30
DGR does not Granger Cause DCHF	(6,6)	4.68*	2.80	2.10	1.77
DJP does not Granger Cause DGR	(7,20)	2.33	1.88	1.57	1.42
DGR does not Granger Cause DJP	(6,5)	1.20	3.02	2.21	1.85
DUK does not Granger Cause DGR	(13,7)	1.71	2.64	2.01	1.72
DGR does not Granger Cause DUK	(6,4)	0.23	3.32	2.37	1.94
DUS does not Granger Cause DGR	(1,8)	3.62*	2.51	1.94	1.67
DGR does not Granger Cause DUS	(6,5)	0.72	3.02	2.21	1.85
Greece 2002-2006					
DCHF does not Granger Cause DGR	(12,1)	34.77*	6.63	3.84	2.71
DGR does not Granger Cause DCHF	(20,20)	0.97	1.88	1.57	1.42
DJP does not Granger Cause DGR	(2,16)	2.29*	2.04	1.67	1.49
DGR does not Granger Cause DJP	(20,20)	0.69	1.88	1.57	1.42
DUK does not Granger Cause DGR	(4,1)	1.35	6.63	3.84	2.71
DGR does not Granger Cause DUK	(20,18)	1.00	1.88	1.57	1.42
DUS does not Granger Cause DGR	(1,1)	3.37	6.63	3.84	2.71
DGR does not Granger Cause DUS	(20,20)	0.47	1.88	1.57	1.42

TABLE 3.1.5: GRANGER CAUSALITY TEST

TYPE OF TEST	AIC			HQ		
Greece	No. of lags	F-stat	p-value	No. of lags	F-stat	p-value
Ireland 1996-1998						
DUKE does not Granger Cause DIRI	2	n/a	n/a	2	2.5518	0.0786**
DIRI does not Granger Cause DUKE		n/a	n/a		1.3836	0.2513
DUSE does not Granger Cause DIRI	2	n/a	n/a	2	6.6889	0.0013**
DIRI does not Granger Cause DUSE		n/a	n/a		0.9720	0.3788
Ireland 1999-2001						
DUK does not Granger Cause DII	3	1.6644	0.1733	1	0.7189	0.3968
DII does not Granger Cause DUK		0.2810	0.8391		0.4857	0.4861
DUS does not Granger Cause DII	2	1.9434	0.1439	1	0.3297	0.5660
DII does not Granger Cause DUS		1.7300	0.1780		1.3596	0.2440
Ireland 2002-2006						
DUK does not Granger Cause DII	2	2.5025	0.0823	1	3.7013	0.0546***
DII does not Granger Cause DUK		2.1202	0.1204		4.0486	0.0444**
DUS does not Granger Cause DII	2	0.4719	0.6239	1	0.0067	0.9347
DII does not Granger Cause DUS		2.7477	0.0645		5.0308	0.0251**

*Reject the null hypothesis. Ho: Y does not cause X. In our case the Stock Prices cause the Exchange Rates or Vice versa. *1% significance level, **5% significance level, ***10%signfiicance level

TABLE 3.1.6: BIVARIATE MODEL FOR GRANGER CAUSALITY TEST

TYPE OF TEST	GRANGER CAUSALITY TEST				
Ireland	No. of lags	F-stat	1% CV*	5%CV**	10%CV***
Ireland 1996-1998					
DUKE does not Granger Cause DIRI	(1,1)	0.28	6.63	3.84	2.71
DIRI does not Granger Cause DUKE	(2,20)	1.14	1.88	1.57	1.42
DUSE does not Granger Cause DIRI	(1,12)	3.09*	2.18	1.75	1.55
DIRI does not Granger Cause DUSE	(2,20)	1.22	1.88	1.57	1.42
Ireland 1999-2001					
DUK does not Granger Cause DII	(1,20)	0.66	1.88	1.57	1.42
DII does not Granger Cause DUK	(7,1)	2.63	6.63	3.84	2.71
DUS does not Granger Cause DII	(1,18)	2.42	1.88	1.57	1.42
DII does not Granger Cause DUS	(7,11)	2.66	2.25	1.79	1.57
Ireland 2002-2006					
DUK does not Granger Cause DII	(3,1)	11.6	6.63	3.84	2.71
DII does not Granger Cause DUK	(18,18)	4.48*	1.88	1.57	1.42
DUS does not Granger Cause DII	(1,1)	6.87*	6.63	3.84	2.71
DII does not Granger Cause DUS	(18,18)	5.34*	1.88	1.57	1.42

*Reject the null hypothesis. Ho: Y does not cause X. In our case the Stock Prices cause the Exchange Rates or Vice versa. *1% significance level, **5% significance level, ***10%signfiicance level

TABLE 3.1.7: GRANGER CAUSALITY TEST 1996-1998

TYPE OF TEST	AIC			HQ		
Greece	No. of lags	F-stat	p-value	No. of lags	F-stat	p-value
Italy 1996-1998						
DCHF does not Granger Cause DIT	1	n/a	n/a	1	1.1046	0.2936
DIT does not Granger Cause DCHF		n/a	n/a		0.2212	0.6383
DJP does not Granger Cause DIT	10	1.6421	0.0907***	1	0.2582	0.6115
DIT does not Granger Cause DJP		1.7478	0.0667***		0.0848	0.7710
DUK does not Granger Cause DIT	5	0.8944	0.5380	1	0.1463	0.7022
DIT does not Granger Cause DUK		1.0711	0.3821		0.5923	0.4418
DUS does not Granger Cause DIT	15	1.3232	0.1816	1	0.3845	0.5354
DIT does not Granger Cause DUS		1.8037	0.0305**		0.0006	0.9800
Italy 1999-2001						
DCHF does not Granger Cause DIT	1	n/a	n/a	1	0.1931	0.6605
DIT does not Granger Cause DCHF		n/a	n/a		4.0378	0.0449**
DJP does not Granger Cause DIT	1	n/a	n/a	1	3.2079	0.0737***
DIT does not Granger Cause DJP		n/a	n/a		1.1433	0.2853
DUK does not Granger Cause DIT	3	1.4440	0.2287	1	0.0038	0.9512
DIT does not Granger Cause DUK		0.7178	0.5415		0.4622	0.4968
DUS does not Granger Cause DIT	1	n/a	n/a	1	0.5905	0.4425
DIT does not Granger Cause DUS		n/a	n/a		0.3841	0.5356
Italy 2002-2006						
DCHF does not Granger Cause DIT	1	n/a	n/a	1	0.1989	0.6557
DIT does not Granger Cause DCHF		n/a	n/a		0.9763	0.3233
DJP does not Granger Cause DIT	1	n/a	n/a	1	0.0371	0.8474
DIT does not Granger Cause DJP		n/a	n/a		1.5853	0.2082
DUK does not Granger Cause DIT	2	1.9477	0.1430	1	3.0748	0.0798***
DIT does not Granger Cause DUK		5.1506	0.0059*		8.3319	0.0040*
DUS does not Granger Cause DIT	1	n/a	n/a	1	0.6508	0.4200
DIT does not Granger Cause DUS		n/a	n/a		3.5152	0.0610***

*Reject the null hypothesis. Ho: Y does not cause X. In our case the Stock Prices cause the Exchange Rates or Viceversa. . *1% significance level, **5% significance level, ***10%signfiicance level

TABLE 3.1.8: BIVARIATE MODEL FOR GRANGER CAUSALITY TEST

TYPE OF TEST	GRANGER CAUSALITY TEST				
Italy	**No. of lags**	**F-stat**	**1% CV**	**5% CV**	**10% CV**
Italy 1996-1998					
DCHF does not Granger Cause DIT	(8,11)	1.12	2.25	1.79	1.75
DIT does not Granger Cause DCHF	(2,20)	0.75	1.88	1.57	1.42
DJP does not Granger Cause DIT	(3,4)	2.17	3.02	2.21	1.85
DIT does not Granger Cause DJP	(2,4)	2.54	3.02	2.21	1.85
DUK does not Granger Cause DIT	(19,19)	0.93	1.88	1.57	1.42
DIT does not Granger Cause DUK	(2,20)	1.44	1.88	1.57	1.42
DUS does not Granger Cause DIT	(19,18)	1.71	1.88	1.57	1.42
DIT does not Granger Cause DUS	(2,20)	0.94	1.88	1.57	1.42
Italy 1999-2001					
DCHF does not Granger Cause DIT	(20,6)	2.93**	2.80	2.10	1.77
DIT does not Granger Cause DCHF	(20,18)	1.13	1.88	1.57	1.42
DJP does not Granger Cause DIT	(4,1)	1.26	6.63	3.84	2.71
DIT does not Granger Cause DJP	(20,20)	1.47	1.88	1.57	1.42
DUK does not Granger Cause DIT	(7,1)	0.43	6.63	3.84	2.71
DIT does not Granger Cause DUK	(20,20)	0.70	1.88	1.57	1.42
DUS does not Granger Cause DIT	(7,1)	0.38	6.63	3.84	2.71
DIT does not Granger Cause DUS	(20,19)	0.94	1.88	1.57	1.42
Italy 2002-2006					
DCHF does not Granger Cause DIT	(12,1)	1.20	6.63	3.84	2.71
DIT does not Granger Cause DCHF	(5,20)	1.54	1.88	1.57	1.42
DJP does not Granger Cause DIT	(11,20)	1.58	1.88	1.57	1.42
DIT does not Granger Cause DJP	(5,19)	1.83	1.88	1.57	1.42
DUK does not Granger Cause DIT	(4,1)	8.65*	6.63	3.84	2.71
DIT does not Granger Cause DUK	(5,20)	1.80	1.88	1.57	1.42
DUS does not Granger Cause DIT	(1,1)	3.52	6.63	3.84	2.71
DIT does not Granger Cause DUS	(5,20)	1.41	1.88	1.57	1.42

*Reject the null hypothesis. Ho: Y does not cause X. In our case the Stock Prices cause the Exchange Rates or Viceversa. . *1% significance level, **5% significance level, ***10%signfiicance level

TABLE 3.1.9: GRANGER CAUSALITY TEST

TYPE OF TEST	AIC			HQ		
Portugal	**No. of lags**	**F-stat**	**p-value**	**No. of lags**	**F-stat**	**p-value**
Portugal 1996-1998						
DCHF does not Granger Cause DPT	6	0.1575	0.9876	2	0.0734	0.9293
DPT does not Granger Cause DCHF		3.0720	0.0056**		0.5204	0.5945
DJP does not Granger Cause DPT	7	2.9763	0.0044*	2	1.9067	0.1493
DPT does not Granger Cause DJP		3.4466	0.0012*		2.1933	0.1123
DUK does not Granger Cause DPT	6	2.0911	0.0522*	2	0.3692	0.6914
DPT does not Granger Cause DUK		1.6141	0.1403		3.4429	0.0325**
DUS does not Granger Cause DPT	6	1.2608	0.2733	2	0.0197	0.9805
DPT does not Granger Cause DUS		1.5370	0.1632		0.9561	0.3849
Portugal 1999-2001						
DCHF does not Granger Cause DPT	2	n/a	n/a	2	0.0175	0.9826
DPT does not Granger Cause DCHF		n/a	n/a		4.6496	0.0099*
DJP does not Granger Cause DPT	3	3.8069	0.0100*	1	0.4405	0.5071
DPT does not Granger Cause DJP		0.8813	0.4504		1.4346	0.2314
DUK does not Granger Cause DPT	3	1.2304	0.2976	1	0.9099	0.3405
DPT does not Granger Cause DUK		0.6898	0.5584		0.1416	0.7068
US does not Granger Cause DPT	3	2.9312	0.0328*	2	0.6509	0.5219
DPT does not Granger Cause US		2.9091	0.0338*		3.9621	0.0194**
Portugal 2002-2006						
DCHF does not Granger Cause DPT	2	n/a	n/a	2	1.4579	0.2331
DPT does not Granger Cause DCHF		n/a	n/a		12.9569	0.0000*
DJP does not Granger Cause DPT	2	0.1318	0.8766	1	0.1699	0.6803
DPT does not Granger Cause DJP		4.3308	0.0134**		7.6001	0.0059*
DUK does not Granger Cause DPT	4	1.5617	0.1822	1	5.4219	0.0200**
DPT does not Granger Cause DUK		3.4049	0.0089*		2.4148	0.1204
DUS does not Granger Cause DPT	3	0.5212	0.6678	2	0.9645	0.3815
DPT does not Granger Cause DUS		6.1141	0.0004*		8.9728	0.0001*

*Reject the null hypothesis. Ho: Y does not cause X. In our case the Stock Prices cause the Exchange Rates or Viceversa. *1% significance level, **5% significance level, ***10%signfiicance level

TABLE 3.1.10: BIVARIATE MODEL FOR GRANGER CAUSALITY TEST

TYPE OF TEST	GRANGER CAUSALITY TEST				
Italy	**No. of lags**	**F-stat**	**1% CV***	**5%CV****	**10%CV*****
Portugal 1996-1998					
DCHF does not Granger Cause DPT	(20,20)	1.24	1.88	1.57	1.42
DPT does not Granger Cause DCHF	(12,20)	0.70	1.88	1.57	1.42
DJP does not Granger Cause DPT	(1,6)	4.91*	2.80	2.10	1.77
DPT does not Granger Cause DJP	(12,20)	1.71	1.88	1.57	1.42
DUK does not Granger Cause DPT	(20,20)	0.88	1.88	1.57	1.42
DPT does not Granger Cause DUK	(12,20)	1.50	1.88	1.57	1.42
DUS does not Granger Cause DPT	(19,18)	1.47	1.88	1.57	1.42
DPT does not Granger Cause DUS	(12,20)	1.19	1.88	1.57	1.42
DCHF does not Granger Cause DPT	(20,20)	1.24	1.88	1.57	1.42
Portugal 1999-2001					
DCHF does not Granger Cause DPT	(20,3)	3.73*	3.78	2.60	2.08
DPT does not Granger Cause DCHF	(1,20)	2.61*	1.88	1.57	1.42
DJP does not Granger Cause DPT	(3,3)	0.88	3.78	2.60	2.08
DPT does not Granger Cause DJP	(1,1)	0.44	6.63	3.84	2.71
DUK does not Granger Cause DPT	(7,1)	0.30	6.63	3.84	2.71
DPT does not Granger Cause DUK	(1,20)	2.84*	1.88	1.57	1.42
US does not Granger Cause DPT	(7,1)	9.89*	6.63	3.84	2.71
DPT does not Granger Cause US	(1,20)	2.87*	1.88	1.57	1.42
Portugal 2002-2006					
DCHF does not Granger Cause DPT	(12,3)	11.72*	3.78	2.60	2.08
DPT does not Granger Cause DCHF	(2,17)	2.69*	1.88	1.57	1.42
DJP does not Granger Cause DPT	(2,17)	2.56*	1.88	1.57	1.42
DPT does not Granger Cause DJP	(2,7)	2.10**	2.64	2.01	1.72
DUK does not Granger Cause DPT	(3,4)	3.75*	3.32	2.37	1.94
DPT does not Granger Cause DUK	(2,17)	2.69*	1.88	1.57	1.42
DUS does not Granger Cause DPT	(1,2)	9.15*	4.61	3.00	2.30
DPT does not Granger Cause DUS	(2,17)	2.62*	1.88	1.57	1.42

*Reject the null hypothesis. Ho: Y does not cause X. In our case the Stock Prices cause the Exchange Rates or Viceversa. *1% significance level, **5% significance level, ***10%signfiicance level

TABLE 3.1.11: GRANGER CAUSALITY TEST

TYPE OF TEST	AIC			HQ		
Greece	No. of lags	F-stat	p-value	No. of lags	F-stat	p-value
Spain 1996-1998						
DCHF does not Granger Cause DSP	2	0.9549	0.3853	1	1.6329	0.2017
DSP does not Granger Cause DCHF		0.6424	0.5263		0.8394	0.3599
DJP does not Granger Cause DSP	18	2.0251	0.0072*	1	0.4419	0.5064
DSP does not Granger Cause DJP		1.9454	0.0107**		0.3150	0.5748
DUK does not Granger Cause DSP	1	n/a	n/a	1	0.8322	0.3619
DSP does not Granger Cause DUK		n/a	n/a		0.2196	0.6395
DUS does not Granger Cause DSP	1	n/a	n/a	1	0.0691	0.7927
DSP does not Granger Cause DUS		n/a	n/a		0.0026	0.9593
Spain 1999-2001						
DCHF does not Granger Cause DSP	2	0.9310	0.3946	1	1.3949	0.2380
DSP does not Granger Cause DCHF		9.7451	0.0001*		19.0948	0.0000*
DJP does not Granger Cause DSP	1	n/a	n/a	1	0.1686	0.6815
DSP does not Granger Cause DJP		n/a	n/a		1.9767	0.1602
DUK does not Granger Cause DSP	1	n/a	n/a	1	1.8163	0.1782
DSP does not Granger Cause DUK		n/a	n/a		0.0370	0.8475
DUS does not Granger Cause DSP	2	n/a	n/a	2	2.9558	0.0527***
DSP does not Granger Cause DUS		n/a	n/a		9.5169	0.0001*
DCHF does not Granger Cause DSP					1.3949	0.2380
Spain 2002-2006						
CHF does not Granger Cause DSP	2	n/a	n/a	2	3.3294	0.0361**
DSP does not Granger Cause CHF		n/a	n/a		35.1256	0.0000*
DJP does not Granger Cause DSP	2	n/a	n/a	2	0.7636	0.4662
DSP does not Granger Cause DJP		n/a	n/a		14.2083	0.0000*
DUK does not Granger Cause DSP	3	0.6334	0.5935	2	0.1724	0.8417
DSP does not Granger Cause DUK		7.9737	0.0000*		11.0802	0.0000*
DUS does not Granger Cause DSP	2	n/a	n/a	2	0.4718	0.6240
DSP does not Granger Cause DUS		n/a	n/a		24.8324	0.0000*

*Reject the null hypothesis. Ho: Y does not cause X. In our case the Stock Prices cause the Exchange Rates or Viceversa. *1% significance level, **5% significance level, ***10%signfiicance level

TABLE 3.1.12: BIVARIATE MODEL FOR GRANGER CAUSALITY TEST

TYPE OF TEST	GRANGER CAUSALITY TEST				
Spain	**No. of lags**	**F-stat**	**1% CV ***	**5% CV ****	**10% CV *****
Spain 1996-1998					
DCHF does not Granger Cause DSP	(18,18)	0.67	1.88	1.57	1.42
DSP does not Granger Cause DCHF	(8,20)	1.19	1.88	1.57	1.42
DJP does not Granger Cause DSP	(1,9)	4.78*	2.41	1.88	1.63
DSP does not Granger Cause DJP	(8,20)	1.81**	1.88	1.57	1.42
DUK does not Granger Cause DSP	(19,20)	0.99	1.88	1.57	1.42
DSP does not Granger Cause DUK	(8,20)	0.60	1.88	1.57	1.42
DUS does not Granger Cause DSP	(19,19)	1.20	1.88	1.57	1.42
DSP does not Granger Cause DUS	(8,20)	0.60	1.88	1.57	1.42
Spain 1999-2001					
DCHF does not Granger Cause DSP	(20,1)	16.18*	6.63	3.84	2.71
DSP does not Granger Cause DCHF	(5,5)	0.98	3.02	2.21	1.85
DJP does not Granger Cause DSP	(4,3)	1.60	3.78	2.60	2.08
DSP does not Granger Cause DJP	(5,1)	0.17	6.63	3.84	2.71
DUK does not Granger Cause DSP	(7,1)	0.05	6.63	3.84	2.71
DSP does not Granger Cause DUK	(5,3)	0.97	3.78	2.60	2.08
DUS does not Granger Cause DSP	(7,1)	19.07*	6.63	3.84	2.71
DSP does not Granger Cause DUS	(5,6)	1.48	2.80	2.10	1.77
Spain 2002-2006					
CHF does not Granger Cause DSP	(12,1)	68.00*	6.63	3.84	2.71
DSP does not Granger Cause CHF	(2,2)	1.16	4.61	3.00	2.30
DJP does not Granger Cause DSP	(14,5)	6.34*	3.02	2.21	1.85
DSP does not Granger Cause DJP	(2,20)	2.53*	1.88	1.57	1.42
DUK does not Granger Cause DSP	(4,2)	11.26*	4.61	3.00	2.30
DSP does not Granger Cause DUK	(2,2)	0.17	4.61	3.00	2.30
DUS does not Granger Cause DSP	(1,1)	47.11*	6.63	3.84	2.71
DSP does not Granger Cause DUS	(2,20)	2.37*	1.88	1.57	1.42

*Reject the null hypothesis. Ho: Y does not cause X. In our case the Stock Prices cause the Exchange Rates or Viceversa. *1% significance level, **5% significance level, ***10%signfiicance level

Appendix 3.2

TABLE 3.2.1: SUMMARY CAUSALITY TEST FOR GERMANY

TYPE OF TEST		**GRANGER CAUSALITY TEST**	
Countries	**Variables**	**AIC**	**HQ**
Hungary	DHGE ⇒ DHGI	Reject Ho	Reject Ho
	DHGI ⇒ DHGE	Accept Ho	Accept Ho
	DGE ⇒ DHGI	Accept Ho	Accept Ho
	DHGI ⇒ DGE	Accept Ho	Accept Ho
	DGE ⇒ DHGE	Accept Ho	Accept Ho
	DHGE ⇒ DGE	Accept Ho	Accept Ho
Poland	DPOE ⇒ DPOI	Reject Ho	Reject Ho
	DPOI ⇒ DPOE	Accept Ho	Accept Ho
	DGE ⇒ DPOI	Accept Ho	Accept Ho
	DPOI ⇒ DGE	Accept Ho	Accept Ho
	DGE ⇒ DPOE	Accept Ho	Accept Ho
	DPOE ⇒ DGE	Accept Ho	Accept Ho
Czech Republic	DCZE ⇒ DCZI	Reject Ho	Reject Ho
	DCZI ⇒ DCZE	Accept Ho	Accept Ho
	DGE ⇒ DCZI	Accept Ho	Accept Ho
	DCZI ⇒ DGE	Accept Ho	Accept Ho
	DGE ⇒ DCZE	Accept Ho	Accept Ho
	DCZE ⇒ DGE	Accept Ho	Accept Ho
Slovakia	DSLE ⇒ DSLI	Accept Ho	Accept Ho
	DSLI ⇒ DSLE	Accept Ho	Accept Ho
	DGE ⇒ DSLI	Accept Ho	Accept Ho
	DSLI ⇒ DUK	Accept Ho	Accept Ho
	DGE ⇒ DSLE	Accept Ho	Accept Ho
	DSLE ⇒ DGE	Accept Ho	Accept Ho

TABLE 3.2.2: SUMMARY CAUSALITY FOR UK

TYPE OF TEST		GRANGER CAUSALITY TEST	
Countries	**Variables**	**AIC**	**HQ**
Hungary	DHGE $\Rightarrow$ DHGI	Reject Ho	Reject Ho
	DHGI $\Rightarrow$ DHGE	Accept Ho	Accept Ho
	DUK $\Rightarrow$ DHGI	Accept Ho	Accept Ho
	DHGI $\Rightarrow$ DUK	Reject Ho	Accept Ho
	DUK $\Rightarrow$ DHGE	Accept Ho	Accept Ho
	DHGE $\Rightarrow$ DUK	Reject Ho	Reject Ho
Poland	DPOE $\Rightarrow$ DPOI	Reject Ho	Reject Ho
	DPOI $\Rightarrow$ DPOE	Accept Ho	Accept Ho
	DUK $\Rightarrow$ DPOI	Reject Ho	Reject Ho
	DPOI $\Rightarrow$ DUK	Accept Ho	Accept Ho
	DUK $\Rightarrow$ DPOE	Accept Ho	Accept Ho
	DPOE $\Rightarrow$ DUK	Reject Ho	Reject Ho
Czech Republic	DCZE $\Rightarrow$ DCZI	Reject Ho	Reject Ho
	DCZI $\Rightarrow$ DCZE	Accept Ho	Accept Ho
	DUK $\Rightarrow$ DCZI	Accept Ho	Accept Ho
	DCZI $\Rightarrow$ DUK	Accept Ho	Accept Ho
	DUK $\Rightarrow$ DCZE	Accept Ho	Accept Ho
	DCZE $\Rightarrow$ DUK	Reject Ho	Reject Ho
Slovakia	DSLE $\Rightarrow$ DSLI	Accept Ho	Accept Ho
	DSLI $\Rightarrow$ DSLE	Accept Ho	Accept Ho
	DUK $\Rightarrow$ DSLI	Accept Ho	Accept Ho
	DSLI $\Rightarrow$ DUK	Accept Ho	Accept Ho
	DUK $\Rightarrow$ DSLE	Accept Ho	Accept Ho
	DSLE $\Rightarrow$ DUK	Reject Ho	Reject Ho

TABLE 3.2.3: SUMMARY CAUSALITY TEST TABLE FOR US

TYPE OF TEST		GRANGER CAUSALITY TEST	
Countries	**Variables**	**AIC**	**HQ**
Hungary	DHGE ⇒ DHGI	Reject Ho	Reject Ho
	DHGI ⇒ DHGE	Accept Ho	Accept Ho
	DUS ⇒ DHGI	Accept Ho	Accept Ho
	DHGI ⇒ DUS	Accept Ho	Accept Ho
	DUS ⇒ DHGE	Accept Ho	Accept Ho
	DHGE ⇒ DUS	Reject Ho	Reject Ho
Poland	DPOE ⇒ DPOI	Reject Ho	Reject Ho
	DPOI ⇒ DPOE	Accept Ho	Accept Ho
	DUS ⇒ DPOI	Reject Ho	Reject Ho
	DPOI ⇒ DUS	Accept Ho	Accept Ho
	DUS ⇒ DPOE	Reject Ho	Reject Ho
	DPOE ⇒ DUS	Accept Ho	Accept Ho
Czech Republic	DCZE ⇒ DCZI	Reject Ho	Reject Ho
	DCZI ⇒ DCZE	Accept Ho	Accept Ho
	DUS ⇒ DCZI	Reject Ho	Reject Ho
	DCZI ⇒ DUS	Accept Ho	Accept Ho
	DUS ⇒ DCZE	Accept Ho	Accept Ho
	DCZE ⇒ DUS	Accept Ho	Accept Ho
Slovakia	DSLE ⇒ DSLI	Accept Ho	Accept Ho
	DSLI ⇒ DSLE	Accept Ho	Accept Ho
	DUS ⇒ DSLI	Accept Ho	Accept Ho
	DSLI ⇒ DUS	Accept Ho	Accept Ho
	DUS ⇒ DSLE	Accept Ho	Accept Ho
	DSLE ⇒ DUS	Accept Ho	Accept Ho

Appendix 3.3

TABLE 3.3.1: Descriptive Statistics

Stock Returns

		Mean	SD	Skewness	Kurtosis	JB
Hungary	Total sample	-5.94E-05	0.0029	0.52	19.65	22741
	Pre Europe	0.000408	0.0152	0.08	7.16	1003
	Post Europe	0.001222	0.0140	-0.34	4.47	63
Czech Republic	Total sample	-1.18E-05	0.0062	0.82	7.55	1911
	Pre Europe	0.000546	0.0129	-0.08	4.19	83
	Post Europe	0.000897	0.0117	-0.51	8.84	837
Slovakia	Total sample	6.99E-05	0.0104	0.38	13.05	8308
	Pre Europe	0.000447	0.0145	-0.62	9.87	2826
	Post Europe	0.001336	0.0114	-0.04	6.21	246
Poland	Total sample	6.35E-04	0.0126	-0.18	5.20	407
	Pre Europe	0.000455	0.0145	0.01	5.43	343
	Post Europe	0.000996	0.0101	-0.71	5.96	257

Exchange Rates

		Mean	SD	Skewness	*Kurtosis*	JB
Hungary	Total sample	-1.10E-04	0.0034	0.04	7.91	1971
	Pre Europe	-5.03E-06	0.0040	2.29	25.50	30550
	Post Europe	0.000172	0.0038	0.51	4.96	116
Czech Republic	Total sample	4.65E-05	0.0040	1.83	20.40	25840
	Pre Europe	-5.79E-05	0.0036	0.05	8.30	1625
	Post Europe	-0.00023	0.0029	-0.09	3.43	5
Slovakia	Total sample	7.08E-04	0.0137	-0.55	9.77	3843
	Pre Europe	-4.79E-05	0.0030	0.62	21.90	20778
	Post Europe	-8.18E-05	0.0026	0.19	9.88	1130
Poland	Total sample	6.21E-04	0.0133	-0.09	5.88	681
	Pre Europe	0.000112	0.0066	0.87	7.61	1407
	Post Europe	-0.00029	0.0050	0.28	3.56	15

TABLE 3.3.2: Augmented Dickey Fuller Test Results

	Variables	Total Sample	Pre Europe	Post Europe
Hungary	E	-44.1*	-16.1*	-18.4*
	S	-28.7*	-26.5*	-5.1*
Czech Republic	E	-31.6*	-22.7*	-24.5*
	S	-9.6*	-36.2*	-21.5*
Slovakia	E	-19.7*	-24.2*	-8.1*
	S	-13.6*	-20.6*	-8.2*
Poland	E	-42.5*	-16.7*	-23.3*
	S	-42.2*	-36.1*	-21.6*

1% critical values for the ADF test

TABLE 3.3.3: Likelihood Ratio Test for EGARCH Model Selection for Conditional Variance Equations

	Stock Returns			**Exchange Rates**		
Country	**Total Sample**	**Pre Europe**	**Post Europe**	**Total Sample**	**Pre Europe**	**Post Europe**
Hungary	1.032	0.078	0.264	1.058	0.03	0.66
Czech Republic	0	4.5	0.006	2.358	0.046	5.392
Slovakia	6439.36*	5.378	2.248	5.88	0.118	0.59
Poland	0.138	5.016	1.268	0.486	1.082	0.006

Note: H_0: EGARCH (1,1), H_1: EGARCH(2,1) The 5% critical value for the LR test distributed as χ^2 with 2 degrees of freedom is 5.99. * indicates rejection of the null hypothesis at 5% significance.

TABLE 3.3.4: Volatility Spillovers Between Stock Returns and Exchange Rate Changes: Total Sample

Estimated Parameters	**Hungary**	**Czech Republic**	**Slovakia**	**Poland**
Volatility Persistence (Stock Returns) ($\sum b_S$)	0.2596 (0.0000	0.1846 (0.000)	0.4905 (0.000)	0.2175 (0.000)
Spillover: from Stock Returns to Exchange Rates ($\sum \delta_{S,E}$)	0.0490 (0.2183)	0.0524 (0.0353)	-0.0209 (0.3951)	-0.0433 (0.169)
Asymmetric Spillover effect:From Stock Returns to Exchange Rates ($\sum \theta_{S,E}$)	0.9105 (0.000)	0.9517 (0.000)	0.9987 (0.000)	0.9478 (0.000)
Volatility Persistence (Exchange Rates) ($\sum b_E$)	0.2103 (0.000)	0.2986 (0.001)	0.2186 (0.002)	0.1064 (0.000)
Spillover: from Exchange Rates to Stock Returns ($\sum \delta_{S,E}$)	-0.0274 (0.423)	0.0719 (0.259)	0.0093 (0.0778)	-0.0028 (0.829)
Asymmetric Spillover effect:From: Exchange Rates to Stock Returns ($\sum \theta_{S,E}$)	0.9263 (0.000)	0.9188 (0.000)	0.8894 (0.000)	0.9898 (0.000)
Correlation Coefficient ($\rho_{S,E}$)	0.3200	0.3810	0.0147	0.3744

TABLE 3.3.5: Diagnostics on Standardised Residuals: Residuals: Total Sample

	Hungary	Czech Republic	Slovakia	Poland
Stock return equation				
Jarque-Bera	2678	311	2442	289
LB(20)	40.00	27.91	228.54	23.22
	(0.005)	(0.112)	(0.000))	(0.278)
$LB^2(20)$	6.83	21.35	18.86	18.66
	(0.997)	(0.377)	(0.531)	(0.544)
Exchange rate equation				
Jarque-Bera	2320	61371	6912	78
LB(20)	13.63	14.52	24.66	17.59
	(0.849)	(0.803)	(0.215)	(0.615)
$LB^2(20)$	10.24	1.11	11.54	12.41
	(0.964)	(1.000)	(0.931)	(0.901)

TABLE 3.3.6: Volatility Spillovers Between Stock Returns and Exchange Rate Changes: Pre Europe

Estimated Parameters	Hungary	Czech Republic	Slovakia	Poland
Volatility Persistence (Stock Returns) ($\sum b_S$)	0.0756 (0.007)	0.1577 (0.000)	0.2023 (0.005)	0.1020 (0.000)
Spillover: from Stock Returns to Exchange Rates ($\sum \delta_{S,E}$)	-0.0370 (0.063)	-0.0249 (0.350)	0.0142 (0.749)	-0.0069 (0.642)
Asymmetric Spillover effect:From Stock Returns to Exchange Rates ($\sum \theta_{S,E}$)	0.9788 (0.000)	0.9620 (0.000)	0.8756 (0.000)	0.9783 (0.000)
Volatility Persistence (Exchange Rates) ($\sum b_E$)	0.3073 (0.002)	0.2460 (0.000)	0.3053 (0.000)	0.1608 (0.006)
Spillover: from Exchange Rates to Stock Returns ($\sum \delta_{S,E}$)	0.0813 (0.250)	-0.0346 (0.431)	0.0440 (0.3280)	0.0953 (0.004)
Asymmetric Spillover effect:From: Exchange Rates to Stock Returns ($\sum \theta_{S,E}$)	0.9117 (0.000)	0.9060 (0.000)	0.8959 (0.000)	0.9032 (0.000)
Correlation Coefficient ($\rho_{S,E}$)	0.0298	0.0017	-0.0502	0.0274

TABLE 3.3.7: Diagnostics on Standardised Residuals: Residuals: Pre Europe

	Hungary	Czech Republic	Slovakia	Poland
Stock return equation				
Jarque-Bera	104	63	5019	78
LB(20)	20.54	30.33	21.89	19.56
	(0.424)	(0.065)	(0.346)	(0.486)
$LB^2(20)$	24.83	16.46	10.62	16.93
	(0.208)	(0.688)	(0.956)	(0.658)
Exchange rate equation				
Jarque-Bera	106756	2110	1572	1976
LB(20)	11.78	11.44	34.56	30.90
	(0.924)	(0.934)	(0.023)	(0.057)
$LB^2(20)$	0.64	8.82	5.61	7.15
	(1.000)	(0.985)	(0.999)	(0.996)

TABLE 3.3.9: Volatility Spillovers Between Stock Returns and Exchange Rate Changes: Post Europe

Estimated Parameters	Hungary	Czech Republic	Slovakia	Poland
Volatility Persistence (Stock Returns) ($\sum b_S$)	0.2103 (0.000)	0.2615 (0.000)	0.2310 (0.003)	0.1426 (0.000)
Spillover: from Stock Returns to Exchange Rates ($\sum \delta_{S,E}$)	-0.0352 (0.471)	-0.1821 (0.000)	0.0364 (0.466)	0.0212 (0.383)
Asymmetric Spillover effect:From Stock Returns to Exchange Rates ($\sum \theta_{S,E}$)	0.9592 (0.000)	0.8801 (0.000)	0.8658 (0.000)	0.9907 (0.000)
Volatility Persistence (Exchange Rates) ($\sum b_E$)	0.0828 (0.111)	0.0873 (0.037)	0.2150 (0.002)	0.0623 (0.306)
Spillover: from Exchange Rates to Stock Returns ($\sum \delta_{S,E}$)	0.1459 (0.003)	-0.0087 (0.763)	-0.0134 (0.827)	0.1261 (0.013)
Asymmetric Spillover effect:From: Exchange Rates to Stock Returns ($\sum \theta_{S,E}$)	0.9654 (0.000)	0.9648 (0.000)	0.9690 (0.000)	0.8495 (0.000)
Correlation Coefficient ($\rho_{S,E}$)	-0.084	-0.012	0.045	0.0142

TABLE 3.3.10: Diagnostics on Standardised Residuals: Residuals: Post Europe

	Hungary	Czech Republic	Slovakia	Poland
Stock return equation				
Jarque-Bera	29	213	432	46
LB(20)	19.55	25.58	38.76	16.19
	(0.487)	(0.180)	(0.007)	(0.705)
$LB^2(20)$	26.71	15.55	8.79	16.65
	(0.144)	(0.744)	(0.985)	(0.676)
Exchange rate equation				
Jarque-Bera	91	2	1308	6
LB(20)	25.38	19.38	26.65	20.49
	(0.187)	(0.497)	(0.145)	(0.428)
$LB^2(20)$	9.71	18.78	6.44	12.66
	(0.973)	(0.536)	(0.998)	(0.891)