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Interlinkages Between Equity, Currency, Precious Metals and Oil Markets: An Emphasis on Emerging Markets

Lucia Morales
Technological University Dublin, lucia.morales@tudublin.ie

UNIVERSITY OF LIMERICK

Lucía de las Nieves Morales Aparicio

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Dedicado a mis Padres,

con todo mi cariño, admiración y respeto

Siempre

Nieves
نور

Dedicated to my Parents with all my

Love, gratitude, admiration and respect

Always

Nieves
نور

To my husband, thank you for being there
Janu S.C & T.Q

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Abstract

This thesis examines the interlinkages between equity, currency, precious metals and oil markets. The study follows an international approach with a special focus on emerging markets in Europe, Asia and Latin America, but without forgetting the importance of the G-7 that represents the most developed markets. The present research also focuses on the existence of interlinkages between these markets and the currency, oil, and precious metals markets. The author of this thesis considered it appropriate to implement such an analysis due to the fact that the relationships between financial markets, currency markets and the above-mentioned commodities markets have not been analyzed to the extent that it is proposed in the present thesis. Using daily data, the study focuses on the investigation of the relationships that exist between these financial and commodity markets for a time period that spans from 1995 to 2008; different time periods and sub-samples are also analysed, in order to obtain an in-depth understanding of the interlinkages between these markets. Both the long-run and the short-run association between these variables are investigated. In doing this, techniques like the Engle and Granger two step, and Johansen cointegration techniques, Vector Error Correction Modelling and Granger causality tests are employed with the main objective of examining the relationship between these financial variables. The study also employs bivariate and trivariate econometric techniques in order to provide sufficient evidence regarding the interlinkages between these markets. As a consequence, the existing evidence is updated and extended by investigating the nature of volatility spillovers between these markets; thus, the sample period is divided into a number of sub periods to analyse the behaviour of these variables before and after the introduction of the Euro, and also before and after the Asian Crisis using GARCH and EGARCH modelling. The main 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 short-run. The results show evidence of a unidirectional causality relationship running from stock returns to exchange rates in some of the countries under analysis, with weak evidence of a causal relationship running from exchange rates to stock returns. In relation to the volatility analysis, there is some commonality regarding the behaviour of the variables, with 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. The analysis of precious metals markets shows that they do not seem to be strongly affected by movements in equity markets; on the other hand, oil prices tend to be positively correlated with precious metals markets, the latter having an important influence on them.

Declaration

I, Lucía de las Nieves Morales Aparicio, declare that this thesis and the work presented in it are my own, and it has been generated by me as the result of my own original research. This thesis is solely the work of the author and it is submitted in partial fulfilment of the requirements of the Doctor of Philosophy in Economics at University of Limerick. I confirm that any material that has been used to the completion of this thesis is accurately presented in the references section, including work that have been presented to conferences and published by the author of this thesis.

Signed: ....

Date: 16th of November 2009

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"You have a choice between a natural stability of gold, and the honesty and intelligence of members of government, with all due respect for those gentlemen, as long as the capitalist system lasts, I advise you to vote for gold"

-George Bernard Shaw-

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CHAPTER I

INTRODUCTION

The issue of interlinkages between several markets such as equity, currency, precious metals and oil, has increasingly captured both the researchers and practitioners' attention. This thesis deals with such interlinkages, with a special focus on emerging markets. This introductory chapter starts with the background and main reasons for attempting this research. The second subsection follows with a discussion of the main research objectives and added value of the research. The third subsection follows with the description of the thesis's structure, where the main regions and markets under analysis are introduced and briefly discussed; finally, the chapter concludes with a few remarks.

1.1 General Background and Motivation for the Research

During the 1990s, there have been important and continuous changes in the world's financial markets. These changes have affected emerging and developed economies alike, especially in terms of eliminating restrictions with regard to capital movements. Technological advances have also played a crucial role allowing individual and institutional investors to trade world wide on a twenty-four hour basis in many assets and markets. The liberalization of capital markets and these technological advances suggest that markets, and especially financial markets, have become more integrated over time; when markets experience an increase in their level of integration, shocks and events that take place in one market can immediately affect other interlinked markets, and can impact directly upon the benefits that investors derive from diversifying their portfolios internationally. If this is the case, and the markets are highly integrated, these benefits will be eradicated in the long-term and investors with long horizons may not benefit from their portfolios (Garret and Spyrou, 1999; Garret, Hyde and Varas, 2004). There will be also a direct effect on the financial stability of the markets, as negative and positive effects will spread among the cointegrated markets; therefore, there is a need for expanding and shedding light for a better understanding of the true nature of relationships between financial markets around the world, and especially with regard to the interlinkages among them. As a consequence, this research is going to focus on examining the levels of connection and integration between the financial markets in the emerging markets in Europe, Asia, and Latin America, and the developed markets represented by the G-7[1]) and commodity markets (precious metals and oil markets). An important reason for attempting this investigation is based on the researcher's interest in improving her knowledge on markets' spillovers effects, and especially in examining whether financial markets have a different behaviour during times of crises and uncertainty, in the background of globalisation. In order to illustrate these situations, it has been considered appropriate to analyse what happened in these markets during the Asian financial crisis, and also when the European single currency was introduced in the Euro zone in 1999. These two time periods are used as they represent particular shocks that had an impact on most of the world economies.

The current economic situation demonstrates that governments, academics and practitioners need to devote more attention to the study and understanding of how their economies behave during times of economic and financial distress, so as to better be prepared to formulate policies that minimise the effects of crises, thereby allowing their economies to recover at a faster pace.

[1] The G-7 encompasses the following countries: Canada, France, Italy, Germany, Japan, the UK and the US.

1.2 Research Objectives, Research Questions and Added Value of the Research

1.2.1 Research Questions and Objectives

The main objective of this thesis is to perform an in depth research that leads to the outcome of adding relevant empirical evidence to the analysis of financial and commodity markets relationships. Therefore, the initial hypothesis of this research postulates a lack of integration between stock and currency markets in emerging economies. After a careful reading of the existing literature in this area, there is no clear evidence that demonstrates with effectiveness the true nature of the relationship between these markets. The analysis of relationships between equity markets and currency markets has captured widespread attention; however, relationships between oil, emerging markets and precious metals markets have received far less attention.

Another issue of great interest is the role of precious metals markets and oil markets when compared to the reaction of the world's stock markets during difficult times. This analysis is gaining in importance as time passes, and if through this research it is feasible to present empirical evidence of the non-existence of relationships between stock markets and precious metals markets, the implication for capital allocations would be enormous.

The main research hypotheses are outlined as follows:

1. As an initial step, this investigation considers that the hypothesis arguing that global markets are becoming more integrated is clearly under question. It is believed that in general developed markets are highly integrated, but this is not applicable when talking about emerging markets, stock returns and exchange rates relationships,

where it is expected to find weak evidence of interdependence between stock and currency markets.

2. The second main hypothesis refers to the analysis of the relationship between stock returns and exchange rates. In this case, the main hypothesis is that exchange rates changes affect stock returns. In order to offer a wide view of the true relationship between these markets, it has been decided to introduce a variety of exchange rates, and to implement the analysis during two particular periods. One of them looks at the effects of the Asian financial crisis on these markets. The other approach analyses the effects of the introduction of the Euro on the world economies.

3. The third topic of interest is the analysis of commodities markets, where the main research interest is focused on precious metals and oil markets. In this case the main research hypothesis is that precious metal markets could have price stability properties, especially during times of financial distress. Therefore, the Asian financial crisis will be taken as an important period of analysis.

1.2.2 Value Added of the Research

This research approach differs in a number of aspects from previous studies in the existing literature. First, the data sample covers a longer and more up to date time period -1995 to 2008 - than existing studies in the area. Second, the research will focus on studying the interlinkages and volatility spillovers between equity, currency, precious metals and oil markets in a combined manner, a clear distinctive feature of this study. Third, the relationship between these financial markets will be analysed, with a particular emphasis on the emerging markets in Eastern Europe, Asia and Latin America. This kind of analysis is very innovative and unique, as it will be covering a broad area, where the empirical evidence on the relationship between these markets will be obtained and most importantly it will be analysed and discussed.

1.3 Structure of the Thesis

The initial approach of this research intends to analyse equity markets and currency markets relationships, with a special attention on emerging markets. Thus, the study will focus on analysing three main regions: East European markets, Latin American markets, and Asian markets. Secondly, the analysis will deal with stock markets' and exchange rates' behaviour with a focus on these markets relationships during the Asian crisis (July 1997 to December 1998). And finally, the analysis of precious metals and oil markets volatility spillovers effects will be presented. The rest of this subsection is a brief discussion of each of the markets and regions included in this thesis.

1.4.1 East European Equity Markets

This study intends to update and provide more evidence regarding the relationship and the integration process between the European equity markets and the major currency markets. In doing this, a first step will be related to the data sample selection, which intends to cover a much updated period of time from 1996 to 2006, with the purpose of paying careful attention to the interlinkages of equity markets and currency markets in Europe. The analysis will focus its attention on the relationship between these two financial markets for four East European countries (Hungary, the Czech Republic, Poland and Slovakia), where three different methodologies will be employed with the objective of performing an in depth analysis of the relationships between these two financial markets. This study will be the first attempt to analyse the relationships between these two variables differentiating between what happened before, during, and after the introduction of the Euro.

1.4.2 G-7 Equity Markets

The aim of this section is to investigate the interdependence of stock returns and exchange rates changes for the G-7 financial markets, with the purpose of identifying which currencies generated a stronger impact on the financial markets in the world major economies before, and after the introduction of the Euro. These results are of key importance for this investigation, as the G-7 markets are be used as a benchmark. The ultimate intention is to compare the behaviour of stock markets and currency markets in the most developed economies, with those of the East European, Asian and Latin American emerging economies.

1.4.3 Asian Equity Markets

The purpose of this analysis is to facilitate a comparison of the relationship between currency depreciation and stock returns before, and after the Asian crisis. In addition to this, it will allow to examine the extent of the differences in the relationship between the stock markets and the exchange rates in this region, and also to draw some conclusions regarding differences and similarities between developed and emerging economies.

1.4.4 Latin American Equity Markets

The aim of this section is to investigate the extent of the relationship between volatility spillovers between stock returns and exchange rates changes for six Latin American financial markets namely: Argentina, Brazil, Chile, Colombia, Mexico, and Venezuela and one European financial market, that of

Spain. The decision to include Spain in the analysis is supported by the high presence of Spanish corporations and investors in the Latin American region. This feature enables us to conduct an analysis of the importance of the Spanish financial markets in the region before, and after the introduction of the Euro. The main expectations are to find evidence of a clear relationship between the Spanish and the Latin American markets before the introduction of the Euro. The objective of this research is to identify whether volatility spillovers between stock markets and exchange rates vary across currencies, and to investigate how this has been affected by the introduction of the Euro.

1.4.5 Precious Metals and Oil Markets

The aim of the chapter is focused on dealing with precious metals markets reactions under the following scenarios: i) First, an analysis of the effects of the Asian crisis (see chapter V) on precious metals returns over the period 1995-2007, paying special attention to the market behaviour over the Asian crisis period (1997-1998), with the intention of analysing the reaction of precious metals returns over a long period, and also of their behaviour during a time of crisis where the major economies were affected by such a serious economic event. ii) Second, an analysis of volatility spillovers between the major financial markets represented by the G-7 economies and the precious metals markets (gold, platinum and silver). The intention is to address the gap in the literature in this area by conducting an in-depth analysis of the relationship between equity and precious metals markets. iii) Finally, an examination of the effects of oil returns on precious metals markets, including the major financial markets (US-Dow Jones Industrial, Japan-Nikkei 225, and UK-FTSE 100) as proxies to identify the existence of interlinkages and volatility spillovers between these markets. This chapter's major objective is to provide empirical evidence on the implications of precious metals returns volatility spillovers for risk management, hedging activities and to contribute to the extension of the research in this area.

1.5 Summary and Conclusions

This research considers of great interest the analysis of the relationship between equity markets, currency markets, precious metals markets and oil prices as they are sources of diversification for investors. By being able to understand what is going on in each of these markets, and how they behave, an investor will have a better chance of diversifying and hedging more profitably his/her investments. For this reason, it was decided to use a worldwide analysis in these areas, which will cover the interaction between the above-mentioned markets with special attention to emerging markets in Asia, Europe, and Latin America. There is a need to understand how this relationship has evolved in the major developed economies; for this reason it was also decided to take the G-7 markets as a benchmark, thereby facilitating a comparative analysis between developed and emerging economies. This research was conducted with the objective of bringing a worldwide picture that enlightens the current understanding of the interlinkages between these different markets.

This thesis will be the first attempt to analyse the relationships between these markets in such a comprehensive way for the countries and markets included in this investigation. This study provides evidence of the attractive characteristics of the markets under study that are useful for portfolio diversification and of considerable significance for hedge and investment fund managers.

The next chapter (Chapter II) presents and discusses the literature review, whereas Chapter III deals with the thesis's data and methodology. In Chapter IV, the empirical results are presented and discussed by region and market. In Chapter V, the empirical results dealing with precious metals and oil markets are described and examined, and finally in Chapter VI conclusions and some recommendations for future research are proposed and discussed.

CHAPTER II

LITERATURE REVIEW

This chapter is structured as follows: first, the analysis of equity markets and currency markets is outlined, where the major findings are organised by region and period. Therefore, the literature starts by discussing research that has been done analysing the world's developed economies markets. Then, it will continue with the presentation of the relevant literature involving the analysis of emerging economies in Asia, Latin America and Europe. In the second part, the studies analysing precious metals markets are presented; in this case, and due to the lack of research, it was decided to organise the findings by period. Third, the literature review concludes with a discussion of the main studies that have been done to-date on precious metal markets, equity markets, and oil markets, an analysis that is also structured by period for the same reason mentioned above. Finally, this chapter concludes by pointing out the thesis's major contributions to the literature in this academic field of research.

2.1 Introduction

The present chapter will present the major studies that have been undertaken to-date, on the relationship between stock prices, foreign exchange rates, precious metals markets and oil prices. This analysis is of interest to academics and practitioners, because these variables play crucial roles in influencing the development of a country's economy. This review is necessary so as to obtain a clear picture of the studies that have been conducted in these areas to-date, and where it is possible to identify clear gaps in the existing research. Especially, there is a lack of analysis regarding stock prices and exchange rates interlinkages in emerging economies, since, as was mentioned in the introductory chapter, most of the research that has been done has paid attention to developed markets. There is also insufficient research done on the role of precious metals markets and oil prices in the world economies. The expectation of relative currency values generates influences on the levels of domestic and foreign interest rates, which in turn affect the present value of a firm's assets, and subsequently impact on the world economies. For this reason, exchange rates play a considerable role in the movements of stock prices, especially for international investors who decide to hold on to their financial assets (Nieh and Lee, 2001). Another fact of great importance is the current world economic situation. Since approximately September 2008, financial markets have been facing challenging times of great instability and uncertainty, that have been compared with what happened during the Great Depression, and with the 1987 markets crash, when the American economy suffered the most. Thus, these are crucial times when investors are looking for alternative options to allocate their capital; also, they are looking for better diversification regarding their choices, so that, as a consequence, they will be able to reduce their exposure to risk. Taking all these facts into account, this research will pay close attention to the analysis of emerging economies, oil markets and precious metals markets, which are presenting interesting characteristics; it is the author's conviction that these markets will become important alternatives for investors. Therefore, they all should be considered as real investment options, and indeed they are worthy of more attention from academics, researchers and practitioners, who should therefore devote more attention to their analysis.

2.2 Equity Markets and Currency Markets

2.2.1. *Developed Economies*

Solnik (1987) analyzed stock 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, the UK and the USA, who represented over 90 per cent of the world's 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 relationship is fairly weak, and it might be caused by the fact that stock returns are a poor proxy for real economic growth.

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 displayed significant cross-sectional differences in their exposure to movements in the dollar, and that there was little evidence that US investors required compensation for bearing exchange risks. He also found that the relationship between stock returns and the value of the dollar differs systematically across industries.

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

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 G-7 countries (Canada, France, Italy, Japan, Germany, the UK, and the US). The methodology used consisted of the Engle-Granger (EG) two steps 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. His analysis 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 to the observed financial factors. The results might be influenced by each country's differences in economic development, government policy, differences in the degree of internationalization and liberalization, and the degree of capital controls from country to country. Therefore, there is a need to homogenize the countries under analysis and to filter the data set by considering economies that share similar characteristics, as this would allow one to get more robust results.

Morley and Pentecost (2000) investigated the nature of the relationship between stock prices and spot exchange rates using monthly data over the period 1982 to 1994 for the G-7 economies. The methodology used consisted of the Engle and Granger test for cointegration between pairs of exchange rate and relative stock market price indices. Their findings indicated that most of the countries tested do not have a common, bilateral long-term trend, with the exception of the UK and Canada. In this case, the data frequency could be a problem, as it is observed that highly frequency data will report better and accurate results.

Griffin and Stulz (2001) examined the importance of exchange rate movements and industry competition for stock returns. They studied 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, the United Kingdom, France, Germany and Japan from 1975 to 1997. Their results showed that the impacts 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. Given that their study is limited to a few countries and also that their time period is quite long, their conclusions should be taken carefully as they are not subject to generalisation. It is clear that the sample is not representative of the world economy, and also that the time period is subject to different economic impacts that should be taken into account in order to filter the data set, as structural breaks affecting the data are a major source of inaccurate estimators.

Nieh and Lee (2001) found no long-term significant relationship between stock prices and exchange rates in the G-7 countries. Their analysis covered the period from October 1, 1993 to February 15, 1996 using daily closing stock market indices and foreign exchange rates for the G-7 countries (Canada, France, Italy, Japan, the UK, Germany, and the US). The methodology used consisted of the Engle-Granger (EG) two steps and the Johansen maximum likelihood cointegration test. They studied the dynamic relationships between the stock prices and the exchange rates for each of the G-7 countries; their results went against most of the previous studies that suggest a significant relationship between stock prices and exchange rates as they rejected the existence of a significant relationship between these two variables. These results are quite surprising, and needed a major discussion and investigation in order to explain why this kind of output was obtained. Again, there could be issues related to the sample under analysis, and also to the techniques employed to investigate these markets interlinkages, in particular the lag length selection criteria used in the analysis should be considered carefully, as the results are quite sensitive to the number of lags used.

Hatemi-J and Irandoust (2002) used the Granger testing procedure developed by Toda and Yamamoto (1995) to analyse the relationship between stock prices and exchange rates in Sweden using monthly nominal effective exchange rates and stock prices covering the period 1993 to 1998. Their results showed that Granger causality is unidirectional and is running from stock prices to effective exchange rates.

Billio and Pelizzon (2003) analysed whether deregulation, globalization, the financial crisis, the convergence in European economies and the introduction of the Euro have produced some effects: (i) on the return distribution of the world market index, (ii) on the volatility spillovers from the world index to European stock markets. They used a Switching Regime Beta model to analyse the implications of the introduction of the Euro on the link between the world index and respectively Germany, France, Italy, Spain and the UK, which are the most capitalized stock markets in Europe. The sampling period was January 1988 to February 2001. Their main findings suggested that the world index volatility and the German market DAX 30 have increased after EMU for most European stock markets. However, they did not observe an increase in the linkages (integration) between European capital markets. As was mentioned in the introductory chapter, the integration of markets is a time varying process that needs a lot of effort and time to be achieved, and at the moment it cannot not be said that markets around the world are integrated. There is consequently a need to be more precise, and to look at the markets on an individual basis.

Shamsuddin and Kim (2003) investigated the integration of the Australian stock market with its two leading partners, the US and Japan, taking into account the interdependence between foreign exchange rates and stock prices. The data used was the end-of-week closing stock price indices for Australia, Japan and the US, and the Australian dollar value of the Japanese yen and US dollar. The national stock indices used were the Standard and Poor's 500 Composite Index for the US, the Tokyo Stock price Index (TOPIX) for Japan and the All Ordinaries Index (AOI) for Australia. They analysed the pre-Asian crisis period that covers two sub-periods: January 1991 to December 1993, and January 1994 to July 1997. The post-Asian crisis period spans over the period January 1999 to May 2001. Their methodology consisted of VAR models and multivariate time series models for each period. They found a cointegrating relationship among the variables prior to the Asian crisis, but such a relationship did not exist in the post-Asian crisis period. The multivariate models indicated that in the pre-crisis period, the Australian stock market was primarily led by the US stock markets (as opposed to Japan); however, in the post-crisis period, the Australian stock markets have become more dependent upon their own past and less on the US market. They also found that stock returns are led by foreign exchange rates but that the former do not significantly influence the latter.

Looking at the research that has been done in the area to-date, and in particular that dealing with developed economies, the major findings tend to be consistent with the idea that stock markets do impact exchange rates, but not the other way around. There is also need to mention that in some cases the results could be influenced by the sample selection (very different countries under investigation), structural breaks, and the methodology selected to investigate this issue; these factors are a major source of discrepancies through the analysis.

2.2.2 *Emerging Economies*

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 present 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 did not Granger cause stock prices and that stock prices did not Granger cause the exchange rates.

Ayayi and Mougoue (1996) examined whether stock prices and exchange rates are related to each other. 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. They employed cointegration and vector error correction modelling techniques and a standard Granger causality test to examine the long-term and short-term association between stock prices and exchange rates. Their results showed no short-term association between stock prices and exchange rates for all four countries. There was also no long-term 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.

Abdalla and Murinde (1997) investigated the interactions between exchange rates and stock prices in the emerging financial markets of India, South Korea, Pakistan and the Philippines. The data set consists of monthly observations from January 1985 to July 1994. 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.

Smyth and Nandha (2003) investigated the interaction between an exchange rate, (US$), 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-term equilibrium relationship between these two financial variables in any of the four countries. Granger causality tests indicated that there was unidirectional 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.

Granger, Huang and Yang (2000) analysed the relationship between stock prices and exchange rates using Asian data. They employed daily data and the methodology consisted of the use of impulse response functions to explore the relationship between the two variables and their dynamics. In addition, they used advanced unit root and cointegration techniques, to study the exchange rates and stock prices for Hong Kong, Indonesia, Japan, South Korea, Malaysia, the Philippines, Singapore, Thailand and Taiwan over the period January 3, 1986 to June 16, 1998. They divided the sample into three sub-periods: period one (1987-crash) covered the period from January 3, 1986 to November 30, 1987; period two (after the crash) started in December 1, 1987 and ended on May 31, 1997 and period three (the Asian flu period), continued from June 1, 1997 through June 16, 1998. Their findings showed that during period one, there existed little interaction between currency and stock markets except for Singapore. The study also indicated that changes in the exchange rates lead stock prices in Singapore. In period two (or after the crash period) there is no definite pattern of interaction between the two markets; however, during period three (the Asian flu period) seven of the nine countries suggested significant relationships between the two markets. In the case of South Korea, changes in the exchange rates led the stock prices. A reverse direction is found in Hong Kong and the Philippines. The rest of the markets (Malaysia, Singapore, Thailand and Taiwan) are characterized by feed back interactions in which changes in exchange rates can take the lead and changes in stock markets can also impact on changes in exchange rates.

Ibrahim (2000) analysed the interactions between stock prices and exchange rates in Malaysia using bivariate as well as multivariate cointegration techniques, and the Granger causality test for the period January 1979 to June 1996. His results suggest the absence of cointegration between stock prices and exchange rates in a bivariate context. However, in a multivariate framework he found that there seems to be a long-term relationship between the stock price index and the exchange rate, reserves and money supply. He also found unidirectional causality from the stock market to the exchange rate. Additionally, a feed back effect from the bilateral RM/US$ rate to the stock market was also observed.

Philaktis and Ravazzolo (2000) investigated the long-term and short-term dynamics between stock prices and exchange rates and the channels through which exogenous shocks impact on these markets through the use of cointegration methodology and multivariate Granger causality tests. They performed their analysis on Hong Kong, Indonesia, Malaysia, Singapore, Thailand and the Philippines over the period 1980 to 1998. Their main findings showed no long-term relationship between the real exchange rate and the local stock market in each Pacific Basin country. The US stock market was found to be an important causal variable, which acts as a conduit through which the foreign exchange and the local markets are linked. The results from the trivariate systems suggest that for all the countries the real exchange rate and US stock prices are positively related to domestic stock prices.

Wu (2000) used an error correction model to explore the asymmetric effects of four different exchange rates on Singapore stock prices, and their effects on economic volatility. The methodology consisted in a p-dimensional vector autoregressive model with Gaussian errors that was formulated into a VECM. The model consisted of six variables: the Strait Times price index of Singapore, Dow Jones Industrial Average Index, four bilateral exchange rates that linked the Singapore dollar with the Malaysian ringgit, Indonesia rupiah, US dollar and Japanese Yen. The study divides the weekly data of the 1990s into four sub-periods: (04/03/1991-01/25/1995), pre-crisis period (02/01/1995-05/25/1997), crisis period (07/02/1997-12/30/1998) and recovery period (01/06/1999-05/31/2000). The results suggest that there is asymmetry in terms of the equilibrium between the stock price and exchange rate relationship with respect to the different countries. It appears that Granger causality runs only in one way from exchange rates to stock prices. The cointegration analysis suggested that for most of the selected periods in the 1990s both the Singaporean currency appreciation against the US dollar, and the Malaysian ringgit depreciation against both the Japanese yen and the Indonesian rupiah, have positive long-term effects on stock prices. These results are quite interesting, as they do not follow the pattern that was found when analysing developed markets, where the main influence is found from stock markets to exchange rates, but with no evidence with regard to a reverse influence.

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. He uses monthly data on the bilateral nominal exchange rates of the four countries, against the US dollar, and the Jakarta Composite Index for Indonesia, the KLSE Composite Index for Malaysia, the PSE Composite Index for the Philippines and the SEI for Thailand's 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 the 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 and between July 1997 and 2003, so as to investigate the effect of the currency crisis on the stock prices before and after the event took place. 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 an error correction model (ECM) and standard Granger Causality tests, he found bidirectional causality for Indonesia and Malaysia and no causality for the Philippines and Thailand over the entire period between these two financial variables. The analysis shows that exchange rates Granger caused stock prices in Indonesia and stock prices led currency markets in Thailand during and after the currency crisis period, and bi-directional causality was detected for Malaysia and the Philippines for both the pre-crisis and post-crisis periods.

Hatemi-J and Roca (2005) used bootstrap causality tests with leveraged adjustments to analyse the link between exchange rates and stock prices in Malaysia, Indonesia, the Philippines and Thailand, before and during the Asian financial crisis of 1997. They used daily data for nominal exchange rates and the Morgan Stanley Capital international price indices for stock prices from 1 January to 31 December 1997. The sample period was divided into two sub-periods: period one from 1 January to 31 July 1997 representing the period before the crisis or the normal situation and period two from 2 July to 31 December 1997 representing the crisis period. They found that during the period before the Asian crisis, and with the exception of the Philippines, exchange rates and stock prices were significantly related, with the direction of causality running from the former to the latter in the case of Indonesia and Thailand, and from the latter to the former in the case of Malaysia. However, during the crisis period, this relationship ceased to exist in any of the countries.

Grambovas (2003) is one of the few studies which analysed this issue and includes certain Eastern European countries, analysing the interaction between exchange rate fluctuations and equity prices for Greece, the Czech Republic, and Hungary. His data set consisted of weekly observations – Friday closing values- of the general stock exchange indices of stock exchanges for Athens (CI), Budapest (BUX), Prague (PX-50), New York (Dow Jones Industrial) and Frankfurt (DAX-30) and spot foreign exchange rates for Greece in relation to the British pound (GBP), Hungary and the Czech Republic in relation to the Deutsche mark (DEM). The data period covers January 1, 1994, to February 28, 2000. He used a trivariate model that included an additional variable as a proxy for the international financial environment based on the rationale that changes in international stock markets can lead to changes in the relevant domestic stock exchange due to issues of international investors' sentiment. The article studies the long-term and short-term dynamics between stock prices and exchanges rates, and the results indicate that there is a relationship between Hungarian exchange rates and stock prices, as well as in the case of Greece. He concluded that these results illustrate that changes in the stock markets may affect exchange rates.

Syriopoulos (2004) analysed the presence of short- and long-term linkages among major emerging Central European stock markets (Poland, the Czech Republic, Hungary and Slovakia), as well as developed markets (Germany and the USA). The sample period is from 1 January 1997 to 20 September 2003. He used an error correction vector autoregressive model to detect cointegration relationships. He found that Central European markets tend to display stronger linkages with their mature counterparts rather than their neighbours.

As it is possible to appreciate, the literature that has been presented so far has shown that there are many empirical studies which have analysed the linkages between exchange rates and stock prices, focusing on the emerging markets and on the main financial markets in the world. A large number of studies have investigated the relationship between stock prices and exchange rates for a variety of countries, using a variety of approaches; this review focuses on the results from relatively recent studies. Yau and Nieh (2006) employed various linear and non-linear time series methodologies to investigate the short-term and long-term relationships among the stock prices of Taiwan and Japan and the NTD/Yen exchange rate during the period of January 1991 to July 2005. They found that the conventional Johansen test and advanced Granger causality test are consistent and both showed no long-term co-movement among the three variables. Furthermore, the results from the Granger causality test showed that bidirectional feedback relationships between the stock prices of Taiwan and Japan are significant. However, there is no significant linkage or causal relationship found between each of the stock prices and the NTD/Yen exchange rate.

Several theoretical models have analysed the link between stock markets and currency markets. The asset market approach to exchange rate determination (Branson, 1983; Frankel, 1983) posits that causality will run from stock prices to exchange rate changes as expectations of financial asset price movements affect the dynamics of exchange rates. Smith (1992) derives an estimator based on an equation for the exchange rate where the stock price is included as an explanatory variable. The goods market approach suggests that causality runs in the opposite direction, from exchange rates to stock prices (Mundell, 1963, 1964; Dornbusch and Fisher, 1980). In these models, movements in exchange rates affect the international competitiveness of firms which in turn affects real income, output and eventually stock prices. These findings are in line with those of Hutson and Stevenson (2009), whose results show that the more open the economy, the more exposed its firms are to exchange rate movements. In Hekman's (1984) model, the exchange rate is an explanatory variable for stock prices.

Much of the available empirical evidence on the linkages between stock markets and exchange rates has concentrated on the first moment[2]. Yang and Doong (2004) note that there is a dearth of empirical evidence that concentrates on the linkages between the second moments of the distribution of the variables.

[2] See for example: Nieh and Lee (2001), Yau and Nieh (2006) for recent evidence on this topic.

A number of studies however have examined the extent to which volatility from one stock market spills over into other stock markets or between different assets[3]. The study by Kanas (2000) was one of the first studies which analysed volatility spillovers from stock returns to exchange rate changes in the US, the UK, Japan, Germany, France and Canada. The author found evidence of spillovers from stock returns to exchange rate changes for all countries except Germany, suggesting that the asset approach to exchange rate determination is valid when formulated in terms of the second moments of the exchange rate distribution for the countries included in his analysis. Volatility spillovers from exchange rate changes to stock returns were insignificant for all countries. Yang and Doong (2004) explored the nature of the mean and volatility transmission mechanism between stock and foreign exchange markets for the G-7 countries. The results point to significant volatility spillovers and to an asymmetric effect from the stock market to the foreign exchange market for France, Italy, Japan and the US, suggesting integration between stock and foreign exchange markets in these countries. Verma, Jackson and Swisher (2005) examined price and volatility spillovers from interest rates and exchange rates to American Depository Receipts (ADRs) originating from Mexico, Brazil and Chile. In terms of volatility spillovers, their results indicated that both interest rates and exchange rates spillover to Brazilian and Chilean ADRs, whereas only exchange rates spillover to Mexican ADRs. In relation to asymmetry, the interest rates of Mexico, Brazil and Chile as well as the exchange rates of Chile, indicate that negative innovations increase volatility more than positive innovations. The only existing evidence on this issue for Asian countries is that of Wu (2005) who examines volatility spillovers between stock prices and exchange rates for Japan, South Korea, Indonesia, the Philippines, Singapore, Thailand and Taiwan for the period 1997-2000, splitting the sample into crisis and recovery periods. He found a bi-directional relationship between the volatility of stock returns and exchange rate changes during the recovery period in all countries except South Korea, as well as significant

[3] See for example: Nelson (1991), Koutmos and Booth (1995), Laopodis (1998).

contemporaneous relationships between the two markets for most of the countries. Furthermore, he found that volatility spillovers increased in the recovery period.

The literature review that has been done so far with regard to the linkages between stock markets, and exchange rates in developed and emerging economies, demonstrates that there is a substantial amount of studies analysing this issue. However, the results appear to be quite mixed, and there is no clear evidence explaining the true nature of the relationship between stock markets and exchange rates. Throughout this analysis, it has become obvious that there are major discrepancies among the studies that have been done; these discrepancies involve issues such as sample size, data frequency, dealings with structural breaks, differences between countries under investigation, and most importantly clear methodology issues. Depending on the model or technique that is used, which can vary from study to study, the results tend to change; therefore, is the author's major concern to deal with the analysis of these issues in a more comprehensive way, so as to present robust and relevant evidence in the area.

2.3 Precious Metals Markets

Mills (2003) investigated the statistical behaviour of daily gold price data from 1971 to 2002. He found that the phenomenon of volatility prices scaling with long-term correlations is important. He found that gold returns are characterised by short-term persistence and scaling with a break point of 15 days. Daily returns are highly leptokurtic with multi-period returns only recovering gaussianity after 235 days.

Batten, Ciner and Lucey (2008) investigated the impact of macroeconomic factors (inflation, monetary aggregates, industrial production, US dollar exchange rates, stock index returns and consumer confidence indices) that affect price returns of precious metals markets (gold, silver, palladium and platinum). They found limited evidence that the same macroeconomic factors jointly influence volatility processes of the precious metals price series, although there is some evidence of volatility feedback between the precious metals series. This finding lends weight to the view that these individual commodities are too distinct to be considered a single asset class or to be represented by a single index.

Most of the research that has been done until now has been mainly focusing on the analysis of the gold market. A main area of interest has been the role of this precious metal as a hedge against inflation. Some studies have also analysed the variables that could be affecting the behaviour of gold prices, but little has been done with regard to the other precious metals (silver, platinum and palladium) as is clearly reflected in the literature review presented. Fortunately, it seems that the trend is changing and that researchers are starting to pay more attention to the other precious metals markets and their behaviour, as they are becoming aware of the importance of these markets in terms of portfolio risk management. But there is still a clear lack of research analysing the reaction of precious metals markets to the different financial crises that had impacted the financial markets in the past. There is also little evidence on the analysis of the relationships between precious metals markets and equity markets, energy markets, major macroeconomic variables, etc. These studies are of key importance as they could provide important information to investors in order to help them diversify their portfolio and to design their hedging strategies.

This thesis's major contribution to the existing literature in this area is that it will provide new evidence on the volatility spillovers analysis. The research approach focuses on a comparative analysis of volatility spillovers between the four precious metals returns (gold, palladium, platinum and silver) over the time period January 1995 to July 2007, using GARCH and EGARCH modelling an analysis that, to the author's best knowledge, has not been done until now.

2.4 Precious Metals Markets, Equity Markets and Oil Markets

There is an extensive literature analysing volatility spillovers in stock markets (Smyth and Nandha, 2003, Ibrahim 2000, Kanas, 2000, Morley and Pentecost

2000). However, the interaction between stock markets, precious metals markets and oil markets has received far less attention. It is well known that the price of various natural resources is of high importance in both policy and business circles (Bernard, et al., 2005). Therefore, the main objective of any work along these lines is to provide an analysis of the interaction existing between the major financial markets represented by the G-7 (Canada, France, Germany, Italy, Japan, the UK and the US) and precious metals markets (gold, platinum and silver), and oil markets based on GARCH (EGARCH) techniques. The key motivation for attempting this research is that precious metals markets and oil markets could represent an important option for investors in order to diversify their investment strategies and portfolios.

Aggarwal, Inclan and Leal (1999) examined the kind of events that caused shifts in the volatility of emerging stock markets, using an iterated cumulative sum squares (ICSS) algorithm to identify the points of shocks/sudden changes in the variance of returns in each market and how long the shift lasts. They identified that the October 1987 crash was the only global event during the period 1985-1995 that caused a significant jump in the volatility of several emerging stock markets. They examined ten of the largest emerging markets in Asia and Latin America. Their findings showed that the high volatility in emerging markets is marked by several shifts; the large changes in volatility seem to be related to important country-specific political, social and economic events. The number of change in variance varies from country to country and they also depend on the frequency of the data. More change points are found with daily returns than with weekly or monthly returns.

Fernández (2004) examined the presence of structural breaks in volatility using two alternative approaches, the iterative cumulative sum of squares (ICSS) algorithm and wavelet analysis, looking at the effect of the outbreak of the Asian crisis and the terrorist attacks on September 11, 2001, on emerging Asian and Latin American markets. She also analyzed North American and European stock markets. Her results showed that the numbers of shifts detected by the two methods were substantially reduced when filtering out the data for conditional heteroskedasticity and serial correlation. In particular, for the filtered stock data, the ICSS algorithm did not find any volatility shifts over 1997-2002, whereas the wavelet analysis found evidence of volatility breakpoints at some given scales of the data and only for 1997-1998.

Fernández and Lucey (2006) analyzed the implications for portfolio management of accounting for conditional heteroskedasticity and structural breaks in long-term volatility. They based their analysis on PGARCH models fitted to the return series. They used weekly data of the Dow Jones Country Titans CBT municipal bond, spot and futures prices of commodities for the period 1992-2005. They also applied their procedure to artificial data generated from distribution functions. They concluded that neglecting GARCH effects and volatility shifts may lead to overestimating financial risk at different time horizons.

The literature review continues presenting significant research looking at the interaction between precious metals markets.

Taylor (1998) investigated precious metals (gold, platinum and silver) reactions against inflation. He tested the hypothesis that precious metals act as short-term and long-term hedges against inflation. He focused his analysis on the period before 1939 and around the second OPEC oil shock in 1979. During no other period could precious metals be used to hedge inflation. His analysis noticed that the belief that precious metals (in particular gold) have frequently acted as hedges against inflation until very recently is completed unfounded. He found that there have been particular periods during the last 80 years when precious metals have been used as a short-term hedge against inflation, but they could not be used to hedge inflation around the first oil crisis in 1973/74 or during the last ten years -1999 to 2009. Since he found a cointegrated relationship between metal prices and the level of the CPI (consumer price index) with the help of a VAR model, it can be inferred that precious metals can be used as a long-term inflation hedge.

Mills (2003) investigated the statistical behaviour of daily gold price data from 1971 to 2002. He found that the phenomenon of volatility prices scaling with long-term correlations is important and that gold returns are characterised by short-term persistence and scaling with a break point of 15 days. Daily returns are highly leptokurtic with multi-period returns only recovering gaussianity after 235 days.

Aggarwal and Lucey (2005) examined the existence of psychological barriers in a variety of daily and intraday gold price series. They analysed three data sets: daily gold prices from the official London AM fix over the period 2/11/1980-31/12/2000, daily data from COMEX for cash and futures gold for the period 2/11/1982-28/11/2002, high frequency data, a set supplied by UBS London over the period 28/08/2001-09/01/2003. They found evidence that psychological barriers at the 100's digits (price levels such as $200, $300, etc) do exist in daily gold prices, while the evidence is weaker for high frequency data for gold. They also found significant evidence of changes in conditional means around psychological barriers.

Xu and Fung (2005) examined patterns of across-market information flows for gold, platinum, and silver futures contracts traded in both the U.S and Japanese markets. They analysed daily data for gold, platinum and silver futures contracts traded in the U.S and Japan over the period from November 1994 to March 2001. Their results indicate that pricing transmissions for precious metals contracts are strong across the two national markets, but information flows appear to lead from the U.S market to the Japanese market in terms of returns. There are strong volatility spillover feedback effects across both markets and their impacts appear to be comparable and similar. The authors also found evidence that intraday pricing information transmission across the two precious metals futures markets is rapid, as offshore trading information can be absorbed in the domestic market within a trading day.

Batten and Lucey (2006) analysed the volatility structure of gold, trading as a futures contract on the Chicago Board of Trade using intraday (high frequency) data from January 1999 to December 2005. They used GARCH modelling and the Garman Klass estimator. They found significant variations across the trading days consistent with microstructure theory[4], although volatility is only slightly positively correlated with volume when measured by tick-count.

Tully and Lucey (2006) investigated the macroeconomic influences on gold using the asymmetric power GARCH model (APGARCH). They examined cash and futures prices of gold and significant economic variables over the 1983-2003 period, paying special attention to two periods, around 1987 and in 2001, the year of the equity market crash. Their results suggest that the APGARCH model provides the most adequate description for the data, with the inclusion of a GARCH term, free power terms and unrestricted leverage effect terms. They also found that the gold cash and futures data over a long period confirmed the US dollar is the main macroeconomic variable which influences gold.

Hiller, Draper and Faff (2006) investigated the role of precious metals in financial markets by analysing daily data for gold, platinum and silver from 1976 to 2004. They included the S&P 500 Index as a proxy for stock market returns from the US investors' perspective. They found that all three precious metals have low correlations with stock index returns, which suggests that these metals may provide diversification within broad investment portfolios. They found that normally financial portfolios that contain precious metals perform significantly better than standard equity portfolios. They also found that precious metals exhibit some hedging capability during periods of abnormal market volatility.

As is possible to appreciate in the literature review carried out, most of the studies have been conducted analysing precious metals markets on their own (Taylor, 1998; Mills, 2003; Aggarwal and Lucey, 2005). Few studies have paid attention to the interlinkages that could exist between stock markets and precious metals markets (Hiller, Draper and Faff 2006), and no study has analysed the interactions between stock markets, precious metals markets and oil markets.

[4] For more details see O'Hara (1998).

Finally, and by way of conclusion with this literature review, the next part will be outlining relevant research taking into account oil markets.

Huan, Masulis and Stoll (1996) examined the relationship of oil futures returns to stock returns during the 1980s using a vector autoregressive (VAR) approach to study the lead-lag relationship between oil futures returns and stock returns while controlling for interest rate effects, seasonality and other effects. Their conclusions were that oil futures returns are not correlated with stock market returns. Despite the frequently cited importance of oil for the economy, the authors found little evidence of such a link. In fact, the lack of correlation suggests that oil futures, like other futures contracts also appear to have little correlation with stocks. This lack of correlation is a good vehicle for diversifying stock portfolios.

Ewing, Malik and Ozfidan (2002) analyzed how volatility in the oil and natural gas sectors changes over time and across markets, by examining the bivariate and univariate time-series properties of oil and natural gas index returns. They analyzed daily closing values for the period from 01/04/1996 to 29/10/1999, and they found that volatility (conditional variance) in oil returns was directly affected by its own volatility, and by the volatility in the natural gas returns. Thus, they found a significant direct and indirect transmission of volatility in oil returns from the natural gas sector to the oil sector, but they did not find that volatility in oil returns was affected by shocks originating in either the oil sector or gas sector. Also, they found an indirect effect of shock in the natural gas sector on the oil sector. The behaviour of natural gas return volatility differs from that of oil.

Al-Eisa, Al-Nsour, and Hammoudeh (2003) provided an institutional analysis of the financial valuations for the individual Gulf Cooperation Council (GCC) markets (Oman, Kuwait, Bahrain, Saudi Arabia and UAE). They examined whether any long-term relationship exists among these markets, using cointegration techniques and investigating the transmission of changes and volatility in oil prices, as represented by the NYMEX oil futures prices, to the individual GCC stock markets, using the vector error correction models and the GARCH models. They analysed daily data for the GCC stock indices and the oil prices that cover the period 15/02/1994 to 25/12/2001. They found that the five GCC markets are strongly cointegrated, which means that they have many long-term relationships and that they co-moved over time. Oil price volatility spillovers are significant in all the GCC markets; this volatility moves in the same direction with the oil volatility at NYMEX, meaning that if the oil prices become more volatile in NYMEX, the share prices in GCC markets feel this volatility.

Agren (2006) studied volatility spillovers from oil prices to stock markets within an asymmetric BEKK model, using weekly data on the aggregate stock markets of Japan, Norway, Sweden, the UK and the USA. He found strong evidence of volatility spillovers for all stock markets with the exception of the Swedish one, where only weak evidence was found. News impacts showed that, although statistically significant, the volatility spillovers are quantitatively small. The stock market's own shocks, which are related to other factors of uncertainty than the oil price, are more prominent than oil shocks.

Spargoli and Zagaglia (2007) studied the linkages between prices of oil futures traded on the New York Mercantile Exchange and the Intercontinental Exchange of London. They estimated a structural BEKK-GARCH model on daily data from the 26^{th} of April 1998 to the 26^{th} of April 2007 on prices of futures. The main conclusion from their analysis is that in normal periods, NYMEX and ICE futures are used by investors for hedging purposes. However, in turbulent periods when there are peaks in the structural conditional variance of both markets, the structural correlation between them is positive and hedging is no longer feasible.

The analysis of the literature shows that oil shocks and stock markets have received much attention with regard to the study of their individual and related behaviour, but there is a clear and astonishing lack of evidence regarding the interaction of these markets with precious metal markets. Therefore, this thesis's objective is to analyze volatility taking into account the ICSS algorithm to detect jumps in volatility using a GARCH (1,1) and a EGARCH (1,1) approach; the intention is to identify sudden changes in variance which will be used to correct the GARCH model. Therefore, it will provide an opportunity to do a comparison between the results without taking into account the jumps and also, what happens after the model is corrected by adding jumps and possible structural breaks; this correction will allow us to demonstrate the existence of a possible bias in the methodology when the data set is not subject to breakpoints adjustments. The same analysis will be done employing an EGARCH model in order to compare the results.

2.5 Major Contributions to the Existing Literature

2.5.1 Equity Markets

The current analysis takes into account four European Equity markets, in particular four East European markets namely, the Czech Republic, Hungary, Poland and Slovakia, for the period 1996-2006. Special attention is devoted to the relationships between equity and currency markets taking into account the domestic currency as well as a wide range of cross exchange rates that analyse the relationship between equity markets and currency markets before, during and after the introduction of the Euro.

The research also pays attention to the relationship of these variables in the Asian Equity Markets (Hong Kong, South Korea, Singapore, Taiwan and Thailand, for the period 1 January 1997 to 7 July 2006) with an emphasis on the Asian crisis and on the introduction of currency depreciation to model volatility spillovers using a GARCH and EGARCH model.

The Latin American Equity Markets are represented by six of the major markets in the area analysed (i.e. Argentina, Brazil, Chile, Colombia, Mexico and Venezuela) and the European equity market is represented by Spain. The Spanish market has been selected due to the high presence of Spanish companies in the area and therefore, due to the important effect that those Spanish investors have in the zone. Special attention is placed on the effects of the Euro and the US dollar. A division between time periods, by taking into account the market behaviour before, during, and after the introduction of the Euro, is done so as to obtain clear evidence on the stock market behaviour. Also, it was decided to introduce cross exchange rates, not just exchange rates based on the domestic currency versus the US dollar as most of the research has done to-date, and as was well illustrated in the literature review. Therefore, this research considers the analysis of the regional currencies versus the hardest currencies, a framework that provides new evidence and also a better understanding of the relationships between stock returns and exchange rates changes.

The G-7 equity markets (Canada, France, Germany, Italy, Japan, the UK and the USA) are also analyzed for the period 1 January 1996 to 31 December 2006. The G-7 equity markets mirror the behaviour of the developed markets. This group is of key importance to the study as it will allow a comparison between different economies. This study is very significant, as it will allow the finding out of whether there are major differences and/or similarities between these different markets. Consequently, it will provide a better understanding of what happens in major developed economies, and indeed in the emerging markets located in Europe, Asia and Latin America.

2.5.2 Precious Metals Markets

Given the economic significance of the precious metals market, it is somewhat surprising to see the paucity of published research investigating the price dynamics and linkages between these assets as between precious metals and other assets (Batten, Ciner, and Lucey, 2008). This thesis's major contribution to the existing literature in this area is of great importance as it allows us to provide new evidence on the volatility spillovers analysis on precious metals markets. The study's main approach focuses on a comparative analysis of volatility spillovers between the four precious metals returns (gold, palladium, platinum and silver) over the time period January 1995 to April 2008, using GARCH and EGARCH modelling. This is aimed at providing new evidence regarding the interaction of precious metals markets, equity markets and oil markets.

As could be inferred from the literature review, there is an extensive literature analysing volatility spillovers in stock markets; however, the interaction between stock markets and precious metals markets has received far less attention. Therefore, a main motivation and interest for this research is to focus on the potential role that precious metals markets could play as an important option for investors in order to diversify their investment strategies and portfolios. In this regard this research's major contribution to the existing literature in this area is that it will provide new evidence on the relationships among these markets by updating and extending the current evidence and introducing a new approach with a particular interest on volatility spillovers analysis. Therefore, this approach focuses on the analysis of volatility spillovers between the seven major stock markets (represented by the G-7), the emerging markets of Asia and Latin America, precious metals markets, and oil prices over the time period 1995 to 2008.

CHAPTER III

DATA AND METHODOLOGY

The objective of this chapter is the presentation of a detailed description of the data sets and the methodology that will be used and implemented to analyse and provide a constructive answer to this thesis's research questions.

Accordingly, this chapter is structured as follows: the first subsection provides a significant description of the different data sets that will be used in the analysis. Once this is concluded, the chapter continues with the presentation of the key econometric models that will be employed, with a careful explanation on how they are going to be implemented.

3.1 Data

This section sets out the details of the data used to analyse the relationship between exchange rates, stock prices, precious metals, and oil markets. The original data set was subject to some modifications; all holidays and other closing days were removed from the sample in order to avoid inconsistencies with the data set, and also in order to avoid problems related to the model estimation that could affect the results of the regression. The data sets were taken from DataStream and the Federal Reserve Statistical Release.

3.1.1 European Equity Markets Data

The data used to analyse the relation between the exchange rates and stock prices in the European context consist of four East European markets, the Czech

Republic, Hungary, Poland and Slovakia, for the period January 1996 to December 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. The data set is detailed as follows: for exchange rates, the Czech Koruna, Hungarian Forint, Polish Zloty, and the Slovak Koruna are selected. For the stock prices, the Prague SE PX, Budapest BUX, Warsaw General Index, and the Slovakia SAX 16 are chosen. 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.

3.1.2 Asian Equity Markets Data

In this subsection, the main analysis has the purpose of investigating volatility spillovers between stock returns and exchange rate changes for five Asian markets, namely Hong Kong, South Korea, Singapore, Taiwan and Thailand, for the period 1 January 1997 to 7 July 2006. The data set consists of daily closing values for the Hang Seng, Strait Times, Korea SE Composite, Taiwan SE Weighted, and the Thailand SE TISCO stock market indices, and the Hong Kong$, Singapore$, South Korea Won, Taiwan New Dollar and Thai Bhat foreign exchange rates against the US$. The sample has a total of 2485 observations for each series. The time period has been selected in order to be consistent with the analysis that will be done in the rest of the emerging economies, and also bearing in mind the fact that the Asian crisis deserves particular investigation.

3.1.3 G-7 Equity Markets Data

The analysis will be conducted with the purpose of investigating volatility spillovers between stock returns and exchange rate changes for the G-7 (Canada, France, Germany, Italy, Japan, the UK and USA) for the period 1 January 1996 to 31 December 2006. As was mentioned before, the time period is selected for consistency purposes with regard to the rest of the research. In order to better understand and analyse the relationship between these two variables, it was decided to split the sample into three sub samples. Initially, the analysis will concentrate on the relationship between these two variables before the irrevocable fixing of exchange rates in the Eurozone; so, the first sub sample will span over the 1996-1998 sub-period. Then the analysis moves to the time period after the fixing of the exchange rates in the eurozone, i.e. after 1999. The author is interested in examining whether the first years of the single currency in the European financial markets affected the relationship between these variables. The sample is therefore split into two sub periods: 1999-2001 covers the period during which the markets were working with the single currency before its physical introduction. Finally, the last period covers 2002-2006, the period when the Euro was physically introduced in the financial markets, allowing us to observe the behaviour of the research variables when the Euro was gradually introduced. The data set consists of daily closing values for the stock market indices in each country, as well as daily closing values for the exchange rates of each country against the Euro, DM, UK£, Swiss Franc (CHF), Japanese Yen and the US$. The main reason for including these exchange rates in the analysis is based of the need to examine whether volatility spillovers are stronger from certain currencies during the sample period. This gives a total of 2766 observations for each series.

3.1.4 Latin American Equity Markets Data

The following subsection focuses on analysing the period 1 January 1998 to 31 December 2006[5], and as has been done previously, this time period will be split into three additional sub samples, in order to provide greater detail and evidence on the analysis of volatility spillovers between stock returns and exchange rates. Thus, the first sub sample analyses 1998, the period prior to the introduction of the Euro. This first subsample will provide valuable information identifying whether the first years of the introduction of the European single currency affected the relationship between these variables given the economic weight of Spain in these countries. The second period cover the years 1999-2001, and the third period spans over the years 2002-2006 when the Euro was physically introduced into circulation. As previously, in order to keep consistency throughout this research the data set consists of daily closing values for the stock market indices in each country as follows: Argentina (Merval), Brazil (Bovespa), Chile (IGPA Gen), Colombia (CSE Index), Mexico (IPC), Venezuela (IBC) and Spain (IBEX 35). Therefore, the sample consists of daily closing values for the exchange rates of each country against the Euro, UK£, Japanese Yen and the US$, and of the exchange rates of each country versus the six Latin American exchange rates. These exchange rates have been included to examine whether volatility spillovers are stronger for certain currencies during the sample period, giving a total of 2176 observations for each series. As was mentioned in the introductory chapter, it is the author's conjecture that some currencies will present different linkages with stock markets. This has not yet been proved, as no research has attempted to introduce a great number of exchange rates, as is going to be done in this chapter.

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[5] In the case of Colombia, we are unable to present results before 2002 as DataStream only provided data for the CSE Index after July 2001.

3.1.5 Precious Metals Markets and G-7 Equity Markets Data

The analysis of precious metals and the G-7 equity markets focuses on the period 1 January 1995 to 31 December 2006. The whole sample will be studied and also, as it was done for the European Union section, it is considered of importance to split the sample into three sub samples, as this will provide greater details and a better understanding of volatility spillovers between stock returns and precious metals returns during the Asian crisis. Thus, the first subsample spans over the years 1995-June 1997, the period prior to the Asian crisis. The main research interest is based on examining if the Asian crisis could generate volatility spillovers between these financial markets. The second subsample will cover the July 1997- 1998 period, when the crisis hit the markets, and finally the last sample period covers the years 1999-2006, with the intention of investigating the behaviour of these markets after the major shock. The data set consists of daily closing values for the stock market indices in each country as follows: Canada (S&P/TSX Composite), France (CAC 40), Germany (DAX30), Italy (MIB 30), Japan (Nikkei 225), the UK (FTSE 100), and the US (Dow Jones Industrial). In the case of the precious metals data, it was decided to take the US$/Troy ounce for gold, the London Free Market Platinum price in US$/Troy ounce, and the Zurich silver price in US$/kilogram, giving a total of 3130 observations for each series.

3.1.6 Precious Metals Markets and the Asian Crisis Data

This section analyses precious markets interlinkages during the Asian crisis, focusing the investigation on the period 1 January 1995 to 31 July 2007. Again, for consistency motives it has been judged appropriate to analyse the whole sample and also to attempt the analysis of three subsamples. Thus, the first subsample spans over the years 1995-June 1997, the period prior to the Asian crisis. The second subsample will cover the July 1997-1998 period when the crisis hit the markets, and finally, the last sample period covers the years 1999-2006. The data set consists of daily closing values for precious metals data; where the US$/Troy ounce is chosen for gold, the London Free Market Platinum price in US$/Troy ounce, the London Free Market Palladium price in US$/Troy once, and the Zurich silver price in US$/kilogram, giving a total of 3282 observations for each series.

3.1.7 Precious Metals Markets, Equity Markets and Oil Prices Data

Finally, and in order to conclude this research, the interactions between precious metals, equity markets and oil prices will be analysed. In this case the data sample will focus on the period 1 January 1995 to 25 April 2008. The data set consists of daily closing values for the stock market indices for the major markets: the US (Dow Jones Industrials), the UK (FTSE-100) and Japan (Nikkei 225). In the case of the precious metals data, the US$/Troy ounce for gold is chosen, the London Free Market Platinum price in US$/Troy ounce, and the Zurich silver price in US$/kilogram, and finally, the oil prices are selected taking into account the Crude Oil Brent, and the Crude Oil-WTI Spot Cushing, giving a total of 3480 observations for each series.

3.2 Methodology

This subsection deals with the main econometrics models that are going to be used in order to get the empirical results. Initially, an explanation of each methodology will be provided. First, the bivariate analysis is introduced, followed with the explanations related to the trivariate analysis; finally, the section concludes dealing with the issue of volatility modelling and complementary techniques, used to improve the research results.

3.2.1 Bivariate Analysis

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; testing for serial correlation of errors, using the Lagrange Multiplier (LMF test); testing for cointegration, using the Engle-Granger procedure and Johansen Cointegration test; the Granger causality test is also used to investigate the causal relationship between stock prices and exchange rates in the markets included in the data sets. In addition to the Granger Causality test, the author has also decided to apply a bivariate causality test, following the methodology used by Abdalla and Murinde (1997). The objective is to obtain results that allow comparisons; this will provide a higher quality level to the study.

As an initial step in the cointegration analysis, a stationarity test will be performed on each of the relevant variables that are included in the analysis; this is done to ensure that the final results from the study 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 roots:

$\Delta Y_t = \gamma Y_{t-1} + \varepsilon_t$ Pure random model. **(3.1)**

$\Delta Y_t = a_0 + \gamma Y_{t-1} + \varepsilon_t$ Model that adds an intercept and drift term. **(3.2)**

$\Delta Y_t = a_0 + \gamma Y_{t-1} + a_{2t} + \varepsilon_t$ Model that adds an intercept and linear time trend. **(3.3)**

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:

$$\Delta Y_t = \alpha + \gamma Y_{t-1} + \sum_{i=2}^{p} \Delta Y_{t-i+1} + \varepsilon_t \qquad \textbf{(3.4)}$$

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 one to verify that the residuals are white noise. The Lagrange Multiplier test is undertaken, as this test is valid in the presence of lagged dependent variables and also it tests for higher order autocorrelation.

$$Y_t = \beta_0 + \beta_1 X_{1t} + \ldots + \beta_k X_{kt} + \mu_t \qquad \textbf{(3.5)}$$

$$\text{with } \mu_t = \rho_1 \mu_{t-1} + \ldots + \rho_p \mu_{t-p} + \varepsilon_t \qquad \textbf{(3.6)}$$

$$\hat{\mu}_t = Y_t - \hat{\beta}_0 - \hat{\beta}_1 X_{1t} - \ldots - \hat{\beta}_k X_{kt} \qquad \textbf{(3.7)}$$

After applying these equations and establishing whether or not the series are stationary, it will be possible to proceed and perform the cointegration test on the variables. The methodology to determine if the variables are cointegrated will involve the use of Engle and Granger technique, which will identify the long - term relationships between stock prices and exchange rates in each market. For this purpose, the long-term estimated equilibrium relationship will be of the form:

$$Y_t = \beta_0 + \beta_1 X_t + \varepsilon_t \qquad \textbf{(3.8)}$$

Following this, and to make the results stronger, there is a need to check for the existence of serial correlation in the residuals, using the Lagrange Multiplier test. If it is found that there is serial correlation in the errors, there will be a need to estimate the following model adding sufficient lags until the series get rid of serial correlation:

$$\hat{Y}_t = a_1\hat{Y}_{t-1} + \sum_{i=1}^{k}\beta_i\Delta\hat{Y}_{t-i} + \varepsilon_t \qquad \textbf{(3.9)}$$

The Johansen Cointegration test is also used to investigate the long-term relationship between stock prices and exchange rates. Enders (2004) notes since the 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. Therefore, the author decided to first estimate the lag selection tests up to 20 lags. In terms of choosing between the various lag length selection criteria the research by Johansen et al (2000) is used. These authors noted that when different information criteria suggests different lag lengths, it is common practice to prefer the Hannan Quinn (HQ) criterion, as the Akaike's information criteria (AIC) tends to overestimate the appropriate number of lags. Due to the above, it has been decided to use both criteria, which will allow verifying if the results obtained using the different criteria are consistent. After performing the VAR models for the Johansen test it is necessary to ensure that there is no serial correlation in the lag length selected from the optimal VAR model. Therefore, the Lagrange Multiplier (LM) test for serial correlation will be implemented up to the number of lags that the VAR indicates. It has also been decided to test for normality on the errors using Cholesky, Doornik and Urzua versions of the Jarque Bera test for normality on the errors, and finally, an additional test for the absence of heteroskedasticity will be done. Once it has been verified that the errors are not serially correlated, normal and homokedastic it will be possible to proceed and conduct the Johansen Cointegration Test. In this regard, there are five possible models to choose from for the Johansen test, and they are specified as follows:

$$H_2\, I: \quad \Pi y_{t-1} + B\, x_t = \alpha\, B'\, y_{t-1} \qquad \textbf{(3.10)}$$

$$H^*_1\, \mathrm{I}: \quad \Pi y_{t-1} + B\, x_t = \alpha\, (B' y_{t-1} + p_0) \qquad \textbf{(3.11)}$$

$$H_1 \text{ I } : \quad \Pi y_{t-1} + B\, x_t = \alpha\, (B' y_{t-1} + p_0) + \alpha_\tau\, \gamma_0 \qquad \mathbf{(3.12)}$$

$$H^* \text{ I } : \quad \Pi y_{t-1} + B\, x_t = \alpha\, (B' y_{t-1} + p_0 + p_1\, t) + \alpha_\tau\, \gamma_0 \qquad \mathbf{(3.13)}$$

$$H \text{ I } : \quad \Pi y_{t-1} + B\, x_t = \alpha\, (B' y_{t-1} + p_0 + p_1\, t) + \alpha_\tau\, (\gamma_0 + \gamma_1\, t) \qquad \mathbf{(3.14)}$$

Equation 3.10 has no deterministic trends in the level data and no intercepts in the cointegrating equations. Equation 3.11 has no deterministic trends in the level data and the cointegrating equations have intercepts. Equation 3.12 has linear trends in the level data, but the cointegrating equations only have intercepts. Equation 3.13 has linear trends in both the level data and the cointegrating equations, and equation 3.14 has quadratic trends in the level data and linear trends in the cointegrating equations. Harris and Sollis (2003) note that model 3.10 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 noted that model 3.14 with quadratic trends is economically hard to justify, since when the variables are entered in logs, as they are in the model used in this research, this would imply an ever increasing or decreasing rate of change. This leaves a choice between models 3.11 to 3.13. Johansen (1992) suggests choosing the appropriate model according to the Pantula principle. Where all three models (equation 3.11 to 3.13) 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. For the Johansen test, Chang and Caudill (2005) note that the λ_{trace} test statistic is more robust to both skewness and excess kurtosis than the λ_{max} test statistic; for comparative purposes, this research shows both the results of the λ_{trace} and the λ_{max} test statistics. This procedure is applied to the current analysis with the objective of obtaining the best results.

The basic idea of the Granger causality test is that a variable X Granger causes Y, if past values of X can help in explaining Y (Koop, 2004). One important detail to bear in mind is that if Granger causality holds, this does not guarantee that the inverse relationship will hold, that is that Y causes X.

Nevertheless, if past values of X have an explanatory power for current values of Y, it at least suggests that X might be causing Y.

The initial model for the causality test will be:

$$Y_t = \alpha_0 + \beta_1 Y_{t-1} + \beta_2 X_{t-1} + \varepsilon_{yt} \tag{3.15}$$

This simple regression model will allow for the interpretation of 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. The coefficient β_2 is the coefficient measuring the influence of X_{t-1} on Yt. The null hypothesis can be stated as follows:

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

If $\beta_2 = 0$, this means that past values of X have no effect on Y and there is 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 it is possible to conclude that X Granger causes Y.

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

An important factor to take into account in the causality analysis is that it could be feasible to find that Y Granger causes X, but there is no need for the opposite relationship to happen, thus X Granger could or could not cause Y. In terms of the current analysis, this means that it will be possible to find that stock prices may cause exchange rates variations, 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. This is expressed as:

$$Y_t = \alpha_0 + \beta_1 Y_{t-1} + \beta_2 X_{t-1} + \varepsilon_{yt} \quad \textbf{(3.16)}$$

$$Y_t = \sum_{i=1}^{n} \alpha_b Y_{i=1} + \sum_{i=1}^{n} \beta_c X_{i=1} + \upsilon_T \quad \textbf{(3.17)}$$

$$X_t = \sum_{i=1}^{n} \lambda_i X_{t-1} + \sum_{j=1}^{n} \gamma_j Y_{t-1} + \upsilon_T \quad \textbf{(3.18)}$$

$$\left.\begin{aligned} H_0 &: \sum_{i=1}^{n} \beta_i = 0 \\ Ha &: \sum_{i=1}^{n} \beta_i \neq 0 \end{aligned}\right\} \text{Hypothesis when X causes Y} \qquad \left.\begin{aligned} H_0 &: \sum_{j=1}^{n} \gamma_i = 0 \\ Ha &: \sum_{j=1}^{n} \gamma_i \neq 0 \end{aligned}\right\} \text{Hypothesis when Y causes X}$$

Following the methodology of Engle and Granger, if it is found that two variables are cointegrated, it will be necessary to estimate an error correction mechanism (ECM). The ECM allows examining the short term behaviour between the various equity markets. To perform the ECM, the author follows the methodology set out in the Granger Representation Theorem. 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 are found to be cointegrated, there will be a need to construct the error correction mechanism that will allow one to assess the validity of the model that it is being used. With this purpose, the estimation of the ECM will be done through the following equation:

$$\Delta Y_t = \beta_0 + \lambda e_{1,t-1} + \beta_1 \Delta Y_{t-1} + \beta_2 \Delta X_{t-1} + \varepsilon_{yt} \quad \textbf{(3.19)}$$

Therefore, if the results suggest that the variables are cointegrated, the ECM for this research will be formulated as follows:

$$\Delta Y_t = \beta_0 + \lambda e_{1,t-1} + \beta_1 \Delta Y_{t-1} + \beta_2 \Delta X_{t-1} + \varepsilon_{yt} \tag{3.20}$$

$$e_{t-1} = Y_{t-1} - \alpha_0 - \beta_1 X_{t-1} \tag{3.21}$$

$\lambda < 0$ Hypothesis to test in the ECM, where e_{t-1} are the residuals from the cointegrating regression.

As the standard Granger causality test is sensitive to the lag length selection, it has been decided to 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 the standard Granger Causality test will be applied to the variables. This will involve the estimation of the following bivariate vector autoregression model (BVAR):

$$EX_t = \sum_{i=1}^{n} \alpha_b \Delta EX_{t-i} + \sum_{i=1}^{n} \beta_c \Delta PI_{t-i} + \upsilon_T \tag{3.22}$$

$$PI_t = \sum_{i=1}^{n} \lambda_i \Delta PI_{t-i} + \sum_{j=1}^{n} \gamma_j \Delta EX_{t-i} + \upsilon_T \tag{3.23}$$

where, EX represents the exchange rates, and PI the stock price index. This notation is going to be applied for the rest of the equations that are going to be presented throughout the rest of the methodology.

The lag length in Equation 3.22 and 3.23 will be selected using a two stage procedure. In order to do this it is necessary to follow different steps. Therefore, as a first stage, it will be needed to run the following regressions:

$$\Delta EX_t = a_1 + \sum_{i=1}^{20} f_i \Delta EX_{t-i} + \varepsilon_{1t} \tag{3.24}$$

$$\Delta PI_t = a_2 + \sum_{i=1}^{20} f_i \Delta PI_{t-i} + \varepsilon_{2t} \tag{3.25}$$

The lag length for equation 3.24 and 3.25 will be selected in order to minimize the AIC. In the second stage, equations 3.17 and 3.18 will be estimated fixing the number of lags on ΔEX (exchange rates in first differences, in equation 3.22) and ΔPI (stock prices in first differences, in equation 3.23) at the optimal level determined in stage 1, and then varying the number of lags on the independent variables from 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 the final results are reliable. The statistics results obtained from this test come from the implementation of the F-test.

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

At this stage it is worth mentioning that alternative techniques measuring cointegration have been developed. In particular, Bierens (1997, page 1) proposes "a consistent cointegration test, as well as estimators of a basis of the space of cointegrating vectors". His approach is based on the same foundations as the Johansen's LR method that is used throughout this thesis. Therefore, it will be very useful to consider future research where this and other approaches are implemented in order to provide a comparative framework that will allow obtaining more robust results.

3.2.2 Trivariate Analysis

After the cointegration analysis has been done, the study proceeds and investigates 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 illustrated below.

$$EX_t = \beta_0 + \beta_1 PI_t + \varepsilon_t \tag{3.26}$$

Economic theory supports the existence of a long-term 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 to this, 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 by the researcher (Grambovas, 2003). Therefore, it has been decided that, in order to improve the analysis in this area, there is a need 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 investors' sentiment. In this analysis, and in order to proxy the international environment the author will introduce three different variables, namely the German, the UK and the US stock markets in order to analyze three different scenarios[6].

The trivariate case can be described as:

$$EX_t = \beta_0 + \beta_1 PI_t + \beta_2 GEI_t + \varepsilon_t \tag{3.27}$$

$$PI_t = \beta_0 + \beta_1 EX_t + \beta_2 GEI_t + \varepsilon_t \tag{3.28}$$

$$EX_t = \beta_0 + \beta_1 PI_t + \beta_2 UKI_t + \varepsilon_t \tag{3.29}$$

$$PI_t = \beta_0 + \beta_1 EX_t + \beta_2 UKI_t + \varepsilon_t \tag{3.30}$$

[6] See page 82 for details regarding the explanation of the main reasons behind the selection of the proxies.

$$EX_t = \beta_0 + \beta_1 PI_t + \beta_2 USI_t + \varepsilon_t \tag{3.31}$$

$$PI_t = \beta_0 + \beta_1 EX_t + \beta_2 USI_t + \varepsilon_t \tag{3.32}$$

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

After the basic battery of econometric techniques have been implemented (Dickey & Fuller Test, LMF, Engle & Granger Test[7]) to establish whether equity markets move together in the long term, there is also an interest in analysing whether there is any causal relationships between the various markets. Thus, the analysis proceeds and implements causality tests between the markets. As was seen above, a critical issue in the Granger causality tests is to establish the optimal number of lags for the variables included in the regression. In this case, it has been decided to use both the Akaike's 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 has been explained in the previous section when the details for the bivariate methodology were set out. Then the initial model for causality test will be:

$$Y_t = \alpha_0 + \beta_1 Y_{t-1} + \beta_2 X_{t-1} + \beta_3 Z_{t-1} + \varepsilon_{yt} \tag{3.33}$$

In this specific case of exchange rates and stock prices, the main equations become:

$$EX_t = \alpha_0 + \beta_1 EX_{t-1} + \beta_2 PI_{t-1} + GEI_{t-1} + \varepsilon_{yt} \tag{3.34}$$

$$PI_t = \alpha_0 + \beta_1 PI_{t-1} + \beta_2 EX_{t-1} + GEI_{t-1} + \varepsilon_{yt} \tag{3.35}$$

[7] See the bivariate analysis section for more details.

$$EX_t = \alpha_0 + \beta_1 EX_{t-1} + \beta_2 PI_{t-1} + UKI_{t-1} + \varepsilon_{yt} \quad \textbf{(3.36)}$$

$$PI_t = \alpha_0 + \beta_1 PI_{t-1} + \beta_2 EX_{t-1} + UKI_{t-1} + \varepsilon_{yt} \quad \textbf{(3.37)}$$

$$EX_t = \alpha_0 + \beta_1 EX_{t-1} + \beta_2 PI_{t-1} + USI_{t-1} + \varepsilon_{yt} \quad \textbf{(3.38)}$$

$$PI_t = \alpha_0 + \beta_1 PI_{t-1} + \beta_2 EX_{t-1} + USI_{t-1} + \varepsilon_{yt} \quad \textbf{(3.39)}$$

This model will allow for the interpretation of the causality relationship between any selected variable (stock prices, or exchange rates) and the three countries used as benchmarks. The regression model implies that last periods values of X have explanatory power for the current value of Y. The 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) it will be feasible to conclude that X Granger causes Y. Therefore, if the alternative hypothesis test leads one to accept the null it will be possible to conclude that Granger causality does not occur.

As before, if the analysis shows evidence of two variables being cointegrated, it will be necessary to estimate an error correction mechanism including a variant (ECM). Thus, in this particular case there will be a need to construct the error correction mechanism through the following equation:

$$\Delta Y_t = \beta_0 + \lambda e_{1,t-1} + \beta_1 \Delta Y_{t-1} + \beta_2 \Delta X_{t-1} + \beta_3 Z_{t-1} + \varepsilon_{yt} \quad \textbf{(3.40)}$$

If it is found that the variables are cointegrated and the residuals are stationary, the ECM will be formulated as follows:

$$\Delta Y_t = \beta_0 + \lambda e_{1,t-1} + \beta_1 \Delta Y_{t-1} + \beta_2 \Delta X_{t-1} + \beta_3 Z_{t-1} + \varepsilon_{yt} \quad \textbf{(3.41)}$$

$$e_{t-1} = Y_{t-1} - \alpha_0 - \beta_2 X_{t-1} - \beta_3 Z_{t-1} \quad \textbf{(3.42)}$$

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

To conclude this section, it would be appropriate to include alternative methodologies as suggested in the bivariate section, in order to enrich the research outcomes.

3.2.3 Volatility Analysis

Following Kanas (2000) the study uses continuously compounded stock returns and exchange rate changes calculated as the first differences of the natural log. That is, S is representing the Stock Returns, $S_t = \ln\left(P_t^s\right) - \ln\left(P_{t-1}^s\right)$ and E is representing the Exchange Rates Changes, $E_t = \ln\left(P_t^e\right) - \ln\left(P_{t-1}^e\right)$.

As an initial step, all the tests that have been performed in the previous sections will be carry out as the basic tests for the volatility study (see page 43 for more details)

Accordingly, once all the basic tests are carried out, it would be possible then to proceed with the volatility analysis and to 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 (all the model terms are explained in detail in table 3.1 of page 71). 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,

$$S_t = a_{s,0} + \sum_{i=1}^{r} a_{s,i} S_{t-i} + \sum_{i=1}^{r} a_{e,i} E_{t-i} + e_{S,t} \qquad \textbf{(3.43)}$$

$$E_t = a_{E,0} + \sum_{i=1}^{r} a_{E,i} E_{t-i} + \sum_{i=1}^{r} a_{S,i} S_{t-i} + e_{E,t} \qquad \textbf{(3.44)}$$

where, St is the stock returns, and Et is the exchange rates changes; as before, this notation would be consistent when describing the next equations, where:

$$e_{S,t} / \Omega_{t-1} \approx N(0, \sigma^2_{S,t}) \qquad \textbf{(3.45)}$$

$$e_{E,t} / \Omega_{t-1} \approx N(0, \sigma^2_{E,t}) \qquad \textbf{(3.46)}$$

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

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

(3.47)

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

(3.48)

and where,

$$\sigma_{S,E,T} = \rho_{S,E} \sigma_{S,t} \sigma_{E,t} \qquad \textbf{(3.49)}$$

Each of the relevant terms in equations (3.43 - 3.49) are summarised as follows:

Table 3.1: Description of Parameters Equations (3.43)-(3.49)

	Stock Returns	**Exchange Rate Returns**
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	$\sigma^2_{S,t}$	$\sigma^2_{E,t}$
Persistence of Volatility	$\sum_{j=1}^{ps} b_{S,j}$	$\sum_{j=1}^{pE} b_{E,j}$
Standardised residuals assumed to be normally distributed with 0 mean and variances of $\sigma^2_{S,t}, \sigma^2_{E,t}$	$z_{S,t} = e_{S,t} / \sigma_{S,t}$ $e_{S,t} / \Omega_{t-1} \sim \mathrm{N}(0,\ \sigma^2_{S,t})$	$z_{E,t} = e_{E,t} / \sigma_{E,t}$ $e_{E,t} / \Omega_{t-1} \sim \mathrm{N}(0,\ \sigma^2_{E,t})$
ARCH effect where the parameters $\theta_{S,S}, \theta_{E,E}$ allow this effect to be asymmetric	$\left[\lvert z_{S,t}\rvert - E\lvert z_{S,t}\rvert + \theta_{S,Sz_{S,t}}\right]$	$\left[\lvert z_{E,t}\rvert - E\lvert z_{E,t}\rvert + \theta_{E,Ez_{E,t}}\right]$
Volatility Spillovers	$\delta_{S,E}\left[\lvert z_{E,t-1}\rvert - E\lvert z_{E,t-1}\rvert + \theta_{S,Ez_{E,t-1}}\right]$	$\delta_{E,S}\left[\lvert z_{S,t-1}\rvert - E\lvert z_{S,t-1}\rvert + \theta_{E,Sz_{SSt-1}}\right]$
Measures of spillovers	$\delta_{S,E}$	$\delta_{E,S}$
Asymmetry of Spillovers[8]	$\theta_{S,E}$	$\theta_{E,S}$
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 of the unrestricted estimate and $L(\tilde{\theta})$ denotes the value of the log likelihood function of the restricted estimate. Bollerslev-Wooldridge robust *t*-statistics are derived to take into account possible non-normality of the residuals.

The sample periods included in the analysis of the Asian financial crisis, in addition to examining volatility spillovers between stock returns and exchange

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

rates for the entire period, are also split in order to compare the effect of volatility spillovers during, and after the crisis. 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 had recovered from the crisis by late 1998. Thus, through the decision of splitting the samples, it is possible to join the crisis period of 2 July 1997 to 31 December 1998 and the post crisis period of 1 January 1999-7 July 2006.[9]

3.2.3.1 EGARCH Specification for Precious Metals Markets

The initial EGARCH model is adjusted to the analysis of Precious Metals markets where PM represents the precious metal under analysis at the time; thus, the main equations are as follows:

$$PMy_t = a_{PMy,0} + \sum_{i=1}^{r} a_{PMy,i} PMy_{t-i} + \sum_{i=1}^{r} a_{PMx,i} PMx_{t-i} + e_{PMy,t} \qquad \textbf{(3.50)}$$

$$PMx_t = a_{PMx,0} + \sum_{i=1}^{r} a_{PMx,i} PMx_{t-i} + \sum_{i=1}^{r} a_{PMy,i} PMy_{t-i} + e_{PMx,t} \qquad \textbf{(3.51)}$$

and where the error term is represented by:

$$e_{PMy,t} / \Omega_{t-1} \approx N(0, \sigma^2_{PMy,t}) \qquad \textbf{(3.52)}$$

$$e_{PMx,t} / \Omega_{t-1} \approx N(0, \sigma^2_{PMx,t}) \qquad \textbf{(3.53)}$$

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

The conditional variances of precious metals returns are specified as follows:

$$\log\sigma^2_{PMy,t} = \exp\left\{c_{PMy,0} + \sum_{j=1}^{pPMy} b_{PMy,j}\log(\sigma^2_{PMy,t-j}) + \delta_{PMy,PMy}\begin{bmatrix}\left(|z_{PMy}| - E|z_{PMy,t-1}| + \theta_{PMy,PMy}z_{,PMy-1}\right) + \\ \delta_{PMy,PMx}\left[\left(|z_{PMx,t-1}| - E|z_{PMx,t-1}| + \theta_{PMy,PMx}z_{PMx,t-1}\right)\right]\end{bmatrix}\right\}$$

(3.54)

$$\log\sigma^2_{PMx,t} = \exp\left\{c_{PMx,0} + \sum_{j=1}^{pPMy} b_{PMx,j}\log(\sigma^2_{PMx,t-j}) + \delta_{PMx,PMx}\begin{bmatrix}\left(|z_{PMx,t-1}| - E|z_{PMx,t-1}| + \theta_{PMx,PMzy}\right) + \\ \delta_{PMx,PMy}\left[\left(|z_{S,t-1PMy}| - E|z_{PMy,t-1}| + \theta_{PMX,S\#PMyzPMx,t-1}\right)\right]\end{bmatrix}\right\}$$

(3.55)

and where:[10]

$$\sigma_{PMy,PMx,T} = \rho_{PMx}\sigma_{PMy,t}\sigma_{PMx,t} \qquad \textbf{(3.56)}$$

3.2.3.2 GARCH Specification for Precious Metals Markets

The original GARCH model is specified with the following equations,

$$PMy = c_0 + \sum_{i=1}^{m}\alpha_i PMx_{t-i} + \varepsilon_{yt}\,; \qquad \textbf{(3.57)}$$

$$PMx = a_0 + \sum_{i=1}^{n}\delta_i PMy_{t-i} + \varepsilon_{xt} \qquad \textbf{(3.58)}$$

Where, the serially correlated errors ε_{yt} and ε_{xt} follow a MA (1) process shown as:

$$\varepsilon_{yt} = \mu_{yt} - \theta\mu_{yt-1} \text{ , and } \quad \varepsilon_{xt} = \mu_{xt} - \theta\mu_{xt-1} \qquad \textbf{(3.59)}$$

The original GARCH model is adjusted to introduce precious metals depreciation into this analysis. The introduction of precious metals depreciation in

[10] For a detailed interpretation of the various terms, please return to page 54, table 3.1.

this model represents a major improvement of the methodology and it is considered as one of the most important contributions of this thesis. The new equations are as follows:

$$PMy = c_0 + \sum_{i=1}^{p} \alpha_i PMx_{t-i} + \sum_{i=1}^{q} \theta\mu_{yt-1} + \mu_{yt} \quad ; \tag{3.60}$$

$$PMx = a_0 + \sum_{i=1}^{r} \delta_i PMy_{t-i} + \sum_{i=1}^{s} \phi_{yt-1} + \mu_{yt} \tag{3.61}$$

where,

$$\mu_{yt} \left| \psi_{yt-1} \sim N(0, h_{yt}) \right., \text{ and } \ \mu_{xt} \left| \psi_{xt-1} \sim N(0, h_{xt}) \right. \tag{3.62}$$

In equations (3.60) and (3.61) Pmy is the precious metals return under analysis at the time (e.g. gold) and PMx is the alternative precious metals return included in the regression (e.g. platinum) on day t. The sub indices y and x will represent in each equation the precious metal return under consideration at each time; this is applicable to the rest of the equations presented in the subsequent sections.

The variance h_{yt} of the error term μ_{yt} is obtained on the information set ψ_y available at time t-1(ψ_{yt-1}); in the model ψ_{yt-1} consists of past conditional variances and past squared error terms. The variance h_{yt} and h_{xt} are given by:

$$h_{yt} = \beta_0 + \sum_{i=1}^{a} \beta_1 h_{yt-1} + \sum_{i=1}^{b} \kappa_1 \mu_{yt-1}^2 \quad \text{and} \tag{3.63}$$

$$h_{xt} = b_0 + \sum_{i=1}^{c} b_1 h_{xt-1} + \sum_{i=1}^{d} c_1 \mu_{xt-1\,xt-1}^2 \tag{3.64}$$

The methodology has also been improved through the adjustment of the original variance equation introducing precious metals markets depreciation; this is a key and major contribution to the current methodology, as will allow for adjusting the results taking into account movements in precious metals markets. Thus the variance equations are presented as follows,

$$h_{yt} = \beta_0 + \sum_{i=1}^{f} \beta_1 h_{yt-1} + \sum_{i=1}^{g} \kappa_1 \mu_{yt-1}^2 + \sum_{i=1}^{j} \gamma_1 (PMx_{t-1})^2 \text{ and} \quad \textbf{(3.65)}$$

$$h_{xt} = b_0 + \sum_{i=1}^{l} b_1 h_{xt-1} + \sum_{i=1}^{v} c_1 \mu_{xt-1}^2 + \sum_{i=1}^{w} \lambda_1 (PMy_{t-1})^2 \quad \textbf{(3.66)}$$

In equation (3.65), PMx is the precious metals returns of the alternative market, and the conditions: $(\beta_0 \geq 0)$, $(1 \geq \beta_1 \geq 0)$, $(1 \geq \kappa_1 \geq 0)$, $(\gamma \geq 0)$, $(\beta_1 + \kappa_1 \leq 1)$ are the customary constraints applied to the parameters to enforce stationarity and a positive conditional variance. In equation (3.66), Pmy is the precious metals returns of the alternative market, and the conditions: $(b_0 \geq 0)$, $(1 \geq b_1 \geq 0)$, $(1 \geq c_1 \geq 0)$, $(\lambda \geq 0)$, $(b_1 + c_1 \leq 1)$ are as has been explained above. The parameters of each of the models outlined throughout this section are $(a_0, \delta, \phi, b_0, b_1, c_1, \lambda_1)$, and $(c_0, \alpha, \theta, \beta_0, \beta_1, \kappa_1, \gamma_1)$; these parameters are estimated using the maximum likelihood method by the BHHH algorithm (Berndt et al., 1974).

The GARCH (1,1) model will examine the effects of precious metals returns depreciation effects on each other through the mean returns equation (Equation 3.60). The other is through the variance equation (Equation 3.65) that depends on the depreciation of the alternative market. The square exchange rate is used to guarantee a positive value of the variance. Bollerslev-Wooldridge robust *t*-statistics are derived to take into account a possible non-normality of the residuals.

The diagnostic tests on the standardised residuals are performed for the GARCH and EGARCH models, which include the Jarque-Bera test for normality, and the Bollerslev-Wooldridge robust t-statistics. The Ljung-Box (LB) statistics will detect that there are no residual linear or non linear dependencies in the errors and the LB statistics for the cross products of the standardised residuals for the two equations are calculated, as these statistics indicate if the assumption of constant correlation over time can be accepted. Finally, the ARCH-LM residual test helps determine whether the standardised residuals exhibit additional ARCH. If the variance equation is correctly specified, there should not be any ARCH left in the standardised residuals.

To conclude this sub-section, it is relevant to take into consideration that Lucey and Voronkova (2008) state that the analysis of correlations between international asset markets has been a cornerstone for making inferences about short-term interdependencies between markets and the presence of diversification benefits. The authors suggest that the analysis of time-varying conditional correlation between international stock markets using the multivariate GARCH dynamic conditional correlation analysis will provide an enriched research scenario (DCC-GARCH; Engle, 2002). Therefore, the estimation of the DCC-GARCH should be considered as an alternative methodology to the one used in this thesis and for future research, since this methodology has become widely used when analysing markets integration issues.

3.2.3.3 ICSS Algorithm

Inclan and Tiao (1994) designed the Iterative Cumulative Sums of Squares (ICSS) algorithm. This algorithm allows for detecting multiple break points in the variance of time series. However, the literature has shown that the ICSS algorithm tends to overstate the number of actual breaks in variance (Fernández, 2004). Bacmann and Dubois (2002) pointed out that the ICSS algorithm is questionable under the presence of conditional heteroskedasticity. They have shown that this problem can be solved by filtering the return series by a GARCH (1,1) model, and by applying the ICSS algorithm to the standardized residuals. The present analysis will test for volatility shifts before and after filtering the data for conditional heteroskedascity and serial correlation for comparison purposes.

The ICSS algorithm assumes that the time series of interest have a stationary unconditional variance over an initial time period until a sudden break takes place. The unconditional variance is then stationary until the next sudden change occurs. This process repeats through time, giving time series observations with a number of m breakpoints in the unconditional variance in n observations. To estimate the number of changes and the point of time of variance shifts, the cumulative sum of squared residuals is used. This is given by the following equations:

$$C_k = \sum_{t=1}^{k} \varepsilon_t^2 \qquad \textbf{(3.67)}$$

Where k = 1,…..T, and {εt} is a series uncorrelated random variable with zero mean and unconditional variance σ_t^2. The variance in each interval is denoted by σ_j^2, j = 0,1,….., NT, where NT is the total number of variance changes in T observations. By letting $1 < \kappa_1 < \kappa_2 < ... < \kappa_{N_T} < T$ be the set of breakpoints, the variance then is defined as:

$$\begin{aligned} \sigma_t^2 &= \sigma_0^2 \quad 1 < t < \kappa_1 \\ &= \sigma_1^2 \quad \kappa_1 < t < \kappa_2 \\ &\quad ... \\ &= \sigma_j^2 \quad \kappa_{N_T} < t < T \end{aligned} \qquad \textbf{(3.68)}$$

with j=0,1,2,…NT

The statistic DK is defined as follows:

$$D_k = \frac{C_k}{C_T} - \frac{k}{T} \qquad \text{with } D_0 = D_T = 0 \tag{3.69}$$

where CT is the sum of the squared residuals from the whole sample period. If there are no changes in variance over the whole sample period, Dk oscillates around zero. Otherwise, if there are one or more shifts in variance, Dk will depart from zero. The critical values, which define the upper and lower limits for the drifts under the null hypothesis of stationary variance, determine the significant change in the variance of the series. If the maximum of the absolute value of the statistic Dk is greater than the critical value, the null hypothesis of no sudden changes is rejected. Let k* be the value of k at which max k¦Dk¦ is attained, and if $\max_k = \sqrt{(T/2)*|D_k|}$ exceeds the critical values, then k* is taken as an estimate of the change point. The term $\sqrt{(T/2)}$ is used to standardize the distribution. The critical value of 1.358 is the 95th percentile of the asymptotic distribution of $\max_k = \sqrt{(T/2)*|D_k|}$. Therefore, upper and lower boundaries can be set at ±1.358 in the Dk plot.

The ICSS is an iterative approach because the process must be repeated over subsamples to identify multiple change points. For example, if a point change is observed at τT, then, this point is used to partition the sample into two subsamples, τT and (τT+1)-T. The CSS is then estimated over both subsamples to identify additional point changes. The process is repeated until no new change points are identified.

3.2.3.4 The GARCH model

Once the change points in variance have been identified the GARCH model is estimated without and with sudden changes in variance. The standard GARCH (1,1) model is defined for the case without sudden changes as follows:

$$Y_t = \mu + \delta_1 X_{t-1} + e_t \tag{3.70}$$

where $e_t | I_{t-1}$ ~ N(0, ht) and ht is given by the variance equation, as follows:

$$h_t = \omega + \alpha e^2{}_{t-1} + \beta h_{t-1} \tag{3.71}$$

The GARCH(1,1) model with sudden changes is given by the following equation:

$Y_t = \mu + \delta_1 X_{t-1} + e_t$, where $e_t | I_{t-1}$ ~ N(0, ht) and ht is in turn given by the following variance equation:

$$h_t = \omega + d_1 D_1 + \ldots + d_n D_n + \alpha e^2{}_{t-1} + \beta h_{t-1} \tag{3.72}$$

The GARCH (1,1) model would be adapted to this analysis, as the analytical approach is based on a bivariate analysis, taking into account precious metals returns vs. stock market returns, and precious metals returns vs. oil returns. Therefore, the mean equation will be adjusted as follows:

$$PMy = c_0 + \sum_{i=1}^{m} \alpha_i SMx_{t-i} + \varepsilon_{yt} \tag{3.73}$$

$$PMy = c_0 + \sum_{i=1}^{m} \alpha_i OR_{t-i} + \varepsilon_{yt} \tag{3.74}$$

with,

$$h_{yt} = \beta_0 + d_1 D_1 + \ldots + d_n D_T + \sum_{i=1}^{a} \beta_1 h_{yt-1} + \sum_{i=1}^{b} \kappa_1 \mu_{yt-1}^2 \tag{3.75}$$

The GARCH(1,1) model with sudden changes taken into account is as follows:

$$Y_t = \mu + \delta_1 X_{t-1} + \delta_2 Z_{t-1} + e_t \tag{3.76}$$

$$h_t = \omega + \alpha e^2{}_{t-1} + \beta h_{t-1} \tag{3.77}$$

where:

Yt = Precious Metals Returns (Gold, Silver and Platinum)
Xt = Stock Markets Returns (Dow Jones Industrials, FTSE 100 and Nikkei 225)
Zt = Crude Oil Brent.

$e_t | I_{t-1} \sim$ N(0, ht) and ht is given by the variance equation

$$h_t = \omega + d_1 D_1 + ... + d_n D_n + \alpha e^2{}_{t-1} + \beta h_{t-1} \quad \textbf{(3.78)}$$

where D1….Dn are the dummy variables taking a value of 1 for each point of sudden change of variance onwards and 0 otherwise. The modified GARCH model incorporates the regime shifts detected by the ICSS algorithms; the persistence of volatility, (i.e. α + β) is predicted to be smaller than that found by the conventional GARCH model. The GARCH (1,1) model would be adapted to this analysis, taking into account precious metals returns vs. stock market returns, and precious metals returns vs. oil returns. Therefore, the mean equation will be adjusted as follows:

$$PMy = c_0 + \sum_{t=1}^{m} \alpha_i SMx_{t-i} + \sum_{t=1}^{n} \lambda_i OR_{t-i} + \varepsilon_{yt} \quad \textbf{(3.79)}$$

$$h_{yt} = \beta_0 + d_1 D_1 + ... + d_n D_T + \sum_{i=1}^{a} \beta_1 h_{yt-1} + \sum_{i=1}^{b} \kappa_1 \mu_{yt-1}^2 \quad \textbf{(3.80)}$$

In this study, continuously compounded stock returns have been assumed; the same procedure will be applied to work out the precious metals returns and oil prices returns, calculated as the first difference of the natural log. That is, if S are Stock Prices, then $S_t = \ln\left(P_t^s\right) - \ln\left(P_{t-1}^s\right)$, and, if PM denote Precious Metals Prices, then $PM_t = \ln\left(P_t^{PM}\right) - \ln\left(P_{t-1}^{PM}\right)$, and finally $OR_t^{OR} = \ln\left(P_t^{OR}\right) - \ln\left(P_{t-1}^{OR}\right)$ in the case of crude oil.

where again,

PMy = Gold, Silver, Platinum.
SM = Dow Jones Industrials, FTSE 100, Nikkei 225.
OR = Crude Oil Brent.

3.2.3.5 The GARCH model and the ICSS Procedure by steps

The ICSS algorithm and the GARCH model were combined in order to improve the volatility analysis. Bacmann and Dubois (2002) point out that the behaviour of the ICSS algorithm is questionable under the presence of conditional heteroskedasticity. They show that one way to avoid this problem is by filtering the return series by a GARCH (1,1) model, and applying the ICSS algorithm to the standardized residuals. Bacmann and Dubois (2002) conclude that structural breaks in unconditional variance are less frequent than was previously shown. This thesis has followed these authors' suggestion and has proceeded with the analysis as follows:

1. Initially, the ICSS algorithm is used in each series to identify possible breakpoints. The results identify a vast number of breaks happening in the series, but more importantly, the breakpoints tend to occur at different points in time; this makes it very difficult to include them in the GARCH equation.
2. In order to solve the previous issue, the GARCH model is implemented, with the objective of filtering the series for heteroskedasticity, and then the residuals from the variance analysis are calculated.
3. A third step consists in running the ICSS algorithm in the errors obtained from the GARCH model. This process allows one to obtain a

reasonable number of breakpoints that can be used in the variance analysis.

4. Finally, a new GARCH model is implemented, using dummy variables to correct for structural instability.
5. The final step consists in comparing the results obtained from the GARCH model without correcting for structural breaks, and the model with dummy variables (correcting for breakpoints).

At this point it is interesting to highlight that Fernández (2004) suggests an alternative approach to testing for homogeneity of the variance based on wavelet analysis, a methodology that she found to be more robust that the ICSS procedure. As a consequence, a new line of research to be followed could be based on contrasting the results obtained in this thesis with an alternative approach based on wavelet analysis.

3.3 Contributions to the Methodology

The major contribution that this thesis provides to the methodology will be divided into three major approaches: the bivariate, trivariate and volatility analysis, where the author introduces some changes to the commonly used tools. These changes allow for improving the normal procedures and also they permit comparisons to be drawn between the results enabling one to determine if the methodology shows consistent results through the samples and subsamples under investigation.

3.3.1 Bivariate Analysis

The bivariate causality test (Abdalla and Murinde, 1997) has been used, and the standard causality test. Knowing that the standard Granger causality test is sensitive to the lag length selection, the major contributions in this model consist in adjusting Abdalla's and Murinde's bivariate approach up to the optimal number of lags selected using the HQ criteria. Therefore, this bivariate approach will serve as a complementary test that allows a comparative analysis to be developed, where the Bivariate Vector Autoregression model (BVAR) will serve as a methodology that helps to check if the results obtained are showing consistency.

3.3.2 Trivariate Analysis

The Trivariate methodology was adjusted to introduce three proxies into the analysis. These variables represent three major indices: the German-DAX 30, the US-Dow Jones Industrials, and the UK-FTSE 100. The clear contribution here is the analysis of a trivariate causality relationship using a bidirectional approach on daily data with the inclusion of a system of three equations that allows one to analyse the influence of three major developed economies in the region. Grambovas (2003) is one of the few studies which analyses trivariate causality issues, and it includes certain East European countries, analysing the interaction between exchange rate fluctuations and equity prices for the Czech Republic and Hungary by using weekly data as well as a unidirectional approach. Therefore, this analysis intends to bring a broader study to this topic as it introduces three proxies in the study, and it also uses daily data that are considered more appropriate when analysing interlinkages between financial markets.

3.3.3 Volatility Analysis

The bivariate analysis that applies and extends the EGARCH (p,q) model used, introduces the lag truncation length of p in the EGARCH model using the Likelihood Ratio (LR) on alternative specifications. In doing this research, EGARCH modelling has been introduced to the analysis of world equity markets. With a broad approach, the study is using domestic and cross exchange rates in order to provide more evidence with regard to the analysis of volatility effects between equity and currency markets. The major contribution in this case consists in taking into account a bidirectional approach that includes a great number of exchange rates. Previous research is based on analyses where the domestic currencies have been used versus the U.S dollar, and no other exchange rates have been included in the study. The author suspects that previous results are quite limited, as researchers did not consider the introduction of alternative exchange rates that bring more evidence of the real nature of the relationship between stock returns and exchange rates changes. This methodology is also used in the study of Precious Metals markets where no evidence of such analysis has been found so far.

The analysis of Precious Metals markets also includes the GARCH (1,1) model that includes as innovative characteristics the introduction in the model of a variable that captures market depreciation. The model examines the effects of precious metals returns depreciation on each other through the mean returns equation, making the variance equation dependent on the depreciation of the alternative markets. This type of methodology has not been used before for the analysis of precious metals markets. Finally, it was also decided that the use of the ICSS algorithm developed by Inclan and Tiao (1994) would represent a major innovation in the study, where this research introduces a multivariate approach which will work out market breakpoints through the GARCH (1,1) standardized residuals. This model is used to analyse volatility persistence on precious metals markets including oil prices and the major stock indices, an approach that appears to be the first one done in this context.

In relation to the non-normality of the errors distribution, the econometric regression was also executed taking into account a t-distribution pattern for the error term, and also a generalised errors distribution (GED) as suggested by Nelson (1991), to account for the conditional distributions of residuals under the effects of excess kurtosis. Consequently, all the regressions were run again with the new distribution for the error term in a representative sample[11]. However, the results obtained were not encouraging as they suffered from different problems:

a) The coefficients become inconsistent and present problems regarding the constraints that the EGARCH model imposes in terms of the appropriate behaviour of the estimators.
b) When the errors tests are performed (LB(20), $LB^2(20)$), the results show that the EGARCH model is not stable. Some studies related to this topic (Kanas 2000 and 2002; Wang and Yang 2006; Wu 2005; Wolfle 2006) tend to use the errors normal distribution and adjust the results for heteroskedasticity using the Bollerslev and Wooldridge algorithm to guarantee that the estimators are robust under non-normality situations. Thus it was considered appropriate to follow this methodology to avoid model estimation problems.
c) Finally, after performing the regressions taking into account both techniques, the results showed that the original results are stronger and consistent with the results in the area; therefore, no further testing was conducted.

[11] The sample under consideration was the Latin American markets.

CHAPTER IV

EMPIRICAL RESULTS:

EMERGING AND DEVELOPED EQUITY MARKETS

The present chapter focuses on the discussion of emerging and developed equity markets interlinkages. Consequently, the analysis is structured as follows: i) In the first part, the main interest is based on analysing East European equity markets relationships, where three main methodologies are implemented. ii) Second, the study looks at the Asian, Latin America and the G-7 equity markets. iii) Third, a comparative analysis between emerging and developed markets is presented, where the main commonalities and differences between the different types of markets are highlighted. iv) Finally, the major conclusions originating from the research are summarised and discussed.

4.1 EAST EUROPEAN EQUITY MARKETS

4.1.1 Introduction

The main objective of this chapter is the analysis of interlinkages between equity and currency markets focusing on key emerging economies located in Eastern Europe, Asia and Latin America, and also on some notable developed economies, represented by the G-7. The chapter starts with a first section dedicated to the analysis of four emerging East European economies, a study that will be conducted on an individual basis, so as to get a better understanding of each country’s circumstances. The importance of this research is supported by the author's findings through the literature review, where it was possible to identify a clear need for research focusing on emerging markets. A huge transformation process has taken place in East European countries that have made substantial strides since 1989 in order to get accession to the EU. Major steps have been done in moving their economies from centrally planned to market economies, with the result that the private sector currently represents half of the Gross National Product of these countries.

According to the European Bank for Reconstruction and Development (EBRD) indicators of transition, the Central and East European Countries, (CEECs) have for the most part successfully liberalized trade and foreign exchange systems. As these economies have become more market-oriented, it is believed that they have also become more integrated with Western Europe, due to the fact that the majority of their trade and transactions are now occurring within the EU. However, because the CEECs are undergoing substantial structural and economic regime changes that allow them to complete their EU accession[12] and subsequently their participation in the euro area, it is hard to know how exposed and vulnerable these economies are, and will remain, to economic shocks until they are fully integrated in the Euro area.

Large current account deficits make these countries clear candidates to face reversals in financial market sentiments, which can lead to currency and financial crises, as the ones suffered by the Asian economies in 1997, Brazil (1998) or in Argentina (2001). Also, current account deficits may be an indicator of other internal problems, and imbalances within the economies. However, over the long-term, the reform of the applicants' economic institutions and archaic political structures, in comparison to the group of advanced Western European nations that have already adopted the Euro, is likely to lead to the former countries being viewed as more secure places for doing business. Such a perception should lead to a reduction in the risk premium associated with the

[12] This process has already taken place in the countries included in this analysis, namely: Poland, the Czech Republic, Hungary and Slovakia.

emerging economies that have to adjust their systems and institutions to the developed economies; therefore, this process will help to foster further investments, stronger trade flows, and other forms of integration that will hasten economic convergence in the future.

It is also necessary to mention that the characteristics of the East European markets included in this study (Poland, the Czech Republic, Hungary and Slovakia) are a key factor in projecting a bright future for these countries. These markets are considered the most developed European emerging markets; they are characterized by a stable performance of their domestic economies, higher growth rates compared to the "old" European economies and relatively low valuations (Syriopoulos, 2004). Therefore, these are some of the major facts that the author took into account when selecting the countries that would be representative, and worthy of analysis as potential emerging economies. Thus, the reformation and reorganization of this region's financial institutions will result in an efficient financial integration of the region with developed European markets; this will have important implications for the new EU members, in order to successfully attract investment to the region.

The main goal of all forms of economic and financial integration are to eliminate the barriers to trade, to flows of factors of production, and to financial flows among the members countries, with the existence of some system of protection against third countries. In light of the major economic integration processes that have occurred in the world's economies during recent years, it is valid to say that at the moment the world economy is clearly divided into three main blocks: 1) the European economic space with the EU, 2) the NAFTA region (Canada, the USA, and Mexico) and 3) China, Japan and South Korea, with ASEAN. With the accession of these countries (the Czech Republic, Hungary, Poland and Slovakia) to the EU, their regional capital markets would gain in terms of greater width, depth, and liquidity; this would allow them to attract foreign direct investment and compete in the international context, which as it is well-known, is one of the key variables that helps to promote higher levels of economic growth and development.

The absence of cointegration, hence the independence of stock markets and currency markets movements is a sign of the existence of profitable opportunities for diversification across these markets. On the other hand, if the findings in this thesis identify the existence of cointegration between these markets, it will mean that it would be very difficult for investors to make profits through diversification techniques in these markets, as effects generated in one market would be immediately transmitted to the other markets.

This study is structured as follows: initially, the investigation starts with a bivariate analysis, with the objective of gathering information regarding the relationship between stock returns and exchange rates in the four East European economies. Then, it continues with a trivariate analysis where three major developed economies are introduced as proxies to assess the international effect in these economies, and therefore to obtain valuable information in relation to the interaction of these markets with some of the most developed economies. Finally, and in order to conclude the section, the volatility analysis is presented, where the focus is in understanding the extent of volatility spillovers between these markets. This study is of great importance, as mentioned before, since information on the relationships between these markets that could potentially represent interesting locations to make profits, is very useful.

4.1.2 Bivariate Analysis

4.1.2.1 Introduction

This sub-section sets out the details of the empirical results that were obtained after applying the data and methodology explained in the previous chapter. The study starts by analysing the relationship between the exchange rates and stock prices for four East European markets, the Czech Republic, Hungary, Poland and Slovakia for the period 1999-2006[13]. The data set consists of daily (5days) closing stock market indices and foreign exchange rates giving a total of 2766 observations for each series. Thus, the data selected consists of: the Czech Koruna, Hungarian Forint, Polish Zloty and the Slovak Koruna, which provide the appropriate number of bilateral exchange rates that will be used for the different countries of the analysis. Accordingly, it was considered that for stock prices, the Prague SE PX, Budapest BUX, Warsaw General Index, Slovakia SAX 16, would be the best representative indices for these markets. 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 allows us to examine the extent of differences in the relationships between the stock markets and the exchange rates between these countries. The results of the empirical analysis are presented in the next sub-section.

4.1.2.2 Unit Roots

The results show that the null hypothesis of existence of unit root in levels for the variables cannot be rejected. Therefore, a modification to the data set should be applied, which means that first differences have to be used, and then the ADF test has to be run again on this new data. At this moment, the results show how the null hypothesis can be rejected in all of the variables and for all of the countries. This means that the series under analysis are an integrated process of order one I(1), implying that the series are all stationary at the same level. Thus, these results enable us to perform the cointegration analysis, as the results will not be spurious.

[13] In the case of the four East European countries, the analysis covers the 1999-2006 period, as we could not get data for these markets prior to 1999. These markets have a rather brief history, since they started after the 1990s.

For comparison purposes, it was decided to perform two other unit root tests, the Phillips-Perron (PP) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) tests. The PP test results are consistent with the results from the ADF, with the exception of the Czech Republic exchange rate (Czech Koruna), that appears to be an I(0). In general, it is concluded that the data is an I(1) process, following the results that were obtained from the ADF test, PP test and KPSS test. With the exception that was mentioned above, the data series are identified as an I(1) process at the 1 per cent significance level.

The next step consists in performing the Lagrange Multiplier test (LMF) to verify the non-existence of errors serial correlation. The p-values indicate that the null hypothesis of serial correlation can be rejected for all the variables at the 1 per cent significance level.

4.1.2.3 Cointegration Analysis

4.1.2.3.1 Cointegration Analysis Results

The first results from the Engle & Granger cointegration test do not allow us to reject the null hypothesis, concluding that there is no relationship between stock prices and exchange rates for any of the countries included in the study. In other words, there is no relationship between the variables in either the long-term or in the short-term.

When comparing the results between the Engel Granger cointegration test and Johansen's test, they clearly show that they are consistent for all the countries. The tests have found no evidence of cointegrating relationships between exchange rates and stock prices using both methodologies. In the case of these emerging countries of Europe, as the variables are not cointegrated, the main conclusion is that they are not moving together either in the long-term or in the short-term. Therefore, there is evidence of independent behaviour between exchange rates and stock prices as the author expected. Furthermore, as was previously mentioned, the non-existence of a cointegration relationship is evidence of possibilities of potential earnings through diversification in these markets.

4.1.2.4 Granger Causality Test

Once the cointegration analysis is concluded the next step is to proceed with the bivariate analysis that in this case will consist in the implementation of two causality models with the purpose of comparing results (see tables 4.1 and 4.2 below) and also of looking for consistency regarding the techniques under use. The causality test intends to identify if stock prices generate any influence on exchange rates and vice versa.

4.1.2.4.1 Causality Test Results

Table 4.1: 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 this 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.

As shown in table 4.1, the results are significant at the 1 per cent level, in the case of Polish stock prices causing the Polish exchange rates (DPOI $\Rightarrow$ DPOE), and at the 5 per cent significance level for the Czech stock prices causing the Czech exchange rates (DCZI$\Rightarrow$DCZE); the null hypothesis's of no causality relationship between the variables is rejected, meaning that in both cases stock prices have a causal effect on exchange rates. These are the only cases were the p-values are significant. These results are not surprising, as the Czech Republic and especially Poland are considered as being the most developed markets in the sample under study, and at the same time, as Poland is the biggest market and tends to reflect higher levels of development. In the remaining cases, the results fail to reject the null hypothesis. Therefore, with the help of the Granger causality test, empirical evidence of non Granger causality running from stock prices to exchange rates is found in the case of Hungary and Slovakia; also, non Granger causality from exchange rates to stock prices is found in all the countries.

TABLE 4.2: 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 this 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.

Following Abdalla and Murinde (1997), a bivariate model for analysing the causal relationship between these two variables is performed. The results from this model are presented in table 4.2, and overall they are consistent with the results from the Granger causality test with two exceptions; the model found indeed causality in the following two cases: DCZE$\Rightarrow$DCZI, and DPOE$\Rightarrow$DPOI. Clearly, the results found evidence of causal effects from the Czech Koruna to the Prague SE PX, and also the results show evidence of causality from the Polish

Zloty to the Warsaw General Index. Considering these two results, that contradict the findings obtained from the Granger causality test, it can be said that for the rest of the cases the results are consistent as no evidence of causality has been found.

The bivariate model has been tested for serial correlation (all results are available in Appendix A). The results show that the model does not contain serial correlation. The model was also verified for the non existence of heterokedasticity through the White's Heterokedasticity test. The findings showed that the variables are free of heterokedasticity. Finally, the model was also tested for normality, but in this case the coefficients for the Jarque Bera test are very high, meaning that the residuals are non normal[14].

4.1.2.5 Analysis and Conclusions of the Bivariate Analysis

As a summary, the analysis of the relationship between exchange rates and stock prices in four Eastern European markets, the Czech Republic, Hungary, Poland and Slovakia using daily data shows that exchange rates and stock prices seem to be independent. There is no evidence of these two variables moving together either in the long-term or in the short-term.

These results are quite surprising, as it was expected that at least the results of the test would confirm the existence of cointegration is some cases, due to the fact that these markets are gradually adjusting their economies fully to become part of the EU. Surprisingly, this did not happen, and instead of that, the findings show an overall result that confirms the non-existence of cointegration between the East European markets under analysis. These results are explained by the need of Eastern European countries to progress in important areas such as

[14] But as the sample size is big enough, there is no need to worry about this issue; for small sizes the condition of normality is compulsory.

corporate and bank restructuring, the reform of the legal and regulatory framework, the need for new financial architecture and strengthening of domestic financial systems, the need for increased transparency and accountability, and the adoption of internationally accepted standards (Nord, 2000). All these changes are being undertaken but it seems that this process is not leading to any dramatic changes in terms of interrelationships between the markets. The integration of these economies is then confirmed as a slow process that requires major changes in macroeconomic policies, especially in fiscal and monetary areas, so that these economies can achieve a certain degree of convergence with the current members of the EU.

In terms of the Granger Causality test, the results are also consistent; there are just a few exceptions where mixed results were found and this happened when applying different methodologies. Thus, the Granger causality test found a unidirectional causal relationship, where the Polish stock prices cause the Polish exchange rates and also where the Czech stock prices cause the Czech exchange rates. The results from Abdalla and Murinde (1997) found evidence of causality between the Czech Koruna and the Prague SE PX, and also between the Polish Zloty and the Warsaw General Index. As it is possible to appreciate, the results for Poland – when taking into account the two methodologies – tend to be contradictory. Therefore, it is not possible to infer any clear conclusion with regard to which variable is causing an effect on the other, or even with regard to the existence of bidirectional causality, as the two methodologies in use are different.

Overall the findings are consistent with the results that Nieh and Lee (2001) got from their analysis, where they did not find significant evidence 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 the case of this particular research, it was found that the results are consistent with their conclusions, as the results did not find strong evidence of the existence of a relationship between these variables.

4.1.3 Trivariate Analysis

4.1.3.1. Introduction

This sub-section investigates the relationship between the exchange rates and stock prices for the same four East European countries, the Czech Republic, Hungary, Poland and Slovakia for the period 1999-2006[15]. In this case, the analysis is based on a trivariate model that will incorporate the international financial environment through the consideration of three world major indices. This analysis is attempting to complement the bivariate analysis already done in this region. The data consists of daily (5 days) closed stock market indices and foreign exchange rates with a total of 2766 observations for each series. The exchange rates included in the analysis are the Czech Koruna, Hungarian Forint, Polish Zloty, and the Slovak Koruna. The stock prices refer to the Prague Se PX, Budapest BUX, Warsaw General Index, and the Slovakia SAX 16. In addition the stock index of the US, the UK and Germany (Dow Jones Industrial, FTSE 100 and DAX 30) are added as proxies for the international financial environment as mentioned above. The inclusion of the US, the UK and German markets is based on the need to capture the possibility that changes in international stock markets can lead to changes in the relevant domestic stock exchanges due to issues of international investors' sentiment.

After considering the improvement of the bivariate analysis through a trivariate methodology, the author considers that it will be possible to get a better understanding of the short-term and long-term dynamics of these markets. Since it is well known in the literature that using monthly data may not be adequate in

[15] The time period for the analysis is subject to the availability of the data for each country.

describing the effect of capital movements, and in order to keep consistency, daily data is used to capture such effects.

4.1.3.2 Empirical Results

Following the steps outlined in the methodology, the analysis begins by performing unit root tests on all the variables[16]. The ADF results indicate the non rejection of the null hypothesis of the existence of a unit root in levels for all the variables. The PP test results are consistent with the results obtained from the ADF. The ADF and PP tests for unit roots are applied on the data in first differences. The null hypothesis of a unit root can be rejected for all the variables and for all countries. This means that the time series are integrated at level one, (being then an I(1) process).

The next step in the analysis consists in performing the Lagrange Multiplier test (LMF) to verify the non-existence of error serial correlation. The p-values indicate that it is possible to reject the null hypothesis of serial correlation for all of the variables at the 1 per cent significance level.

The results from the Johansen methodology indicate that there is no evidence of a cointegrating relationship between the stock price and exchange rate in Hungary; all three models capturing the international financial environment are consistent in showing a lack of cointegration. This is also the case for Poland and the Czech Republic. As was discussed before, these results could be explained by the fact that these markets are quite young in comparison to the developed and mature markets, and that they are also under a process of adjustment to EU regulations. This means that possibilities of potential gains could be materialised if diversification techniques are used to design portfolio strategies. It is the author's firm belief that these potential gains could last for the short to medium

[16] The econometric results are generated from the Eviews package, and detailed results are available in Appendix B.

term, as once the East European economies become fully adjusted to EU regulations, these markets will become more integrated with the EU stock markets, and such opportunities of profits would disappear. It is only in the case of Slovakia when Germany is added as a proxy that the null hypothesis of no cointegration is rejected at a 1 per cent significance level. Hence the results allow us to conclude that a long-term relationship exists between the Slovakian exchange rate and stock prices, where the German stock price is included as an additional explanatory variable in the cointegrating regression.

The results from the causality test, together with the optimal number of lags are outlined in tables 4.3 to 4.5 presented below.

The results from Hungary (see tables 4.3 to 4.5, first line of results) fail to reject the null hypothesis of no causality from the Hungarian exchange rates to Hungarian stock prices, in all three models.

TABLE 4.3: GRANGER CAUSALITY TEST WHEN GERMANY IS USED AS A PROXY

Type of Test		AIC			HQ		
Countries	**Variables**	**No. of lags**	**F-stat**	**p-value**	**No. of lags**	**F-stat**	**p-value**
Hungary	DHGE ⇒ DHGI	8	8.8924	5.02E-12*	2	30.7212	7.3E-14*
	DHGI ⇒ DHGE		1.7869	0.0751		1.4436	0.2363
	DGE ⇒ DHGI		1.0674	0.3831		1.0777	0.3405
	DHGI ⇒ DGE		1.3899	0.1958		2.6375	0.0717
	DGE ⇒ DHGE		1.1138	0.3504		0.4653	0.6280
	DHGE ⇒ DGE		0.7590	0.6394		0.4825	0.6173
Poland	DPOE ⇒ DPOI	3	31.4354	7.7E-20*	2	46.3932	2.1E-20*
	DPOI ⇒ DPOE		2.3643	0.0693		2.0603	0.1276
	DGE ⇒ DPOI		0.4410	0.7236		0.5942	0.5520
	DPOI ⇒ DGE		0.9387	0.4210		1.2792	0.2785
	DGE ⇒ DPOE		2.0706	0.1021		1.5683	0.2086
	DPOE ⇒ DGE		0.9732	0.4044		1.2198	0.2954
Czech Republic	DCZE ⇒ DCZI	2	8.9009	0.0001*	1	16.9571	4.0E-05*
	DCZI ⇒ DCZE		1.0899	0.3364		1.6113	0.2044
	DGE ⇒ DCZI		1.9374	0.1443		0.1093	0.7409
	DCZI ⇒ DGE		1.1601	0.3136		2.1132	0.1461
	DGE ⇒ DCZE		2.1796	0.1133		4.3715	0.0366
	DCZE ⇒ DGE		0.3393	0.7122		0.1121	0.7378
	DSLE ⇒ DSLI	5	2.2379	0.0481	1	0.0213	0.8838
	DSLI ⇒ DSLE		0.7379	0.5949		0.5789	0.4468
	DGE ⇒ DSLI		1.2556	0.2805		1.0222	0.3121

Slovakia	DSLI $\Rightarrow$ DUK		0.3858	0.8588		1.7889	0.1812
	DGE $\Rightarrow$ DSLE		1.0329	0.3964		0.0694	0.7921
	DSLE $\Rightarrow$ DGE		1.7483	0.1204		0.3540	0.5519

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

The results do find other causal relationships from the international financial proxies to Hungarian exchange rates or stock prices or from Hungarian stock prices to Hungarian exchange rates. These findings indicate that Hungarian stock and currency markets are not affected by the Dow Jones, FTSE100 and DAX 30 movements, while there is a causal relationship running from the Hungarian Forint to the Hungarian stock market. In the case of Poland, the results fail to reject the hypothesis of no causality from the Polish exchange rate to Polish stock prices in all three models (tables 4.3 to 4.5); furthermore the results from table 4.4 show that there is evidence of causality from the UK stock prices to Polish stock prices, as well as from the US stock prices to Polish stock prices and also to Polish exchange rates as shown by the results from table 4.5.

TABLE 4.4: GRANGER CAUSALITY TEST WHEN THE UK IS USED AS A PROXY

Type of Test		AIC			HQ		
Countries	**Variables**	**No. of lags**	**F-stat**	**p-value**	**No. of lags**	**F-stat**	**p-value**
Hungary	DHGE $\Rightarrow$ DHGI	9	6.93055	6.9E-10*	2	30.7212	7.3E-14*
	DHGI $\Rightarrow$ DHGE		1.5042	0.1406		1.4436	0.2363
	DUK $\Rightarrow$ DHGI		1.5758	0.1168		3.57403	0.0282
	DHGI $\Rightarrow$ DUK		2.5386	0.0067*		0.9867	0.3729
	DUK $\Rightarrow$ DHGE		0.4479	0.9091		0.4492	0.6381
	DHGE $\Rightarrow$ DUK		3.7895	9.4E-05*		17.7896	2.2E-08*
Poland	DPOE $\Rightarrow$ DPOI	4	23.6292	4.2E-19*	3	31.4354	7.7E-20*
	DPOI $\Rightarrow$ DPOE		2.4260	0.0460		23.6432	0.06933
	DUK $\Rightarrow$ DPOI		8.2227	1.4E-06*		10.3958	8.7E-07*
	DPOI $\Rightarrow$ DUK		0.9445	0.4371		1.34603	0.2577
	DUK $\Rightarrow$ DPOE		0.7203	0.5779		0.6521	0.5816
	DPOE $\Rightarrow$ DUK		34.5073	7.2E-28*		46.6145	1.7E-28*
Czech Republic	DCZE $\Rightarrow$ DCZI	2	8.9009	0.0001*	2	8.9009	0.0001*
	DCZI $\Rightarrow$ DCZE		1.0899	0.3364		1.0899	0.3364
	DUK $\Rightarrow$ DCZI		0.4500	0.6376		0.4500	0.6376
	DCZI $\Rightarrow$ DUK		0.5348	0.5858		0.5348	0.5858
	DUK $\Rightarrow$ DCZE		2.2525	0.1054		2.2525	0.1054
	DCZE $\Rightarrow$ DUK		11.0857	1.6E-05*		11.0857	1.6E-05*
	DSLE $\Rightarrow$ DSLI		1.8685	0.0826		0.0213	0.8838
	DSLI $\Rightarrow$ DSLE		0.9124	0.4848		0.5789	0.4468

Slovakia	DUK ⇒ DSLI	6	1.0851	0.3689	1	1.6165	0.2037
	DSLI ⇒ DUK		0.2115	0.9732		0.0918	0.7619
	DUK ⇒ DSLE		0.6490	0.6910		0.9094	0.3403
	DSLE ⇒ DUK		3.6092	0.0014*		15.3750	9.1E-05*

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

The results tend to confirm the influence of the US market in this economy, as it affects its stock and currency market. These results are not surprising as Poland is considered as the most developed market in the region, and in accordance with the behaviour of most of the developed economies markets, it also tends to be affected by movements in the US economy. For the Czech Republic, the causality tests show causality from the Czech exchange rate to Czech stock prices in all three models (tables 4.3 to 4.5).

TABLE 4.5: GRANGER CAUSALITY TEST WHEN THE US IS USED AS A PROXY

Type of Test		AIC			HQ		
Countries	**Variables**	**No. of lags**	**F-stat**	**p-value**	**No. of lags**	**F-stat**	**p-value**
Hungary	DHGE ⇒ DHGI	3	22.0793	4.6E-14*	3	22.0793	4.6E-14*
	DHGI ⇒ DHGE		0.9498	0.4156		0.9498	0.4156
	DUS ⇒ DHGI		3.0363	0.0281		3.0363	0.0281
	DHGI ⇒ DUS		1.2050	0.3064		1.2050	0.3064
	DUS ⇒ DHGE		0.3716	0.7735		0.3716	0.7735
	DHGE ⇒ DUS		12.0775	7.8E-08*		12.0775	7.8E-08*
Poland	DPOE ⇒ DPOI	3	31.4354	7.7E-20*	3	31.4354	7.7E-20*
	DPOI ⇒ DPOE		2.3643	0.0693		2.3643	0.0693
	DUS ⇒ DPOI		58.7405	2.4E-36*		58.7405	2.4E-36*
	DPOI ⇒ DUS		0.4232	0.7363		0.4232	0.7363
	DUS ⇒ DPOE		6.2810	0.0003*		6.2810	0.0003*
	DPOE ⇒ DUS		0.7215	0.5390		0.7215	0.5390
Czech Republic	DCZE ⇒ DCZI	3	5.9475	0.0004*	3	5.9475	0.0004*
	DCZI ⇒ DCZE		1.2655	0.2845		1.2655	0.2845
	DUS ⇒ DCZI		30.6942	2.2E-19*		30.6942	2.2E-19*
	DCZI ⇒ DUS		0.1942	0.9003		0.1942	0.9003
	DUS ⇒ DCZE		1.2210	0.3005		1.2210	0.3005
	DCZE ⇒ DUS		0.2400	0.8684		0.2400	0.8684
Slovakia	DSLE ⇒ DSLI	1	1.8668	0.0826	6	0.0213	0.8838
	DSLI ⇒ DSLE		0.9124	0.4848		0.5789	0.4468
	DUS ⇒ DSLI		1.1182	0.3489		2.1792	0.1400
	DSLI ⇒ DUS		0.9635	0.4484		0.9368	0.3332
	DUS ⇒ DSLE		1.5813	0.1485		2.8888	0.0893
	DSLE ⇒ DUS		0.6477	0.6920		0.4752	0.4906

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

The results from table 4.5 show that there is also causality running from the US stock prices to the Czech stock prices. Finally, in the case of Slovakia the results indicate that there is no evidence of a causal relationship between the stock price and exchange rate in all three models (see tables 4.3 to 4.5, last rows of results), as well as no causality between any of the international financial markets and Slovakian stock prices or exchange rates. The results for Slovakia differ from the findings for the Czech Republic, Hungary and Poland, and considering that this market is the smallest and less developed, these results are not shocking. The results from the analysis of cointegration relationships show evidence of cointegration between stock prices and the exchange rates for Slovakia, and Germany is included as a proxy for the international financial environment; there is a need to include the error correction term in the causality tests in order to get an unbiased result. The results indicate that the ECM is significant at the 1 per significance level, thus there is also a short- term dynamic relationship between the stock prices of the German market and the exchange rates and stock prices in Slovakia.

The trivariate analysis that has been done when considering the three international proxies shows that the Dow Jones Industrials is a source of causal effects on the Polish stock and currency markets, as well as on the Czech stock markets. As was mentioned previously, these two markets and especially the Polish one are the most developed among the East European markets, and they are sharing similar patterns with the world’s most developed economies that tend to be affected by shocks originating from the US stock markets. These findings confirm that when analysing stock and currency markets relationships the US markets should be also considered as it seems to be improbable to find a market that will not be affected by the US markets to some extent.

4.1.3.3 Analysis and Conclusions

This section sets out to investigate the relationship between stock prices and exchange rates in four East European economies when a third variable is included in the study, with the objective of finding out the international shocks that could affect these economies. The results from the cointegration tests indicated that there is no long-term relationship between exchange rates and stock markets. The findings are thus consistent with the results of Smyth and Nandha (2003), Nieh and Lee (2001) and Bahamani-Oskooee and Sohrabian (1992), noting that these authors analysed completely different markets. The major conclusions from this study are similar to the general findings that the existing literature in this area has shown, and which is characterised by the absence of any significant evidence of a long-term relationship between stock prices and exchange rates.

The results from the causality tests indicate that, normally, a movement in the exchange rate causes movements in stock prices; thus, causality is unidirectional with no evidence of causality from stock prices to exchange rates in most of the countries and cases of analysis. Furthermore, what happens on international stock markets can also affect the respective domestic stock markets and exchange rate movements, as reflected in the significant causal relationship from the US stock market to most of the European markets. To a lesser extent, there is also evidence of some influence from the UK stock market on the East European markets; but the effect from the German market is less clear. The lack of a general international stock market influence on the East European stock exchanges indicates that the East European markets are not as integrated with the world financial markets as the big European stock markets are, the only exception being that the US market generates an effect on the Polish stock and currency market, and on the Czech stock market. These 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 and Polish stock markets and would lead to increased demand for their currencies, and therefore, to an appreciation of the exchange rate. An 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. In this case for example investors should consider that they can diversify their portfolio taking into account East European markets but they will also need to consider hedging strategies that protect their investment from shocks that could originate from the US markets.

4.1.4 Volatility Analysis

4.1.4.1 Introduction

The present analysis will be conducted with the purpose of investigating volatility spillovers between stock returns and exchange rate changes for the four East European Markets (the Czech Republic, Hungary, Poland and Slovakia) for the period 1996-2006[17]. It has been decided to divide the sample period into two subperiods that would analyse the behaviour of these markets before 2004, a time period when these countries did not belong to the EU, and after 2004, when these countries became part of the EU. The data set consists of daily (5days) closed stock market indices and foreign exchange rates with a total of 2766 observations for each series. For the exchange rates, the domestic exchange rates is used (the Czech Koruna, Hungarian Forint, Polish Zloty, and the Slovak Koruna, against the US dollar), and the stock prices used are the Prague SE PX, Budapest BUX,

[17] All results are available in Appendix C. The omission of some results through the thesis is motivated by the high volume of results that were obtained from the calculations.

Warsaw General Index, and the Slovakia SAX 16. All data are taken from DataStream, and the Federal Reserve Statistic Release.

4.1.4.2. Empirical Results

This subsection presents and discusses the key results obtained from the volatility analysis. First, a description of the series statistics is outlined; afterwards, the findings regarding volatility issues are presented and discussed.

4.1.4.2.1 Descriptive Statistics

The study starts by presenting the results obtained from the descriptive statistics for stock returns and exchange rates that will set the characteristics of the sample. For the entire period, the sample means of stock returns are positive for Slovakia and Poland, while the mean is negative for Hungary and the Czech Republic. The results are positive for all the countries during the first period, as well as and after the 1st of May 2004, when the countries joined the EU. The highest mean returns were for Poland, (6.35E-04), followed by Slovakia (6.99E-05), for the pre-European Union period; the mean returns were highest for the Czech Republic, (0.000546) and Poland, (0.000455), followed by Slovakia and Hungary for the same period, whereas for the post-EU period they were highest for Slovakia (0.001336) followed by Hungary (0.00122), Poland (0.000996) and the Czech Republic (0.000897). The standard deviation of the stock returns range from 0.29 per cent to 1.26 per cent for the entire period and from 1.29 per cent to 1.52 per cent for the pre-European period (before 2002) and from 1.40 per cent to 1.01 per cent for the post-European period (after 2004). This indicates that the volatility of stock returns in general were lower in the period after the countries joined the EU, than compared with the period before EU membership. These results support the hypothesis of stability that EU adhesion generates in the markets, and also provide some evidence of the effects that in the long-term this membership could have in terms of market integration. The skewness and kurtosis coefficients indicate that stock returns are leptokurtic in relation to the normal distribution. This a common finding for stock returns, as Caporale et al (2002) noticed. The Jarque-Bera (JB) tests are very high, meaning that the null hypothesis of stock returns normally distributed is rejected for all the countries in all the periods.

The descriptive statistics for the exchange rate returns show that the sample means are positive for the entire period for the Czech Republic, Slovakia and Poland. For the pre-EU period, the means are positive just for Poland and for the post-EU period they are positive only for Hungary. The volatility of the exchange rate returns ranged from 1.33 per cent (Poland) to 4 per cent (Czech Republic) for the entire period. During the pre-EU period the highest volatility was found in Poland with 6.6 per cent and the lowest in Slovakia with 3 per cent; in the post-EU period, it moved between 2.6 per cent (Slovakia) to 5 per cent (Poland), the highest volatility period being the pre-EU one. This is explained by all the economic adjustment processes that took place before these countries were able to join the EU. These economies had to comply with EU regulations and requirements in order to be fully part of the EU; as a consequence, their economies have been able to improve their financial markets, thus creating more stability, a characteristic that is reflected by the reduction in their volatility coefficients.

After analysing the descriptive statistics of the data, the next step consists in the presentation of the results derived from the econometric models. The results from the ADF tests statistics show that the null hypothesis of the existence of unit root in levels is rejected for all variables in all periods, indicating that all series are I(0).

Given that all the variables are integrated at the same level, the main conclusion is that the variables are cointegrated, implying that there is a long-term relationship between stock returns and exchange rate returns for all the countries in all the periods. Therefore, is not necessary to implement the Johansen's (1992) cointegration test. Hence, the analysis proceeds with the application of the likelihood ratio (LR) test in order to determine the truncation length (p) for the conditional equations in the bivariate EGARCH model. The LR test is performed on an individual basis on the stock returns and exchange rate conditional variance equations to determine the optimal lag length for the EGARCH specification of each equation.

The results showed that we select the EGARCH (1,1) for all the countries in all the periods with the exception of Slovakia where the EGARCH (2,1) model is selected for the entire period. The results from the EGARCH model estimations, are set out in tables 4.6 to 4.8, for the total sample, and also, for before, and after 2004 respectively. This analysis will present results in terms of volatility persistence, volatility spillover effects and asymmetric spillover effects.

4.1.4.2.2 Volatility Persistence

In relation to the coefficients on the volatility persistence terms, the results from tables 4.6 to 4.8 (first and seven rows) indicate that there is significant persistence in stock returns volatility for all the countries during the three periods.

TABLE 4.6: 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 (0.000)*	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	0.9263 (0.000)*	0.9188 (0.000)*	0.8894 (0.000)*	0.9898 (0.000)*

($\sum \theta_{S,E}$)				
Correlation Coefficient ($\rho_{S,E}$)	0.3200	0.3810	0.0147	0.3744

*1% significance level, **5% significance level, ***10% significance level

For the exchange rate equation, the results show that the coefficients are all significant for the entire period and for the pre-EU period, while it is found that for the post-EU period, volatility persistence for exchange rate returns are not significant in the case of Hungary and Poland, but are significant for the Czech Republic and Slovakia. A necessary condition for the volatility persistence terms to be stable is that the value of the estimated coefficients should be less than one (Wu, 2005). For this analysis, this condition applies in all of the cases.

4.1.4.2.3 Volatility Spillovers

The coefficients for the volatility spillover effects presented in tables 4.6 to 4.8 (rows three and nine) from stock returns to exchange rate returns show that the coefficients are not significant for all the countries, for the three periods of analysis, with the exception of the Czech Republic, where the coefficient is significant after the country joined the EU.

TABLE 4.7: Volatility Spillovers between Stock Returns and Exchange Rate Changes: Pre Europe (before 2004)

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	0.9117 (0.000)*	0.9060 (0.000)*	0.8959 (0.000)*	0.9032 (0.000)*

($\sum\theta_{S,E}$)				
Correlation Coefficient ($\rho_{S,E}$)	0.0298	0.0017	-0.0502	0.0274

*1% significance level, **5% significance level, ***10% significance level

The non-existence of significant spillovers in these countries indicates the existence of a potential for diversification between stock markets and currency markets. This could be translated as follows: when the stock market is affected by a shock or economic hit, this effect will tend to be isolated; therefore, there is no transmission effect to the currency markets or in the opposite direction. Surprisingly, these results show that the volatility of stock returns is not a determinant of the volatility of the exchange rate, suggesting the non existence of integration between these two markets. The results also indicate that volatility information contained in stock prices does not impact on the behaviour of exchange rates in these markets.

In terms of volatility spillovers from exchange rates to stock markets, it is found that the estimated coefficients are insignificant for all the countries for the entire period, and that they are insignificant as well for the pre-EU period with the exception of Poland. Identical results are found for the post-EU period; in this case, Hungary is the exception, where a significant coefficient is found.

4.1.4.2.4 Asymmetric Spillovers

Finally, and in order to conclude the presentation of this analysis's major findings, the results for the asymmetric spillover effects from stock returns to exchange rates are presented in tables 4.6 to 4.8 (rows five and eleven).

The results show that the coefficients are significant in the case of asymmetric spillover effects from stock returns to exchange rates and from exchange rates to stock returns in all the countries for all time periods. The positive sign on all significant coefficients indicates that unexpected good news on stock returns has a greater impact on volatility than unexpected bad news.

TABLE 4.8: Volatility Spillovers between Stock Returns and Exchange Rate Changes: Post Europe (after 2004)

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

*1% significance level, **5% significance level, ***10% significance level

A possible explanation for this is that good news on stock prices may have a greater impact on demand for currency, which increases volatility, as foreign investors want to increase holdings of rising stock. Also, good news on exchange rates may have a greater impact on demand for stocks as investors switch between holdings of stocks and currency, so impacting on stock market volatility.

4.1.4.2.5 Diagnostic Tests

The Jarque-Bera (JB) test indicates that the null hypothesis of residuals normally distributed is rejected in almost all the cases (justifying the use of Bollerslev-Wooldridge robust t-statistics). The only exception was found when analysing the residuals for the exchange rate equation in the post-EU period for the Czech Republic and Poland where the residuals are normally distributed, results that are quite surprising as a non-normal distribution tends to be common in these series.

The Ljung-Box statistics for all three periods and for all countries indicate that there are no residual linear dependencies, with two exceptions. There is linear dependency in the stock return equation for Hungary and Slovakia for the total sample, although for the pre-EU period and post-EU period separately the dependencies are absent.

4.1.4.2.6 Conclusions

The aim of this section has been to provide empirical evidence of the linkage between volatility of stock prices and volatility of exchange rates for four East European countries (Hungary, the Czech Republic, Slovakia and Poland).

The empirical results show that volatility in stock returns and exchange rates tended to decrease after the countries joined the European Union. These results could be explained by the fact that transition economies start their stabilization process by influencing exchange rates, when they move from a floating exchange rate regime to a fixed exchange rate regime. In the present case, it is obvious that these countries have moved into a fixed regime, as they had to peg their currency to the Euro. This whole process results in a decrease in the exchange rate volatility that is clearly reflected by the results after the countries have joined the EU. Fixed exchange rates regimes are strongly associated with open economies countries, which increases their credibility in the financial markets, and creates attractive conditions for potential investors. The recent years in terms of exchange rates policies for these countries have been marked by a major trend: an increasing orientation of the exchange rate prices policies towards the Euro, where the exchange rates of these economies have been pegged to the European currency (Egert and Lahroche Revil, 2003).

In terms of volatility spillover effects from stock returns to exchange rates returns, there are no significant spillovers in these countries. This suggests the non existence of integration between these two markets. When analysing the spillover effects from exchange rates to stock markets it is found that there is a lack of significant spillovers from exchange rates to stock returns, a situation that can be explained as suggested by Jorion (1990); according to that author, the positive exchange rate volatility on stock returns for some firms offsets negative exchange rate volatility for other firms, to give an insignificant effect afterwards.

Finally, asymmetric spillover effects are found to be relevant for all the countries, from stock returns to exchange rates, with all the coefficients having positive signs. This is interpreted as follows: good news has a greater impact on volatility than unexpected bad news.

The results show that the lack of volatility spillovers between stock markets and exchange rates in most of the countries creates the perfect conditions for investors in terms of diversifying their portfolios in the East European countries that have been analysed.

4.1.5 Analysis and Conclusions

The objective of this chapter's first section has been to provide empirical evidence of the relationship between equity markets and currency markets in four key emerging economies in Eastern Europe. The most important characteristic of this research is that it has included the study of East European countries that have not been analysed in this field before.

The main findings from the bivariate analysis could be summarised as follows: the results show that the individual pair wise analysis does not identify a cointegration relationship in the majority of the countries included in the sample when exchange rates and stock prices are analysed. A comparison done with the results of the Johansen cointegration technique finds that the results are consistent. They confirm the non existence of cointegration relationships in almost all the cases.

The causality test is not able to identify a causal relationship running from stock prices to exchange rates or vice versa. In a few cases only, the results show evidence of an unidirectional relationship, although the results are not very helpful in clarifying the causal relationship between these variables due to the fact that two different methodologies were implemented. Therefore, it is possible to state that these two markets seem to be unrelated.

The trivariate analysis results show consistency with the bivariate analysis, indicating that there is no long-term relationship between exchange rates and stock markets. The findings are thus consistent with the general results that have been obtained analysing interlinkages between stock and currency markets, where different countries have been analysed and where the major findings showed that there is no significant evidence of a long-term relationship between stock prices and exchange rates (see for example: Smyth and Nandha (2003), Nieh and Lee (2001), Bahamani-Oskooee and Sohrabian (1992) and Grambovas (2003)).

The results from the causality tests indicate that normally movements in the exchange rate cause movements in stock prices; thus, causality is unidirectional with very little evidence of bidirectional causality running between exchange rates and stock markets in most of the countries and cases of analysis. The results prove that there is a low integration process in the area, and that these markets are not yet integrated with the world financial markets.

Finally, the last sub-section of the chapter examined the volatility linkages between stock returns and exchange rates in the four emerging East European markets. Two main periods were examined, corresponding to the pre-EU (1996-2004) and the post-EU (2004-2006) periods. The findings show evidence of unidirectional volatility spillovers. The coefficients for spillover effects from stock returns to exchange rates appear to be significant in almost all the cases for the three periods of analysis, but there are a few exceptions with regard to the above mentioned results.

Volatility spillovers from exchange rates to stock returns appear as not being 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 of a direct impact on future changes of stock prices. Taking into account that this thesis analyses different countries, it is worth mentioning that the general conclusion in the existing literature when analysing volatility relationships between stock returns and exchange rates changes tends to be consistent, and tends to how that a unidirectional relationship exists from stock returns to exchange rates; it is in this context where this research findings tend to be consistent with the other authors' findings.

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, while risk management will have to take into consideration the linkages between these two markets in order to design appropriate strategies.

4.2 *ASIAN EQUITY MARKETS*

4.2.1 Introduction

The main objective in this section is the study of volatility spillovers between stock returns and exchange rates in five Asian emerging economies (Hong Kong, South Korea, Singapore, Taiwan and Thailand), and in particular, the changes that took effect during the Asian financial crisis. The reason for conducting such a study is the need to understand if this economic event did generate effects in the relationship between stock returns and exchange rates changes in other major economies around the world. The Asian emerging markets deserve special attention due to the fact that these countries are gaining in economic importance, and also because they are increasingly linked to other regions, in particular to the EU. More recently, these countries have been developing new alliances with Latin American countries, where Chile and Mexico are considered key economies that will play a crucial role in their relationships in the coming years. The main interest of this section is the analysis of interlinkages between these two markets in emerging economies. In particular, the author is very keen in knowing if the economic crisis that hit this part of the world during 1997 to 1998 also propagated around the world, hitting other countries and affecting other markets. During the current times of financial turmoil and economic distress, where high levels of uncertainty have spread among investors, and where the world economies seem to be moving into a downward spiral, it is very important to get a better understanding of the financial markets relationships. Accordingly, a better knowledge of the real behaviour of the major financial markets in the world could help governments, investors, academics and practitioners to design more effective economic and investment strategies. The author's particular interest in the Asian countries is justified by the rapid development that these economies experienced since the 1960s, when they were then newly-industrialised emerging economies. Taking all these facts into consideration, the author is very interested by the fact that during the 1990s these countries started to face increasing economic problems that culminated with the Asian financial crisis in July 1997 to December 1998. After this event took place, it is very important to note that this part of the world was able to recover quite quickly. Therefore, it is considered of relevance to research the existence of potential benefits derived from the allocation of capital in these markets during times of uncertainty, as it could be likely that investors could benefit from lower losses during times of financial and economic distress. The other major reason for considering the Asian financial crisis is the analysis of the dimension that this event could have had on other markets, and in particular on some commodities markets, like precious metals and oil markets.

But before the empirical findings are presented and discussed, it is worth highlighting the special characteristics of the Asian markets[18], and how they

[18] The Asian financial crisis is an important event and this thesis just provides some brief comments about it. More information can be found in the following research papers: Corsetti,

evolved after this shock took place. Firstly, the Asian countries under analysis experienced an incredible economic and financial revolution during the 1960s. For example, South Korea went from being a poor nation to being transformed into an economically driven power house. During 1963, the country experienced an economic reform that shifted the nature of its economic relationships with the rest of the world. South Korea moved from an inward economy to an outward one, emphasizing its exports. According to government reports, over the next forty years, South Korea's per-capita GDP grew by a factor of 10, which is more than the US has accomplished over the past century. But this transformation was not just confined to this country; other East or South East Asian countries such as Hong Kong, Taiwan, Singapore, Malaysia, Thailand, Indonesia and China accompanied South Korea in this process of economic and financial development at different points in time. Therefore, these countries entered into a phase of economic growth that allowed them to move from being considered as Third World countries, onto the adoption of the most developed economies' practices.

The economic situation of these countries was very healthy prior to the 1990s, when they financed most of their high investment from domestic savings. However, after 1990s substantial financial outflows took place in the developing Asian countries and they began to run large current account deficits as a share of GDP. At this stage some economists worried that the high deficits would have the same effects as it did Mexico in the late 1994. Others attributed the large capital flow and rapid growing rate to the macro-economically stable economies that gave rise to expectations of profitable investment opportunities in the area.

In 1997 these Asian economies experienced a severe financial crisis, where three major weaknesses stood out: i) a productivity slow down, ii) weak banking regulations, and iii) the lack of a legal framework. Some of these problems were shared with Latin American Countries, and looking to recent events, this is exactly what has started to unfold since 2008, when the world

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Pesenti, and Roubini, (1998), Marshall (1998), Radelet and Sachs (1998), Zuang and Dowling (2002).

economy started to show signs of economic slowdown, and where weak banking regulations and legal frameworks are major causes of the economic crisis.

It is commonly thought that the Asian economic downturn started in July 1997, with the devaluation of the Thai baht. During the first half of 1997 speculation on the devaluation of the baht led to an accelerating loss of foreign currency, and on July 2, 1997 the government attempted a controlled 15 per cent devaluation that led to speculation against the currencies of Malaysia, Indonesia and eventually South Korea. At that moment, the Asian economies were facing many troubles that resulted in a dramatic reversal of their current accounts positions, mostly due to the huge drop in imports, as their economies contracted. The currencies eventually stabilized and interest rates decreased; however, there were spillovers from the region's slump that caused slowdowns or recessions in several neighboring countries like Hong Kong, Singapore, New Zealand and Japan, and also in parts of Europe and Latin America. China and Taiwan went largely unscathed in the crisis, being able to maintain capital controls and having current accounts surpluses over the pre crisis period.

Fortunately, the downturn was V-shaped, and after the sharp output contraction in 1998 growth rates returned in 1999, supported by the depreciated currencies that spurred higher exports.

This brief analysis of the events that took place during the Asian financial crisis highlights the importance of understanding these markets behaviour and their linkages with the rest of the world markets. This is especially true nowadays, where it is believed that the world economies are facing the most important downturn since the Great Depression. Taking these facts into consideration, it is this thesis's objective to analyse the interactions between stock markets and currency markets during this period. Consequently, and as has been discussed in previous chapters, the major expectations are to find evidence of independent behaviour between these two markets in the emerging economies. This would imply that investors will have greater profit opportunities through diversification and for investment protection and risk reduction during times of financial distress in these markets, if the a priori suspicions of independence are then confirmed. The rest of the chapter is organised as follows: the next subsection presents and discusses the main empirical results and finally, the section concludes with a discussion of the importance of the findings.

4.2.2 Empirical Results

This analysis is being conducted with the ultimate purpose of investigating volatility spillovers between stock returns and exchange rate changes for five Asian markets namely, Hong Kong, South Korea, Singapore, Taiwan and Thailand, for the period 1 January 1997 to 7 July 2006. The data set consists of daily closing values for the Hang Seng, Strait Times, Korea SE Composite, Taiwan Se Weighted, and Thailand SE TISCO stock market indices, and the Hong Kong$, Singapore$, South Korea Won, Taiwan New Dollar and Thai Bhat foreign exchange rates against the US$. The final sample has a total of 2485 observations.

4.2.2.1 Descriptive Statistics

The descriptive statistics for stock returns and exchange rates summarise the statistical characteristics of the sample. For the entire period, the sample means of stock returns are positive for all countries except Taiwan as well as being positive for Hong Kong and South Korea during the Asian crisis period (1997-1998) and negative for the other countries in the crisis period. These results reflect how the financial crisis impacted in different ways on the five economies. As was mentioned in the previous sections, these countries suffered in a different manner during the economic downturn, due to the main financial and economic differences between them. In the post crisis period, the mean of all stock returns was positive. The highest mean returns were for South Korea at 2.78 per cent followed by Thailand at 1 per cent for the entire sample; during the crisis period, they were highest for Hong Kong and Korea, and for the post crisis period they were highest for Singapore, followed by Korea and Hong Kong, with Taiwan having the lowest mean returns in the post crisis period. The standard deviations, that are an initial measure of volatility, of the stock returns range from 0.7 per cent to 2.7 per cent for the entire period and from 0.5 per cent to 3.2 per cent in the crisis period and 0.03 per cent to 1.9 per cent in the post crisis period, indicating that the volatility of stock returns in general were lower in the post crisis period than during the financial crisis. As expected, the standard deviations show how the stock returns were more volatile during the crisis, reaching a level of 3.2 per cent. As it is possible to observe, before the crisis was officially declared, the standard deviation of the stock markets returns of this area was moving around 2.7 per cent, and this could be interpreted as a sign of instability appearing in the early years. Both the skewness and kurtosis coefficients indicate that stock returns are leptokurtic relative to the normal distribution. The Jarque-Bera test also rejects the hypothesis that stock returns are normally distributed in all countries.

The descriptive statistics for the exchange rate returns show that the sample means are positive for all countries for the entire period except for Taiwan and Korea; for the crisis period, the means were negative only for Taiwan and Thailand, and for the post crisis period they were negative only for Korea and Singapore. The volatility of exchange rate returns ranged from 0.04 per cent in Hong Kong to 1.06 per cent in South Korea for the entire period; volatility was higher during the crisis period than during the post crisis period for all countries. In relation to the volatility of the exchange rates changes, this appears to be lower than the volatility experienced by the stock returns in these markets, which is quite surprising as the markets problems started with the devaluation of their currencies. This early information is important, because at this early stage it seems that these markets could be behaving slightly differently to the shock. Again the skewness and kurtosis statistics indicate that the distribution of exchange rate returns are non-normal and the Jarque-Bera test also rejects the hypothesis of normally distributed returns for all periods and for all countries.

The results from the ADF tests indicates that we can reject the null hypothesis of the existence of unit roots in levels for all variables in all periods indicating that all series are *I(0)*.[19]

In relation to the EGARCH (p,q) model, we have decided to verify which model would better explain the relationship between the variables. In this case the same procedure that was attempted when analysing the East European countries is followed, therefore, it was decided to run the EGARCH (1,1) and EGARCH (2,1) for each case, and using the Maximum Likelihood function (the whole procedure is explained in detail in the Methodology section), that enables us to select the better model for each case. This is done in order to get the most robust results. The results indicate that for the entire period the EGARCH (2,1) is selected in the case of Hong Kong, Taiwan and Thailand for stock prices, and for Hong Kong, South Korea, Taiwan and Thailand in the case of exchange rate changes. The EGARCH (1,1) model is selected for South Korea and Singapore for stock prices and for Singapore for exchange rate changes. For the crisis period, the EGARCH (2,1) model is chosen for stock prices for Hong Kong and Singapore and the EGARCH (1,1) for Singapore, Taiwan and Thailand. In the case of exchange rates for the crisis period, the EGARCH (2,1) is the selected model for Korea and Thailand, and the EGARCH (1,1) for Hong Kong, Singapore and Taiwan. For the post crisis period, the EGARCH (2,1) is selected for stock prices for Hong Kong and Taiwan, as well as for exchange rates for Hong Kong, Singapore, Taiwan and Thailand; the EGARCH (1,1) is selected for stock prices for the post crisis period for Korea, Singapore and Thailand, and for exchange rates for Korea.

The estimated parameters from the EGARCH estimation are set out in tables 5.1 to 5.3 (see following pages) for the total sample, the crisis period and the post crisis period respectively.

[19] The LMF test results indicated that the ADF tests were free from serial correlation; for brevity the test results are not showed here, but can be found in Appendix E.

4.2.2.2 Volatility Persistence

First, in relation to the coefficients on the volatility persistence term, the results presented in tables 4.9 to 4.11 (rows one and four in each table) indicate that there is significant persistence in stock returns volatility for South Korea, Singapore and Thailand, while the coefficient is insignificant for Hong Kong and Taiwan for the entire period. During the post crisis period, it is found that the coefficient is significant in the case of South Korea, Singapore, Taiwan, and Thailand, whereas with regard to Hong Kong there is no evidence of volatility persistence. For the crisis period, the persistence of volatility is significant for Hong Kong, South Korea and Taiwan; in relation to Singapore and Thailand the coefficients are not significant. When analysing the exchange rate equation, related to the total sample the coefficients are significant in the case of all countries; regarding the crisis period, volatility persistence is significant for all countries except Taiwan and Thailand and for the post crisis period for all countries except Taiwan and Thailand.

Table 4.9: Volatility Spillovers Between Stock Returns and Exchange Rate Changes: Total Sample

Estimated Parameters	**Hong Kong**	**South Korea**	**Singapore**	**Taiwan**	**Thailand**
Volatility Persistence (Stock Returns) ($\sum b_S$)	-0.0073 (0.9053)	0.1126 (0.000)*	0.1892 (0.000)*	0.0195 (0.7407)	0.6658 (0.000)*
Spillover: from Stock Returns to Exchange Rates ($\sum \delta_{S,E}$)	-0.0610 (0.000)*	-0.0367 (0.0203)**	-0.0568 (0.0084)*	-0.0655 (0.000)*	-0.1567 (0.1087)
Asymmetric Spillover effect:From Stock Returns to Exchange Rates ($\sum \theta_{S,E}$)	0.9888 (0.000)*	0.9931 (0.000)*	0.9874 (0.000)*	0.9813 (0.000)*	0.8159 (0.000)*
Volatility Persistence (Exchange Rates) ($\sum b_E$)	0.4119 (0.000)*	0.5357 (0.000)*	0.1210 (0.000)*	0.6394 (0.000)*	0.4119 (0.000)*
Spillover: from Exchange Rates to Stock Returns ($\sum \delta_{S,E}$)	-0.0355 (0.3960)	0.0413 (0.2273)	0.0180 (0.2142)	-0.0448 (0.3973)	-0.0355 (0.3960)
Asymmetric Spillover effect:From: Exchange Rates to Stock Returns ($\sum \theta_{S,E}$)	0.9874 (0.000)*	0.9809 (0.000)*	0.9927 (0.000)*	0.9240 (0.000)*	0.9874 (0.000)*
Correlation Coefficient ($\rho_{S,E}$)	-0.037	-0.095	-0.136	-0.146	0.109

*1% significance level, **5% significance level, ***10% significance level

Wu (2005) notes that a necessary condition for the volatility persistence terms to be stable and consistent in the model is that the value of the estimated coefficients should be less than one; otherwise the model would be presenting instability and the results would not be reliable regarding their interpretation. For the current findings, this condition applies to all the results in almost all the cases except for Hong Kong exchange rates during the crisis and post crisis periods and for Taiwan stock returns during the post crisis period. These results therefore provide support that the model used for the analysis is an appropriate one and that in most of the cases, the information that was obtained from the estimation is consistent and reliable. Thus, it can be concluded that volatility persistence is an important characteristic of the world's major markets, and consistently these Asian emerging financial markets are showing similar results. The results are also consistent with the ones that were obtained when analysing East European markets and they reflect that when markets suffer from a shock the effects tend to last, which is also explained by volatility clustering behaviour.

4.2.2.3 Volatility Spillovers

In terms of the coefficients for the volatility spillover effects from stock returns to exchange rate changes, the results presented in tables 4.9 to 4.11 (rows two and five) show that there are some significant differences between the results for the three time periods. All coefficients are significant for the entire sample. During the crisis, the coefficients are significant for Korea, Singapore and Thailand while for the post crisis period, volatility spillovers from stock markets to exchange rates were only significant for Hong Kong.

The significant coefficients indicate that the volatility of stock returns was a determinant of the volatility of the exchange rate, as well as, indicative of integration between stock markets and exchange rate markets. Furthermore, where significant, the results indicate that volatility information contained in stock prices impacted on the behaviour of exchange rates in these markets.

Table 4.10: Volatility Spillovers Between Stock Returns and Exchange Rates: Crisis period

Estimated Parameters	**Hong Kong**	**South Korea**	**Singapore**	**Taiwan**	**Thailand**
Volatility Persistence (Stock Returns) ($\sum b_S$)	0.3065 (0.025)**	0.6575 (0.0056)*	0.1607 (0.018)**	0.1855 (0.000)*	0.1652 (0.065)***
Spillover: from Stock Returns to Exchange Rates ($\sum \delta_{S,E}$)	0.1325 (0.000)*	0.1091 (0.0023)*	-0.1598 (0.000)*	0.0030 (0.9396)	-0.1742 (0.001)*
Asymmetric Spillover effect: From Stock Returns to Exchange Rates ($\sum \theta_{S,E}$)	0.9970 (0.000)*	0.9879 (0.000)*	0.9673 (0.000)*	0.9849 (0.000)*	0.8526 (0.000)*
Volatility Persistence (Exchange Rates) ($\sum b_E$)	1.0078 (0.000)*	0.5219 (0.000)*	0.5664 (0.000)*	0.2043 (0.0252)**	-0.2545 (0.646)
Spillover: from Exchange Rates to Stock Returns ($\sum \delta_{S,E}$)	0.0318 (0.872)	0.0425 (0.5217)	0.0635 (0.341)	-0.1279 (0.0116)**	0.4472 (0.526)
Asymmetric Spillover effect: From Exchange Rates to Stock Returns ($\sum \theta_{S,E}$)	0.7190 (0.000)*	0.9868 (0.000)*	0.9640 (0.000)*	0.9773 (0.000)*	0.7155 (0.005)*
Correlation Coefficient ($\rho_{S,E}$)	0.000	0.222	-0.212	0.213	0.040

*1% significance level, **5% significance level, ***10% significance level

The lack of significant spillovers in the post crisis period in all markets at the 1 per cent significance level could indicate that governments were able to learn quickly from what happened during the time of instability and therefore, they could implement policies that allowed them to isolate their currencies from fluctuations in their markets, and especially portfolio managers were able to implement hedging strategies that reduced their exposure to risk. These findings are quite relevant, as they indicate potential for diversification between stock markets and currency markets in these countries.

In terms of volatility spillovers from exchange rates to stock markets, it is found that for the entire period the coefficients are insignificant for all the countries. An identical situation is shown for the crisis period, where it is found that all the estimated coefficients are insignificant, while in the post crisis period, significant volatility spillovers from exchange rates to stock markets were found for Hong Kong, Taiwan and Thailand. The lack of significant spillovers from exchange rate changes to stock returns found here for some countries is consistent with the results that were put forward by authors like Yang and Doong (2005) when analysing Asian economies.

In addition to this, the use of instruments to hedge exchange rate risk may reduce the impact of exchange rate volatility on stock markets. Grant and Marshall, (1997), and Bodnar *et al.* (1995) note that the use of hedging instruments to ameliorate exchange rate risk is pervasive amongst larger companies who are the main components of national stock markets indices. The lack of significant spillovers from exchange rates to stock markets in the post crisis period may thus be indicative of the wider use of hedging techniques by firms listed on the stock markets in these countries than during the crisis; it is also likely that the crisis itself may have contributed to more extensive use of hedging against foreign exchange rate risk.

In this case, the author agrees with the possibility of the offsetting effects generated by the actions of investors in the markets. As the results show, there was evidence of some spillovers before the Asian crisis; therefore, a learning process took place during this time period. Investors became aware of the influence of currency markets on the stock markets and therefore, they started to apply sophisticated hedging techniques to eliminate or minimise their exposure to this kind of risk.

4.2.2.4 Asymmetric Spillovers

For the asymmetric spillover effects from stock returns to exchange rates, the results are presented in tables 4.9 to 4.11 (see row three and six), and it is found that there are significant coefficients for all countries and for all time periods.

Similarly, the asymmetric spillover effects from exchange rates to stock prices are significant for all countries and for all time periods.

Table 4.11: Volatility Spillovers Between Stock Returns and Exchange Rates: Post crisis period

Estimated Parameters	Hong Kong	South Korea	Singapore	Taiwan	Thailand
Volatility Persistence (Stock Returns) ($\sum b_S$)	-0.0895 (0.276)	0.1903 (0.000)*	0.0919 (0.000)*	1.6651 (0.000)*	0.3466 (0.000)*
Spillover: from Stock Returns to Exchange Rates ($\sum \delta_{S,E}$)	-0.0296 (0.035)**	-0.0434 (0.116)	-0.0376 (0.052)***	-0.1362 (0.003)*	-0.0311 (0.5694)
Asymmetric Spillover effect: From Stock Returns to Exchange Rates ($\sum \theta_{S,E}$)	0.9920 (0.000)*	0.9811 (0.000)*	0.9918 (0.000)*	1.0019 (0.000)*	0.9558 (0.000)*
Volatility Persistence (Exchange Rates) ($\sum b_E$)	1.6849 (0.000)*	0.1124 (0.000)*	0.4703 (0.000)*	-0.0577 (0.377)	-0.0580 (0.368)
Spillover: from Exchange Rates to Stock Returns ($\sum \delta_{S,E}$)	-0.7321 (0.000)*	-0.0066 (0.687)	0.0341 (0.200)	-0.0625 (0.000)*	-0.0627 (0.000)*
Asymmetric Spillover effect: From Exchange Rates to Stock Returns ($\sum \theta_{S,E}$)	0.7373 (0.000)*	0.9521 (0.000)*	0.9302 (0.000)*	0.9825 (0.000)*	0.9834 (0.000)*
Correlation Coefficient ($\rho_{S,E}$)	-0.006	-0.045	-0.023	0.004	-0.077

*1% significance level, **5% significance level, ***10% significance level

The existence of insignificant coefficients indicate that the spillover effects in these instances are symmetric; in other words, positive and negative shocks have the same impact on volatility, or a decrease in stock returns has the same impact on exchange rate volatility as an increase in stock return. The positive sign on all significant coefficients indicates that unexpected good news has a greater impact on volatility than unexpected bad news. One possible explanation for this is that good news on stock prices may have a greater impact on demand for currency so increasing volatility as foreign investors want to increase holdings of rising stocks; good news on exchange rates may have a greater impact on demand for stocks as investors switch between holdings of stocks and currency, so impacting on stock market volatility. The correlation coefficients for the standardised residuals from the stock and exchange rate equations are significant for Korea, Taiwan and Singapore for the entire period and the crisis period indicating significant contemporaneous relationships between the two markets in these countries for these periods. The only significant correlation for the post crisis period is for Thailand.

4.2.2.5 Diagnostic Tests

The diagnostic test performed in this analysis indicates that when looking to normality behaviour, the Jarque-Bera test indicates that we reject the hypothesis that the residuals are normally distributed. This finding, and as happened with the East European analysis, justify the use of the Bollerslev-Wooldridge robust *t*-statistics that will make the results stronger. The Ljung-Box statistics for all three periods for all countries indicate that there are no residual linear dependencies. The exceptions to this is the existence of a linear dependency in the exchange rate equation for Singapore and Thailand, in the stock return equation for Thailand, for Thailand and South Korea in the exchange rate equation for the total sample, and for Singapore for the crisis sample. It should be noted that for the crisis and post crisis periods separately, the linear dependencies are absent[20], with the exception of Singapore.

4.2.3 Analysis and Conclusions

This section sets out to examine the volatility linkages between stock returns and exchange rates in a number of Asian markets that encompass newly industrialised as well as emerging economies such as Thailand.

The whole period 1997-2006 is studied, as well as sub-periods so as to compare and contrast the volatility linkages between the two markets during the Asian financial crisis. The main results indicated that for most markets, there exists significant persistence in the volatility of both exchange rates and stock returns in all periods, a characteristic that has been found to be common in the general literature when analysing interlinkages between these two variables. In addition to this, the results showed significant volatility spillovers between stock returns and exchange rates during the crisis period for Hong Kong, South Korea, Singapore and Thailand. While Wu (2005) investigates this relationship for a

[20] Kanas (2000) found similar linear dependencies for the UK in the stock return equation.

number of Asian countries, his sample ends in 2000; the current results are broadly consistent with those for the crisis period even though in this study the crisis sample period is slightly different than the one used by Wu (2005). However, there are some differences in this investigation findings for the post crisis period; in particular and in contrast to Wu (2005) there are no volatility spillovers between the stock and currency markets in Korea, Taiwan and Thailand and no volatility spillovers from currency markets to stock markets in South Korea and Singapore.

The results overall indicate that since the Asian financial crisis, there exists significant scope for investors and portfolio managers to diversify their assets between stocks and currencies in these markets. In particular, the lack of volatility spillovers between stock markets and exchange rates in most of the countries (South Korea and Thailand for the entire period, Taiwan during the crisis period and Hong Kong, South Korea, Singapore and Thailand for the post crisis period), and between exchange rates and stock markets in all countries with the exception of Hong Kong, Taiwan and Thailand in the post crisis period indicates that there is scope for investors to diversify their investments in these markets.

When doing a comparative analysis of the major findings for East European and Asian emerging economies, there is a need to highlight that some of the markets analysed are still immature, and they are undertaking fiscal and monetary policy adjustments that allow them to reflect most developed markets' characteristics. They also share a common pattern with regard to the lack of interlinkages between stock returns and exchange rates which makes these economies' financial markets attractive with real potential with regard to the making of profits derived from diversification strategies.

4.3 LATIN AMERICAN EQUITY MARKETS

4.3.1 Introduction

Throughout this section, the research focuses on the Latin American economies that are other emerging markets showing interesting economic developments. Along with Eastern Europe and Asia, Latin America has been deemed a very attractive destination for extending markets in terms of the variety of choices that investors will have when designing their portfolios; in addition to this, governments should analyse the Latin American emerging economies in order to identify new investment opportunities that incentivise national companies' business expansions. This issue is considered of high importance, especially within the European Community, where currently Spain is the second biggest international investor in the area after the US, and is the main investor from the EU, accounting for more than 40 per cent of the total investment (Galan and Benito, 2006). In particular, Spanish multinationals such as Telefónica, Endesa, Banco Santander and BBVA have invested very aggressively in Latin America. Spain has invested a lot of capital in the electricity, communications, and financial sectors in countries such as Brazil, Argentina, Chile, Mexico, Colombia and Venezuela; therefore, the a priori expectations are to find evidence of strong linkages between these economies and the Spanish currency.

Given this scenario, it is of great interest to identify the role of the Spanish currency in the area before and after the introduction of the Euro. It is obvious that with the introduction of the Euro, it became more difficult to appreciate and detect any interaction or linkage that could exist between the Spanish currency market and the Latin American economies as the Euro dilutes the Spanish currency representation in these economies. It is well known that Latin American economies are facing important challenges to align their economies with the rest of the developed world's economies, in order to become more integrated with these markets.

In spite of major financial crises like Mexico (1994), Brazil (1998) and Argentina (2001), the Latin American region has been able to maintain a commitment to macroeconomic stability during the 1990s, which together with the growing liberalization of markets have driven the area to a high level of integration (Mercosur and NAFTA). Even though Latin America has made much progress over the last 20 years, in terms of liberalization, integration and modernization, it still has a long way to go. But it is expected that this region will become a prime destination for foreign direct investment for both the US and the EU. Regional integration such as NAFTA and Mercosur, and Free Trade Agreements (FTAs) have been flourishing in this region since the 1990s.

On the other hand, Asian countries have continued expanding their trade through market integration by means of formal agreements based on regional schemes such as APEC and AFTA (Hosono and Nshijima, 2003). This expansion has been reflected during the last few years, where a country like Japan has showed an increasing interest in bilateral FTAs between Latin America and Asia (Japan-Mexico and Japan-Chile FTA discussions). Latin American countries also have been seeking to extend their relationships with Asian countries. In particular, Mexico and Chile are showing strong commitment and enthusiasm in forming a bilateral framework with the Asian region. Negotiations with Japan and South Korea have become a core focus for Mexico, who is looking for less dependency on the US economy. Japan, South Korea and other East Asian countries are increasingly more convinced of the need to strengthen their links and cooperation with Latin America, since North American and European countries are moving in this direction. Indeed, East Asian countries substantially lag behind the US, Canada and European countries in their foreign direct investment in the region. Therefore, East Asian firms are in a disadvantageous position in terms of competition in the area of trade and investment with US and EU firms. In addition to this, it should be mentioned that Latin America has always been important for Asian countries because of its abundant resources of minerals and foodstuffs.

After taking all these facts into consideration it is quite clear that the emerging economies in the Latin American and Asian regions will be major economies to consider in the future. Therefore, the current analysis will be focusing on stock returns and exchange rates changes interlinkages, where special attention will be paid to the Euro and the US dollar effects on these markets. The reason for introducing the Euro into the study is explained by the Spanish presence in these markets as was discussed above. Accordingly, it was decided to divide the sample into three different periods of analysis, so this partition would identify if the Spanish currency did generate an influence in these markets before the introduction of the Euro. The a priori expectations are that this should be the case; therefore, after the virtual introduction of the Euro in the financial markets in 1999, it is expected that the Euro would not be able to reflect the importance of the Spanish currency in these markets.

The rest of the section is organised as follows: first the analysis starts with the presentation and discussion of the empirical findings and concludes by highlighting the major implications of the results.

4.3.2 Empirical Results

This analysis focuses on the period 1 January 1998 to 31 December 2006[21] which will be split into three sub samples in order to provide greater detail and a better understanding of volatility spillovers between stock returns and exchange rates. Thus the first sub sample analyses 1998, the period prior to the introduction of the Euro. There is also an interest in examining whether the first years of the

[21] In the case of Colombia, it was not possible to present results before 2002 as DataStream only provided data for the CSE Index after July 2001. All the results are presented in Appendix F.

introduction of the Euro affected the relationship between the variables; thus, the sample is also split into two sub periods as follows: 1999-2001 covers the period when exchange rates were fixed against the Euro but the currency was not physically introduced, and 2002-2006 covers the period when the Euro was physically introduced in the markets. The motivation for doing this kind of analysis is based on the author's belief of the possibility of highly volatile markets during the first years of the European currency being settled in the financial markets around the world. Therefore, it is evident that this event could have a particular effect on emerging and world developed economies. Investors could have felt a lack of confidence regarding the new currency, and therefore, this could have been reflected in high levels of volatility in these markets. This analysis is also relevant with regard to the emerging economies in the Asian region, but considering that this research's objective is to analyse the impact of two different events that generated uncertainty in the markets, it was decided to focus on analysing the effects of the Asian crisis on the Asian economies, and the effects of the introduction of the Euro on the Latin American region's economies, which would provide different evidence of how these markets reacted to two different events.

The data set consists of daily closing values for the stock market indices in each country as follows: Argentina (Merval), Brazil (Bovespa), Chile (IGPA Gen), Colombia (CSE Index), Mexico (IPC) and Venezuela (IBC). To analyse the importance of the Euro, the Spanish market was introduced, and will be represented by Spain's (IBEX 35). Thus the sample will be formed by daily closing values for the exchange rates of each country against the Euro, UK£, Japanese Yen and the US$ and the Canadian$, and also by exchange rates of each country versus the six Latin American exchange rates. These exchange rates have been introduced into the analysis for the following reasons: i) first, the study will analyse if there is any significant relationship between stock returns in this region and the strongest currencies of the world; therefore, the Euro, British Pound, Japanese Yen and the US and Canadian dollars are included in the analysis. ii)

Second, and as was pointed out in the literature review, most of the studies have devoted their attention to the analysis of the relationship between emerging stock markets versus the American dollar; so this research is interested in knowing the nature of the relationship between these markets and other major currencies. iii) Finally, and as was also seen in the literature review, there is a clear lack of studies analysing the interaction between stock markets and the exchange rates of their neighbouring economies. Therefore, the author speculates that including these exchange rates to examine whether volatility spillovers are stronger from certain currencies, than others, would represent an important contribution to this area of research. Data was taken from DataStream and the Federal Reserve Statistic Release, giving a total of 2176 observations for each series.

4.3.2.1 Descriptive Statistics

The analysis begins by providing descriptive statistics for stock returns and exchange rates.[22] For the stock returns of each country for 1998, it is found that the means are negative in all the cases, with the exception of the Spanish stock market, IBEX 35. During 1999-2001 the performance of stock markets generally improved with the sample means of stock returns positive for all countries with the exception of Argentina (Merval) and Spain (IBEX 35). For the 2002-2006 period, the means of all the indices are positive and generally of a higher magnitude than for 1999-2001, indicating further improved performance over this period. The results obtained from the means analysis showed that before the introduction of the Euro the markets were reacting by presenting negative results. This could be explained by the effects of the Asian Financial crisis. Afterwards, the markets present positive results, with the exception of Argentina, an economy that suffered an economic downturn during 2001 that affected therefore the performance of its equity and currency markets during this period.

[22] All the results regarding our empirical test are available in the Appendix F. Only a few relevant tables have been included through the thesis.

The standard deviations of the stock returns provide information about the volatility of the markets in each period. All stock markets exhibited higher volatility during 1998 prior to the introduction of the Euro; the standard deviation of stock returns in all markets declined during the 1999-2001 period, and was lowest in all markets for 2002-2006. The standard deviation for 1998 ranged from 1.15 per cent (IGPA Gen) to 3.63 per cent (Bovespa) while for 1999-2001 it was between 0.7 per cent (IGPA Gen) and 2.56 per cent (Merval) and between 0.6 per cent (IGPA Gen) to 2.1 per cent (Merval). The high levels of volatility affect the first subsample, and considering that this period includes the time when the Asian financial crisis hit the markets, these results are not surprising. This means that the Euro did not generate as much uncertainty in the markets as the Asian crisis did. An interesting fact that needs to be mentioned is the behaviour of the Chilean stock market, where its volatility was the lowest in all periods. On the other hand, volatility in the case of Argentina was generally the highest, particularly in the aftermath of the introduction of the Euro. As mentioned before, this effect has its explanation in the particular circumstances of the Argentinean economy during these years.

The descriptive statistics for the exchange rate returns are presented for each country to capture the behaviour of the exchange rates on an individual basis. Overall, there is a considerable variation in the sign and magnitude of the means and standard deviations both over time, across countries and across the various bilateral exchange rates that are included in the analysis.

In 1998, Mexico was the only country for which the means of the exchange rates were positive in all instances; for Venezuela, they were positive against all the ‘hard’ currencies while in Chile the means were negative for all of the Latin American bilateral exchange rates. Although for Argentina, Brazil and Venezuela the means were negative against the Colombian and Mexican Peso, they were positive against the Chilean Peso. For all other countries, a mix of positive and negative means across the bilateral exchange rates reflecting both appreciations and depreciations of the various bilateral exchange rates during this period can be observed. As it was mentioned in previous paragraphs, during 1998 this region was suffering from the consequences of the Asian markets crisis, and the impact that this event had in the Latin American region was not homogeneous. Also, there is a need of being aware of the individual characteristics and level of development of the economies of the countries in this region. These markets are very different and are characterised by their lack of intra-regional integration; therefore the information that is showed by the descriptive statistics is just a clear reflection of these facts.

For the 1999-2001 period, Brazil was the only country where the means of all exchange rate returns were positive while in the case of Chile they were all negative; both Mexico and Argentina exhibited negative mean returns across all bilateral exchange rates except for the Euro and Chilean Peso, with the return also negative for Argentina against the Mexican Peso. Venezuela showed positive mean returns against all the ‘hard’ currencies in contrast to the Euro where they were negative; the Euro also showed positive mean returns against all the Latin American currencies during this period with the exception of the Argentinean Peso.

For the period since the Euro was introduced into circulation, all mean returns were positive for Argentina, and almost all positive for Venezuela; Chile and Mexico showed positive mean returns across all hard currencies excluding the Euro. In fact, all Latin American currencies showed positive mean returns against the Canadian dollar, the Japanese Yen and the British pound. While Brazil had negative mean returns against all other Latin American exchange rates, for the rest of the exchange rates in other countries, no discernable patterns are evident and, as for the earlier periods, a mix of positive and negative means across the other bilateral exchange rates reflecting both appreciation and depreciation of the various bilateral exchange rates during this period can be observed.

With regard to the standard deviation of the exchange rates for the period prior to the introduction of the Euro, for all countries volatility was generally lowest against the US dollar and highest against the Yen, except for Argentina where volatility was highest against the US dollar and for the Spanish Peseta where volatility was highest against the Columbian Peso. For the 1999-2001 period, again volatility for the Latin American bilateral exchange rates was generally lowest against the US dollar and highest against the Brazilian Real. For the Euro, the standard deviation of volatility was lowest against the British pound, and highest against the Brazilian Real. For the final period of analysis, again the standard deviation was lowest against the US dollar for most bilateral exchange rates and highest against the Argentinean Peso. The magnitude of the standard deviations were similar in the earlier two periods and showed a slight increase for the final period. The results obtained from the analysis of the volatility associated with these exchange rates reflect an overall low volatility regarding these economies and the US dollar. This situation could be explained by the strong trade and investment interlinkages that exist between this region and the American economy. These facts drive these economies to pay a lot of attention to their exposure to the US currency and therefore, they would be implementing strategies and using tools, like hedging techniques, to minimise the effects of the dollar depreciation or appreciation in their economies. Regarding the rest of the currencies, each country would face different circumstances, depending on their international relationships. In the cases where a high volatility exists because two economies are not integrated, the controls regarding exchange rates movements will be weaker in those markets. Therefore, there is a clear opportunity for diversification between these economies.

The results from the ADF tests statistics indicate the rejection of the null hypothesis of the existence of unit root in levels for all variables in all periods indicating that all series are *I(0)*.[23]

In order to establish the correct lag length for the EGARCH model, the Likelihood Ratio test is applied; this procedure is implemented in order to get the best model for each market. Therefore, the results become more robust.

[23] The LMF test results indicated that the ADF tests were free from serial correlation; for brevity we do not show the test results here. All results are available in Appendix F.

For the stock return equation, the EGARCH (1,1) model is chosen for Argentina for 1998, for Mexico and Venezuela for 1999-2001 and for Columbia, Chile and Venezuela for 2000-2002 across all bilateral exchange rates. For the other countries there was a mix of (1,1) and (2,1) models chosen for the different bilateral exchange rates. For the exchange rate equation, there was less consistency across countries and time periods in the selection of the EGARCH model with a mixture of (1,1) and (2,1) chosen for each country for each bilateral exchange rate.

The estimated parameters from the EGARCH estimation are set out in Tables 4.12 to 4.20, for the three periods of analysis (1998, 1999-2001 and 2002-2006). The *p*-values are given in parentheses beneath each coefficient estimate.

4.3.2.2 Volatility Persistence

First, the coefficients obtained for the volatility persistence term associated with each country stock returns and exchange rates changes, are presented in table 4.12 for 1998, table 4.13 for 1999-2001 and table 4.14 for 2002-2006. The results vary depending on the country and the equation, but the majority of terms are significant for both the stock returns and exchange rate changes in all three periods. An interesting feature of the results which reflects the inclusion of more than one bilateral exchange rate in the analysis is that the persistence of volatility varies across the different bilateral exchange rates. This finding could be translated as follows: volatility persistence will have a high repercussion in those markets where the level of integration is higher, than in those others where a lack of interlinkages exists.

The results also indicate that the introduction of the Euro (tables 4.13 and 4.14) did not generate any general effect on the persistence of the volatility of stock returns and exchange rates as it has not had a uniform impact across the financial markets in Latin American markets. This means that the Latin American economies do not have a strong relationship with the European markets. As was argued before, these markets are particularly connected with the Spanish economy, but after the Euro was introduced in the financial markets, the currency effects that were generated by the Spanish domestic currency, the Peseta, were diluted. Thus, as the Euro is a cocktail of the euro area currencies, the Spanish presence in this currency would not generate a strong effect due to the fact that Spain is one of the weakest economies in the EMU.

Table 4.12: EGARCH RESULTS: VOLATILITY PERSISTENCE 1998

ARGENTINA	**A.Peso/B.Real**	**A.Peso/Ch.Peso**	**A.Peso/Co.Peso**	**A.Peso/M.Peso**	**A.Peso/Bolivar**	**A,Peso/C$**	**A.Peso/¥**	**A.Peso/$**	**A.Peso/£**	**A.Peso/Pta**
Stock Returns	0.1180	0.0738	0.1202	0.1921	0.1163	0.1296	0.1160	0.1202	0.1278	0.1193
	(0.018)**	(0.099)***	(0.019)**	(0.028)**	(0.029)**	(0.010)*	(0.030)**	(0.014)**	(0.015)**	(0.015)**
Exchange Rates	0.6476	1.0905	0.6433	0.5174	0.4604	0.6236	0.0737	0.2025	0.4063	0.0760
	(0.008)*	(0.000)*	(0.000)*	(0.011)**	(0.000)*	(0.000)*	(0.616)	(0.003)*	(0.040)**	(0.378)
BRAZIL	**Real/A.Peso**	**Real/Ch.Peso**	**Real/Co.Peso**	**Real/M.Peso**	**Real/Bolivar**	**Real/C$**	**Real/¥**	**Real/$**	**Real/£**	**Real/Pta**
Stock Returns	0.1795	-0.2339	0.1824	0.2071	0.1838	-0.1483	0.2026	0.1776	0.1875	0.1862
	(0.000)*	(0.033)**	(0.000)*	(0.001)*	(0.000)*	(0.180)	(0.000)*	(0.001)*	(0.000)*	(0.000)*
Exchange Rates	0.6007	0.9780	0.6573	0.4413	0.3898	0.2031	0.4367	0.3790	0.1170	0.1557
	(0.000)*	(0.001)*	(0.000)*	(0.011)**	(0.018)**	(0.004)*	(0.027)**	(0.000)*	(0.437)	(0.194)
CHILE	**Ch.Peso/A.Peso**	**Ch.Peso/Real**	**Ch.Peso/Co.Peso**	**ChPeso/M.Peso**	**ChPeso/Bolivar**	**Ch Peso/C$**	**Ch Peso/¥**	**ChPeso/$**	**ChPeso/£**	**ChPeso/Pta**
Stock Returns	0.4565	0.4658	0.5399	0.1879	0.4858	0.1974	0.5301	0.2140	0.5464	0.5285
	(0.003)*	(0.003)*	(0.000)*	(0.005)*	(0.002)*	(0.011)**	(0.000)*	(0.011)**	(0.000)*	(0.000)*
Exchange Rates	0.8334	0.8061	0.2669	0.9325	0.5231	0.1073	0.3902	0.8369	-0.1081	-0.4321
	(0.003)*	(0.011)**	(0.214)	(0.000)*	(0.020)**	(0.454)	(0.065)***	(0.003)*	(0.027)**	(0.011)**
MEXICO	**M.Peso/A.Peso**	**M.Peso/.Real**	**M.Peso/Ch.Peso**	**M.Peso/Co.Peso**	**M.Peso/Bolivar**	**M.Peso/C$**	**M.Peso/¥**	**M.Peso/$**	**M.Peso/£**	**M.Peso/Pta**
Stock Returns	0.1751	0.1625	0.0268	0.1592	0.0947	0.0481	0.1008	0.1712	0.2241	0.0051
	(0.183)	(0.2157)	(0.857)	(0.186)	(0.447)	(0.710)	(0.046)**	(0.197)	(0.004)*	(0.967)
Exchange Rates	0.4524	0.7116	0.3004	0.4602	0.3477	0.3213	0.4996	0.4315	0.5704	0.3344
	(0.002)*	(0.000)*	(0.845)	(0.003)*	(0.0198)**	(0.008)*	(0.001)*	(0.002)*	(0.000)*	(0.025)**
VENEZUELA	**Bolivar/A.Peso**	**Bolivar/Real**	**Bolivar/Ch.Peso**	**Bolivar/Co.Peso**	**Bolivar/M.Peso**	**Bolivar/C$**	**Bolivar/¥**	**Bolivar/$**	**Bolivar/£**	**Bolivar/Pta**
Stock Returns	0.3952	0.4218	0.3852	0.4574	0.7363	0.4410	0.4454	0.3982	0.4288	0.4392
	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*
Exchange Rates	0.2423	0.5317	0.5736	0.2797	0.3611	0.5350	0.6054	0.3386	0.4371	0.1456
	(0.266)	(0.007)*	(0.007)*	(0.252)	(0.017)**	(0.000)*	(0.000)*	(0.124)	(0.000)	(0.389)
SPAIN	**Pta/A.Peso**	**Pta/Real**	**Pta/Ch.Peso**	**Pta/Co.Peso**	**Pta/M.Peso**	**Pta/Bolivar**	**Pta/C$**	**Pta/¥**	**Pta/$**	**Pta/£**
Stock Returns	0.1529	0.1555	0.1669	0.0106	0.1432	0.1519	0.1399	0.1712	0.1545	0.1610
	(0.007)*	(0.007)*	(0.007)*	(0.971)	(0.015)**	(0.090)***	(0.007)*	(0.008)*	(0.007)*	(0.007)*
Exchange Rates	0.0383	0.1250	-0.1573	-0.9401	0.2805	0.1654	0.0994	0.2775	0.0243	0.0226
	(0.696))	(0.250)	(0.000)*	(0.064)***	(0.063)***	(0.301)	(0.280)	(0.128)	(0.805)	(0.901)

*1% significance level, **5% significance level, ***10% significance level

Table 4.13: EGARCH RESULTS: VOLATILITY PERSISTENCE 1999-2001

ARGENTINA	**A.Peso/B.Real**	**A.Peso/Ch.Peso**	**A.Peso/Co.Peso**	**A.Peso/M.Peso**	**A.Peso/Bolivar**	**A,Peso/C$**	**A.Peso/¥**	**A.Peso/$**	**A.Peso/£**	**A.Peso/€**
Stock Returns	0.2312	0.2029	0.2065	-0.0035	0.1947	0.1864	0.1895	0.1941	0.1983	0.1989
	(0.012)**	(0.000)*	(0.000)*	(0.871)	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*
Exchange Rates	0.1498	0.3307	0.3272	0.2041	0.5339	0.0687	0.0476	0.5916	0.0806	0.0508
	(0.001)*	(0.000)*	(0.003)*	(0.283)	(0.002)*	(0.067)***	(0.074)***	(0.000)*	(0.357)	(0.625)
BRAZIL	**Real/A.Peso**	**Real/Ch.Peso**	**Real/Co.Peso**	**Real/M.Peso**	**Real/Bolivar**	**Real/C$**	**Real/¥**	**Real/$**	**Real/£**	**Real/€**
Stock Returns	0.2384	0.2073	0.2744	0.1800	0.2283	0.2294	0.2299	0.2326	0.2140	0.2388
	(0.067)***	(0.101)	(0.050)**	(0.002)*	(0.065)***	(0.060)***	(0.084)***	(0.069)***	(0.072)***	(0.047)**
Exchange Rates	0.1490	0.2078	0.2883	0.3588	0.1582	0.2382	0.1460	0.1709	0.0681	0.0571
	(0.000)*	(0.005)*	(0.000)*	(0.053)**	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.024)**	(0.051)***
CHILE	**Ch.Peso/A.Peso**	**Ch.Peso/Real**	**Ch.Peso/Co.Peso**	**ChPeso/M.Peso**	**ChPeso/Bolivar**	**Ch Peso/C$**	**Ch Peso/¥**	**ChPeso/$**	**ChPeso/£**	**ChPeso/€**
Stock Returns	0.4975	0.4933	0.4240	0.4618	0.4988	0.4878	0.5264	0.5018	0.5040	0.4135
	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*
Exchange Rates	0.3191	0.1990	0.3200	0.1251	0.3800	0.2864	0.2242	0.3660	0.2985	0.3074
	(0.001)*	(0.006)*	(0.000)*	(0.075)***	(0.000)*	(0.092)***	(0.370)	(0.004)*	(0.005)*	(0.031)**
MEXICO	**M.Peso/A.Peso**	**M.Peso./Real**	**M.Peso/Ch.Peso**	**M.Peso/Co.Peso**	**M.Peso/Bolivar**	**M.Peso/C$**	**M.Peso/¥**	**M.Peso/$**	**M.Peso/£**	**M.Peso/€**
Stock Returns	0.0829	0.0965	0.0945	0.1000	0.0812	0.0955	0.0876	0.0776	0.0922	0.0365
	(0.058)***	(0.008)*	(0.0133)**	(0.013)**	(0.060)***	(0.014)**	(0.023)**	(0.0855)***	(0.019)**	(0.657)
Exchange Rates	0.2733	0.3437	0.2161	0.3392	0.1407	-0.0024	0.0144	0.2475	0.1725	0.0363
	(0.189)	(0.063)**	(0.001)*	(0.022)**	(0.576)	(0.985)	(0.697)	(0.099)***	(0.108)	(0.001)*
VENEZUELA	**Bolivar/A.Peso**	**Bolivar/Real**	**Bolivar/Ch.Peso**	**Bolivar/Co.Peso**	**Bolivar/M.Peso**	**Bolivar/C$**	**Bolivar/¥**	**Bolivar/$**	**Bolivar/£**	**Bolivar//€**
Stock Returns	0.1532	0.1575	0.1465	0.1486	0.1590	0.1548	0.1465	0.1483	0.1588	0.1470
	(0.001)*	(0.000)*	(0.002)*	(0.001)*	(0.003)*	(0.002)*	(0.001)*	(0.001)*	(0.002)*	(0.001)*
Exchange Rates	0.5208	0.1620	0.3901	0.3593	0.0551	-0.0113	0.0276	0.5999	0.0576	-0.0148
	(0.004)*	(0.138)	(0.000)*	(0.007)*	(0.770)	(0.919)	(0.156)	(0.000)*	(0.242)	(0.877)
SPAIN	**€/A.Peso**	**€/Real**	**€/Ch.Peso**	**€/Co.Peso**	**€/M.Peso**	**€/Bolivar**	**€/C$**	**€/¥**	**€/$**	**€/£**
Stock Returns	0.1204	0.1186	0.1130	0.1213	0.1235	0.1239	0.1179	0.0032	0.1209	0.1268
	(0.000)*	(0.0001)*	(0.001)*	(0.001)*	(0.000)*	(0.000)*	(0.000)*	(0.976)	(0.000)*	(0.000)*
Exchange Rates	-0.0070	0.2007	0.3763	0.1263	0.0414	0.0221	-0.0203	0.2581	-0.0979	0.1395
	(0.942)	(0.070)***	(0.015)**	(0.047)**	(0.668)	(0.804)	(0.631)	(0.001)*	(0.230)	(0.011)**

*1% significance level, **5% significance level, ***10% significance level

Table 4.14: EGARCH RESULTS: VOLATILITY PERSISTENCE 2002-2006

ARGENTINA	A.Peso/B.Real	A.Peso/Ch.Peso	A.Peso/Co.Peso	A.Peso/M.Peso	A.Peso/Bolivar	A,Peso/C$	A.Peso/¥	A.Peso/$	A.Peso/£	A.Peso/€
Stock Returns	0.0646	0.2203	0.2058	0.0424	0.2206	0.1957	0.1990	0.1982	0.2058	0.2104
	(0.504)	(0.002)*	(0.001)*	(0.689)	(0.001)*	(0.000)*	(0.000)*	(0.000)*	(0.001)*	(0.001)*
Exchange Rates	0.2729	0.3816	0.2881	1.1702	0.1770	1.0972	0.0660	0.4477	0.9272	0.9467
	(0.001)*	(0.001)*	(0.001)*	(0.000)*	(0.470)	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*
BRAZIL	**Real/A.Peso**	**Real/Ch.Peso**	**Real/Co.Peso**	**Real/M.Peso**	**Real/Bolivar**	**Real/C$**	**Real/¥**	**Real/$**	**Real/£**	**Real/€**
Stock Returns	-0.1031	0.0857	-0.1199	-0.0861	-0.1088	0.0845	-0.1116	0.1054	-0.1079	0.0872
	((0.170)	(0.008)*	(0.161)	(0.293)	(0.148)	(0.007)*	(0.168)	(0.001)*	(0.227)	(0.004)*
Exchange Rates	0.1445	0.2806	0.2675	0.1876	0.6537	0.2712	0.1897	0.2888	0.1882	0.1986
	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*
CHILE	**Ch.Peso/A.Peso**	**Ch.Peso/Real**	**Ch.Peso/Co.Peso**	**ChPeso/M.Peso**	**ChPeso/Bolivar**	**Ch Peso/C$**	**Ch Peso/¥**	**ChPeso/$**	**ChPeso/£**	**Ch.Peso/€**
Stock Returns	0.1578	0.1692	0.1581	0.1643	0.1652	0.1592	0.1562	0.1593	0.1735	0.1597
	(0.030)**	(0.008)*	(0.022)**	(0.014)**	(0.007)*	(0.024)**	(0.030)**	(0.022)**	(0.004)*	(0.026)**
Exchange Rates	0.3830	0.3236	0.3987	0.3255	0.2765	0.3620	0.3184	0.3810	0.3335	0.3550
	(0.036)**	(0.000)*	(0.000)*	(0.020)**	(0.000)*	(0.001)*	(0.030)**	(0.007)*	(0.008)*	(0.002)*
COLOMBIA	**Co.Peso/A.Peso**	**Co.Peso/Real**	**Co.Peso/Ch.Peso**	**Co.Peso/M.Peso**	**Co.Peso/Bolivar**	**Co.Peso/C$**	**Co.Peso/¥**	**Co.Peso/$**	**Co.Peso/£**	**Co.Peso/€**
Stock Returns	0.3842	0.3805	0.3746	0.3837	0.3826	0.3832	0.3851	0.3848	0.3815	0.3750
	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*
Exchange Rates	0.2577	0.2765	0.3829	0.2072	0.0807	0.1704	0.0962	0.3400	0.1103	-0.0590
	(0.035)**	(0.000)*	(0.000)*	(0.000)*	(0.373)	(0.001)*	(0.012)**	(0.000)*	(0.007)*	(0.403)
MEXICO	**M.Peso/A.Peso**	**M.Peso.Real**	**M.Peso/Ch.Peso**	**M.Peso/Co.Peso**	**M.Peso/Bolivar**	**M.Peso/C$**	**M.Peso/¥**	**M.Peso/$**	**M.Peso/£**	**M.Peso/€**
Stock Returns	0.1050	0.1064	0.1066	0.1069	0.1020	0.1069	0.1090	0.1128	0.1106	0.1011
	(0.002)*	(0.001)*	(0.000)*	(0.002)*	(0.000)*	(0.002)*	(0.002)*	(0.001)*	(0.001)*	(0.002)*
Exchange Rates	0.3161	0.1912	0.3166	0.2136	-0.2842	0.0267	0.0469	0.1106	0.0096	0.0577
	(0.000)*	(0.000)*	(0.014)**	(0.000)*	(0.293)	(0.070)***	(0.032)**	(0.002)*	(0.503)	(0.009)*
VENEZUELA	**Bolivar/A.Peso**	**Bolivar/Real**	**Bolivar/Ch.Peso**	**Bolivar/Co.Peso**	**Bolivar/M.Peso**	**Bolivar/C$**	**Bolivar/¥**	**Bolivar/$**	**Bolivar/£**	**Bolivar/€**
Stock Returns	0.2401	0.2645	0.2274	0.3096	0.3580	0.3147	0.2875	0.2655	0.3115	0.2526
	(0.006)*	(0.001)*	(0.008)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.051)**	(0.000)*	(0.001)*
Exchange Rates	0.6627	0.4720	0.2565	-0.1562	-0.3189	-0.2236	-0.2259	0.2340	-0.2789	-0.1218
	(0.000)*	(0.000)*	(0.000)*	(0.351)	(0.150)	(0.264)	(0.183)	(0.130)	(0.085)	(0.375)
SPAIN	**€/A.Peso**	**€/Real**	**€/Ch.Peso**	**€/Co.Peso**	**€/M.Peso**	**€/Bolivar**	**€/C$**	**€/¥**	**€/$**	**€/£**
Stock Returns	0.1468	0.1466	0.1582	0.1526	0.1474	0.1420	0.1430	0.1460	0.1525	0.1477
	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*
Exchange Rates	0.6286	0.2351	0.4991	0.1288	0.0787	0.6264	0.0349	0.0616	0.0602	0.0231
	(0.000)*	(0.000)*	(0.000)*	(0.001)*	(0.003)*	(0.000)*	(0.486)	(0.017)**	(0.001)*	(0.113)

*1% significance level, **5% significance level, ***10% significance level

4.3.2.3 Volatility Spillovers

In terms of the coefficients for the volatility spillovers, the results are presented in tables 4.15 to 4.17 according to the three periods under investigation. In this case, there is some degree of variation across countries, over time and for the various bilateral exchange rates included in the analysis. Dealing first with spillovers from stock markets to exchange rates, for Brazil and Mexico, significant spillovers are found in all three time periods to all bilateral exchange rates at the 10 per cent significance level, with most results being significant at the 1 per cent significance level. Similarly for Spain, all spillover coefficients were significant for all bilateral exchange rates at the 1 per cent level, with the exception of the Mexican Peso in the 1998 period which was insignificant. For the other countries, there are fewer instances both over time and across the bilateral exchange rates in terms of spillovers from the stock market. In Argentina, for the 1998 period, all coefficients are significant for all bilateral exchange rates at least at the 10 per cent significance level, but this situation changes for the 1999-2001 and 2002-2006 periods where the finding show significant spillovers from the stock market only to the Brazilian Real and Mexican Peso. For Chile, there were significant spillovers at least at the 5 per cent significance level from the stock market only to all Latin American exchange rates excluding the Mexican Peso in 1998; these spillovers were absent in the 1999-2001 and 2002-2006 periods. In contrast, for Venezuela there were no significant spillovers from the stock market to any currency in the 1998 period; spillovers were significant to all currencies for 1999-2001, and then only for the Argentinean Peso, Brazilian Real and Chilean Peso for the 2002-2006 period. Volatility spillovers were absent from the stock market to all currencies for Colombia for 2002-06.

Significant coefficients are indicative of integration between stock markets and exchange rate markets as well as indicating that the volatility of stock returns is a determinant of the volatility of the exchange rate and that information contained in stock prices impacts on the behaviour of exchange rates in these markets. The lack of consistency over time and across countries and bilateral exchange rates indicate that the degree of integration of stock and currency markets varies depending on the currency, and is not constant over time. This demonstrates that there is a lack of integration between these markets and therefore, it shows clear signs of the existence of some potential for diversification between stock markets and currency markets in these countries.

In terms of volatility spillovers from exchange rates to stock markets the results are also presented in tables 4.15 to 4.17. As above, the results are less significant and consistent across countries, and over time as the spillovers from stock markets to exchange rates. Dealing first with the volatility spillovers from the Latin American bilateral exchange rates to stock markets, the results show that for Argentina and Brazil there were no significant spillovers at the 5 per cent significance level neither in 1998 nor in the 2002-2006 period with significant spillovers only from the Mexican Peso to the Argentinean stock market and from the Colombian Peso and the Bolivar to the Brazilian stock market in the 1999-2001 period. For Mexico, again there were no significant spillovers in the 1998 period but volatility spillovers from the Chilean Peso in 1999-2001, and the Real in 2002-2006, to the Mexican stock market. In the case of Chile, significant spillovers were found from the Colombian Peso in 1998 and from the Mexican Peso in 1999-2001 but significant spillovers from all of the Latin American bilateral exchange rates were completely absent for the 2002-2006 period. There were significant spillovers for Venezuela in all three periods, but there were some differences across the three periods with the Argentinean Peso and the Real significant in 1998, the Chilean Peso and the Bolivar significant for 1999-2001 and the Real significant for the 2002-2006 period. For Colombia, during 2002-2006, significant volatility spillovers were found from the Real to the Bolivar to the Colombian stock exchange for this period. The most significant spillovers for Spain were found from the Real and the Chilean and Colombian Pesos in 1998, from the Chilean and Mexican Peso for 1999-2001 and from the Mexican Peso and the Bolivar for 2002-2006. Thus, collectively the results from the estimated coefficients of the volatility spillovers from the Latin American exchange rates to the stock markets examined indicate that the existence of spillovers are dynamic in nature and not constant over time. The major trend is the non existence of significant results, something common to all three periods. Furthermore, the lack of consistency across countries indicates that the impact of volatility spillovers from any single Latin American currency is not uniform across different stock markets. The major implications of such results could be found in terms of making profits from investments in the region. Due to the fact that this area is showing a dynamic pattern, as well as inconsistency in markets behaviour and uncertainty, it is the author's contention that interesting opportunities for realising important earnings are possible in the short-term. Investors could benefit in two ways; they could design strategies based on diversification through stock markets and currency markets, and also across the countries.

Dealing now with the volatility spillovers from the 'harder' currencies, there appears to be some similarities in their impact on the Latin American stock markets. For 1998, there were significant volatility spillovers from the domestic currencies against the Yen for Argentina, Brazil, Venezuela and Mexico, with the Peseta also significant for Argentina in this period. For Chile, volatility spillovers to the stock market were significant from the Chilean Peso against the US dollar while for Spain; spillovers from the Canadian dollar and US dollar were significant.

In the period since the introduction of the Euro, for Argentina, Brazil and Mexico, significant spillovers were observed from the domestic currencies against the British pound and the stock market in both the 1999-2001 and 2002-2006 periods with significant spillovers also from the Canadian dollar and US dollar for Mexico. The significant effects observed in Mexico in relation to the Canadian and US currency are explained by the strong relationships that exist between these countries (NAFTA agreement). These were the only significant spillovers common to both periods after the Euro was introduced; for all other significant coefficients, results differ for the 1999-2001 and 2002-2006 periods. For example, there were no significant spillovers for Chile or Spain for 1999-2001, but for 2002-2006, spillovers from the British pound were significant for Chile and from the Canadian dollar they were significant for Spain. Similarly, significant spillovers were found from the Euro (€) to the Brazilian stock market only for 1999-2001, from the Euro (€) to the Mexican stock market only for 2002-2006, from the Canadian dollar (C$) to the Venezuelan stock market only in 1999-2001 while for 2002-2006, spillovers were significant form the Yen, US dollar and British pound to the Venezuelan stock market.

The presence of significant volatility spillover coefficients indicate that volatility of the relevant bilateral exchange rates was a determinant of the volatility of the stock markets and that information contained in exchange rates impacted on the behaviour of stock markets in these countries. Overall, volatility spillovers are much more prevalent from the various stock markets to the various bilateral exchange rates than is the case for the volatility spillovers from the various bilateral exchange rates to the stock markets in the countries examined. This could be interpreted as a major influence on the countries of some of the world's strongest economies' currencies which makes more difficult a portfolio investment strategy of diversification between developed and emerging economies. In this case the investor should pay careful attention to the individual emerging economies and their particular relationships with the world developed economies, so as to include, in their strategies, those markets that are not integrated. The more widespread presence of significant spillovers from the Peseta to stock markets in the pre Euro period compared to the Euro in the post Euro period is indicative of the dilution effect that the Euro generated in terms of the Spanish currency, and also of the possibility of a wider use of hedging techniques by firms listed on the stock markets in these countries after the introduction of the Euro; it may be that the Euro's status as a global currency resulted in increased hedging than was the case for the Peseta in order to insulate against the volatility of the Euro.

Considering the results from the volatility spillovers from the stock market to exchange rates and from exchange rates to stock markets together, it is possible to highlight a number of instances where the spillovers are bidirectional in nature between the two markets. For 1998, there are significant bidirectional spillovers between: the Yen and the Peseta; the stock markets of Argentina and Brazil; the Colombian Peso and the Chilean stock market and the Yen and the Mexican stock market, as well as for the Real, Chilean Peso, Bolivar and the British pound for the Spanish stock market. For 1999-2001, spillovers were significant in both directions between the Mexican Peso and the Argentinean stock market, for the Chilean Peso and the Mexican stock market, the Mexican Peso and Canadian dollar, and the Venezuelan stock market, and for the Real and Colombian Peso and the Real and the Spanish stock market. In the more recent 2002-2006 period, there were significant bidirectional volatility spillovers for the Bolivar, Yen and the US$ and the Brazilian stock market, the Real, British pound, the Euro, and the Mexican stock market, the Real and the Venezuelan stock market, and the Mexican Peso, Bolivar and Canadian dollar and the Mexican stock market.

These results show that there were no significant bidirectional relationships that were common to all three periods. However, it was found a bidirectional relationship in the case of the British pound and the Brazilian stock market, and for the Canadian dollar and the US dollar and the Mexican stock market in relation to both post Euro periods; the result for Mexico is not surprising given the geographical proximity of Mexico to the US and Canada and their strong relationships. The significant spillovers in both directions can be taken as evidence of a high degree of integration between stock and currency markets in these countries, which is not surprising as has been mentioned; these countries share strong relationships regarding trade and investment. Therefore, the degree of level of integration appears to be currency specific rather than a general feature of financial markets in these countries, which means that for the rest of these countries this kind of integration is not so clear. As was mentioned before, the results show evidence of the possibility of diversification through the region, and in particular, the author concludes that important earnings could be obtained in the short-term. As these markets show a lack of stability and consistency regarding the relationships between the markets, it would be necessary to re-design strategies covering short periods in order to minimise risk exposure, and to get the maximum benefits from these markets.

Table 4.15: EGARCH RESULTS: VOLATILITY SPILLOVERS 1998

ARGENTINE	**A.Peso/B.Real**	**A.Peso/Ch.Peso**	**A.Peso/Co.Peso**	**A.Peso/M.Peso**	**A.Peso/Bolivar**	**A,Peso/C$**	**A.Peso/¥**	**A.Peso/$**	**A.Peso/£**	**A.Peso/Pta**
Stock Returns	-0.1198	-0.1227	-0.1215	-0.0808	-0.1239	-0.1325	-0.1171	-0.1193	-0.1212	-0.1228
	(0.006)*	(0.004)*	(0.005)*	(0.094)***	(0.005)*	(0.001)*	(0.009)*	(0.012)**	(0.011)**	(0.004)*
Exchange Rates	-0.2939	-0.0373	-0.0601	-0.1235	0.1950	-0.2365	0.2383	-0.0494	0.1941	0.2119
	(0.212)	(0.685)	(0.667)	(0.197)	(0.055)***	(0.089)***	(0.015)**	(0.440)	(0.067)***	(0.012)**
BRAZIL	**Real/A.Peso**	**Real/Ch.Peso**	**Real/Co.Peso**	**Real/M.Peso**	**Real/Bolivar**	**Real/C$**	**Real/¥**	**Real/$**	**Real£**	**Real/Pta**
Stock Returns	-0.2004	-0.2124	-0.1974	-0.1909	-0.1970	-0.2100	-0.1968	-0.1970	-0.1985	-0.1949
	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*
Exchange Rates	0.2357	0.0136	-0.0421	-0.0927	0.1681	-0.0399	0.2383	0.1328	0.1817	0.2487
	(0.099)***	(0.876)	(0.808)	(0.403)	(0.114)	(0.519)	(0.039)**	(0.211)	(0.096)***	(0.010)*
CHILE	**Ch.Peso/A.Peso**	**Ch.Peso/Real**	**Ch.Peso/Co.Peso**	**ChPeso/M.Peso**	**ChPeso/Bolivar**	**Ch Peso/C$**	**Ch Peso/¥**	**ChPeso/$**	**ChPeso/£**	**ChPeso/Pta**
Stock Returns	-0.0677	-0.0626	-0.0644	-0.0364	-0.0558	-0.0401	-0.0498	-0.0389	-0.0451	-0.0504
	(0.001)*	(0.006)*	(0.006)*	(0.227)	(0.027)**	(0.222)	(0.069)***	(0.255)	(0.128)	(0.064)***
Exchange Rates	-0.1696	-0.0998	0.2164	-0.1882	-0.0426	0.1071	0.1795	-0.1385	0.0581	0.0716
	(0.061)***	(0.256)	(0.022)**	(0.131)	(0.718)	(0.225)	(0.115)	(0.116)	(0.106)	(0.040)**
MEXICO	**M.Peso/A.Peso**	**M.Peso.Real**	**M.Peso/Ch.Peso**	**M.Peso/Co.Peso**	**M.Peso/Bolivar**	**M.Peso/C$**	**M.Peso/¥**	**M.Peso/$**	**M.Peso/£**	**M.Peso/Pta**
Stock Returns	-0.0945	-0.0957	-0.1190	-0.0920	-0.1065	-0.1112	-0.1164	-0.0944	-0.1159	-0.1010
	(0.021)**	(0.018)**	(0.003)*	(0.032)**	(0.008)*	(0.004)*	(0.003)*	(0.020)**	(0.010)*	(0.023)**
Exchange Rates	0.1833	0.1207	0.0924	0.0174	0.1314	0.0656	0.1540	0.1721	-0.0601	0.0878
	(0.250)	(0.176)	(0.516)	(0.885)	(0.381)	(0.353)	(0.045)**	(0.260)	(0.201)	(0.316)
VENEZUELA	**Bolivar/A.Peso**	**Bolivar/Real**	**Bolivar/Ch.Peso**	**Bolivar/Co.Peso**	**Bolivar/M/Peso**	**Bolivar/C$**	**Bolivar/¥**	**Bolivar/$**	**Bolivar/£**	**Bolivar/Pta**
Stock Returns	0.0127	-0.0029	0.0028	-0.0445	-0.1057	-0.0318	-0.0299	0.0155	-0.0266	-0.0301
	(0.855)	(0.968)	(0.968)	(0.513)	(0.386)	(0.639)	(0.662)	(0.833)	(0.700)	(0.666)
Exchange Rates	-0.3142	-0.5089	0.0332	0.0815	-0.1339	0.1544	0.3037	-0.2828	0.0721	0.3733
	(0.020)**	(0.004)*	(0.797)	(0.381)	(0.376)	(0.124)	(0.016)**	(0.038)**	(0.133)	(0.001)*
SPAIN	**Pta/A.Peso**	**Pta/Real**	**Pta/Ch.Peso**	**Pta/Co.Peso**	**Pta/M.Peso**	**Pta/Bolivar**	**Pta/C$**	**Pta/¥**	**Pta/$**	**Pta/£**
Stock Returns	-0.1133	-0.1127	-0.1069	0.0097	-0.1086	-0.1129	-0.1301	-0.1003	-0.1130	-0.1083
	(0.008)*	(0.007)*	(0.008)*	(0.967)	(0.006)*	(0.007)*	(0.002)*	(0.016)**	(0.008)*	(0.008)*
Exchange Rates	-0.1344	-0.1915	-0.0844	0.6922	-0.0656	0.3478	-0.0981	0.2074	-0.1494	-0.2178
	(0.094)***	(0.020)**	(0.039)**	(0.025)**	(0.491)	(0.002)*	(0.207)	(0.052)***	(0.058)***	(0.012)**

*1% significance level, **5% significance level, ***10% significance level

Table 4.16: EGARCH RESULTS: VOLATILITY SPILLOVERS 1999-2001

ARGENTINA	**A.Peso/B.Real**	**A.Peso/Ch.Peso**	**A.Peso/Co.Peso**	**A.Peso/M.Peso**	**A.Peso/Bolivar**	**A,Peso/C$**	**A.Peso/¥**	**A.Peso/$**	**A.Peso/£**	**A.Peso/€**
Stock Returns	-0.0918	-0.0649	-0.0720	-0.0606	-0.0676	-0.0691	-0.0673	-0.0688	-0.0679	-0.0682
	(0.000)*	(0.202)	(0.157)	(0.000)*	(0.180)	(0.160)	(0.178)	(0.172)	(0.177)	(0.179)
Exchange Rates	-0.0400	-0.0375	-0.0168	-0.2451	-0.1437	-0.0212	0.0371	-0.0965	-0.0320	-0.0915
	(0.196)	(0.704)	(0.822)	(0.047)**	(0.235)	(0.363)	(0.104)	(0.271)	(0.016)**	(0.210)
BRAZIL	**Real/A.Peso**	**Real/Ch.Peso**	**Real/Co.Peso**	**Real/M.Peso**	**Real/Bolivar**	**Real/C$**	**Real/¥**	**Real/$**	**Real£**	**Real/€**
Stock Returns	-0.0576	-0.0607	-0.0633	-0.1352	-0.0574	-0.0560	-0.0517	-0.0561	-0.0537	-0.0560
	(0.027)**	(0.021)**	(0.004)*	(0.022)**	(0.028)**	(0.031)**	(0.077)***	(0.027)**	(0.012)**	(0.055)***
Exchange Rates	0.0477	0.0307	-0.0121	0.0080	0.0502	0.0667	0.0370	0.0477	0.0661	0.0593
	(0.118)	(0.496)	(0.781)	(0.797)	(0.066)***	(0.073)***	(0.083)***	(0.131)	(0.000)*	(0.001)*
CHILE	**Ch.Peso/A.Peso**	**Ch.Peso/Real**	**Ch.Peso/Co.Peso**	**ChPeso/M.Peso**	**ChPeso/Bolivar**	**Ch Peso/C$**	**Ch Peso/¥**	**ChPeso/$**	**ChPeso/£**	**ChPeso/€**
Stock Returns	-0.0001	-0.0054	-0.0271	0.0118	0.0098	0.0004	-0.0071	0.0021	-0.0062	-0.0228
	(0.996)	(0.804)	(0.609)	(0.271)	(0.541)	(0.984)	(0.744)	(0.915)	(0.780)	(0.654)
Exchange Rates	0.0320	-0.0402	-0.0744	-0.2074	0.0332	-0.0257	0.0091	0.0381	-0.0068	-0.0479
	(0.756)	(0.330)	(0.156)	(0.000)*	(0.709)	(0.811)	(0.431)	(0.742)	(0.872)	(0.561)
MEXICO	**M.Peso/A.Peso**	**M.Peso.Real**	**M.Peso/Ch.Peso**	**M.Peso/Co.Peso**	**M.Peso/Bolivar**	**M.Peso/C$**	**M.Peso/¥**	**M.Peso/$**	**M.Peso/£**	**M.Peso/€**
Stock Returns	-0.0723	-0.0708	-0.0754	-0.0774	-0.0705	-0.0793	-0.0637	-0.0718	-0.0742	-0.0792
	(0.011)**	(0.005)*	(0.004)*	(0.006)*	(0.009)*	(0.007)*	(0.013)**	(0.011)**	(0.064)***	(0.005)*
Exchange Rates	0.2262	-0.0118	0.2128	0.0455	0.1831	0.2099	0.0573	0.2353	0.1945	-0.0549
	(0.074)***	(0.689)	(0.000)*	(0.585)	(0.095)***	(0.005)*	(0.072)***	(0.024)**	(0.000)*	(0.434)
VENEZUELA	**Bolivar/A.Peso**	**Bolivar/Real**	**Bolivar/Ch.Peso**	**Bolivar/Co.Peso**	**Bolivar/M.Peso**	**Bolivar/C$**	**Bolivar/¥**	**Bolivar/$**	**Bolivar/£**	**Bolivar//€**
Stock Returns	0.1042	0.1018	0.1072	0.1057	0.1277	0.1076	0.1065	0.1100	0.1083	0.1048
	(0.043)**	(0.052)***	(0.043)**	(0.041)**	(0.044)**	(0.041)**	(0.030)**	(0.040)**	(0.051)***	(0.037)**
Exchange Rates	0.1527	-0.0496	-0.0500	0.0005	-0.1903	-0.0290	0.0284	0.1386	0.0461	-0.1158
	(0.236)	(0.048)**	(0.663)	(0.995)	(0.024)**	(0.000)*	(0.145)	(0.096)***	(0.218)	(0.116)
SPAIN	**€/A.Peso**	**€/Real**	**€/Ch.Peso**	**€/Co.Peso**	**€/M.Peso**	**€/Bolivar**	**€/C$**	**€/¥**	**€/$**	**€/£**
Stock Returns	-0.1010	-0.0956	-0.1039	-0.0938	-0.0982	-0.1002	-0.0986	-0.1033	-0.1007	-0.0978
	(0.000)*	(0.000)*	(0.000)*	(0.003)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*
Exchange Rates	-0.0240	0.0665	0.0176	0.0900	0.0893	-0.0216	-0.0144	-0.0881	0.0133	-0.0650
	(0.716)	(0.000)*	(0.850)	(0.021)**	(0.147)	(0.642)	(0.633)	(0.063)***	(0.785)	(0.070)***

*1% significance level, **5% significance level, ***10% significance level

Table 4.17: EGARCH RESULTS: VOLATILITY SPILLOVERS 2002-2006

ARGENTINA	**A.Peso/B.Real**	**A.Peso/Ch.Peso**	**A.Peso/Co.Peso**	**A.Peso/M.Peso**	**A.Peso/Bolivar**	**A,Peso/C$**	**A.Peso/¥**	**A.Peso/$**	**A.Peso/£**	**A.Peso/€**
Stock Returns	-0.0474	-0.0266	-0.0304	-0.0469	-0.0266	-0.0363	-0.0334	-0.0333	-0.0308	-0.0275
	(0.074)***	(0.402)	(0.280)	(0.079)***	(0.389)	(0.183)	(0.224)	(0.233)	(0.278)	(0.334)
Exchange Rates	-0.0217	-0.0425	-0.0193	-0.0164	0.2450	0.0170	-0.0107	-0.0042	0.0204	0.0049
	(0.450)	(0.131)	(0.434)	(0.497)	(0.08)***	(0.405)	(0.599)	(0.879)	(0.000)*	(0.853)
BRAZIL	**Real/A.Peso**	**Real/Ch.Peso**	**Real/Co.Peso**	**Real/M.Peso**	**Real/Bolivar**	**Real/C$**	**Real/¥**	**Real/$**	**Real£**	**Real/€**
Stock Returns	-0.0881	-0.0616	-0.0742	-0.0822	-0.0916	-0.0512	-0.0858	-0.0515	-0.0809	-0.0584
	(0.000)*	(0.002)*	(0.000)*	(0.000)*	(0.000)*	(0.010)*	(0.000)*	(0.012)**	(0.000)*	(0.003)*
Exchange Rates	0.0168	0.0572	0.0413	0.0607	0.5731	0.0433	0.0486	0.0614	0.0503	0.0404
	(0.587)	(0.158)	(0.09)***	(0.065)***	(0.000)*	(0.129)	(0.013)**	(0.026)**	(0.041)**	(0.139)
CHILE	**Ch.Peso/A.Peso**	**Ch.Peso/Real**	**Ch.Peso/Co.Peso**	**ChPeso/M.Peso**	**ChPeso/Bolivar**	**Ch Peso/C$**	**Ch Peso/¥**	**ChPeso/$**	**ChPeso/£**	**Ch.Peso/€**
Stock Returns	-0.0237	-0.0264	-0.0223	-0.0242	-0.0205	-0.0240	-0.0241	-0.0229	-0.0266	-0.0221
	(0.364)	(0.342)	(0.385)	(0.349)	(0.424)	(0.370)	(0.356)	(0.380)	(0.299)	(0384)
Exchange Rates	0.0403	-0.0692	0.0309	-0.0225	-0.1126	0.0488	0.0638	0.0469	0.0239	0.0009
	(0.171)	(0.059)***	(0.358)	(0.717)	(0.158)	(0.092)***	(0.000)*	(0.381)	(0.537)	(0.989)
COLOMBIA	**Co.Peso/A.Peso**	**Co.Peso/Real**	**Co.Peso/Ch.Peso**	**Co.Peso/M.Peso**	**Co.Peso/Bolivar**	**Co.Peso/C$**	**Co.Peso/¥**	**Co.Peso/$**	**Co.Peso/£**	**Co.Peso/€**
Stock Returns	-0.0203	-0.0200	-0.0228	-0.0196	-0.0201	-0.0197	-0.0199	-0.0189	-0.0181	-0.0222
	(0.543)	(0.552)	(0.504)	(0.561)	(0.545)	(0.557)	(0.552)	(0.57)	(0.587)	(0.505)
Exchange Rates	0.0171	-0.0486	-0.0243	0.0065	0.2585	0.0125	0.0292	-0.0052	0.0288	-0.0054
	(0.467)	(0.044)**	(0.690)	(0.809)	(0.000)*	(0.644)	(0.262)	(0.887)	(0.101)	(0.824)
MEXICO	**M.Peso/A.Peso**	**M.Peso.Real**	**M.Peso/Ch.Peso**	**M.Peso/Co.Peso**	**M.Peso/Bolivar**	**M.Peso/C$**	**M.Peso/¥**	**M.Peso/$**	**M.Peso/£**	**M.Peso/€**
Stock Returns	-0.1778	-0.1683	-0.1844	-0.1774	-0.1797	-0.1751	-0.1772	-0.1761	-0.1796	-0.1792
	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*
Exchange Rates	0.0152	-0.0621	0.0269	-0.0064	-0.1577	0.0463	0.0066	-0.1796	0.0300	-0.0480
	(0.420)	(0.049)**	(0.689)	(0.813)	(0.088)***	(0.000)*	(0.686)	(0.035)**	(0.003)*	(0.001)*
VENEZUELA	**Bolivar/A.Peso**	**Bolivar/Real**	**Bolivar/Ch.Peso**	**Bolivar/Co.Peso**	**Bolivar/M.Peso**	**Bolivar/C$**	**Bolivar/¥**	**Bolivar/$**	**Bolivar/£**	**Bolivar/€**
Stock Returns	0.1430	0.1771	0.1516	0.1158	0.1174	0.1162	0.1300	0.1315	0.1246	0.1584
	(0.065)***	(0.035)**	(0.051)***	(0.176)	(0.162)	(0.194)	(0.129)	(0.149)	(0.163)	(0.044)**
Exchange Rates	-0.0636	-0.4502	0.1105	-0.0142	0.1637	0.0122	0.2634	-0.4810	0.2151	0.0270
	(0.691)	(0.000)*	(0.184)	(0.734)	(0.047)**	(0.848)	(0.014)**	(0.000)*	(0.004)*	(0.672)
SPAIN	**€/A.Peso**	**€/Real**	**€/Ch.Peso**	**€/Co.Peso**	**€/M.Peso**	**€/Bolivar**	**€/C$**	**€/¥**	**€/$**	**€/£**
Stock Returns	-0.0868	-0.0879	-0.0807	-0.0799	-0.0876	-0.0820	-0.0914	-0.0920	-0.0737	-0.0929
	(0.000)*	(0.000)*	(0.001)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.001)*	(0.000)*
Exchange Rates	-0.0100	0.0415	-0.0547	-0.0111	-0.0412	0.3375	-0.1051	-0.0111	0.0152	0.0168
	(0.867)	(0.118)	(0.503)	(0.597)	(0.012)**	(0.020)**	(0.003)*	(0.619)	(0.215)	(0.158)

*1% significance level, **5% significance level, ***10% significance level

4.3.2.4 Asymmetric Spillovers

The results for the asymmetric spillover effects are presented in tables 4.18 to 4.20 for each period under analysis respectively. The results from stock returns to exchange rates show that the coefficients are significant in almost all cases for all periods. Exceptions are found for the asymmetric spillover effects running from exchange rates to stock returns during 1998, for the coefficients for the Argentina Peso/Yen, the Brazilian Real/Pta, the Venezuelan Bolivar/Canadian dollar and the Bolivar/Pta, and finally for the Spanish Pta/Real, Pta/Colombian Peso and the Pta/Bolivar. During 1999-2001, the coefficients are significant with the following exceptions: for Argentina in the case of the Argentinean Peso/€, for Venezuela in the case of the Bolivar/€ and for Spain in the case of the €/Argentinean Peso, €/Chilean Peso and the €/Bolivar. The existence of insignificant coefficients indicates that the spillover effects in these instances are symmetric, that is that positive and negative shocks have the same impact on volatility, and that the markets would not react in a different way to positive or negative events that take place in the domestic and world economies. This kind of puzzling result is possibly explained by the lack of integration between the markets under analysis, and as there is no relationship between them, the model is just unable to capture such effects. Thus, the general significance of most of the asymmetry coefficients justifies the use of the EGARCH model to capture asymmetry in the impact of good and bad news, but it seems to need a correction in the model that allows us to filter for abnormalities.

Table 4.18: EGARCH RESULTS: ASYMMETRIC SPILLOVERS 1998

ARGENTINA	**A.Peso/B.Real**	**A.Peso/Ch.Peso**	**A.Peso/Co.Peso**	**A.Peso/M.Peso**	**A.Peso/Bolivar**	**A,Peso/C$**	**A.Peso/¥**	**A.Peso/$**	**A.Peso/£**	**A.Peso/Pta**
Stock Returns	0.9774	0.9853	0.9765	0.9793	0.9754	0.9775	0.9778	0.9771	0.9746	0.9774
	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*
Exchange Rates	0.9721	0.9274	0.9707	0.9536	0.7274	0.9013	-0.2404	0.9850	0.8163	0.7305
	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.4884)	(0.000)*	(0.000)*	(0.000)*
BRAZIL	**Real/A.Peso**	**Real/Ch.Peso**	**Real/Co.Peso**	**Real/M.Peso**	**Real/Bolivar**	**Real/C$**	**Real/¥**	**Real/$**	**Real£**	**Real/Pta**
Stock Returns	0.9590	0.9577	0.9577	0.9581	0.9581	0.9534	0.9590	0.9595	0.9568	0.9568
	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*
Exchange Rates	0.9080	0.9461	0.9698	0.9584	0.7348	0.9871	0.7365	0.9508	-0.1031	0.5212
	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.800)	(0.078)***
CHILE	**Ch.Peso/A.Peso**	**Ch.Peso/Real**	**Ch.Peso/Co.Peso**	**ChPeso/M.Peso**	**ChPeso/Bolivar**	**Ch Peso/C$**	**Ch Peso/¥**	**ChPeso/$**	**ChPeso/£**	**ChPeso/Pta**
Stock Returns	1.0025	1.0016	1.0021	0.9909	0.9994	0.9849	0.9969	0.9819	0.9941	0.9970
	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*
Exchange Rates	0.9662	0.9592	0.8808	0.9385	0.9006	0.9303	0.7863	0.9613	0.9278	0.9557
	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*
COLOMBIA	**Co.Peso/A.Peso**	**Co.Peso/Real**	**Co.Peso/Ch.Peso**	**Co.Peso/M.Peso**	**Co.Peso/Bolivar**	**Co.Peso/C$**	**Co.Peso/¥**	**Co.Peso/$**	**Co.Peso/£**	**Co.Peso/Pta**
Stock Returns	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Exchange Rates	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
MEXICO	**M.Peso/A.Peso**	**M.Peso.Real**	**M.Peso/Ch.Peso**	**M.Peso/Co.Peso**	**M.Peso/Bolivar**	**M.Peso/C$**	**M.Peso/¥**	**M.Peso/$**	**M.Peso/£**	**M.Peso/Pta**
Stock Returns	0.9838	0.9844	0.9880	0.9740	0.9848	0.9818	0.9787	0.9843	0.9796	0.9817
	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*
Exchange Rates	0.9496	0.9575	0.9576	0.9557	0.9656	0.9608	0.8739	0.9533	0.9806	0.9496
	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*
VENEZUELA	**Bolivar/A.Peso**	**Bolivar/Real**	**Bolivar/Ch.Peso**	**Bolivar/Co.Peso**	**Bolivar/M.Peso**	**Bolivar/C$**	**Bolivar/¥**	**Bolivar/$**	**Bolivar/£**	**Bolivar/Pta**
Stock Returns	0.9025	0.8882	0.8960	0.8921	0.4907	0.8999	0.8841	0.9044	0.9088	0.8829
	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*
Exchange Rates	0.5408	-0.3285	0.8993	1.0131	0.9640	0.0443	0.4920	0.5897	-0.8563	0.2228
	(0.003)*	(0.002)*	(0.000)*	(0.000)*	(0.000)*	(0.889)	(0.000)*	(0.000)*	(0.000)*	(0.189)
SPAIN	**Pta/A.Peso**	**Pta/Real**	**Pta/Ch.Peso**	**Pta/Co.Peso**	**Pta/M.Peso**	**Pta/Bolivar**	**Pta/C$**	**Pta/¥**	**Pta/$**	**Pta/£**
Stock Returns	0.9559	0.9563	0.9559	0.0100	0.9508	0.9557	0.9550	0.9575	0.9561	0.9578
	(0.000)*	(0.000)*	(0.000)*	(0.985)	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*
Exchange Rates	0.7593	0.5692	0.9536	0.0055	0.9536	0.2028	0.8677	0.7877	0.7289	0.7933
	(0.000)*	(0.100)	(0.000)*	(0.986)	(0.000)*	(0.412)	(0.000)*	(0.000)*	(0.001)*	(0.000)*

*1% significance level, **5% significance level, ***10% significance level

Table 4.19: EGARCH RESULTS: ASYMMETRIC SPILLOVERS 1999-2001

ARGENTINA	**A.Peso/B.Real**	**A.Peso/Ch.Peso**	**A.Peso/Co.Peso**	**A.Peso/M.Peso**	**A.Peso/Bolivar**	**A,Peso/C$**	**A.Peso/¥**	**A.Peso/$**	**A.Peso/£**	**A.Peso/€**
Stock Returns	0.9976	0.9429	0.9425	1.0008	0.9424	0.9517	0.9451	0.9419	0.9430	0.9407
	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*
Exchange Rates	0.9900	0.9640	0.9647	0.6661	0.9527	0.9823	0.9790	0.9356	0.9947	0.5654
	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.281)
BRAZIL	**Real/A.Peso**	**Real/Ch.Peso**	**Real/Co.Peso**	**Real/M.Peso**	**Real/Bolivar**	**Real/C$**	**Real/¥**	**Real/$**	**Real£**	**Real/€**
Stock Returns	0.9695	0.9690	0.9667	0.9143	0.9698	0.9677	0.9665	0.9696	0.9692	0.9672
	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*
Exchange Rates	0.9863	0.9743	0.9753	0.9901	0.9862	0.9783	0.9823	0.9851	0.9812	0.9784
	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)	(0.000)*	(0.000)*	(0.000)*	(0.000)*
CHILE	**Ch.Peso/A.Peso**	**Ch.Peso/Real**	**Ch.Peso/Co.Peso**	**ChPeso/M.Peso**	**ChPeso/Bolivar**	**Ch Peso/C$**	**Ch Peso/¥**	**ChPeso/$**	**ChPeso/£**	**ChPeso/€**
Stock Returns	0.9725	0.9657	0.7714	0.9938	0.9888	0.9749	0.9670	0.9760	0.9678	0.7712
	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*
Exchange Rates	0.9515	0.9751	0.7870	0.8310	0.9263	0.6013	0.9843	0.7161	-0.6735	0.6662
	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*
MEXICO	**M.Peso/A.Peso**	**M.Peso.Real**	**M.Peso/Ch.Peso**	**M.Peso/Co.Peso**	**M.Peso/Bolivar**	**M.Peso/C$**	**M.Peso/¥**	**M.Peso/$**	**M.Peso/£**	**M.Peso/€**
Stock Returns	0.9309	0.9514	0.9389	0.9378	0.9350	0.9335	0.9447	0.9301	0.9388	0.9351
	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*
Exchange Rates										
	0.6965	0.9902	0.7753	0.8276	0.7429	0.4723	0.9581	0.7312	0.6319	-0.3415
	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.096)***
VENEZUELA	**Bolivar/A.Peso**	**Bolivar/Real**	**Bolivar/Ch.Peso**	**Bolivar/Co.Peso**	**Bolivar/M/Peso**	**Bolivar/C$**	**Bolivar/¥**	**Bolivar/$**	**Bolivar/£**	**Bolivar//€**
Stock Returns	0.9364	0.9354	0.9333	0.9371	0.9131	0.9346	0.9388	0.9356	0.9338	0.9378
	(0.000)*	(0.000)*	(0.000)*	(0.000)	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.006)*
Exchange Rates	0.9521	0.9898	0.9833	0.9675	0.7416	0.9871	0.9833	0.9362	-0.8267	0.4357
	(0.000)*	(0.000)*	(0.000)*	(0.000)	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.361)
SPAIN	**€/A.Peso**	**€/Real**	**€/Ch.Peso**	**€/Co.Peso**	**€/M.Peso**	**€/Bolivar**	**€/C$**	**€/¥**	**€/$**	**€/£**
Stock Returns	0.9647	0.9664	0.9637	0.9606	0.9622	0.9656	0.9653	0.9601	0.9651	0.9617
	(0.000)*	(0.000)*	(0.000)*	(0.000)	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*
Exchange Rates	0.0672	0.9796	0.4898	0.8359	0.4465	0.5670	-0.9410	0.6346	-0.8240	0.8902
	(0.979)	(0.000)*	(0.011)**	(0.000)	(0.007)*	(0.581)	(0.000)*	(0.000)*	(0.001)*	(0.000)*

*1% significance level, **5% significance level, ***10% significance level

Table 4.20: EGARCH RESULTS: ASYMMETRIC SPILLOVERS 2002-2006

ARGENTINA	**A.Peso/B/Real**	**A.Peso/Ch.Peso**	**A.Peso/Co.Peso**	**A.Peso/M.Peso**	**A.Peso/Bolivar**	**A,Peso/C$**	**A.Peso/¥**	**A.Peso/$**	**A.Peso/£**	**A.Peso/€**
Stock Returns	0.9615	0.9568	0.9609	0.9622	0.9590	0.9628	0.9623	0.9621	0.9609	0.9603
	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*
Exchange Rates	0.9968	0.9961	0.9966	-0.9030	0.9971	-0.9204	0.9964	0.9966	-0.9199	-0.9119
	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*
BRAZIL	**Real/A.Peso**	**Real/Ch.Peso**	**Real/Co.Peso**	**Real/M.Peso**	**Real/Bolivar**	**Real/C$**	**Real/¥**	**Real/$**	**Real£**	**Real/€**
Stock Returns	0.9486	0.9647	0.9585	0.9504	0.9472	0.9685	0.9474	0.9678	0.9505	0.9667
	(0.000)*	(0.002)*	(0.000)*	(0.000)*	(0.000)*	(0.010)*	(0.000)*	(0.012)**	(0.000)*	(0.003)*
Exchange Rates	0.9970	0.9083	0.9739	0.9795	0.7564	0.9541	0.9790	0.9722	0.9704	0.9546
	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*
CHILE	**Ch.Peso/A.Peso**	**Ch.Peso/Real**	**Ch.Peso/Co.Peso**	**ChPeso/M.Peso**	**ChPeso/Bolivar**	**Ch Peso/C$**	**Ch Peso/¥**	**ChPeso/$**	**ChPeso/£**	**Ch.Peso/€**
Stock Returns	0.9398	0.9377	0.9408	0.9453	0.9454	0.9378	0.9411	0.9409	0.9408	0.9431
	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*
Exchange Rates	0.9957	0.8765	0.9659	0.8148	0.9823	0.9900	0.9988	0.9682	0.9819	0.7978
	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*
COLOMBIA	**Co.Peso/A.Peso**	**Co.Peso/Real**	**Co.Peso/Ch.Peso**	**Co.Peso/M.Peso**	**Co.Peso/Bolivar**	**Co.Peso/C$**	**Co.Peso/¥**	**Co.Peso/$**	**Co.Peso/£**	**Co.Peso/€**
Stock Returns	0.9259	0.9258	0.9234	0.9266	0.9261	0.9251	0.9261	0.9270	0.9277	0.9276
	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*
Exchange Rates	0.9981	0.9679	0.8267	0.9654	0.9925	0.9469	0.9450	0.9645	0.9617	0.9415
	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*
MEXICO	**M.Peso/A.Peso**	**M.Peso.Real**	**M.Peso/Ch.Peso**	**M.Peso/Co.Peso**	**M.Peso/Bolivar**	**M.Peso/C$**	**M.Peso/¥**	**M.Peso/$**	**M.Peso/£**	**M.Peso/€**
Stock Returns	0.9223	0.9290	0.9215	0.9179	0.9225	0.9217	0.9187	0.9201	0.9184	0.9245
	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*
Exchange Rates	0.9969	0.9796	0.8004	0.9631	0.9505	0.9916	0.9929	0.9184	0.9844	0.9946
	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*
VENEZUELA	**Bolivar/A.Peso**	**Bolivar/Real**	**Bolivar/Ch.Peso**	**Bolivar/Co.Peso**	**Bolivar/M.Peso**	**Bolivar/C$**	**Bolivar/¥**	**Bolivar/$**	**Bolivar/£**	**Bolivar/€**
Stock Returns	0.7804	0.7702	0.7679	0.8350	0.8534	0.8272	0.8058	0.8095	0.8091	0.7835
	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*
Exchange Rates	-0.8867	0.7246	0.9810	0.9496	0.9624	0.9858	0.9337	0.9807	0.9643	0.9772
	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*
SPAIN	**€/A.Peso**	**€/Real**	**€/Ch.Peso**	**€/Co.Peso**	**€/M.Peso**	**€/Bolivar**	**€/C$**	**€/¥**	**€/$**	**€/£**
Stock Returns	0.9772	0.9792	0.9765	0.9764	0.9772	0.9775	0.9764	0.9763	0.9769	0.9764
	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*
Exchange Rates	-0.9028	0.9478	0.7988	0.9622	0.9850	-0.5760	-0.6516	0.9855	0.9921	0.9999
	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*

*1% significance level, **5% significance level, ***10% significance level

4.3.*2.5 Diagnostic Tests*

The diagnostic test results show similar results obtained for the previous analyses where the results indicate the rejection of the null hypothesis that the residuals are normally distributed. The Ljung-Box statistics for all three periods for all countries indicate that there are no residual linear or non linear dependencies. There are some exceptions where the coefficient was not significant but the problem was corrected after introducing more lags into the test. Finally, and in order to check the validity of the assumption of constant correlation adopted in the estimation of the bivariate models (Kanas, 2000), the LB statistics for the cross products of the standardised residuals from the stock returns equation and from the exchange rate equation are calculated and these statistics indicated that the assumption of constant correlation over time can be accepted.

4.3.3 Analysis and Conclusions

This section sets out to summarise the major findings dealing with the examination of volatility linkages between stock returns and exchange rates in six Latin American countries and in one European country. The analysis was thus broader in scope than existing research in that a number of bilateral exchange rates were included in the study which permitted the examination of whether volatility spillovers existed to the same extent across exchange rates. It was decided to introduce a variety of bilateral exchange rates in order to get a better understanding of the relationship between stock returns and exchange rates. As was possible to appreciate in the literature review, there is a general agreement on the existence of a unidirectional relationship running between these markets. It is believed that stock returns impact on exchange rates, but that the reverse effect does not occur. But considering that the majority of the studies have introduced the US dollar as the only currency to analyse this effect, is the author’s belief that these studies results need to be considered carefully as a consequence of this limitation. In addition to this, no research to date has explicitly focused on the impact of the introduction of the Euro on volatility spillovers between these financial markets. In order to address these gaps in the literature, this section examined three main periods, covering the time period before the introduction of the Euro, immediately after the introduction of the Euro when the currency was not yet in circulation, and finally the period corresponding to when the currency was in circulation.

Overall, the results show evidence of a lack of integration between the markets, but when significant coefficients are found they show that the volatility of stock prices affects the volatility of exchange rates in a much more widespread way than the volatility of exchange rates affects the volatility of stock prices. But the main result is the lack of significant volatility spillovers in these markets, which clearly indicates that there is potential for diversification between stock markets and currency markets in certain instances. It also highlighted a number of situations where the spillovers are bidirectional in nature between the two markets, although there were no significant bidirectional relationships that were common to all three periods. The more widespread presence of significant spillovers from the Peseta to stock markets in the pre Euro period than from the Euro in the post Euro period, is a reflection of the effect that the European currency generated on the relevance of the Spanish currency market in the region.

These results are consistent with those of Kanas (2000) and Yang and Doong (2004) who both found evidence of volatility spillovers from stock returns to exchange rates. However, this study's findings differ on the evidence of spillovers in the opposite direction from exchange rates to stock markets; these studies found no significant spillovers while the current study found that although volatility spillovers are much less prevalent from the various bilateral exchange rates to the stock markets in the countries examined, as well as less consistent across countries and over time than the spillovers from stock markets to exchange rates, they nonetheless are present in certain instances. The difference between these results and existing studies on volatility spillovers between exchange rates and stock markets likely reflects the larger number of bilateral exchange rates included in the analysis. Thus, further research along these lines is required in order to establish more comprehensively the true nature of spillovers from exchange rates to equity markets which should provide valuable information on the possibilities for diversifying holdings of stocks and currencies in investment portfolios, as well as the potential for hedging amongst these assets.

4.4 THE G-7 EQUITY MARKETS

4.4.1 The G-7 Equity Markets and the Introduction of the Euro

This section focuses on analysing interlinkages between stock returns and exchange rates in the world's most developed economies that are represented by the G-7 economies (Canada, France, Italy, Germany, Japan, the U.K and the U.S). The study's initial framework is to analyse what kind of linkages exist between these markets, using an EGARCH model to study their volatility patterns. After this analysis is conducted, a second aspect of interest is the identification of similarities and differences between the emerging economies of the different regions that we have analysed in the previous chapters (East European countries, East Asian countries and Latin American countries), and the G-7 economies. Therefore, the G-7 results are taken as a comparator; the main reason behind this study is indeed to use the results on the developed economies stocks and exchange markets as a benchmark so as to better understand the characteristics of developed and emerging economies. In this new scenario, there is also a need to remember that the analysis is looking at two different time periods: the Asian crisis period, and the introduction of the Euro period. Another fact that would need to be noticed is that the G-7 economies are quite different from each other. The fact that their levels of development are not the same has to be considered carefully when arriving at general conclusions, as they would be subjected to a high degree of bias. Thus, in order to minimise the possible effects that would be derived from this situation, there is a need to clarify that the study being performed is based on a country by country analysis. This means, that the stock markets of each country are studied in a unique context where a variety of exchange rates are included in the investigation. The main advantage of attempting this kind of analysis is the opportunity of obtaining information regarding the stock market and the exchange rate under consideration by country, which will facilitate the results discussion, as every country will be analysed according to their results; it will also enable us to draw some general conclusions in terms of main differences and points in common between the different regions under research.

The rest of the section is organised as follows: the presentation of empirical results, then the major findings derived from the comparison of emerging economies with the G-7 economies, and finally the section's conclusions.

4.4.2 Empirical Results

This section's purpose is the presentation and discussion of the main findings obtained after investigating volatility spillovers between stock returns and exchange rate changes for the G-7[24] (Canada, France, Germany, Italy, Japan, the UK and the USA) for the period 1 January 1996 to 31 December 2006, a time period that is consistent with the ones used for the analysis of emerging economies. In order to analyse the relationship between these two variables, the sample is split into three sub samples which provide more detail and a better understanding of volatility spillovers between the two variables, and also keeps the analysis aligned with the studies that have been done in previous sections. Initially, the relationship between these two variables is analysed before the introduction of the Euro, i.e. for the period 1996-1998. Then the study proceeds

[24] All the results for this section can be found in Appendix D.

analysing the time period after the introduction of the Euro, that is, from 1999-2006. Furthermore, there is also an interest in examining whether the first years of the single currency in the European financial markets affected the relationship between the two variables. The first sub period, after the irrevocable locking of exchange rates took place, covers 1999-2001. The second sub period, 2002-2006, corresponds to a period where the Euro was physically introduced in the financial markets. The data set consists of daily closing values for the stock market indices in each country, as well as daily closing values for the exchange rates of each country against the Euro, DM, UK pound (£), Swiss Franc (CHF), Japanese Yen (¥) and the US dollar ($). Data was taken from DataStream and the Federal Reserve Statistic Release, giving a total of 2766 observations for each series.

4.4.2.1 Descriptive Statistics

The analysis begins by providing descriptive statistics for stock returns and exchange rates, in order to summarise the statistical characteristics of the sample. For the stock returns of each country for 1996-1998 it is found that the means are positive in all the cases, with the exception of the Nikkei 225, where the Japanese economy's lost decade would have influenced it. During 1999-2001, the sample means of stock returns are positive in the case of Canada, France and the US, while for Germany, Italy, Japan and the UK stock returns means are negative. During 2002-2006 the means of all the indices are positive. The standard deviations (SD) of the stock returns provide information about the volatility of the markets during the three periods. In general, all the markets show higher volatility during the initial years of the introduction of the Euro on financial markets than during 1999 to 2001. This is not surprising, as the introduction of the European currency was a major event, which led to insecurity for financial investors; therefore, this sentiment was translated onto the markets, and was reflected by volatile behaviour in the stocks. The SD ranges from 1.23 per cent (Dow Jones) to 1.58 per cent (DAX 30). The standard deviations for

2002-2006 range from 0.81 per cent (S&P/TSX Composite) to 1.61 per cent (DAX 30). The skewness and kurtosis coefficients indicate that stock returns are leptokurtic relative to the normal distribution.

The descriptive statistics for the exchange rate returns are presented for each country, to capture the behaviour of the exchange rates on an individual country basis. Overall, there is a wide variation in the sign and magnitude of the means and standard deviations both over time, across countries and across the various bilateral exchange rates included in the analysis. This diversity of results is explained by the differences on each country and their reactions to different events in the economy, like the Asian financial crisis, the dot.com bubble that took place during this period and of course the introduction of the Euro that is subject of this section's study. For Canada, during 1996-1998 the means of the exchange rates are positive in the case of the C$/$, C$/£ and the C$/¥, while the C$/CHF and the C$/DM means are negative. During 1999-2001, the means for the C$/€ and the C$/$ are positive while the C$/£, C$/¥ and the C$/CHF are negative, and during 2002-2006 the means for all the exchange rates are negative. The SD show that, as with the stock returns, the exchange rates are more volatile during the first years of the introduction of the Euro on financial markets, where the SD range from 0.36 per cent (C$/$) to 0.79 per cent (C$/¥).

For the period prior to the introduction of the Euro (1996-1998), what is remarkable is that the results are a mixture of positive and negative means, depending on the country and the currency under analysis. Positive results are explained by the tranquillity of the markets with regard to the Euro introduction process, while the negative results could also be driven by some sort of influence derived from the Asian crisis that could be lasting on the markets. For France, the results show that the means are positive in the case of the Franc/$, Franc/£ and the Franc/¥, while the means are negative for the Franc/CHF and the Franc/DM. For Germany, the means for the DM/$, DM/£, and the DM/¥ are positive, while the DM/CHF mean is negative. For Italy, for this period the means are positive for the Lira/$, Lira/£, while the Lira/¥, Lira/CHF and the Lira/DM are negative.

During 1999-2001 the €/$ and the €/£ means are negative while the €/¥ and the €/CHF are positive; this situation reverses during 2002-2006 when the €/$ and the €/£ means are positive and the €/¥ and the €/CHF means are negative. As with Canada, it is also found that in this case the volatility in the exchange rates is higher during the 1999-2001 period than in the other periods, ranging from 0.24 per cent (€/CHF) and 0.90 per cent (€/¥).

For Japan, during 1996-1998 the means for the ¥/$, and the ¥/£ are positive while those for the ¥/CHF and the ¥/DM are negative; during 1999-2001, the ¥/€ and the ¥/CHF means are negative, while the ¥/$ and the ¥/£ are positive, and finally during 2002-2006 the means are positive in all the cases with the exception of the ¥/$ which is negative. The volatility of these markets was higher during the 1999-2001 period, as in the previous cases, with the SD ranging from 0.71 per cent (¥/$) to 1 per cent (¥/CHF). The results for Japan have to be considered differently than for the rest of the countries, as the results are affected by the 'lost decade' experienced by the country, and also by the level of uncertainty derived from the Asian crisis and the introduction of the Euro.

For the UK for 1996-1998, the means for all the exchange rates are negative; these results can be explained by the effects of the Asian crisis, and also by the uncertainty generated by the Euro process. During 1999-2001 the means are positive in all the cases with the exception of the £/CHF. In this case, the British economy did not reflect any significant effect with regard to the market uncertainty that could be derived from the introduction of the Euro, or even from the September 11, 2001 terrorist attack in the US. These results are quite surprising as the UK has strong relationships with the US and European economies. Finally, during 2002-2006 the means are negative in all cases; these results are explained by the economic slow down experienced by the U.K economy since 2001. The SD coefficients indicate that the exchange markets were more volatile during 1999-2001 than in the other periods, where volatility ranges from 0.51 per cent (£/€ and £/$) to 1 per cent (£/¥).

For the US, the mean coefficients are positive during 1996-1998 in all the cases, with the exception of the \$/£, which reflects that the US did not suffer to a great extent from the Asian crisis. During 1999-2001 the means are negative in all the cases with the exception of the €/£ where the means are positive. These results are explained by a lack of confidence generated by the introduction of the Euro, and later on by the September 11, 2001 terrorist attacks. Finally during 2002-2006 the means are positive with the exception of the \$/€, which is negative, results that could be explained by the European economic slowdown experienced during these years. The SD coefficients show that again the exchange rates were more volatile during 1999-2001 than in the rest of the period, ranging from 0.49 per cent (\$/£) to 0.7 per cent (\$/¥).

The results from the ADF test statistics indicate that the null hypothesis of the existence of unit root in levels for all variables is rejected in all periods indicating that all series are *I(0).*

In order to establish the correct lag length for the EGARCH model, the Likelihood Ratio test is applied; this is done in order to get the best model for the analysis of the two variables relationship. Dealing firstly with the stock return equations, for the 1996-1998 period, the EGARCH (1,1) model is chosen for the DM/\$ for Germany and for the \$/£, \$/Yen and the \$/DM for the US. For the 1999-2001 period the EGARCH (1,1) is selected for Canada for the C\$/\$, C\$/¥ and the C\$/CHF. For Germany and Japan for the same period, this model was also chosen for all bilateral exchanges rates. In the case of the 2002-2006 period for France regarding the €/\$ and the €/¥, as well as for Germany for the €/¥ and for Japan for all bilateral exchange rates, the (1,1) model was selected on the basis of the LR results. Finally, and in relation to all countries for all other exchange rates the EGARCH (2,1) model was selected for the stock return equation.

When applying the model selection criterion for the exchange rate equation, during the 1996-1998 period the EGARCH (1,1) model is chosen for Canada in the case of the C\$/\$, for France for the FR/DM, for Germany for the DM./\$ and for Japan for the Y/CHF. In the case of the 2002-2006 period, again the (1,1) model is selected for Canada for the C$/$ and the C$/£, for France and Italy for the €/$, for the UK for the £/€, and the £/CHF and finally in the case of the US for the $/€ and the $/£. Again, for all countries and for all other exchange rates in each period, the EGARCH (2,1) model was chosen for the exchange rate equation.

4.4.2.2 Volatility Persistence

Firstly, in relation to the coefficients on the volatility persistence term, the results for all three periods are presented throughout tables 4.21 to 4.23, and their main characteristic is that they vary depending on the country and the respective equation under analysis. In general, it has nevertheless been found that the majority of terms are significant for both the stock returns and exchange rate changes. Regarding the significance of volatility persistence in stock returns, Italy was the only country for which the volatility persistence term was significant in all periods across all bilateral exchange rates. France also showed consistency across all time periods for all exchange rates with only the €/CHF being not significant in 2002-2006 (see table 4.23). There appears to be more consistency between the pre Euro period (see table 4.21) and the 2002-2006 period for certain countries; for example, for Canada and the UK, all bilateral exchange rates are significant for the stock return equation in both periods (tables 4.22 and 4.23) but insignificant for the 1998-2001 (table 4.21) period. While all coefficients were significant across all exchange rates for Japan in the pre-Euro period (table 4.21), there was no significant persistence evident after the introduction of the Euro (tables 4.22 and 4.23). In contrast, there was no significant volatility persistence in the US apart from the $/CHF prior to the Euro (table 4.21) and for the 1999-2001 period (table 4.22), but for 2002-2006 (table 4.23) all bilateral exchange rates were insignificant on the stock returns. For the persistence of volatility of exchange rates, an interesting feature of the results which reflects the analysis of more than one exchange rate, is that the persistence of volatility of exchange rates varies depending on which bilateral exchange rate is included in the EGARCH model. Overall, there appears to be more widespread persistence in the 1996-1998 period (table 4.21) and the 2002-2006 period (table 4.23) than the 1991-2001 period (table 4.22) for Canada, Japan, Germany and Italy. Only for the US and France was there more significant volatility persistence across exchange rates in the 2002-2006 period (table 4.23) than in the periods prior to this, while for the UK the 2002-2006 period (table 4.23) showed a decline in the significance of volatility persistence across exchange rates compared to earlier periods. Thus, the impact of the introduction of the Euro on the persistence of the volatility of stock returns and exchange rates has not had a uniform impact across the financial markets in the G-7.

As can be seen from the results, each country has been affected in a different manner by the introduction of the Euro, and also the results are different depending on the currency that is taken under consideration. These findings are quite logical as depending on their international relationships, stock returns and exchange rates will be affected in a stronger way by countries with stronger investments linkages, than by countries with weaker relationships. In general terms the introduction of the Euro seems to generate an effect in stock markets and currencies, but as mentioned before, the Euro is an amalgamation of the euro-area currencies, so the stronger economies would have a higher representation in the currency than the weaker economies; therefore, when analysing the interaction of the Euro with other exchange rates and stock markets, this situation would be reflected by insignificant relationships with the countries or currencies for which the economic interlinkages are weaker.

Table 4.21 EGARCH RESULTS VOLATILITY PERSISTENCE 1996-1998

Canada	**C$/$**	**C$/¥**	**C$/DM**	**C$/CHF**	**C$/£**
Stock Returns	0.2749	0.2083	0.2766	0.2706	0.2828
	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*
Exchange Rates	0.1335	0.2671	0.2173	0.1132	0.0866
	(0.004)*	(0.002)*	(0.004)*	(0.038)**	(0.005)*
France	**FR/$**	**FR/£**	**FR/¥**	**FR/CHF**	**FR/DM**
Stock Returns	0.1279	0.1314	0.1270	0.1278	0.1322
	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*
Exchange Rates	0.0171	0.0569	0.1826	0.0436	0.6480
	(0.837)	(0.0386)**	(0.000)*	(0.088)***	(0.000)*
Germany	**DM/$**	**DM/£**	**DM/¥**	**DM/CHF**	
Stock Returns	0.1345	-0.0596	0.1538	-0.0314	
	(0.000)*	(0.4952)	(0.000)*	(0.7285)	
Exchange Rates	-0.1973	-0.1532	-0.1936	-0.1417	
	(0.652)	(0.026)**	(0.000)*	(0.0311)**	
Italy	**LIRA/CHF**	**LIRA/¥**	**LIRA/DM**	**LIRA/£**	**LIRA/$**
Stock Returns	0.2081	0.2652	0.1914	0.2522	0.2534
	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*
Exchange Rates	0.0303	0.2463	0.1422	0.1098	0.1059
	(0.207)	(0.006)*	(0.000)*	(0.002)*	(0.003)*
Japan	**¥/$**	**¥/£**	**¥/CHF**	**¥/DM**	
Stock Returns	0.0450	0.0607	0.0528	0.0483	
	(0.033)**	(0.008)*	(0.0130)**	(0.0215)**	
Exchange Rates	0.2261	0.2589	0.1903	0.1523	
	(0.0235)**	(0.004)*	(0.093)***	(0.000)*	
UK	**£/$**	**£/¥**	**£/CHF**	**£/DM**	
Stock Returns	0.0741	0.0851	0.0873	0.0862	
	(0.002)*	(0.001)*	(0.001)*	(0.001)*	
Exchange Rates	-0.0017	0.2637	0.0549	0.0638	
	(0.891)	(0.002)*	(0.107)	(0.017)**	
US	**$/£**	**$/¥**	**$/CHF**	**$/DM**	
Stock Returns	-0.0332	-0.0306	0.1396	-0.0381	
	(0.741)	(0.760)	(0.005)*	(0.723)	
Exchange Rates	0.0063	0.2147	0.0425	-0.0863	
	(0.647)	(0.017)**	(0.570)	(0.287)	

*1% significance level, **5% significance level, ***10% significance level

Table 4.22 EGARCH RESULTS VOLATILITY PERSISTENCE 1999-2001

Canada	**C$/$**	**C$/¥**	**C$/CHF**	**C$/£**	**C$/€**
Stock Returns	-0.11603	-0.1227	-0.1101	-0.1016	-0.1172
	(0.286)	(0.237)	(0.279)	(0.327)	(0.304)
Exchange Rates	-0.1667	0.0292	-0.0409	0.0959	-0.0225
	(0.159)	(0.189)	(0.274)	(0.220)	(0.746)
France	**€/$**	**€/£**	**€/¥**	**€/CHF**	
Stock Returns	0.1021	0.0966	0.0978	0.0939	
	(0.028)**	(0.042)**	(0.027)**	(0.041)**	
Exchange Rates	-0.1106	0.2804	0.1108	0.1558	
	(0.072)***	(0.001)*	(0.068)***	(0.002)*	
Germany	**€/$**	**€/£**	**€/¥**	**€/CHF**	
Stock Returns	-0.1973	-0.1532	-0.1936	-0.1417	
	(0.013)**	(0.080)***	(0.021)**	(0.109)	
Exchange Rates	-0.1122	0.2794	0.0965	0.1614	
	(0.103)	(0.001)*	(0.092)***	(0.001)*	
Italy	**€/CHF**	**€/¥**	**€/£**	**€/$**	
Stock Returns	0.2301	0.2535	0.2627	0.2671	
	(0.001)*	(0.000)*	(0.000)*	(0.000)*	
Exchange Rates	0.1536	0.1058	0.2543	-0.1050	
	(0.003)*	(0.079)***	(0.003)*	(0.124)	
Japan	**¥/€**	**¥/$**	**¥/£**	**¥/CHF**	
Stock Returns	-0.1268	-0.1209	-0.1261	-0.1059	
	(0.2795)	(0.272)	(0.251)	(0.085)***	
Exchange Rates	0.0929	0.0430	0.0171	-0.1059	
	(0.097)***	(0.066)***	(0.503)	(0.334)	
UK	**£/€**	**£/$**	**£/¥**	**£/CHF**	
Stock Returns	0.0691	0.0689	0.0599	0.0660	
	(0.059)***	(0.106)	(0.106)	(0.073)***	
Exchange Rates	0.0858	0.1377	0.1879	0.0728	
	(0.211)	(0.115)	(0.000)*	(0.130)	
US	**$/€**	**$/£**	**$/¥**	**$/CHF**	
Stock Returns	0.0550	0.0860	0.0388	0.0540	
	(0.147)	(0.238)	(0.292)	(0.124)	
Exchange Rates	-0.0537	0.0860	0.0516	-0.0557	
	(0.272)	(0.238)	(0.028)**	(0.458)	

*1% significance level, **5% significance level, ***10% significance level

Table 4.23 EGARCH RESULTS VOLATILITY PERSISTENCE 2002-2006

Canada	**C$/$**	**C$/¥**	**C$/CHF**	**C$/£**	**C$/€**
Stock Returns	0.0886	0.0794	0.0821	0.0871	0.0981
	(0.001)*	(0.004)*	(0.002)*	(0.002)*	(0.001)*
Exchange Rates	0.1044	0.0548	0.1240	0.0371	0.0455
	(0.014)**	(0.044)**	(0.000)*	(0.597)	(0.386)
France	**€/$**	**€/£**	**€/¥**	**€/CHF**	
Stock Returns	-0.0568	-0.0618	-0.0672	0.0947	
	(0.492)	(0.417)	(0.406)	(0.000)*	
Exchange Rates	-0.1165	0.0402	0.0466	0.0957	
	(0.115)	(0.005)*	(0.029)**	(0.001)*	
Germany	**€/$**	**€/£**	**€/¥**	**€/CHF**	
Stock Returns	0.1116	0.1063	-0.0230	0.1035	
	(0.000)*	(0.000)*	(0.781)	(0.000)*	
Exchange Rates	0.0596	0.0377	0.0459	0.0914	
	(0.005)*	(0.008)*	(0.036)**	(0.002)*	
Italy	**€/CHF**	**€/¥**	**€/£**	**€/$**	
Stock Returns	0.0660	0.0774	0.0741	0.0832	
	(0.000)*	(0.000)*	(0.000)*	(0.000)*	
Exchange Rates	0.0919	0.0488	0.0447	-0.0934	
	(0.001)*	(0.029)**	(0.002)*	(0.209)	
Japan	**¥/€**	**¥/$**	**¥/£**	**¥/CHF**	
Stock Returns	-0.0693	-0.0437	-0.0461	-0.0606	
	(0.359)	(0.581)	(0.555)	(0.442)	
Exchange Rates	0.0491	-0.0040	0.0942	0.1363	
	(0.019)**	(0.962)	(0.259)	(0.007)*	
UK	**£/€**	**£/$**	**£/¥**	**£/CHF**	
Stock Returns	0.0814	0.0883	0.0741	0.0720	
	(0.000)*	(0.000)*	(0.000)*	(0.000)*	
Exchange Rates	0.1052	-0.0158	0.0226	-0.0887	
	(0.070)***	(0.131)	(0.431)	(0.233)	
US	**$/€**	**$/£**	**$/¥**	**$/CHF**	
Stock Returns	0.0663	0.0654	0.0585	0.0664	
	(0.000)*	(0.000)*	(0.001)*	(0.000)*	
Exchange Rates	-0.0843	0.1561	0.0136	0.0544	
	(0.254)	(0.007)*	(0.873)	(0.007)*	

*1% significance level, **5% significance level, ***10% significance level

4.4.2.3 Volatility Spillovers

The results for volatility spillovers effects are presented in tables 4.24 to 4.26[25]. In terms of the coefficients for the volatility spillover effects, firstly there is a large degree of consistency across countries and time periods for spillovers from stock returns to exchange rate changes. The results find significant spillovers at the 5 per cent level in the cases of Canada, France, Japan and the UK for all periods (tables 4.24 to 4.26) and all bilateral exchange rates. For Germany, in the period prior to the introduction of the Euro, the DM/$ was the only exchange rate

[25] The tables are organised as follows: the first table (4.24) presents the results for the first sub period (1996-1998); the second table (4.25) for the second sub period (1999-2002) and the third tables (4.26) the results for the third sub period (2002-2006).

for which there were not significant volatility spillovers from the stock market, with significant spillovers evident from the stock market to all exchange rates after 1999. Thus, the volatility of stock returns had an important influence and has been a determinant of volatility of all bilateral exchange rates included in the analysis of these countries. Furthermore, the impact of stock market volatility on exchange rates has not been altered significantly by the introduction of the Euro in the sense that the cross exchange rates against the $, Yen, £ and the CHF existed prior to the introduction of the Euro as well as after it across nearly all G-7 markets. This could be explained by the fact that these economies are quite strong and investors take special care in keeping their risk exposure strategies under control, so that even with the kind of uncertainty derived from the introduction of the Euro, investors' hedging techniques would be monitored and updated. In addition to this, it is also found that for the pre Euro period, Italy was the only country in the G-7 for which there were no volatility spillover effects from the stock market to any of the bilateral exchange rates included in the study. After the Euro was introduced, the $/£ exchange rate was the only exchange rate where no volatility spillovers were evident from the US stock market at the 5 per cent level, although it was significant at the 10 per cent level.

The significant coefficients indicate that the volatility of stock returns was a determinant of the volatility of the exchange rate and that information contained in stock prices impacted on the behaviour of exchange rates in these markets. Significant coefficients are also indicative of integration between stock markets and exchange rate markets; given that the G-7 markets are the most developed financial markets globally, the existence of integration is not surprising and a priori expectations were aligned with such a result. In addition, the lack of spillovers in Italy in the pre Euro period can be taken as evidence that the stock and currency markets in Italy were not as integrated as in other more developed G-7 countries. Furthermore, where the coefficients are insignificant, this indicates that prior to the introduction of the Euro there was some potential for diversification between stock markets and currency markets in these countries.

In terms of volatility spillovers from exchange rates to stock markets, the results are less significant across countries and over time. For the 1996-1998 period (table 4.24), Canada, Germany and Italy had no significant spillovers. For the other countries included in the analysis, there were a number of bilateral exchange rates where significant spillovers were evident from exchange rates to stock returns at the 5 per cent level; for the period prior to the introduction of the Euro, there were significant spillovers for France for the FR/DM, for Japan for the Yen/CHF, for the UK for the £/$ and for the US for the $/£ exchange rates. After the Euro was introduced there is some commonality regarding exchange rates; the results find significant volatility spillover effects for stock markets. For the €/Yen and the Yen/CHF the volatility spillovers were significant for the stock markets in France, Germany and Italy, the Yen/€ and the Yen/CHF for the Japanese stock market, the £/€ and £/CHF for the UK market and the $/C$ for the US market. For the 2002-2006 period (table 4.26), again there were only a small number of all exchange rates included for which significant volatility spillovers into stock markets were observed; for Canada for the C$/£, for Japan for the Yen/£, for the UK for the £/€ and £/$. No significant spillovers were evident in France, Germany or Italy.

The lack of significant spillovers from exchange rates to stock markets in the pre Euro period could be indicative of wider use of hedging by firms listed on the stock markets in these countries than after the introduction of the Euro. It may also be the case that the adoption of the Euro brought greater volatility to certain stock markets given the global nature of the currency which investors would not have been exposed to prior to the Euro's introduction. Another fact to take into account is that the G-7 economies show a high level of integration; therefore, there is an important level of cross investment among these countries. Consequently, the use of sophisticated techniques dealing with risk management and exposure are implemented as common practice and this is reflected by the markets through the existence of insignificant coefficients capturing spillover effects.

Table 4.24 EGARCH RESULTS VOLATILITY SPILLOVERS 1996-1998

Canada	**C$/$**	**C$/¥**	**C$/DM**	**C$/CHF**	**C$/£**
Stock Returns	-0.1079 (0.005)*	-0.0585 (0.023)**	-0.0998 (0.010)*	-0.0987 (0.010)*	-0.0954 (0.008)*
Exchange Rates	0.0147 (0.577)	0.0834 (0.067)***	0.0744 (0.145)	0.0458 (0.356)	0.0583 (0.121)
France	**FR/$**	**FR/£**	**FR/¥**	**FR/CHF**	**FR/DM**
Stock Returns	-0.0531 (0.017)**	-0.0655 (0.003)*	-0.0599 (0.010)*	-0.0635 (0.003)*	-0.0688 (0.002)*
Exchange Rates	-0.0309 (0.537)	0.0270 (0.117)	0.0208 (0.558)	0.0265 (0.229)	0.1147 (0.018)**
Germany	**DM/$**	**DM/£**	**DM/¥**	**DM/CHF**	
Stock Returns	-0.0339 (0.170)	-0.0750 (0.005)*	-0.0494 (0.040)**	-0.0603 (0.018)**	
Exchange Rates	-0.0367 (0.441)	0.0176 (0.247)	0.0128 (0.716)	0.0362 (0.255)	
Italy	**Lira/$**	**Lira/£**	**Lira/¥**	**Lira/CHF**	**Lira/DM**
Stock Returns	-0.0204 (0.495)	-0.0376 (0.303)	-0.0141 (0.627)	-0.0341 (0.327)	-0.0376 (0.290)
Exchange Rates	-0.0195 (0.074)***	0.0601 (0.157)	0.0162 (0.577)	0.0174 (0.419)	0.0121 (0.692)
Japan	**¥/$**	**¥/£**	**¥/CHF**	**¥/DM**	
Stock Returns	-0.1320 (0.000)*	-0.1324 (0.000)*	-0.1364 (0.000)*	-0.1416 (0.000)*	
Exchange Rates	-0.0586 (0.1997)	-0.0587 (0.307)	-0.1899 (0.005)*	-0.0116 (0.736)	
UK	**£/$**	**£/¥**	**£/CHF**	**£/DM**	
Stock Returns	-0.0516 (0.000)*	-0.0653 (0.000)*	-0.0596 (0.000)*	-0.0629 (0.000)*	
Exchange Rates	-0.0402 (0.035)**	0.0580 (0.304)	-0.0063 (0.686)	-0.0136 (0.352)	
US	**$/£**	**$/¥**	**$/CHF**	**$/DM**	
Stock Returns	-0.1577 (0.000)*	-0.1601 (0.000)*	-0.1363 (0.000)*	-0.1583 (0.000)*	
Exchange Rates	0.0493 (0.019)**	0.0392 (0.384)	0.0904 (0.072)***	-0.0332 (0.506)	

*1% significance level, **5% significance level, ***10% significance level

Table 4.25 EGARCH RESULTS VOLATILITY SPILLOVERS 1999-2001

Canada	**C$/$**	**C$/¥**	**C$/CHF**	**C$/£**	**C$/€**
Stock Returns	-0.1014 (0.000)*	-0.1031 (0.000)*	-0.1078 (0.000)*	-0.1093 (0.000)*	-0.0619 (0.029)**
Exchange Rates	-0.0693 (0.259)	0.0252 (0.117)	-0.0054 (0.794)	0.0244 (0.556)	0.0180 (0.743)
France	**€/$**	**€/£**	**€/¥**	**€/CHF**	
Stock Returns	-0.0954 (0.002)*	-0.0805 (0.009)*	-0.0806 (0.011)**	-0.0671 (0.024)**	
Exchange Rates	-0.0210 (0.639)	-0.0753 (0.255)	0.0824 (0.008)*	0.1331 (0.008)*	
Germany	**€/$**	**€/£**	**€/¥**	**€/CHF**	
Stock Returns	-0.1217 (0.001)*	-0.1131 (0.002)*	-0.1106 (0.002)*	-0.1075 (0.002)*	
Exchange Rates	-0.0158 (0.723)	-0.0800 (0.232)	0.0665 (0.023)**	0.1333 (0.008)*	
Italy	**€/CHF**	**€/¥**	**€/£**	**€/$**	
Stock Returns	-0.0815 (0.002)*	-0.0928 (0.018)**	-0.0961 (0.011)**	-0.1009 (0.008)*	
Exchange Rates	-0.1292 (0.011)**	-0.0770 (0.013)**	-0.0793 (0.229)	-0.0143 (0.745)	
Japan	**¥/€**	**¥/$**	**¥/£**	**¥/CHF**	
Stock Returns	-0.0939 (0.0505)***	-0.0896 (0.004)*	-0.0894 (0.004)*	-0.0840 (0.001)*	
Exchange Rates	-0.0617 (0.031)**	-0.0349 (0.094)***	-0.0242 (0.3777)	-0.0840 (0.006)*	
UK	**£/€**	**£/$**	**£/¥**	**£/CHF**	
Stock Returns	-0.1015 (0.052)***	-0.1166 (0.035)**	-0.1117 (0.041)**	-0.1101 (0.039)**	
Exchange Rates	-0.1385 (0.002)*	-0.0556 (0.227)	-0.0024 (0.956)	0.0515 (0.073)***	
US	**$/€**	**$/£**	**$/¥**	**$/CHF**	
Stock Returns	-0.1372 (0.000)*	0.0740 (0.0831)***	-0.1324 (0.000)*	-0.1306 (0.000)*	
Exchange Rates	0.0270 (0.560)	0.0740 (0.083)***	0.0323 (0.136)	-0.0004 (0.989)	

*1% significance level, **5% significance level, ***10% significance level

Table 4.26 EGARCH RESULTS VOLATILITY SPILLOVERS 2002-2006

Canada	**C$/$**	**C$/¥**	**C$/CHF**	**C$/£**	**C$/€**
Stock Returns	-0.0803 (0.000)*	-0.0850 (0.000)*	-0.0836 (0.000)*	-0.0833 (0.000)*	-0.0939 (0.000)*
Exchange Rates	-0.0081 (0.656)	-0.0104 (0.657)	0.0073 (0.751)	0.0145 (0.012)**	0.0977 (0.097)
France	**€/$**	**€/£**	**€/¥**	**€/CHF**	
Stock Returns	-0.1149 (0.000)*	-0.1304 (0.000)*	-0.1156 (0.000)*	-0.1297 (0.000)*	
Exchange Rates	0.0032 (0.814)	0.0043 (0.727)	0.0032 (0.863)	-0.0023 (0.925)	
Germany	**€/$**	**€/£**	**€/¥**	**€/CHF**	
Stock Returns	-0.0949 (0.000)*	-0.1109 (0.000)*	-0.1083 (0.000)*	-0.0991 (0.000)*	
Exchange Rates	0.0069 (0.571)	0.0053 (0.664)	0.0004 (0.982)	-0.0041 (0.866)	
Italy	**€/CHF**	**€/¥**	**€/£**	**€/$**	
Stock Returns	-0.0983 (0.000)*	-0.0923 (0.000)*	-0.0996 (0.000)*	-0.0868 (0.000)*	
Exchange Rates	0.0022 (0.925)	-0.0031 (0.867)	0.0035 (0.775)	0.0032 (0.799)	
Japan	**¥/€**	**¥/$**	**¥/£**	**¥/CHF**	
Stock Returns	-0.0506 (0.0477)**	-0.0598 (0.025)**	-0.0595 (0.026)**	-0.0583 (0.029)**	
Exchange Rates	0.0007 (0.971)	0.0241 (0.682)	-0.1276 (0.033)**	-0.0055 (0.892)	
UK	**£/€**	**£/$**	**£/¥**	**£/CHF**	
Stock Returns	-0.1205 (0.000)*	-0.1189 (0.000)*	-0.1244 (0.000)*	-0.1278 (0.000)*	
Exchange Rates	0.0958 (0.041)**	-0.0340 (0.000)*	0.0218 (0.2887)	-0.0024 (0.757)	
US	**$/€**	**$/£**	**$/¥**	**$/CHF**	
Stock Returns	-0.0802 (0.000)*	-0.0810 (0.000)*	-0.0852 (0.000)*	-0.0777 (0.000)*	
Exchange Rates	-0.0080 (0.494)	-0.1030 (0.020)**	-0.0662 (0.272)	-0.0035 (0.801)	

*1% significance level, **5% significance level, ***10% significance level

4.4.2.4 Asymmetric Spillovers

The results for asymmetric spillover effects from stock returns to exchange rates are presented in tables 4.27 to 4.29. The results show that the coefficients are significant in all the cases and for all periods. Analysing asymmetric spillover effects from exchange rates to stock returns the results show some differences; during 1996-1998 (table 4.27) the coefficients are significant in almost all the cases, with the exception of Canada where the C$/DM coefficient is insignificant. France shows an insignificant coefficient in the case of the FR/$; for Germany, the DM/$ relationship is insignificant and finally the $/DM relationship for the US is insignificant as well. During 1999-2001 (table 4.28), the results share the same characteristics; in general terms, the coefficients are significant but there are a few exceptions in relation to the following countries where the coefficients are insignificant: in the case of Canada, it is found that the coefficients are insignificant for the C$/$, C$/£ and the C$/€. The analysis for France, Germany and Italy show that the €/£, and for the US the $/CHF, show insignificant coefficients. Analysing the last period 2002-2006 (table 4.29) the results show that again the coefficients are significant in almost all the cases. A few exceptions were found where the coefficients are insignificant; this was the case for Japan (¥/$ and ¥/£), for the UK (£/€) and for the US ($/£ and $/¥). If significant coefficients regarding asymmetric spillovers effects are found it means that bad news generate a higher impact on the markets than good news, and knowing that an insignificant coefficient means that the effect is symmetric, it is possible to conclude that the existence of insignificant coefficients in this area could be explained by a low level of integration between some markets. So, when a particular positive or negative event takes place in one country, this would not affect the other economy, due to a low level of integration. Another reason could be found in the time periods under analysis. As was mentioned at the beginning of the study, the G-7 countries are very different individual economies, and also the time period under investigation is quite long. So it could be possible that the series suffers from structural breaks, and it is well-known that statistical models tend to underperform under such circumstances. The subdivision of the whole sample under analysis into different sub periods could be minimising the structural break negative effects on the results. It is worth mentioning that each economy has different internal problems that could generate structural breakpoints. Thus, it would be necessary to study each economy in greater detail and adjust the model to capture the existence of odd periods.

Table 4.27 EGARCH RESULTS ASYMMETRIC SPILLOVERS 1996-1998

Canada	**C$/$**	**C$/¥**	**C$/DM**	**C$/CHF**	**C$/£**
Stock Returns	0.9642 (0.000)*	0.9742 (0.000)*	0.9665 (0.000)*	0.9674 (0.000)*	0.9660 (0.000)*
Exchange Rates	0.9874 (0.000)*	0.9027 (0.000)*	-0.1972 (0.598)	0.8954 (0.000)*	0.9896 (0.000)*
France	**FR/$**	**FR/£**	**FR/¥**	**FR/CHF**	**FR/DM**
Stock Returns	0.9899 (0.000)*	0.9907 (0.000)*	0.9893 (0.000)*	0.9902 (0.000)*	0.9876 (0.000)*
Exchange Rates	-0.3573 (0.104)	0.9926 (0.000)*	0.9804 (0.000)*	0.9811 (0.000)*	0.9507 (0.000)*
Germany	**DM/$**	**DM/£**	**DM/¥**	**DM/CHF**	
Stock Returns	0.9931 (0.000)*	0.9843 (0.000)*	0.9895 (0.000)*	0.9859 (0.000)*	
Exchange Rates	-0.4816 (0.289)	0.9930 (0.000)*	0.9846 (0.000)*	0.9767 (0.000)*	
Italy	**Lira/$**	**Lira/£**	**Lira/¥**	**Lira/CHF**	**Lira/DM**
Stock Returns	0.9613 (0.000)*	0.9355 (0.000)*	0.9634 (0.000)*	0.9406 (0.000)*	0.9351 (0.000)*
Exchange Rates	0.9945 (0.000)*	0.9390 (0.000)*	0.9983 (0.000)*	0.9829 (0.000)*	0.9749 (0.000)*
Japan	**¥/$**	**¥/£**	**¥/CHF**	**¥/DM**	
Stock Returns	0.9874 (0.000)*	0.9856 (0.000)*	0.9870 (0.000)*	0.9861 (0.000)*	
Exchange Rates	0.9405 (0.000)*	0.9097 (0.000)*	0.5479 (0.000)*	0.9867 (0.000)*	
UK	**£/$**	**£/¥**	**£/CHF**	**£/DM**	
Stock Returns	0.9947 (0.000)*	0.9937 (0.000)*	0.9948 (0.000)*	0.9943 (0.000)*	
Exchange Rates	0.9934 (0.000)*	0.9102 (0.000)*	0.9871 (0.000)*	0.9924 (0.000)*	
US	**$/£**	**$/¥**	**$/CHF**	**$/DM**	
Stock Returns	0.9372 (0.000)*	0.9399 (0.000)*	0.9615 (0.000)*	0.9475 (0.000)*	
Exchange Rates	0.9964 (0.000)*	0.9554 (0.000)*	0.7299 (0.000)*	-0.4999 (0.472)	

*1% significance level, **5% significance level, ***10% significance level

Table 4.28 EGARCH RESULTS ASYMMETRIC SPILLOVERS 1999-2001

Canada	**C$/$**	**C$/¥**	**C$/CHF**	**C$/£**	**C$/€**
Stock Returns	0.9385	0.9398	0.9413	0.9365	0.9682
	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*
Exchange Rates	0.3974	0.9778	0.9169	-0.6604	-0.7229
	(0.285)	(0.000)*	(0.000)*	(0.047)**	(0.329)
France	**€/$**	**€/£**	**€/¥**	**€/CHF**	
Stock Returns	0.9415	0.9437	0.9484	0.9483	
	(0.000)*	(0.000)*	(0.000)*	(0.000)*	
Exchange Rates	-0.8955	-0.0025	0.9047	0.9597	
	(0.000)*	(0.994)	(0.000)*	(0.000)*	
Germany	**€/$**	**€/£**	**€/¥**	**€/CHF**	
Stock Returns	0.9181	0.9084	0.9152	0.9118	
	(0.000)*	(0.000)*	(0.000)*	(0.000)*	
Exchange Rates	-0.8885	-0.0042	0.9204	0.9614	
	(0.000)*	(0.990)	(0.000)*	(0.000)*	
Italy	**€/CHF**	**€/¥**	**€/£**	**€/$**	
Stock Returns	0.9426	0.9385	0.9375	0.9371	
	(0.000)*	(0.000)*	(0.000)*	(0.000)*	
Exchange Rates	0.9608	0.9054	0.0176	-0.8917	
	(0.000)*	(0.000)*	(0.963)	(0.000)*	
Japan	**¥/€**	**¥/$**	**¥/£**	**¥/CHF**	
Stock Returns	0.9325	0.9337	0.9325	0.9391	
	(0.000)*	(0.000)*	(0.000)*	(0.000)*	
Exchange Rates	0.9236	0.9795	0.9611	0.9391	
	(0.000)*	(0.000)*	(0.000)*	(0.000)*	
UK	**£/€**	**£/$**	**£/¥**	**£/CHF**	
Stock Returns	0.9306	0.9173	0.9214	0.9183	
	(0.000)*	(0.000)*	(0.000)*	(0.000)*	
Exchange Rates	-0.7294	-0.7077	0.9824	0.9439	
	(0.000)*	(0.000)*	(0.000)*	(0.000)*	
US	**$/€**	**$/£**	**$/¥**	**$/CHF**	
Stock Returns	0.9662	-0.7464	0.9643	0.9698	
	(0.000)*	(0.000)*	(0.000)*	(0.000)*	
Exchange Rates	-0.9072	-0.7464	0.9831	0.7417	
	(0.000)*	(0.000)*	(0.000)*	(0.102)	

*1% significance level, **5% significance level, ***10% significance level

Table 4.29 EGARCH RESULTS ASYMMETRIC SPILLOVERS 2002-2006

Canada	**C$/$**	**C$/¥**	**C$/CHF**	**C$/£**	**C$/€**
Stock Returns	0.9658 (0.000)*	0.9649 (0.000)*	0.9658 (0.000)*	0.9651 (0.000)*	0.9562 (0.000)*
Exchange Rates	0.9763 (0.000)*	0.9703 (0.000)*	0.9570 (0.000)*	0.9923 (0.000)*	-0.6080 (0.002)*
France	**€/$**	**€/£**	**€/¥**	**€/CHF**	
Stock Returns	0.9858 (0.000)*	0.9844 (0.000)*	0.9864 (0.000)*	0.9858 (0.000)*	
Exchange Rates	0.9824 (0.000)*	0.9983 (0.000)*	0.9946 (0.000)*	0.9669 (0.000)*	
Germany	**€/$**	**€/£**	**€/¥**	**€/CHF**	
Stock Returns	0.9878 (0.000)*	0.9871 (0.000)*	0.9857 (0.000)*	0.9874 (0.000)*	
Exchange Rates	0.9868 (0.000)*	0.9986 (0.000)*	0.9947 (0.000)*	0.9662 (0.000)*	
Italy	**€/CHF**	**€/¥**	**€/£**	**€/$**	
Stock Returns	0.9880 (0.000)*	0.9878 (0.000)*	0.9869 (0.000)*	0.9877 (0.000)*	
Exchange Rates	0.9670 (0.000)*	0.9944 (0.000)*	0.9975 (0.000)*	0.9842 (0.000)*	
Japan	**¥/€**	**¥/$**	**¥/£**	**¥/CHF**	
Stock Returns	0.9750 (0.000)*	0.9698 (0.000)*	0.9695 (0.000)*	0.9699 (0.000)*	
Exchange Rates	0.9943 (0.000)*	-0.2654 (0.894)	0.0039 (0.991)	0.8993 (0.000)*	
UK	**£/€**	**£/$**	**£/¥**	**£/CHF**	
Stock Returns	0.9872 (0.000)*	0.9877 (0.000)*	0.9876 (0.000)*	0.9876 (0.000)*	
Exchange Rates	-0.2906 (0.368)	0.9963 (0.000)*	0.9589 (0.000)*	0.9936 (0.000)*	
US	**$/€**	**$/£**	**$/¥**	**$/CHF**	
Stock Returns	0.9925 (0.000)*	0.9924 (0.000)*	0.9930 (0.000)*	0.9925 (0.000)*	
Exchange Rates	0.9889 (0.000)*	-0.0108 (0.970)	-0.3173 (0.687)	0.9810 (0.000)*	

*1% significance level, **5% significance level, ***10% significance level

4.4.2.5 Diagnostic Tests

The diagnostic tests performed share common patterns with the ones done for the emerging economies; for example, the Jarque-Bera test indicates that the residuals are not normally distributed. The Ljung-Box statistics for all three periods and for all countries indicate that there are no residual linear or non linear dependencies, and as has been found before, in this case there are also some exceptions where the coefficient was not significant but the problem was corrected after introducing more lags into the test. Finally, to check the validity of the assumption of constant correlation adopted in the estimation of the bivariate models (Kanas, 2000), the LB statistics for the cross products of the standardised residuals from the stock returns equation and from the exchange rate equation are calculated and these statistics indicate that the assumption of constant correlation over time can be accepted.

4.4.3 Developed Economies versus Emerging Economies: A Comparative Approach

Throughout the last three sections of this chapter, a detailed analysis of interlinkages between stock and currency markets in three regions characterised by a number of emerging economies (e.g. Eastern Europe, East Asia and Latin America) was conducted. These have been compared to the most developed economies in the world represented by the G-7. Each section has approached an individual analysis among the major stock markets in each region, versus a variety of exchange rates.

The current analysis has also introduced two important time periods in the world's recent economic history: i) first, the study looked at the Asian emerging economies during times of a critical economic environment; this was achieved by the analysis of the relationship of the two markets during the Asian financial crisis. ii) Secondly, due to the lack of research in the area, it was considered of relevance to undertake an analysis of the major consequences of the introduction of the Euro in emerging economies in Europe and Latin America.

Analysing the existing literature on the relationships between stock and currency markets in the G-7, and in particular considering the work done by Zapatero (1995), the author has learnt that in fully integrated markets, like the developed economies amalgamated in the G-7, there is a clear linkage between the volatility of stock prices and the volatility of exchange rates. However, previous research analysing these two markets' relationship have not been able to find relevant evidence with regard to the effect that exchange rates generate on stock markets. After a careful analysis of past and current research on stock returns and exchange rates, it is possible to infer that a major problem of the existing studies (Choi, 1995; Kanas, 2000; Morsley and Pentecost, 2000; Griffin and Stulz, 2001; Nieh and Lee, 2001, Yang and Doong, 2004) is that they have focused their attention exclusively on spillovers derived from the domestic currency versus the American dollar, and the stock markets. Most of these studies have found evidence of a unidirectional effect running from stock returns to exchange rates, but no relevant evidence has been presented with regard to a reverse effect. However, Yang and Doong (2002) noted that, given the rapid integration and deregulation of international financial markets during recent years, exchange rates have become more sensitive to stock market innovations. This possible effect has not been properly identified by the existing research, due to the lack of analysis considering a variety of exchange rates and their influence on stock markets. It is also important to mention that another factor that could be affecting the general findings of no effects generated from the exchange rates to the stock markets could be explained by the use of risk management techniques in most countries against the American dollar and other major currencies like the Japanese Yen, Euro and British pound. The use of these techniques has clearly offset currency effects on companies, and therefore diminished the possible effects that fluctuations in currencies could generate on the stock markets. Therefore, this kind of action hinders researchers getting a real framework of the true relationship that exists between these financial markets.

In relation to the existing literature analysing the emerging economies that have been considered, for example, Fang (2002) found evidence of currency depreciation adversely affecting stock returns in the case of five East Asian economies (Hong Kong, Singapore, South Korea, Taiwan and Thailand). The analysis focused on the Asian markets during and after the financial crisis hit the region, and Fang (2002) found evidence of an existing bidirectional relationship between these markets for some of the countries. Chowdhury (2004) found that the markets of Indonesia and Malaysia are affected by bidirectional causality, while no evidence of causality exists for the Philippines and Thailand. His results also vary depending on the time period under analysis.

As was outlined and highlighted by the literature review, there is an extensive amount of research devoted to the analysis of the interaction between equity and currency markets. However, the findings are mixed and controversial, and do not clarify the true kind of relationship that exists between these two markets. There is a certain degree of confusion regarding the interaction that exists between these markets in the different economies of the world. There is no distinction at all made of the differences and similarities between developed and emerging economies, and there is a big amount of research looking at the effects that run from the stock markets to the exchange rates, but little has been done on the reverse relationship.

For these reasons, a discussion highlighting this thesis's main findings with regard to emerging and developed economies is presented in the following subsection.

4.4.3.1 Comparison between the world most developed economies and some major emerging economies

When looking at the results that were obtained with regard to volatility persistence and asymmetric spillovers, the results illustrate a great degree of consistency between emerging economies and the G-7, where in almost all the cases the coefficients analysing volatility persistence and asymmetric spillover appear to be significant; these results are also consistent with the main findings in previous research in the area. Therefore, these findings are not surprising as financial markets data is characterised for showing high levels of volatility persistence; thus, when any shock or event takes place, its effects tend to last in financial markets, as volatility tends to show clustering patterns. In relation to asymmetric spillover effects, the analysis also provides important and consistent results, as the significance of the coefficients just reflects that financial markets would not be affected in the same manner by different types and intensities of economic shocks or news. Therefore, financial markets are able to differentiate between good and bad news and as a consequence they will be affected in a different manner by them.

This study's major finding, when analysing volatility spillovers between stock and currency markets seems to diverge from previous studies. In this particular area, a mixture of results was found, and can be differentiated by region as follows:

a) *East European Emerging Economies:* in this case, the period of analysis looks at the effects that were generated by the introduction of the Euro in the Euro zone. In this regard, before and after the introduction of the single currency, the coefficients for volatility spillover effects from stock returns to exchange rates appear to be insignificant, with the exception of the Czech Republic where the coefficient is significant after the introduction of the Euro. Therefore, any movements or shock taking place in stock markets would not be transmitted to the currencies. The same result is found when exchange rates are analysed. The results also show that no clear effect exists between these markets in any direction. Therefore, the results suggest the non-existence of integration between these two markets, a situation that could be explained by the immaturity of these economies and especially by the effects generated by the transition period that they were involved in, with the final goal of joining EMU and as a consequence adopting the Euro as their currency.

b) *Asian Emerging Economies:* the results for Asia were generated in a different context. In this case, the study focused on the analysis of the effects before, during and after the Asian financial crisis, as it was considered that the Euro would not have such an impact in these markets, comparable to the shock that took place in 1997. The analysis of volatility spillovers for this region brings the following results: i) in terms of volatility spillovers from stock returns to exchange rates, there are some significant differences between the results, for the three time periods under analysis. For the entire sample, all the coefficients are significant, a result that has to be taken carefully as it could be affected by structural breaks (the crisis). ii) During the crisis, the coefficients are significant for South Korea, Singapore and Thailand. iii) For the post crisis period, the coefficients are significant in the case of Hong Kong. Again these results show evidence of the differences that exist between these markets and countries, and how the crisis affected them. Another factor that could be influencing the results is the quick recovery that these markets experienced after 1998, which resulted in some kind of stability for the markets; therefore, no major shocks affected the region, and as a consequence volatility spillover effects are not identified. In relation to exchange rates spillovers to stock markets, the main findings show insignificant coefficients for all the countries and periods of analysis, with the only significant coefficients associated for the post crisis period in the case of Hong Kong, Taiwan and Thailand. These results confirm that there is a need to include a variety of exchange rates, as is done for the Latin American region and for the developed economies.

c) *Latin America Emerging Economies:* in this case, the period of analysis considers the effects of the introduction of the Euro; the reasons for doing this research are based on the importance of Spanish investment in the region, and the need to identify if the introduction of the Euro as the official currency in Spain could dilute the identification of influences from the Spanish currency on the Latin American stock markets. In this case, the results for the volatility spillovers coefficients present some degree of variation across countries and time for the various bilateral exchanges. Similar findings are encountered when analysing spillover effects from exchange rates to stock markets. The presence of significant coefficients indicates that the volatility of the world dominant currencies (US dollar, Japanese Yen, and British Pound) are determinants of shocks in stock markets. These results are very interesting, as one could identify some instances where spillovers were bidirectional in nature between the two markets. These results imply that bidirectional spillovers can be taken as evidence of a high degree of integration between stock markets and the major currencies. These kinds of results are not found when looking at the linkages between stocks returns and exchange rates of neighbouring countries. Therefore, it seems that the level of integration would be more currency specific in this part of the world. When comparing these results to the ones obtained for the Asian region, it is evident that there is some effect running from the exchange rates to stock markets, which the analysis did not detect in the Asian case as the exchange rates under consideration were limited to the region and the U.S dollar.

d) *The G-7 Countries:* when looking at the coefficients analysing volatility spillover effects, a large degree of consistency across countries and time periods is found. For spillovers running from stock returns to exchange rates, the results are consistent with the major findings in the existing literature. So it is possible to conclude that shocks in stock markets are very important in determining volatility in the exchange rate markets, and also confirm the high level of integration that exists between them. These results are not surprising, as the G-7 join together the most developed financial markets globally. In terms of volatility spillovers from exchange rates to stock markets, the results are less significant across countries and overtime. However, a number of bilateral exchange rates are found where significant spillovers are evident from exchange rates to stock returns, results that are consistent with the Latin American results where similar evidence was found.

This thesis's major finding reflects that the results are affected to some extent by the introduction of a large number of bilateral exchange rates, and this puts into question the generalised assumption that exchange rates will not generate effects on stock markets. The author expected to find evidence of exchange rates driven stock markets, and the results have confirmed her suspicions. The emerging economies and developed economies under analysis have shown that there is evidence of exchange rates affecting the stock markets. Another important conclusion derived from this thesis is that the relationship between these financial markets is not unidirectional, as stated in previous research, where most of the studies found that stock markets influence exchange rates, but no evidence of the reverse effect has been presented.

4.4.4 Analysis and Conclusions

This chapter fills a gap in the literature, where no research to date has explicitly focused on the impact of the introduction of the Euro and the Asian financial crisis on volatility spillovers between stock markets and currency markets around the world. In order to address this gap in the literature, three main periods have been examined, covering the time period before the introduction of the Euro, immediately after the irrevocable locking of exchange rates when the currency was still not in circulation, and finally the period starting with the introduction of the currency in the financial markets. The analysis also looked at the effects before, during and after the Asian financial crisis.

The results overall show that the volatility of stock prices affects the volatility of exchange rates, but there is also important evidence with regard to the volatility of exchange rates affecting the volatility of stock prices. The cases where a lack of significant spillovers in these markets is found indicate that there is potential for diversification between stock markets and currency markets in certain instances. The main difference between these results and existing studies on volatility spillovers between exchange rates and stock markets could reflect the larger number of bilateral exchange rates included in the current study. Thus, further research along these lines is required in order to establish more comprehensively the true nature of spillovers from exchange rates to equity markets which should provide valuable information on the possibilities for diversifying holdings of stocks and currencies in investment portfolios, as well as the potential for hedging amongst these assets.

This thesis's finding is very significant, as the results provide evidence that supports the idea of currency markets affecting stock markets. In this regard, Hutson and Stevenson (2009) demonstrate that the more open the economy, the more exposed its firms are to exchange rates movements. Therefore, future research analysing exchange rates influence on stock markets should focus on looking at countries' levels of openness, as this is a matter that directly affects the degree of countries' firms' exchange rates exposure. Another issue to take into consideration that could affect the results obtained is the kind of integration that the regions under analysis could be facing. As suggested by Barari (2004), there has been a trend towards increased regional integration relative to global integration and this affected the markets until the mid-1990s. A distinct change in trend is noted during the second half of the 1990s, when a process of global integration became faster in comparison with regional integration. Therefore, further research along these lines is needed in order to gain a better understanding of the implications of regional and global integration in currency and stock markets relationships; more precisely, it would be relevant to look at changes of patterns during and after the current financial crisis.

CHAPTER V

EMPIRICAL RESULTS:

PRECIOUS METALS MARKETS

The current chapter is organised as follows: i) First, the analysis starts with a brief introduction, where a discussion of the importance of analysing precious metals and oil markets is highlighted. ii) The next subsection deals with the main findings regarding precious metals markets and the effects of the Asian crisis on them. iii) Then, the analysis follows with a discussion of the relationship between precious metals and the G-7. iv) In the next part, the study focuses on studying the interaction between precious metals and three of the most developed economies and oil prices. Finally, the chapter's conclusions are provided.

5.1 Introduction

The purpose of this chapter is to focus on the analysis of precious metals markets and of the interlinkages existing between gold, silver, platinum and palladium. This study hypothesises the idea of the existence of low levels of integration between precious metals among themselves, and also in terms of interlinkages between the G-7 stock markets and precious metals. If these suspicions are to be confirmed by the research findings, and precious metals are not highly integrated with these markets, investors would have great opportunities to diversify their portfolios in the commodities markets, and in particular in precious metals markets.

The existing literature shows that little attention has been paid to the study of interlinkages between stock markets and precious metals markets and in particular to the analysis of volatility spillovers among them. Hillier, Draper and Faff (2006) notice that gold, platinum and silver have the potential to play a diversifying role in investment portfolios, as precious metals exhibit some hedging capability during periods of abnormal markets volatility. As a consequence, this analysis is motivated by the results obtained from previous studies, where precious metals markets appeared to be an interesting option for investors to diversify their portfolios and to implement their hedging techniques.

In conducting this research, two methodologies will be implemented. As in the previous chapter, the EGARCH (p,q) framework has been employed to keep consistency, and also because it has been demonstrated to be a good model to investigate volatility in financial markets. It is also a good model that provides rich information, as it allows the analysis of volatility persistence, volatility spillovers, and asymmetric spillovers. On the other hand, there is also need to check some of these results to determine if they are consistent, as has been demonstrated by the existing research, when analysing markets interaction the results tend to vary depending on the methodology applied. Thus it is relevant to implement an additional study of volatility persistence through a GARCH (p,q) model which is a great tool that allows a comparative analysis with the EGARCH (p,q) output.

The results from this study are of particular importance to investors due to the fact that stock markets are influenced by shocks in oil and precious metals markets, while precious metals markets are seen as more stable and secure assets. Therefore, the independent behaviour of precious metals regarding oil and equity markets during times of crises, and the long term upward trend that these markets are facing represent highly valuable information for investors who would be able to design their investment strategies taking into account the use of precious metals in the composition of their portfolios. This research's initial hypothesis posits the important implication of the new role that precious metals markets could develop for investors; thus this new approach complements the analysis carried out so far and his is indeed a topic worthy for research.

The current economic and financial situation is one where equity markets are under intense pressure, a situation that appears to be aggravated by the American economy's deep downturn since the late 2008. This situation leads one to wonder about the consequences for the rest of the world economies if the US enters into a deep crisis. Anxious investors seeking for new and safer havens could realise that precious metals markets, oil, and emerging markets are sources of investment opportunities that should be taken into consideration.

5.2 *PRECIOUS METALS MARKETS: THE EFFECTS OF THE ASIAN CRISIS*

In this section, the analysis focuses on the period that spans from 1 January 1995 to 31 July 2007. The study will focus on looking at the full sample, and also it has been considered appropriate to split the whole sample into three sub samples in order to provide greater details and a better understanding of volatility spillovers between precious metals returns, as has been done previously when analysing stock markets and exchange rates interlinkages. Thus the first sub sample spans over January 1995-June 1997, the period prior to the Asian crisis. As the author is interested in examining if the Asian crisis could generate volatility spillovers between these commodities markets the second subsample will cover the July 1997-December 1998 period when the crisis hit the markets; finally, the last sample period covers the years 1999- July 2007, where the main idea is to analyse the behaviour of these markets immediately after the major shock, and subsequently. The main reason for splitting the sample in this way is based on the notion of structural breaks and their influence in econometric analysis. The Asian crisis took effect during July 1997 to December 1998, so there is a need to check what the behaviour of these markets was during this period, and how the markets reacted before and after this event took place.

Another reason for considering the Asian financial crisis is hypothesising that precious metals markets are less volatile during times of financial distress than equity and currency markets. Therefore, investors would face fewer losses if they diversified their investments taking into account these properties of the precious metals markets. Another fact of interest is the importance of the Asian crisis on the world economy; therefore, this is a relevant period that could not be ignored by this research. The data set consists of daily closing values for precious metals data, where the following selection was done: US$/Troy ounce for gold, the London Free Market Platinum price in US$/Troy ounce, the London Free Market Palladium price in US$/Troy once, and the Zurich silver price in US$/kilogram. All the data series are from DataStream International, giving a total of 3282 observations for each series.

5.2.1 Empirical Results

5.2.1.1 EGARCH Specification

First, the basic descriptive statistics of the dataset are presented which provide the details and characteristics of the series. Second, we present the results of the unit roots analysis, the likelihood ratio tests performed and the basic tests that provide the necessary information to identify which EGARCH (p,q) specification is the most appropriate to model the variables. Finally, the results of the EGARCH analysis are presented, results that provide information on volatility persistence, volatility spillovers and asymmetric spillovers effects from stock returns to precious metals returns and on the other way around.

5.2.1.2. Descriptive Statistics

The analysis of the descriptive statistics on precious metals returns are presented for the four periods of analysis. During those sub-periods, almost all markets present positive and small values, the exceptions being gold and silver for the period prior to the Asian crisis (January 1995-June 1997) where the means are negative. During the Asian crisis (July 1997-December 1998) the results show negative means in the case of gold and platinum. After the financial crisis, all the means for the four precious metals are positive. The analysis of the returns volatility for all the samples shows that overall palladium is the most volatile of the four precious metals, with a standard deviation moving in a range of 1.64 per cent prior to the crisis to 2.75 per cent during the crisis time. Gold is the less volatile with a 0.44 per cent standard deviation prior to the crisis as the minimum value and with a 0.97 percent as the highest value after the financial crisis. These results confirm the idea that gold tends to present stability properties during times of turmoil, as it is the metal that suffers the least during the crisis. With regard to platinum and palladium standard deviations move around 1.01 per cent to 1.83 per cent during the four periods. The skewness and kurtosis coefficients indicate that precious metals returns are leptokurtic relative to the normal distribution. The Jarque-Bera test also rejects the hypothesis that precious metals returns are normally distributed in all the cases.

5.2.1.3 Unit Roots and Likelihood Tests

The results from the ADF tests statistics indicate the rejection of the null hypothesis of the existence of a unit root in levels for all variables during all periods indicating that all series are *I(0)*.[26]

In order to establish the correct lag length for the EGARCH model, the Likelihood Ratio test is applied. There is a mix of (1,1) and (2,1) models chosen for the different bivariate models, where the (1,1) model seems to be dominant.

The estimated parameters from the EGARCH estimation are set out in tables 5.1 to 5.3, for the four periods of analysis (1995-2006, January 1995-June 1997, July 1997-December 1998 and 1999-06). The results for the GARCH (1,1)

[26] The LMF test results indicated that the ADF tests were free from serial correlation; for brevity the test results are not showed here, but they are available in Appendix H.

and the diagnostic test are presented in tables 5.4 to 5.7. The *p*-values are given in parentheses beneath each coefficient estimate.

5.2.1.4 Volatility Persistence (EGARCH)

The volatility persistence results from the EGARCH model are presented in table 5.1, and the coefficients analysing the volatility persistence term vary depending on the precious metals and the equation under analysis, but it is found that in the majority of the cases the coefficients are significant. This result is not surprising given that persistence is a feature shared by precious metals markets, and financial markets data. The analysis of the coefficients by period reveals that during 1995 to July 2007, the coefficients are significant in all cases. The coefficients are all significant prior to the Asian crisis (1995-June 1997), with the exception for palladium-gold where the coefficient appears to be insignificant. An interesting feature of these results is the insignificant coefficients obtained for the period when the Asian financial crisis happened; it was expected to find significant coefficients during this particular time as the effect of the Asian crisis could be dragging all the markets into recession. These expectations are not supported by the findings as it seems that precious metals markets could be suffering at a lower scale the effects of the financial turmoil. These results are a clear sign of the different behaviour reflected by precious metals, and the stable properties argued at the beginning of this section seem to be confirmed. Almost all the coefficients appear to be insignificant with the exception of palladium-silver, silver-gold, silver-palladium and silver-platinum. The results for the coefficients for the final period 1999-July 2007 are all significant.

So far, the main difference when analysing precious metals markets is the insignificant coefficients that were found during the Asian crisis. A significant coefficient regarding volatility persistence implies that a deviation of the price from its expected value will cause the variance of the price to be larger than expected. This means that the amplitude of returns fluctuations represents the amount of the variation of the returns during a short-time. In the presence of a long memory process on volatility the fluctuations will remain in the markets for a while with the uncertainty that this situation will bring to the markets; this is something that has important consequences in terms of risk management. Investors base their decisions on expectations; therefore, the diversity of expectations causes a variability of stock returns, and the results obtained from this section are implying low volatility persistence affecting precious metals markets. It seems that the instability and uncertainty that lasted in the stock markets during this particular time did not affect to the same extent precious metals markets. The insignificance of the volatility persistence coefficients found in this analysis on the precious metals returns could reflect that in general, the Asian crisis did not generate a great impact on these markets. This can be explained by the investors' expectations regarding the belief of stability in the precious metals prices; therefore, their expectations tend to be constant and stable over time, a situation that will be translated in the precious metals markets returns by a lower fluctuation in their prices.

Therefore, the volatility persistence analysis shows that overall there are insignificant coefficients on precious metals returns during a time of crisis in the financial stock markets, and that this event seems not to generate a great impact on precious metals markets. The results also indicate that precious metals markets are connected to some extent, but in general their integration could be classified as a weak one. Therefore, these findings indicate that precious metals returns fluctuations do not generate impacts on them, indicating that when any of the precious metals markets faces fluctuations, these movements will not be transmitted to the other ones, or that the impact would be quite low.

5.2.1.5 Volatility Spillovers (EGARCH)

The analysis of the coefficients for the volatility spillovers results are presented in table 5.2, and they are quite mixed across the various time periods.

The main results show evidence of volatility spillovers between precious metals markets at the 1 per cent, 5 per cent and 10 per cent significance levels. Some exceptions are found with regard to this evidence, but most of them are affecting particular time periods. For example, when looking at the results per sample period, it is found that during the whole sample 1995-July 2007 the coefficients are significant in the case of volatility running from gold to the other metals; there is however weak evidence of the opposite trend, where the only coefficient that is significant is volatility spillovers running from platinum to gold. In relation to the period prior to the Asian crisis (1995-June 1997), the results show insignificant coefficients in the case of volatility spillovers from gold to any of the other metals, while the results show that in these cases the opposite effect appears to be significant, meaning that the other metals generate impacts on the gold market. Regarding the Asian crisis period (July 1997-1998) the coefficients are insignificant in the case of volatility from gold to the other precious metals, and they are significant from platinum to gold and from silver to gold. Again, and as happened regarding volatility persistence, it seems that the Asian crisis did generate an influence on financial markets, but its effects regarding precious metals markets are not so clear. Then, the results allow us to assume that precious metals markets are not highly influenced by shocks affecting stock markets. Regarding the rest of the metals, there are spillover effects running from platinum to silver, platinum to palladium, silver to palladium and silver to platinum. Finally, during the last period of study (1999-July 2007) the results are quite mixed; significant volatility spillovers can be seen from gold to palladium and platinum, silver to gold, platinum to palladium, silver to platinum and platinum to silver.

The results show that gold is the only one that generates an influence on the rest of the markets, but there is no evidence of the other metals generating an impact or influencing gold prices. It seems that silver, palladium and platinum are integrated to some extent with gold, but there is a lack of integration among them. These results are quite important, as it is possible to conclude from them that any shock in the gold markets would affect the rest of the precious metals, but there is no strong evidence of gold being affected by shocks in the rest of the precious metals. Then, it is possible to infer that there is a unidirectional causal relationship among these markets, where all of them are depending on gold.

5.2.1.6 Asymmetric Spillovers (EGARCH)

The results for the asymmetric spillover effects are presented in table 5.3 and they show that the coefficients are significant in almost all cases for all periods, with the following exceptions: during 1995-June1997 the coefficient is insignificant in the case of the equation for silver-platinum. During July 1997-1998 the coefficients are insignificant in the cases of gold-palladium, gold-silver, palladium-silver, platinum-silver, platinum-palladium, silver-palladium and silver-platinum. The existence of insignificant coefficients indicates that the spillover effects in these instances are symmetric; this implies that positive and negative shocks have the same impact on volatility. The results show that, in general, bad news will generate a greater impact on these markets than good news, which it is consistent with a priori expectations and also it line with the results obtained with regard to financial markets.

Table 5.1: EGARCH RESULTS VOLATILITY PERSISTENCE

1995-July 2007						1995-June 1997					
Gold-Palladium	Gold-Platinum	Gold-Silver	Palladium-Platinum	Palladium-Silver	Platinum-Silver	Gold-Palladium	Gold-Platinum	Gold-Silver	Palladium-Platinum	Palladium-Silver	Platinum-Silver
0.2324	0.2312	0.2354	0.1934	0.2451	0.2026	0.1877	0.2548	0.2048	0.1527	0.3993	0.2515
(0.006)*	(0.006)*	(0.003)*	(0.000)*	(0.000)*	(0.000)*	(0.149)	(0.001)*	(0.005)*	(0.069)***	(0.000)*	(0.000)*
Palladium-Gold	Platinum-Gold	Silver-Gold	Platinum-Palladium	Silver-Palladium	Silver-Platinum	Palladium-Gold	Platinum-Gold	Silver-Gold	Platinum-Palladium	Silver-Palladium	Silver-Platinum
0.2517	0.2864	0.4561	0.2870	0.4638	0.4607	0.2518	0.2310	0.4698	0.2318	0.6009	0.4693
(0.006)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*
July 1997-1998						**1999-July 2007**					
Gold-Palladium	Gold-Platinum	Gold-Silver	Palladium-Platinum	Palladium-Silver	Platinum-Silver	Gold-Palladium	Gold-Platinum	Gold-Silver	Palladium-Platinum	Palladium-Silver	Platinum-Silver
0.1041	0.1134	-0.0037	0.2008	0.3660	0.1045	0.2391	0.2412	0.2602	0.2908	0.2569	0.2092
(0.376)	(0.322)	(0.963)	(0.141)	(0.034)**	(0.420)	(0.011)**	(0.010)**	(0.001)*	(0.000)*	(0.000)*	(0.000)*
Palladium-Gold	Platinum-Gold	Silver-Gold	Platinum-Palladium	Silver-Palladium	Silver-Platinum	Palladium-Gold	Platinum-Gold	Silver-Gold	Platinum-Palladium	Silver-Palladium	Silver-Platinum
0.2312	0.0762	0.3632	0.0716	0.3388	0.3551	0.2631	0.2351	0.5220	0.2341	0.5271	0.5193
(0.115)	(0.569)	(0.001)*	(0.571)	(0.004)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*

*1% significance level, **5% significance level, ***10% significance level

Table 5.2: EGARCH RESULTS VOLATILITY SPILLOVERS

1995-July 2007						1995-June 1997					
Gold-Palladium	Gold-Platinum	Gold-Silver	Palladium-Platinum	Palladium-Silver	Platinum-Silver	Gold-Palladium	Gold-Platinum	Gold-Silver	Palladium-Platinum	Palladium-Silver	Platinum-Silver
0.0608	0.0627	0.0708	0.7386	0.0085	0.0646	0.0383	-0.0183	0.0528	0.1067	0.1272	0.1549
(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.806)	(0.003)*	(0.411)	(0.776)	(0.321)	(0.022)**	(0.041)**	(0.003)*
Palladium-Gold	Platinum-Gold	Silver-Gold	Platinum-Palladium	Silver-Palladium	Silver-Platinum	Palladium-Gold	Platinum-Gold	Silver-Gold	Platinum-Palladium	Silver-Palladium	Silver-Platinum
0.0127	0.0713	0.0405	0.0693	0.0385	0.0401	0.0815	0.1406	-0.2097	0.1565	-0.0037	-0.2110
(0.703)	(0.000)*	(0.205)	(0.000)*	(0.269)	(0.233)	(0.008)*	(0.033)**	(0.002)*	(0.001)*	(0.933)	(0.002)*
July 1997-1998						**1999-July 2007**					
Gold-Palladium	Gold-Platinum	Gold-Silver	Palladium-Platinum	Palladium-Silver	Platinum-Silver	Gold-Palladium	Gold-Platinum	Gold-Silver	Palladium-Platinum	Palladium-Silver	Platinum-Silver
0.0357	0.0324	0.0702	0.0836	0.0243	0.2289	-0.1824	-0.1844	0.0347	-0.0072	-0.0113	0.0596
(0.528)	(0.574)	(0.367)	(0.644)	(0.936)	(0.004)*	(0.047)**	(0.042)**	(0.641)	(0.863)	(0.789)	(0.030)**
Palladium-Gold	Platinum-Gold	Silver-Gold	Platinum-Palladium	Silver-Palladium	Silver-Platinum	Palladium-Gold	Platinum-Gold	Silver-Gold	Platinum-Palladium	Silver-Palladium	Silver-Platinum
0.0343	0.2313	0.3976	0.2180	0.2938	0.3471	-0.0041	0.0642	-0.2361	0.0645	-0.2012	-0.2270
(0.717)	(0.007)*	(0.000)*	(0.009)*	(0.001)*	(0.000)*	(0.919)	(0.028)**	(0.039)**	(0.027)**	(0.132)	(0.045)**

*1% significance level, **5% significance level, ***10% significance level

Table 5.3: EGARCH RESULTS ASYMMETRIC SPILLOVERS

1995-July 2007						1995-June 1997					
Gold-Palladium	Gold-Platinum	Gold-Silver	Palladium-Platinum	Palladium-Silver	Platinum-Silver	Gold-Palladium	Gold-Platinum	Gold-Silver	Palladium-Platinum	Palladium-Silver	Platinum-Silver
0.9864	0.9859	0.9784	0.1679	0.9364	0.9778	0.9444	0.9463	0.9465	0.9592	0.7920	0.9392
(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*
Palladium-Gold	Platinum-Gold	Silver-Gold	Platinum-Palladium	Silver-Palladium	Silver-Platinum	Palladium-Gold	Platinum-Gold	Silver-Gold	Platinum-Palladium	Silver-Palladium	Silver-Platinum
0.9334	0.9701	0.9590	0.9720	0.9466	0.9522	0.9768	0.9521	-0.3552	0.9445	0.9936	-0.3534
(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.251)	(0.000)*	(0.000)*	(0.255)
July 1997-1998						**1999-July 2007**					
Gold-Palladium	Gold-Platinum	Gold-Silver	Palladium-Platinum	Palladium-Silver	Platinum-Silver	Gold-Palladium	Gold-Platinum	Gold-Silver	Palladium-Platinum	Palladium-Silver	Platinum-Silver
-0.7072	-0.7230	0.6558	0.8855	0.5863	-0.2353	0.9844	0.9844	0.8219	0.8770	0.9206	0.9723
(0.116)	(0.054)***	(0.363)	(0.000)*	(0.130)	(0.516)	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*
Palladium-Gold	Platinum-Gold	Silver-Gold	Platinum-Palladium	Silver-Palladium	Silver-Platinum	Palladium-Gold	Platinum-Gold	Silver-Gold	Platinum-Palladium	Silver-Palladium	Silver-Platinum
0.7328	-0.1952	0.3174	-0.3392	0.2849	0.3002	0.9218	0.9613	0.8547	0.9593	0.8115	0.8499
(0.003)*	(0.612)	(0.099)***	(0.362)	(0.309)	(0.205)	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*

*1% significance level, **5% significance level, ***10% significance level

5.2.1.7 GARCH Results

The returns-generating process results are presented in tables 5.4 to 5.7 according to the time periods (first the results for the whole sample, followed by each of the subsamples in chronological order). It is possible to draw the following conclusions from them. First, there is a significantly positive relationship between the precious metals returns. Overall, there is a significant negative relationship between precious metal returns and metals returns depreciation, with most of the coefficients appearing to be negative. This situation reflects that, in general terms, when the precious metals markets are appreciating, there is a trend of increasing returns for almost all the markets, but when the prices of any of these markets depreciates, the prices of the rest of the markets will tend to drop as well.

Examining the estimates, it can be appreciated that for all four periods of analysis all variance parameters are positive and statistically significant. The analysis of the results for each period finds that during 1995-July 2007 (table 5.4) the palladium-silver equations show negative coefficients, with GARCH parameter sums indicating high volatility shock persistence for all the cases, with the exception of palladium-silver, where the coefficients sum is 0.018 for the palladium-silver relationship, and 0.31 for silver-palladium. This implies that volatility persistence tends to last in the markets, and considering that volatility tends to exhibit a clustering behaviour, this means that when markets are volatile the effects tend to last for a while, characteristics that are shared with financial markets to some extent.

Table 5.4: Estimates of the GARCH (1,1): 1995-July 2007

Parameters	Gold-Palladium	Gold-Platinum	Gold-Silver	Palladium-Platinum	Palladium-Silver	Platinum-Silver
c_0	0.0000 (0.710)	-0.0001 (0.528)	0.0000 (0.878)	-0.0003 (0.115)	0.0000 (0.949)	0.0000 (0.794)
α	0.0733 (0.000)*	0.2006 (0.000)*	0.2150 (0.000)*	0.7476 (0.000)*	0.0456 (0.000)*	0.1627 (0.000)*
θ	0.0000 (0.968)	-0.0002 (0.055)**	-0.0004 (0.001)*	0.0014 (0.000)*	0.1756 (0.359)	-0.0006 (0.013)**
β_0	0.0000 (0.030)**	0.0000 (0.179)	0.0000 (0.002)*	0.0000 (0.044)**	0.0000 (0.000)**	0.0000 (0.073)***
β_1	0.0583 (0.000)*	0.0571 (0.000)*	0.2078 (0.000)*	0.1934 (0.000)*	-0.0407 (0.017)**	0.1137 (0.000)*
κ_1	0.9390 (0.000)*	0.9398 (0.000)*	0.6751 (0.000)*	0.7386 (0.000)*	0.0594 (0.003)*	0.8724 (0.000)*
γ_1	0.0007 (0.060)**	0.0026 (0.044)**	0.0236 (0.000)*	0.1679 (0.000)*	0.8324 (0.000)*	0.0088 (0.002)*
$\beta_1 + \kappa_1$	0.9973	0.9969	0.8829	0.9320	0.0187	0.9861
Parameters	Palladium-Gold	Platinum-Gold	Silver-Gold	Platinum-Palladium	Silver-Palladium	Silver-Platinum
a_0	0.0001 (0.194)	0.0000 (0.800)	0.0003 (0.165)	0.0002 (0.147)	0.0002 (0.084)**	0.0001 (0.656)
δ	0.5425 (0.000)*	0.4971 (0.000)*	0.9334 (0.000)*	0.3093 (0.000)*	0.0640 (0.000)*	0.3395 (0.000)*
ϕ	0.0008 (0.044)**	-0.0007 (0.001)*	-0.0030 (0.000)*	-0.0001 (0.588)	-0.0014 (0.000)*	-0.0025 (0.000)*
b_0	0.0000 (0.014)**	0.0000 (0.005)*	0.0000 (0.000)*	0.0000 (0.000)*	0.0000 (0.000)*	0.0001 (0.000)*
b_1	0.1307 (0.000)*	0.1020 (0.000)*	0.1733 (0.000)*	0.1863 (0.000)*	-0.0865 (0.000)*	0.2826 (0.000)*
c_1	0.8341 (0.000)*	0.8846 (0.000)*	0.5800 (0.000)*	0.6891 (0.000)*	0.4012 (0.000)*	0.3354 (0.000)*
λ_1	0.1188 (0.017)*	0.0320 (0.000)*	0.4010 (0.000)*	0.0266 (0.000)*	0.2838 (0.000)*	0.2212 (0.000)*
$b_1 + c_1$	0.9649	0.9866	0.7533	0.8754	0.3147	0.6180

*1% significance level, **5% significance level, ***10% significance level

During 1995-June 1997 (table 5.5), the estimates are positive and statistically significant in all the cases, the exception being the silver-platinum equation where the coefficient is negative. The GARCH parameter sum is quite high for all the equations with the exception of silver-palladium (0.57) and silver-platinum (0.24).

Table 5.5: Estimates of the GARCH (1,1): 1995-June 1997

Parameters	Gold-Palladium	Gold-Platinum	Gold-Silver	Palladium-Platinum	Palladium-Silver	Platinum-Silver
c_0	-0.0001 (0.378)	-0.0001 (0.486)	-0.0001 (0.257)	-0.0003 (0.439)	-0.0007 (0.083)**	-0.0005 (0.069)***
α	0.0845 (0.000)*	0.2806 (0.000)*	0.1389 (0.000)*	0.8995 (0.000)*	0.2742 (0.000)*	0.2505 (0.000)*
θ	-0.0002 (0.283)	-0.0005 (0.002)*	-0.0003 (0.021)**	0.0005 (0.294)	0.0002 (0.692)	-0.0008 (0.002)*
β_0	0.0000 (0.020)**	0.0000 (0.009)*	0.0000 (0.180)	0.0000 (0.290)	0.0000 (0.134)	0.0000 (0.064)***
β_1	0.1022 (0.000)*	0.1498 (0.001)*	0.1113 (0.011)**	0.2078 (0.000)*	0.1847 (0.000)*	0.1857 (0.027)**
κ_1	0.8309 (0.000)*	0.6185 (0.000)*	0.8377 (0.000)*	0.5995 (0.000)*	0.7569 (0.000)*	0.7154 (0.000)*
γ_1	0.0019 (0.1758)	0.0274 (0.000)*	0.0010 (0.181)	0.2781 (0.020)**	-0.0105 (0.314)	0.0138 (0.022)**
$\beta_1 + \kappa_1$	0.9331	0.7683	0.9490	0.8074	0.9416	0.9012
Parameters	Palladium-Gold	Platinum-Gold	Silver-Gold	Platinum-Palladium	Silver-Palladium	Silver-Platinum
a_0	-0.0004 (0.328)	-0.0003 (0.325)	-0.0003 (0.439)	-0.0002 (0.368)	-0.0001 (0.849)	0.0001 (0.849)
δ	0.8245 (0.000)*	0.8977 (0.000)*	0.8995 (0.000)*	0.3705 (0.000)*	0.2761 (0.000)*	0.7744 (0.000)*
ϕ	-0.0003 (0.595)	-0.0010 (0.001)*	0.0005 (0.294)	0.0000 (0.957)	-0.0009 (0.013)**	-0.0027 (0.000)*
b_0	0.0000 (0.371)	0.0000 (0.045)**	0.0000 (0.290)	0.0000 (0.017)**	0.0001 (0.000)*	0.0001 (0.000)*
b_1	0.1006 (0.021)**	0.2315 (0.001)*	0.2078 (0.000)*	0.0925 (0.004)*	0.5521 (0.000)*	0.2527 (0.003)*
c_1	0.8259 (0.000)*	0.6787 (0.000)*	0.5995 (0.000)*	0.6343 (0.000)*	0.0278 (0.397)	-0.0043 (0.944)
λ_1	0.2215 (0.353)	0.0973 (0.101)	0.2781 (0.020)**	0.0442 (0.000)*	0.0347 (0.074)***	0.5253 (0.000)*
$b_1 + c_1$	0.9264	0.9102	0.8074	0.7268	0.5799	0.2484

*1% significance level, **5% significance level, ***10% significance level

The results for the Asian crisis period (table 5.6) show that gold-platinum and silver-platinum coefficients are the only ones that appear to be negative. The GARCH parameter sum is moving between 0.54 as the lowest value to 0.98 as the highest. The results of the GARCH model are showing some degree of weak volatility persistence in the markets reflected by coefficients moving around 0.50 and 0.60. These results show some consistency with the results that where obtained from the EGARCH analysis, where the Asian crisis seems to generate a minor effect on precious metals markets. In this case there is need to be careful with the interpretation of the results, as depreciation has been introduced in the estimation of the GARCH model, something that was not attempted in the EGARCH analysis.

Table 5.6: Estimates of the GARCH (1,1): July 1997-1998

Parameters	Gold-Palladium	Gold-Platinum	Gold-Silver	Palladium-Platinum	Palladium-Silver	Platinum-Silver
c_0	-0.0004 (0.230)	-0.0003 (0.348)	-0.0006 (0.066)***	0.0014 (0.171)	0.0007 (0.486)	-0.0003 (0.622)
α	0.0347 (0.004)*	0.1386 (0.000)*	0.1482 (0.000)*	0.7310 (0.000)*	0.0997 (0.117)	0.2243 (0.000)*
θ	0.0005 (0.185)	0.0002 (0.048)**	0.0001 (0.690)	0.0027 (0.023)**	0.0036 (0.008)*	-0.0014 (0.069)***
β_0	0.0000 (0.210)	0.0000 (0.228)	0.0000 (0.039)**	0.0000 (0.643)	0.0000 (0.192)	0.0001 (0.206)
β_1	0.0278 (0.390)	-0.0194 (0.498)	0.0503 (0.166)	0.1240 (0.014)**	0.1037 (0.004)*	0.0971 (0.193)
κ_1	0.7166 (0.000)*	0.6825 (0.006)*	0.6446 (0.000)*	0.8335 (0.000)*	0.8771 (0.000)*	0.5983 (0.015)**
γ_1	-0.0008 (0.453)	0.0128 (0.140)	0.0187 (0.001)*	0.1049 (0.162)	-0.0058 (0.740)	0.0255 (0.174)
$\beta_1 + \kappa_1$	0.7444	0.6631	0.6949	0.9575	0.9809	0.6954
Parameters	Palladium-Gold	Platinum-Gold	Silver-Gold	Platinum-Palladium	Silver-Palladium	Silver-Platinum
a_0	0.0007 (0.507)	0.0000 (0.968)	-0.0007 (0.342)	-0.0005 (0.441)	-0.0006 (0.450)	-0.0008 (0.318)
δ	0.2155 (0.140)	0.5953 (0.000)*	0.8391 (0.000)*	0.2857 (0.000)*	0.1017 (0.002)*	0.2939 (0.000)*
ϕ	0.0023 (0.096)***	-0.0020 (0.011)**	-0.0013 (0.205)	-0.0017 (0.019)**	-0.0008 (0.452)	-0.0011 (0.283)
b_0	0.0000 (0.038)**	0.0001 (0.044)**	0.0002 (0.000)*	0.0001 (0.068)***	0.0003 (0.000)*	0.0001 (0.000)*
b_1	0.0887 (0.002)*	0.1058 (0.015)**	0.4846 (0.000)*	0.1129 (0.198)	0.1972 (0.001)*	0.2617 (0.014)**
c_1	0.9011 (0.000)*	0.5081 (0.011)**	0.0579 (0.553)	0.4597 (0.051)***	-0.3174 (0.000)*	0.3134 (0.028)**
λ_1	-0.4434 (0.000)*	0.0859 (0.565)	-0.3310 (0.000)*	0.0204 (0.007)*	0.0454 (0.010)**	-0.0164 (0.763)
$b_1 + c_1$	0.9898	0.6139	0.5424	0.5726	-0.1202	0.5752

*1% significance level, **5% significance level, ***10% significance level

The results for the final sample (1999-July 2007, table 5.7) show that the coefficients are positive in all the cases, with a GARCH parameter sum moving between 0.63 to 0.94, which indicates high volatility shock persistence for all the cases. This means that precious metals markets behaviour tends to be different during times of financial distress, but their behaviour tends to be aligned with financial markets exhibiting volatility persistence behaviour during the rest of the time.

The coefficients that take into account precious metals returns depreciation (λ>0 and γ>0) are positive and significant in almost all the cases with the exceptions of palladium-silver and silver-platinum during 1995-June 1997. During the Asian crisis the parameters are negative in the case of gold-palladium, palladium-silver, palladium-gold, silver-gold, and silver-palladium and silver-platinum. Overall, the results show that precious metals depreciation, and in particular depreciation in gold prices is a source of volatility on precious metals markets.

In general, the results regarding volatility persistence seem to be consistent with the findings on the EGARCH model where evidence of volatility persistence between these markets was also found.

Table 5.7: Estimates of the GARCH (1,1): 1999-July 2007

Parameters	Gold-Palladium	Gold-Platinum	Gold-Silver	Palladium-Platinum	Palladium-Silver	Platinum-Silver
c_0	0.0004 (0.020)*	0.0003 (0.114)	0.0003 (0.055)***	-0.0005 (0.067)***	0.0003 (0.453)	0.0007 (0.005)*
α	0.1133 (0.000)*	0.2368 (0.000)*	0.2647 (0.000)*	0.7088 (0.000)*	0.2020 (0.000)*	0.1089 (0.000)*
θ	-0.0001 (0.690)	-0.0002 (0.323)	-0.0008 (0.000)*	0.0019 (0.000)*	0.0013 (0.009)*	-0.0005 (0.097)***
β_0	0.0000 (0.000)*	0.0000 (0.000)*	0.0000 (0.000)*	0.0000 (0.016)**	0.0000 (0.082)***	0.0000 (0.000)*
β_1	0.1546 (0.000)*	0.1407 (0.000)*	0.1777 (0.000)*	0.2079 (0.000)*	0.1713 (0.000)*	0.1866 (0.000)*
κ_1	0.5673 (0.000)*	0.5817 (0.000)*	0.4558 (0.000)*	0.7125 (0.000)*	0.7248 (0.000)*	0.7270 (0.000)*
γ_1	0.0115 (0.001)*	0.0340 (0.009)*	0.0535 (0.000)*	0.1603 (0.000)*	0.0461 (0.056)***	0.0165 (0.018)**
$\beta_1 + \kappa_1$	0.7219	0.7224	0.6335	0.9204	0.8961	0.9136
Parameters	Palladium-Gold	Platinum-Gold	Silver-Gold	Platinum-Palladium	Silver-Palladium	Silver-Platinum
a_0	0.0002 (0.608)	0.0005 (0.042)**	0.0005 (0.108)	0.0006 (0.001)*	0.0008 (0.044)**	0.0005 (0.139)
δ	0.5128 (0.000)*	0.4112 (0.000)*	0.8531 (0.000)*	0.2993 (0.000)*	0.1350 (0.000)*	0.2395 (0.000)*
ϕ	0.0012 (0.024)**	-0.0007 (0.009)*	-0.0034 (0.000)*	-0.0001 (0.708)	-0.0008 (0.067)***	-0.0025 (0.000)*
b_0	0.0000 (0.014)**	0.0000 (0.005)*	0.0000 (0.002)*	0.0000 (0.000)*	0.0001 (0.000)*	0.0001 (0.000)*
b_1	0.1667 (0.000)*	0.1410 (0.000)*	0.1416 (0.000)*	0.2077 (0.000)*	0.2192 (0.002)*	0.2285 (0.000)*
c_1	0.7610 (0.000)*	0.8081 (0.000)*	0.6021 (0.000)*	0.6070 (0.000)*	0.4926 (0.000)*	0.5124 (0.000)*
λ_1	0.1394 (0.037)**	0.0362 (0.013)**	0.3417 (0.000)*	0.0272 (0.000)*	0.0476 (0.004)*	0.1033 (0.025)**
$b_1 + c_1$	0.9277	0.9492	0.7437	0.8147	0.7119	0.7409

*1% significance level, **5% significance level, ***10% significance level

5.2.1.8 Standardised Residuals

The Jarque-Bera test indicates that we reject the hypothesis that the residuals are normally distributed in all the cases, hence justifying the use of the Bollerslev-Wooldridge robust *t*-statistics. In the case of the EGARCH model, the Ljung-Box statistics for all four periods for all precious metals equations indicate that there are no residual linear or non linear dependencies in most of the cases.

There are some exceptions where the coefficients are not significant but the problem is corrected after introducing more lags into the test; a similar situation is found in the case of the GARCH results. Finally, to check the validity of the assumption of constant correlation adopted in the estimation of the bivariate models, the LB statistics for the cross products of the standardised residuals from the precious metals returns equation are calculated and these statistics indicate that the assumption of constant correlation over time can be accepted in almost all the cases, with the exception of palladium-gold during 1995-July 2007. During July 1997-1998 the assumption of constant correlation over time cannot be accepted in the cases of palladium-platinum, palladium-silver, and finally during 1999-July 2007 in the cases of palladium-gold and silver-palladium, on the EGARCH model. Regarding the GARCH results, the exceptions were found during 1995-July 2007 in the cases of gold-palladium, palladium silver and platinum silver. This is also the case for July 1997-1998 in the case of gold-platinum and palladium-silver, and finally during the 1999-July 2007 the exception was gold-palladium. These exceptions are normally corrected after increasing or decreasing the number of lags in the test, therefore the problem tends to be corrected.

The ARCH-LM residual test results show that overall the variance equation for the EGARCH model is correctly specified; the null hypothesis of remaining ARCH effects in the equation is rejected in almost all the cases. The exceptions are: during the crisis period (July 1997-1998) in the case of palladium-platinum, palladium-silver, palladium-gold, silver-gold, silver-palladium and silver-platinum. This problem is corrected after increasing or decreasing the number of lags used in the estimation. The test results shows that the variance equation is correctly specified as well for the GARCH model, as the null hypothesis is rejected in almost all the cases, the exceptions being: silver-palladium for the whole sample and during the Asian crisis (1995-July 2007 and July 1997-1998). These results then confirm that the model selections have been the appropriate ones.

5.2.1.9 Analysis and Conclusions

This section investigated the existence of volatility effects in precious metals returns, using GARCH and EGARCH modelling. The empirical results indicate that precious metals depreciation under conditions of stable and unstable markets situations tends to decrease the mean stock return and also increase market volatility. The results show that there is clear evidence of volatility persistence between precious metals returns, but that this persistence was not so obvious during the Asian financial crisis, where it seems that these markets were affected to a lower extent by this shock than in the case of the financial markets. In terms of volatility spillover effects, the main findings are that there is evidence of volatility spillovers running in a unidirectional way from gold to the rest of the metals markets; some evidence of bidirectional spillovers exist, but the results tend to be quite mixed across the time periods. However, there is little evidence suggesting that any of the other precious metals influence the gold market. And finally, the results from asymmetric spillover effects show that negative news has a stronger impact in these markets than positive news, a finding which is consistent with the results found for financial markets.

The analysis above from the Asian crisis is helpful in illustrating what could happen with these markets during current times, as precious metals markets did suffer to a lower extent the effects of the Asian crisis, and by looking at these markets during these moments of financial turmoil, it is obvious that precious metals markets are not affected in the same manner as financial markets. Considering that precious metals are performing quite well during these times and associating their behaviour to what happened during the Asian crisis it is possible to speculate that the current economic turmoil will have a lower effect on precious metals markets when compared to stock markets. Therefore, they should be considered as a real investment alternative, and also with regard to their role in terms of risk management, hedging activities and indeed as a new market option to allocate capital.

5.3 PRECIOUS METALS AND THE G-7 EQUITY MARKETS

5.3.1 Introduction

The aim of this section is the analysis of the interactions between the world's major equity markets represented by the G-7 markets and precious metals markets, where gold, silver and platinum are analysed. After looking at precious metals markets interlinkages and finding out that there are indeed possibilities of investment across these markets, and knowing that emerging economies are also presenting interesting characteristics for investors' diversification, one wonders about precious metals markets relationships with regard to the world's most developed economies. Therefore, the author considers that a natural path to follow is to move into both the investigation of precious metals and some of the developed world's stock markets (represented by the G-7 economies), as this thesis posits the idea of the existence of opportunities for diversification among these markets too.

The analysis focuses on the period 1 January 1995 to 31 December 2006, where the whole sample is analysed in conjunction with three sub samples. Thus, the first sub sample spans over the years 1995-June 1997, the period prior to the Asian crisis. Where the main interest is focused in examining if the Asian crisis did generate volatility spillovers between these financial and commodities markets, the second subsample will cover the July 1997-1998 period where the crisis hit the markets; and finally, the last sample period covers the years 1999-2006, where the analysis focuses on the behaviour of these markets after the major shock. The data set consists of daily closing values for the stock market indices in each country as follows: Canada (S&P/TSX Composite), France (CAC 40), Germany (DAX30), Italy (MIB 30), Japan (Nikkei 225), the UK (FTSE 100) and the US (Dow Jones Industrial). In the case of the precious metals data, the following indices were chosen: the US$/Troy ounce for gold, the London Free Market Platinum price in US$/Troy ounce and the Zurich silver price in

US$/kilogram. All the data series are from DataStream International, giving a total of 3130 observations for each series.

5.3.2 Empirical Results

5.3.2.1 Descriptive Statistics

The analysis starts with the presentation of the descriptive statistics due to the fact that in this case the study focuses on the Asian crisis, and not on the introduction of the Euro in the financial markets; therefore the subsamples will be looking at different periods. Starting with the descriptive statistics of stock returns, a common trend is found. During the four periods of analysis, almost all markets present positive and small mean values, the exceptions being the Nikkei 225 for the whole period, (and as was explained in previous analyses these results are explained by the Japanese lost decade), the DAX 30 for 1995-June 1997 and the Nikkei 225 for July 1997-1998, where the means are negative. With regard to the precious metals markets, the situation is rather different. The results show that for the whole sample the mean for platinum is negative while for gold and silver, the means are positive, and when the sub samples are analysed, the situation changes. During the time prior to the crisis i.e. from 1995 to June 1997, gold and silver are showing negative means, results that are also negative for these two metals and platinum during the crisis; the results for the last sub sample are showing positive means in all the cases. The analysis of the stock returns volatility for all the samples shows that overall the Nikkei 225, DAX 30 and the MIB 30 are the most volatile stock returns series, with a standard deviation moving from 1.35 per cent to 1.49 per cent during 1995-2006; the most volatile period is during July 1997-1998 where the values were moving from 1.67 per cent to 1.80 per cent. In terms of the precious metals markets, silver is the one that exhibits the most volatile returns series in all the periods under analysis, reaching the highest values for all three metals during the crisis period where the standard deviations are moving from 0.69 per cent to 1.75 per cent, while the rest of the metals appear as more stable.

5.3.2.2 Unit Roots and Likelihood Tests

The results from the ADF tests statistics indicate all variables are stationary during all periods indicating that all series are *I(0)*.[27] Therefore, the analysis proceeds to perform a volatility analysis using EGARCH (*p,q*) modelling.

The results for the volatility analysis are presented through tables 5.8 to 5.10 in the following pages.

5.3.2.3 Volatility Persistence

The results analysing volatility persistence are presented in table 5.8 for all the periods under analysis. Looking at the results it is possible to appreciate how the coefficients vary depending on the country and the equation under analysis, but it is found that in the majority of the cases the coefficients are insignificant in the case of volatility persistence running from stock returns to precious metals returns, which shows that shocks affecting stock markets do not tend to be transmitted to precious metals markets, and more importantly, if there is any effect, it will not last. This result is surprising given that volatility persistence is a feature of many financial markets data and a priori expectations are to find significant coefficients in these markets in most of the cases. One major consequence of these first results is the lack of integration between precious metals markets and stock markets. Therefore, shocks in stock markets do not tend to generate a great influence in precious metals and therefore, they will not last for a long time. In relation to the individual countries, the results are quite mixed. In the case of Canada, the results are showing insignificant coefficients during the

[27] The LMF test results indicated that the ADF tests were free from serial correlation; for brevity the results from all the text are not presented here, but they are all available in Appendix G.

period July 1997 to 1998 from stock returns to platinum and silver; there are also insignificant coefficients in the latest period 1999 to 2006 in the case of silver. The analysis of Italy shows insignificant coefficients in the latest period of analysis from stock returns to all the three precious metals returns, and finally in the case of the UK the coefficients are insignificant from stock returns to precious metals returns during 1995 to June 1997 and in the case of platinum and silver during July 1997 to 1998. An interesting feature that deserves to be highlighted from these results is the insignificant coefficients obtained for the period where the Asian financial crisis happened; the a priori expectation is to find significant coefficients during this particular time as the effect of the Asian crisis could be impacting negatively all financial and commodities markets leading them into recession. This expectation seems to be confirmed in the case of stock markets, but not for precious metals markets.

When the results for volatility persistence from precious metals returns to stock returns are analysed, the results are consistent in almost all the cases. The coefficients appear to be significant for the whole period of analysis, meaning that any shock affecting precious metals markets tend to affect and last in the stock markets; however, a few exceptions occur and they are located during the Asian crisis time period, where in most of the cases insignificant coefficients were found. For example in the case of Canada, France, Italy, the UK, and the USA, the coefficients are insignificant in the case of gold and platinum during July 1997-1998. With regard to the rest of the time periods the results found insignificant coefficients for France in the case of gold and finally for Japan there is an insignificant coefficient during 1999-2006 with regard to gold. Therefore, the volatility persistence analysis shows that overall there are no significant coefficients from stock returns to precious metals returns. This result indicates that stock markets returns fluctuations do not generate larger impacts on the precious metals markets. The opposite results are obtained for precious metals returns to stock returns, where almost all the coefficients appear to be significant. This indicates that when the precious metals markets face fluctuations, this movement will be transmitted to the stock markets, taking into account that precious metal markets are seen as more stable markets than stock markets. The fluctuations generated in precious metals markets will be perceived as a sign of uncertainty in the rest of the markets where predictions and expectations will be affected and therefore these changes will be transmitted in the markets in terms of prices fluctuations, and therefore, volatility in returns.

Volatility persistence is a common finding in financial markets returns, a situation that is reflected by the findings of significant coefficients, and in this analysis that is the case when looking at the coefficients for volatility persistence effects from metals markets to stock markets. In the few cases where insignificant coefficients were found with regard to the precious metals returns, this result could reflect that, in general, investors expect stability in the precious metals prices; therefore, their expectations tend to be constant and stable over time, a situation that will be translated in the precious metals markets returns by lower fluctuations in their prices.

Table 5.8: EGARCH RESULTS VOLATILITY PERSISTENCE

	1995-2006			1995-June 1997			July 1997-1998			1999-2006		
Canada	S-Gold	S-Platinum	S-Silver	S-Gold	S-Platinum	S-Silver	S-Gold	S-Platinum	S-Silver	S-Gold	S-Platinum	S-Silver
Stock Returns	0.1554	0.1557	0.1532	0.2500	0.2418	0.2320	0.1535	0.1742	0.1750	0.1141	0.1157	0.0442
	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.001)*	(0.009)*	(0.013)**	(0.013)**	(0.000)**	(0.000)*	(0.498)
	Gold-S	Platinum-S	Silver-S	Gold-S	Platinum-S	Silver-S	Gold-S	Platinum-S	Silver-S	Gold-S	Platinum-S	Silver-S
Precious Metals	0.2396	0.2820	0.4082	0.1965	0.2330	0.5267	0.0976	0.2536	0.4913	0.2512	0.2293	0.4291
	(0.000)*	(0.000)*	(0.000)*	(0.002)*	(0.001)*	(0.000)*	(0.154)	(0.021)**	(0.000)*	(0.009)*	(0.000)*	(0.000)*
France	S-Gold	S-Platinum	S-Silver	S-Gold	S-Platinum	S-Silver	S-Gold	S-Platinum	S-Silver	S-Gold	S-Platinum	S-Silver
Stock Returns	0.0228	0.0198	0.0228	0.0703	0.0739	0.0732	0.0842	0.0862	0.0697	0.0057	-0.0004	0.0014
	(0.696)	(0.732)	(0.696)	(0.022)**	(0.013)**	(0.011)**	(0.143)	(0.126)	(0.199)	(0.941)	(0.995)	(0.985)
	Gold-S	Platinum-S	Silver-S	Gold-S	Platinum-S	Silver-S	Gold-S	Platinum-S	Silver-S	Gold-S	Platinum-S	Silver-S
Precious Metals	0.2587	0.2855	0.4328	0.2008	0.2286	0.4730	0.1113	0.2599	0.4753	0.2764	0.2308	0.4721
	(0.001)*	(0.000)*	(0.000)*	(0.012)**	(0.001)*	(0.000)*	(0.182)	(0.018)**	(0.000)*	(0.002)*	(0.000)*	(0.000)*
Germany	S-Gold	S-Platinum	S-Silver	S-Gold	S-Platinum	S-Silver	S-Gold	S-Platinum	S-Silver	S-Gold	S-Platinum	S-Silver
Stock Returns	-0.0403	-0.0496	-0.0483	-0.1257	-0.1181	-0.1196	0.1231	0.1262	0.1197	-0.0313	-0.0432	-0.0424
	(0.493)	(0.392)	(0.403)	(0.070)***	(0.276)	(0.268)	(0.018)**	(0.018)**	(0.023)**	(0.696)	(0.582)	(0.590)
	Gold-S	Platinum-S	Silver-S	Gold-S	Platinum-S	Silver-S	Gold-S	Platinum-S	Silver-S	Gold-S	Platinum-S	Silver-S
Precious Metals	0.2628	0.2808	0.4248	0.2305	0.2303	0.4643	0.1222	0.2546	0.4999	0.2747	0.2342	0.4581
	(0.001)*	(0.000)*	(0.000)*	(0.003)*	(0.002)*	(0.000)*	(0.152)	(0.021)**	(0.000)*	(0.004)*	(0.000)*	(0.000)*
Italy	S-Gold	S-Platinum	S-Silver	S-Gold	S-Platinum	S-Silver	S-Gold	S-Platinum	S-Silver	S-Gold	S-Platinum	S-Silver
Stock Returns	0.1728	0.1732	0.1734	0.3079	0.3279	0.3327	0.2302	0.2314	0.2300	0.0534	0.0539	0.0546
	(0.000)*	(0.000)*	(0.000)*	(0.002)*	(0.001)*	(0.001)*	(0.000)*	(0.000)*	(0.000)*	(0.505)	(0.513)	(0.507)
	Gold-S	Platinum-S	Silver-S	Gold-S	Platinum-S	Silver-S	Gold-S	Platinum-S	Silver-S	Gold-S	Platinum-S	Silver-S
Precious Metals	0.2533	0.2832	0.4177	0.2014	0.2284	0.4726	0.1127	0.2650	0.4829	0.2594	0.2330	0.4494
	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.172)	(0.014)**	(0.000)*	(0.006)*	(0.000)*	(0.000)*
Japan	S-Gold	S-Platinum	S-Silver	S-Gold	S-Platinum	S-Silver	S-Gold	S-Platinum	S-Silver	S-Gold	S-Platinum	S-Silver
Stock Returns	0.0432	0.0374	0.0396	0.0737	0.0646	0.0678	0.0669	-0.0122	0.0125	-0.0675	-0.0667	-0.0661
	(0.493)	(0.562)	(0.535)	(0.142)	(0.146)	(0.111)	(0.042)**	(0.497)	(0.596)	(0.265)	(0.287)	(0.278)
	Gold-S	Platinum-S	Silver-S	Gold-S	Platinum-S	Silver-S	Gold-S	Platinum-S	Silver-S	Gold-S	Platinum-S	Silver-S
Precious Metals	0.2337	0.2810	0.4127	0.2037	0.2280	0.4894	0.1199	0.2241	0.4693	0.2440	0.2287	0.4332
	(0.006)*	(0.000)*	(0.000)*	(0.005)*	(0.003)*	(0.000)*	(0.122)	(0.073)***	(0.000)*	(0.012)**	(0.000)*	(0.000)*
UK	S-Gold	S-Platinum	S-Silver	S-Gold	S-Platinum	S-Silver	S-Gold	S-Platinum	S-Silver	S-Gold	S-Platinum	S-Silver
Stock Returns	0.0971	0.0980	0.0977	0.0026	0.0241	0.0012	0.0490	0.0709	0.0732	0.0858	0.0867	0.0837
	(0.000)*	(0.000)*	(0.000)*	(0.967)	(0.707)	(0.983)	(0.000)*	(0.011)**	(0.010)*	(0.000)*	(0.000)*	(0.000)*
	Gold-S	Platinum-S	Silver-S	Gold-S	Platinum-S	Silver-S	Gold-S	Platinum-S	Silver-S	Gold-S	Platinum-S	Silver-S
Precious Metals	0.2642	0.2827	0.4395	0.2099	0.2326	0.4956	0.1122	0.2585	0.4742	0.2767	0.2382	0.4773
	(0.002)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.182)	(0.020)**	(0.000)*	(0.004)*	(0.000)*	(0.000)*
US	S-Gold	S-Platinum	S-Silver	S-Gold	S-Platinum	S-Silver	S-Gold	S-Platinum	S-Silver	S-Gold	S-Platinum	S-Silver
Stock Returns	0.0226	0.0224	0.0211	-0.1711	-0.1378	-0.1377	0.0646	0.0704	0.0748	0.0058	0.0650	0.0648
	(0.703)	(0.706)	(0.722)	(0.210)	(0.272)	(0.279)	(0.162)	(0.186)	(0.184)	(0.934)	(0.000)*	(0.000)*
	Gold-S	Platinum-S	Silver-S	Gold-S	Platinum-S	Silver-S	Gold-S	Platinum-S	Silver-S	Gold-S	Platinum-S	Silver-S
Precious Metals	0.2481	0.2842	0.4191	0.2179	0.2411	0.4861	0.1036	0.2584	0.4734	0.2610	0.2381	0.4551
	(0.004)*	(0.000)*	(0.000)*	(0.008)*	(0.001)*	(0.000)*	(0.161)	(0.020)**	(0.000)*	(0.008)*	(0.000)*	(0.000)*

*1% significance level, **5% significance level, *** 10% significance level

5.3.2.4 Volatility Spillovers

Dealing first with spillovers from stock markets to precious metals returns, the main results show evidence of volatility spillovers from these markets to the precious metals markets at the 1 per cent, 5 per cent and 10 per cent significance levels (the results are presented in table 5.9). However, some exceptions are found with regard to this evidence but most of them are affecting particular time periods. For example, when analysing the results per sample period, it is found that during the whole sample 1995-2006 all the coefficients are significant for all the countries and all the markets. In relation to the period prior to the Asian crisis (1995-June 1997), the results show insignificant coefficients in the case of Canada and Italy. Regarding the Asian crisis period (July 1997-1998) the coefficients are insignificant for all three periods just in the case of Italy. Finally during the last period of study (1999-2006) all the results appear to be significant.

In terms of volatility spillovers from precious metals returns to stock returns, the results are significant and consistent across countries and over time in most of the cases. As happened when analysing the relationship from stock returns to precious metals returns a few exceptions are found. The results for the whole sample show that the coefficients are significant in all the cases through all the countries. Regarding the time periods prior to and during the Asian crisis it is found that in all the countries and only in the case of gold, the coefficients are insignificant. And finally during the last period of study the coefficients are insignificant in relation to silver in the cases of France, Germany and Italy.

Significant coefficients are indicative of integration between stock markets and precious metals markets as well as indicating that the volatility of stock returns was a determinant of the volatility of precious metals returns and also in the inverse case. This means that the information contained in stock prices impacted on the behaviour of precious metals returns and the opposite way around in these markets. The consistency found in these results is evidence of some level of integration between these markets. These results show that these markets are immediately influenced; this means that at times of shocks or crises, precious metals markets negative movements will cause a major impact on stock markets, while negative effects in stock markets will tend to affect to a lesser extent precious metals. These results are quite surprising, as this research's major expectation was supporting a lack of significant coefficients in term of volatility spillovers among these markets. As was argued in one of the initial research hypotheses, a lack of integration between stock markets and precious metals markets was expected. However, these expectations are weakly supported by the results derived from the analysis, where there seems to be certain connections between these markets. Nevertheless, while the results present some degree of integration between these markets, is the author's suspicion that these linkages could be quite weak, as most of the previous results have been aligned and supporting the suggestion of a lack of relationship among these markets.

Table 5.9: EGARCH RESULTS VOLATILITY SPILLOVERS

	1995-2006			1995-June 1997			July 1997-1998			1999-2006		
Canada	S-Gold	S-Platinum	S-Silver	S-Gold	S-Platinum	S-Silver	S-Gold	S-Platinum	S-Silver	S-Gold	S-Platinum	S-Silver
Stock Returns	-0.0636	-0.0641	-0.0597	-0.0562	-0.0580	-0.0592	-0.1263	-0.1313	-0.1266	-0.0511	-0.0497	-0.0492
	(0.000)*	(0.000)*	(0.000)*	(0.171)	(0.149)	(0.135)	(0.006)*	(0.009)*	(0.013)**	(0.000)*	(0.000)*	(0.000)*
	Gold-S	Platinum-S	Silver-S	Gold-S	Platinum-S	Silver-S	Gold-S	Platinum-S	Silver-S	Gold-S	Platinum-S	Silver-S
Precious	0.0554	-0.0653	0.0486	0.0407	0.1534	-0.2106	0.0694	0.1464	0.1492	0.0838	0.0669	0.0491
Metals	(0.013)**	(0.063)***	(0.002)*	(0.425)	(0.002)*	(0.003)*	(0.128)	(0.053)***	(0.079)***	(0.000)*	(0.027)**	(0.093)***
France	S-Gold	S-Platinum	S-Silver	S-Gold	S-Platinum	S-Silver	S-Gold	S-Platinum	S-Silver	S-Gold	S-Platinum	S-Silver
Stock Returns	-0.0653	-0.0666	-0.0662	-0.0369	-0.0340	-0.0347	-0.1271	-0.1287	-0.1234	-0.0827	-0.0847	-0.0839
	(0.000)*	(0.000)*	(0.000)*	(0.056)***	(0.082)***	(0.062)***	(0.000)*	(0.000)*	(0.001)*	(0.000)*	(0.000)*	(0.000)*
	Gold-S	Platinum-S	Silver-S	Gold-S	Platinum-S	Silver-S	Gold-S	Platinum-S	Silver-S	Gold-S	Platinum-S	Silver-S
Precious	0.0561	0.0608	0.0442	0.0698	0.1623	-0.2050	0.0543	0.1495	0.1458	0.0793	0.0662	0.0418
Metals	(0.000)*	(0.002)*	(0.022)**	(0.227)	(0.001)*	(0.006)*	(0.269)	(0.044)**	(0.087)***	(0.000)*	(0.023)**	(0.205)
Germany	S-Gold	S-Platinum	S-Silver	S-Gold	S-Platinum	S-Silver	S-Gold	S-Platinum	S-Silver	S-Gold	S-Platinum	S-Silver
Stock Returns	-0.0729	-0.0748	-0.0743	0.1578	0.1632	0.1616	-0.1402	-0.1371	-0.1402	-0.0810	-0.0831	-0.0830
	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.007)*	(0.006)*	(0.006)*
	Gold-S	Platinum-S	Silver-S	Gold-S	Platinum-S	Silver-S	Gold-S	Platinum-S	Silver-S	Gold-S	Platinum-S	Silver-S
Precious	0.0512	0.0602	0.0445	0.0538	0.1597	-0.2174	0.0525	0.1474	0.1413	0.0775	0.0666	0.0432
Metals	(0.001)*	(0.002)*	(0.017)**	(0.341)	(0.000)*	(0.002)*	(0.285)	(0.047)**	(0.095)***	(0.000)*	(0.025)**	(0.172)
Italy	S-Gold	S-Platinum	S-Silver	S-Gold	S-Platinum	S-Silver	S-Gold	S-Platinum	S-Silver	S-Gold	S-Platinum	S-Silver
Stock Returns	-0.0425	-0.0423	-0.0423	0.0284	0.0273	0.0220	-0.0419	-0.0393	-0.0416	-0.0896	-0.0904	-0.0902
	(0.018)**	(0.020)**	(0.019)**	(0.614)	(0.631)	(0.696)	(0.284)	(0.317)	(0.290)	(0.000)*	(0.000)*	(0.000)*
	Gold-S	Platinum-S	Silver-S	Gold-S	Platinum-S	Silver-S	Gold-S	Platinum-S	Silver-S	Gold-S	Platinum-S	Silver-S
Precious	0.0545	0.0610	0.0435	0.0520	0.1541	-0.2055	0.0589	0.1478	0.1465	0.0799	0.0667	0.0406
Metals	(0.000)*	(0.002)*	(0.031)**	(0.366)	(0.002)*	(0.004)*	(0.237)	(0.041)**	(0.087)***	(0.000)*	(0.025)**	(0.251)
Japan	S-Gold	S-Platinum	S-Silver	S-Gold	S-Platinum	S-Silver	S-Gold	S-Platinum	S-Silver	S-Gold	S-Platinum	S-Silver
Stock Returns	-0.0919	-0.0927	-0.0914	-0.1258	-0.1205	-0.1199	-0.1201	-0.1365	-0.1267	-0.0711	-0.0720	-0.0715
	(0.000)*	(0.000)*	(0.000)*	(0.051)***	(0.042)**	(0.035)**	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*
	Gold-S	Platinum-S	Silver-S	Gold-S	Platinum-S	Silver-S	Gold-S	Platinum-S	Silver-S	Gold-S	Platinum-S	Silver-S
Precious	0.0570	0.0616	0.0474	0.0497	0.1522	-0.2200	0.0745	0.1617	0.1583	0.0842	0.0670	0.0498
Metals	(0.000)*	(0.001)*	(0.006)*	(0.363)	(0.003)*	(0.003)*	(0.142)	(0.031)**	(0.060)***	(0.000)*	(0.022)**	(0.098)***
UK	S-Gold	S-Platinum	S-Silver	S-Gold	S-Platinum	S-Silver	S-Gold	S-Platinum	S-Silver	S-Gold	S-Platinum	S-Silver
Stock Returns	-0.0840	-0.0861	-0.0840	-0.0960	-0.1111	-0.1099	0.9512	-0.0967	-0.0922	-0.1047	-0.1055	-0.1029
	(0.000)*	(0.000)*	(0.000)*	(0.038)**	(0.014)**	(0.010)**	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*
	Gold-S	Platinum-S	Silver-S	Gold-S	Platinum-S	Silver-S	Gold-S	Platinum-S	Silver-S	Gold-S	Platinum-S	Silver-S
Precious	0.0523	0.0613	0.0448	0.0598	0.1516	-0.2127	0.0599	0.1461	0.1471	0.0796	0.0678	0.0435
Metals	(0.000)*	(0.002)*	(0.016)**	(0.280)	(0.003)*	(0.004)*	(0.231)	(0.049)**	(0.084)***	(0.000)*	(0.024)**	(0.000)*
US	S-Gold	S-Platinum	S-Silver	S-Gold	S-Platinum	S-Silver	S-Gold	S-Platinum	S-Silver	S-Gold	S-Platinum	S-Silver
Stock Returns	-0.0942	-0.0947	-0.0950	-0.0440	-0.0492	-0.0464	-0.1600	-0.1643	-0.1705	-0.0927	-0.0940	-0.0939
	(0.000)*	(0.000)*	(0.000)*	(0.076)***	(0.058)***	(0.073)***	(0.001)*	(0.002)*	(0.001)*	(0.000)*	(0.000)*	(0.000)*
	Gold-S	Platinum-S	Silver-S	Gold-S	Platinum-S	Silver-S	Gold-S	Platinum-S	Silver-S	Gold-S	Platinum-S	Silver-S
Precious	0.0526	0.0608	0.0455	0.0507	0.1514	-0.2178	0.0688	0.1422	0.1484	0.0795	0.0669	0.0443
Metals	(0.001)*	(0.002)*	(0.012)**	(0.378)	(0.003)*	(0.003)*	(0.151)	(0.054)**	(0.083)**	(0.000)*	(0.027)**	(0.000)*

*1% significance level, **5% significance level, *** 10% significance level

5.3.2.5 Asymmetric Spillovers

For the asymmetric spillover effects from stock returns to precious metals returns the results show that the coefficients are significant in almost all cases for all periods, with the following exceptions: during 1995-June 1997 the coefficients are insignificant in the cases of all countries with regard to silver and during July 1997-1998 for Japan in the case of silver and for the UK from stock returns to gold. There are just few instances where insignificant coefficients are found and these happen before and during the Asian crisis; the results just show that during times of instability markets do not tend to differentiate between good and bad news.

5.3.2.6 Diagnostic Test

The diagnostic test main results are consistent with previous research done in this thesis, were the residuals for the series are not found to be normally distributed. But, overall the residuals test confirms that there are no major problems derived from the model selection.

Table 5.10: EGARCH RESULTS ASYMMETRIC SPILLOVERS

	1995-2006			**1995-June 1997**			**July 1997-1998**			**1999-2006**		
Canada	S-Gold	S-Platinum	S-Silver	S-Gold	S-Platinum	S-Silver	S-Gold	S-Platinum	S-Silver	S-Gold	S-Platinum	S-Silver
Stock Returns	0.9836	0.9829	0.9844	0.9277	0.9274	0.9306	0.9562	0.9545	0.9558	0.9894	0.9890	0.9895
	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*
	Gold-S	Platinum-S	Silver-S	Gold-S	Platinum-S	Silver-S	Gold-S	Platinum-S	Silver-S	Gold-S	Platinum-S	Silver-S
Precious Metals	0.9894	0.9800	0.9942	0.9596	0.9453	-0.2926	0.7840	0.8492	0.4162	0.9855	0.9602	0.9924
	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.379)	(0.000)*	(0.000)*	(0.030)**	(0.000)*	(0.000)*	(0.000)*
France	S-Gold	S-Platinum	S-Silver	S-Gold	S-Platinum	S-Silver	S-Gold	S-Platinum	S-Silver	S-Gold	S-Platinum	S-Silver
Stock Returns	0.9875	0.9875	0.9875	0.9889	0.9882	0.9879	0.9452	0.9456	0.9489	0.9834	0.9834	0.9835
	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*
	Gold-S	Platinum-S	Silver-S	Gold-S	Platinum-S	Silver-S	Gold-S	Platinum-S	Silver-S	Gold-S	Platinum-S	Silver-S
Precious Metals	0.9905	0.9825	0.9944	0.9459	0.9443	-0.2901	0.7429	0.8449	0.4360	0.9871	0.9614	0.9924
	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.428)	(0.010)**	(0.000)*	(0.017)**	(0.000)*	(0.000)*	(0.000)*
Germany	S-Gold	S-Platinum	S-Silver	S-Gold	S-Platinum	S-Silver	S-Gold	S-Platinum	S-Silver	S-Gold	S-Platinum	S-Silver
Stock Returns	0.9812	0.9807	0.9809	0.8733	0.8657	0.8703	0.9556	0.9573	0.9563	0.9780	0.9774	0.9774
	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*
	Gold-S	Platinum-S	Silver-S	Gold-S	Platinum-S	Silver-S	Gold-S	Platinum-S	Silver-S	Gold-S	Platinum-S	Silver-S
Precious Metals	0.9904	0.9820	0.9945	0.9452	0.9430	-0.3135	0.7428	0.8486	0.4623	0.9866	0.9601	0.9925
	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.333)	(0.006)*	(0.000)*	(0.005)*	(0.000)*	(0.000)*	(0.000)*
Italy	S-Gold	S-Platinum	S-Silver	S-Gold	S-Platinum	S-Silver	S-Gold	S-Platinum	S-Silver	S-Gold	S-Platinum	S-Silver
Stock Returns	0.9832	0.9838	0.9837	0.6769	0.6921	0.6877	0.9490	0.9506	0.9491	0.9775	0.9778	0.9778
	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*
	Gold-S	Platinum-S	Silver-S	Gold-S	Platinum-S	Silver-S	Gold-S	Platinum-S	Silver-S	Gold-S	Platinum-S	Silver-S
Precious Metals	0.9905	0.9822	0.9942	0.9504	0.9460	-0.3106	0.7398	0.8554	0.4442	0.9861	0.9592	0.9922
	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.363)	(0.011)**	(0.000)*	(0.014)**	(0.000)*	(0.000)*	(0.000)*
Japan	S-Gold	S-Platinum	S-Silver	S-Gold	S-Platinum	S-Silver	S-Gold	S-Platinum	S-Silver	S-Gold	S-Platinum	S-Silver
Stock Returns	0.9642	0.9640	0.9645	0.9617	0.9651	0.9682	0.9777	0.9825	0.9803	0.9624	0.9628	0.9635
	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*
	Gold-S	Platinum-S	Silver-S	Gold-S	Platinum-S	Silver-S	Gold-S	Platinum-S	Silver-S	Gold-S	Platinum-S	Silver-S
Precious Metals	0.9894	0.9825	0.9942	0.9502	0.9462	-0.2889	0.7381	0.8148	0.3453	0.9854	0.9634	0.9926
	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.391)	(0.006)*	(0.000)*	(0.238)	(0.000)*	(0.000)*	(0.000)*
UK	S-Gold	S-Platinum	S-Silver	S-Gold	S-Platinum	S-Silver	S-Gold	S-Platinum	S-Silver	S-Gold	S-Platinum	S-Silver
Stock Returns	0.9890	0.9890	0.9892	0.7759	0.7607	0.7904	0.6980	0.9861	0.9851	0.9862	0.9862	0.9871
	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.172)	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*
	Gold-S	Platinum-S	Silver-S	Gold-S	Platinum-S	Silver-S	Gold-S	Platinum-S	Silver-S	Gold-S	Platinum-S	Silver-S
Precious Metals	0.9906	0.9819	0.9943	0.9429	0.9463	-0.3043	0.7371	0.8425	0.4404	0.9868	0.9573	0.9925
	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.392)	(0.012)**	(0.000)*	(0.017)**	(0.000)*	(0.000)*	(0.000)*
US	S-Gold	S-Platinum	S-Silver	S-Gold	S-Platinum	S-Silver	S-Gold	S-Platinum	S-Silver	S-Gold	S-Platinum	S-Silver
Stock Returns	0.9823	0.9825	0.9823	0.9736	0.9688	0.9699	0.9464	0.9411	0.9364	0.9909	0.9917	0.9917
	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*
	Gold-S	Platinum-S	Silver-S	Gold-S	Platinum-S	Silver-S	Gold-S	Platinum-S	Silver-S	Gold-S	Platinum-S	Silver-S
Precious Metals	0.9901	0.9823	0.9942	0.9450	0.9442	-0.3052	0.7691	0.8461	0.4257	0.9866	0.9574	0.9925
	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.355)	(0.001)*	(0.000)*	(0.025)**	(0.000)*	(0.000)*	(0.000)*

*1% significance level, **5% significance level, *** 10% significance level

5.3.2.7 Analysis and Conclusions

The main findings of this subsection can be summarised as follows: in terms of volatility persistence, the analysis shows that overall there are no significant coefficients from stock returns to precious metals returns, and when volatility persistence is analysed from precious metals to stock returns, almost all the coefficients appear to be significant. The analysis of the coefficients for the volatility spillovers shows that the results are quite consistent across countries and markets over time in most of the cases. This means that information from stock markets affects precious metals markets and also on the reverse direction. The results from the asymmetric spillovers analysis show that overall good news has less of an impact in the markets than bad news.

After getting the results from the EGARCH methodology, and taking into account that even though the results show that stock returns and precious markets returns are influenced by the information, reactions, shocks and events that take place in any of them, a question that will be necessary to address in future research is which markets are affected to a greater extent. If it is found that stock returns are affected more negatively than precious metals, it will mean that investors will be able to use precious metals to diversify their portfolio.

Investors can use precious metals markets to diversify their portfolio in situations were the national currency is depreciating, or where the stock markets returns decrease. Also, it will be interesting to analyse if in some instances it could be possible that the precious metals returns could be higher than the stock markets returns. Tully and Lucey (2006) found that dollar depreciation and a growing risk of dollar devaluation are likely to strengthen investors' demand for gold. Financial analysts have attributed the rise in gold's price to the depreciation of the dollar's value on international markets. Traditionally, gold has played a significant role during times of political and economic crisis and during equity market crashes. This is still the case in a post Bretton-Woods era, and the author is wondering if this would be also the case during this time of financial distress.

5.4 *PRECIOUS METALS MARKETS: AN ICSS APPROACH*

5.4.1 Introduction

In this section, the main focus is the analysis of the interactions between the world's major equity markets, the oil market and precious metals markets. The study will look at the period 1 January 1995 to 25 April 2008. The data set consists of daily closing values for the stock market indices for the major markets: the US (Dow Jones Industrials), the UK (FTSE-100) and the Japanese (Nikkei 225). As in the case of the precious metals data, and being consistent with the research done in previous sections, the following indices have been chosen: the US$/Troy ounce for gold, the London Free Market Platinum price in US$/Troy ounce, the Zurich silver price in US$/kilogram, and finally the oil prices taking into account the Crude Oil Brent. All the data series are from DataStream International, giving a total of 3480 observations for each series.

All details regarding methodological issues are as have been settled down in chapter three; therefore, we proceed to present and discuss the analysis's major findings.

5.4.2 Empirical Results

5.4.2.1 Descriptive Statistics

A brief discussion regarding the descriptive statistics is presented as the sample has been updated and it covers a more extended period of analysis than in previous section; also, oil prices have been included as a new variable. When looking to the statistics for precious metals returns they show a common trend. The three markets present positive and small mean values. The standard deviation indicates that the gold market is the less volatile with a coefficient of 0.89 per cent; the silver returns are the most volatile with a coefficient of 1.73 per cent and finally platinum shows a 1.36 per cent standard deviation. In the case of stock returns, the situation is slightly different; the results show that the mean values for the Down Jones, and the FTSE 100 are positive. This is consistent with the results that were obtained for the precious metals returns, while the results for the Nikkei 225 are showing a negative mean. The analysis of the stock returns volatility shows that overall the Nikkei 225 is the most volatile stock returns series, with a daily standard deviation of 1.39 per cent; regarding the Dow Jones the standard deviation is 1.03 per cent and in the case of the FTSE 100 the value is 1.07 per cent. The analysis of oil returns represented by the Brent returns show a small positive mean values. The volatility analysis shows that the oil returns are the most volatile in relation to stock returns and precious metals returns, showing a coefficient of 2.24 per cent. The skewness and kurtosis coefficients indicate that stock returns, precious metals returns and oil returns are leptokurtic and negatively skewed regarding the normal distribution. The Jarque-Bera test also rejects the hypothesis that stock returns, precious metals returns and oil returns are normally distributed in all the cases, all characteristics that are common to financial and commodities data.

5.4.2.2 Unit Roots Tests

The results from the ADF tests statistics indicate that we can reject the null hypothesis of the existence of a unit root in levels for all variables during all periods indicating that all series are *I(0)*.[28]

5.4.2.3 ICSS Break Points

First it is decided to run the algorithm using the original series to work out the number of break points. The number of sudden changes in volatility is quite high; the main problem is the non existence of common break points between the

[28] The LMF test results indicated that the ADF tests were free from serial correlation; for brevity the results are not showed here, but they are all available in Appendix I.

sudden changes in volatility for the different indices. This is a major problem in order to introduce all the break points in the variance equation. Another problem is the number of observations that should be considered as breakpoints. In this case it should be considered carefully if it is appropriate to eliminate an important number of observations from the data set. This action could generate its own break point, due to the fact that there will be an important gap between the observation that generated the jump and the last observation included in the sample where it is considered that the volatility shock disappeared. In order to solve this problem, it is considered appropriate to implement a GARCH (1,1) using the mean equation for each of the precious metals under analysis. Through the results it is possible to appreciate how the numbers of sudden changes in volatility have been reduced for each of the precious metals equations and also, how the problem of getting different numbers and days on volatility jumps is solved.

5.4.2.4 Volatility Results

5.4.2.4.1 Gold Analysis

The analysis of the GARCH(1,1) model for the Gold equation (table 5.11) shows a significant negative relationship between gold returns and the Dow Jones returns, a positive significant coefficient in the case of Gold-FTSE 100, while the coefficient is insignificant regarding the Nikkei 225. The results for the GARCH (1,1), with dummies, show an insignificant relationship between the Gold returns and the three stock markets returns. The results also show that there is a significant positive relationship between the gold market returns and the Brent returns; both the GARCH(1,1) and the GARCH(1,1), with dummies, show a positive significant relation between precious metal returns and oil returns, with all the coefficients being significant at the 1 per cent and 5 per cent levels of significance. This situation reflects that, in general when the oil markets are appreciating there is a trend of increasing returns for the gold market. The results from the two models differ regarding the influence of stock markets on precious metals markets. When the simple GARCH (1,1) model is estimated, where no correction for structural breaks is introduced, the model presents significant coefficients regarding influences from the Dow Jones index and the FTSE-100 on the Gold market. But when the model is improved through the use of dummy variables that correct the sample for structural breaks, the results show that shocks in stock markets do not affect the gold market. These results are clearly consistent with the ones obtained in the previous section analysing the G-7 stock markets influences on precious metals markets, where weak evidence of such effects were also found. These results confirm the author's suspicions that precious metals markets are a clear alternative for new investments.

Table 5.11: Gold Analysis

	Gold-Dow Jones Industrials-Brent		**Gold-FTSE 100-Brent**		**Gold-Nikkei 225-Brent**	
	GARCH (1,1)	GARCH(1,1) with dummies	*GARCH (1,1)*	GARCH(1,1) with dummies	*GARCH (1,1)*	GARCH(1,1) with dummies
c0	0.0000	0.0000	-0.0001	0.0001	-0.0001	-0.0001
	(0.789)	(0.665)	(0.550)	(0.682)	(0.643)	(0.275)
α	-0.0349**	-0.0042	0.0351*	-0.0083	0.0115	0.0062
	(0.015)	(0.762)	(0.009)	(0.688)	(0.213)	(0.480)
λ	0.0209*	0.0149**	0.0146**	0.0287*	0.0145**	0.0229*
	(0.000)	(0.011)	(0.012)	(0.001)	(0.013)	(0.000)
β0	0.0000**	0.0000**	0.0000**	0.0000*	0.0000**	0.0000*
	(0.018)	(0.011)	(0.021)	(0.000)	(0.011)	(0.000)
β1	0.0505*	0.0535*	0.0515*	0.1746*	0.0527*	0.1284*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
κ1	0.9510*	0.9483*	0.9504*	0.7582*	0.9491*	0.8567*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
β1+ κ1	1.00	1.00	1.00	0.932	1.00	0.984

*1% significance level, **5% significance level and ***10% significance level. β1 is the coefficient for previous shocks and κ1 is the coefficient for persistence.

By examining the variance estimates, it is possible to appreciate that for both models the GARCH parameter for volatility persistence is moving between 0.75 as the lowest value to 0.95 as the highest. With regard to volatility persistence the sum of the GARCH coefficients is close to 1 implying extreme persistence in volatility for both GARCH models, the GARCH(1,1) and the GARCH(1,1), with dummies, confirming the theory of volatility clustering behaviour that argues that when markets are volatile the effect tends to persist in the markets for a while.

5.4.2.4.2 Silver Analysis

The analysis of the GARCH (1,1) model for the Silver equation shows an insignificant relation between silver returns and the Dow Jones returns, while a positive significant coefficient is found in the case of Silver-FTSE 100, and Silver-Nikkei 225 (table 5.12). These results are confirmed by the output obtained from the GARCH(1,1), with dummies, which also shows an insignificant relationship between Silver returns and the Dow Jones returns and a significant relationship between Silver returns and the FTSE 100 and the Nikkei 225.

Table 5.12: Silver Analysis

	Silver-Dow Jones Industrials-Brent		**Silver-FTSE 100-Brent**		**Silver-Nikkei 225-Brent**	
	GARCH (1,1)	GARCH(1,1) with dummies	*GARCH (1,1)*	GARCH(1,1) with dummies	*GARCH (1,1)*	GARCH(1,1) with dummies
c0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0004
	(0.885)	(0.910)	(0.905)	(0.926)	(0.941)	(0.194)
α	0.0135	0.0074	0.0542**	0.0427**	0.0570*	0.0661*
	(0.539)	(0.728)	(0.011)	(0.043)	(0.000)	(0.000)
λ	0.0333*	0.0317*	0.0323*	0.0340*	0.0300*	0.0635*
	(0.000)	(0.001)	(0.001)	(0.000)	(0.002)	(0.000)
β0	0.0000*	0.0000*	0.0000*	0.0002	0.0000*	0.0000*
	(0.001)	(0.008)	(0.002)	(0.314)	(0.002)	(0.000)
β1	0.0579*	0.0562*	0.0572*	0.0836*	0.0580*	0.1386*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
κ1	0.9393*	0.9414*	0.9404*	0.9093*	0.9394*	0.8245*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
β1+ κ1	0.996	0.997	0.997	0.992	0.997	0.962

*1% significance level, **5% significance level and ***10% significance level. β1 is the coefficient for previous shocks and κ1 is the coefficient for persistence.

The results also show that there is a significant positive relationship between the silver market returns and the Brent returns; both the GARCH (1,1) and the GARCH (1,1), with dummies, show a positive significant relationship between the silver precious metal returns and oil returns, with all the coefficients being significant at the 1 per cent and 5 per cent significance levels. This situation reflects that, in general when the oil markets are appreciating there is a trend of increasing returns for the silver market, a result that is consistent with the findings for the gold market. So far, it seems that there is a higher level of interaction between precious metals markets and oil markets than with stock markets.

Examining the variance estimates it can be appreciated that for both models, the GARCH parameters for volatility persistence are positive and significant with all the coefficients moving between 0.82 as the lowest value to 0.94 as the highest.

5.4.2.4.3 Platinum Analysis

The analysis of the GARCH (1,1) model for the Platinum equation (table 5.13) shows a significant positive relation between platinum returns and the Dow Jones returns and the Nikkei 225, and an insignificant coefficient in the case of Platinum-FTSE 100.

Table 5.13: Platinum Analysis

	Platinum-Dow Jones Industrials-Brent		**Platinum-Silver-FTSE 100-Brent**		**Platinum-Silver-Nikkei 225-Brent**	
	GARCH (1,1)	GARCH(1,1) with dummies	*GARCH (1,1)*	GARCH(1,1) with dummies	*GARCH (1,1)*	GARCH(1,1) with dummies
c0	0.0002	0.0002	0.0003	0.0002	0.0003	0.0002
	(0.187)	(0.263)	(0.147)	(0.215)	(0.114)	(0.175)
Α	0.0540*	0.0423**	0.0279	0.0175	0.0447*	0.0403*
	(0.005)	(0.019)	(0.208)	(0.414)	(0.004)	(0.004)
Λ	0.0294*	0.0296*	0.0279*	0.0288*	0.0272*	0.0245*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.004)
β0	0.0000*	0.0000*	0.0000*	0.0000*	0.0000*	0.0000*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
β1	0.1312*	0.1392*	0.1307*	0.1374*	0.1310*	0.1337*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
κ1	0.8609*	0.8574*	0.8608*	0.8593*	0.8607*	0.8620*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
β1+ κ1	0.991	0.996	0.990	0.996	0.991	0.995

*1% significance level, **5% significance level and ***10% significance level. β1 is the coefficient for previous shocks and κ1 is the coefficient for persistence.

The results for the GARCH (1,1), with dummies, are consistent with the results from the GARCH (1,1). The findings also show that there is a significant positive relationship between the platinum market returns and the Brent returns; both the GARCH (1,1) and the GARCH (1,1), with dummies, show a positive significant relation between precious metal returns and oil returns, with all the coefficients being significant at the 1 per cent and 5 per cent significance levels. This situation reflects that, in general when the oil markets are appreciating there is a trend of increasing returns for the platinum market, as happened with the gold and silver markets.

Examining the variance estimates, the results show that for both models, the GARCH parameter for volatility persistence is moving between 0.85 as the lowest value to 0.86 as the highest.

With regard to volatility persistence, the coefficients for each of the equations are significant, with the characteristic of a reduction in the magnitude of the GARCH coefficients for the GARCH with dummies. The sum of the GARCH coefficients is close to 1 in all the cases implying extreme persistence in volatility for both GARCH models (GARCH (1,1) and the GARCH (1,1) with dummies), results that are influenced by the volatility persistence that characterise equity markets. This means that platinum is affected by shocks derived from equity markets, and the effects tend to last to a lesser extent, as the coefficients from the model incorporating the dummy variables tend to reduce the magnitude of the volatility coefficients. Overall, the results show that the GARCH model with dummies tends to correct the level of volatility persistence as is possible to appreciate in the reduction of the coefficients magnitude. The results also show weak evidence regarding the influence of stock returns on precious metals returns, while the oil market seems to have a direct effect on the precious metals markets.

5.4.2.4.5 Standardized Residuals

The diagnostic tests on the standardised residuals for both GARCH models[29] indicates that the residuals are non-normally distributed in all the cases. With regard to the ARCH-LM residual test, results show that overall the variance equation for the GARCH model is correctly specified, as we reject the null hypothesis of remaining ARCH effects in the equation in almost all the cases. This problem is corrected after increasing or decreasing the number of lags used in the estimation. The test results show that the variance equation is correctly specified as well for the GARCH dummy model.

[29] The results are not shown for brevity, being available in Appendix I.

5.4.2.4.6 Analysis and Conclusions

In this analysis of precious metals, major stock indices and oil returns, the Inclan and Tiao (1994) iterative cumulative sums of squares (ICSS) algorithm has been used to identify sudden shifts in volatility in precious metals markets (Gold, Platinum and Silver), three major stock markets (Dow Jones Industrials, FTSE 100, and Nikkei 225) and one oil price (Crude Oil Brent). First, the analysis implemented the ICSS algorithm to identify sudden changes in variance using each series individually. The results show a great number of breakpoints and inconsistencies among each of the series under analysis in relation to finding common points that allow one to find out the relevant dummy variables that should be included in the GARCH model to analyze volatility persistence. Therefore, and in order to avoid the overestimation of breakpoints detected by the ICSS algorithm it is considered appropriate to use the GARCH (1,1) model to obtain the standardized residuals, which are used to estimate the relevant volatility jumps that are identified as the main dummy variables to analyze the relationship between precious metals returns, stock returns, and oil returns.

First the normal GARCH (1,1) model is employed, and afterwards the ICSS-GARCH extended model is implemented, which incorporates the volatility breakpoints identified by the ICSS algorithm. The main results show that there is a significant positive relationship between precious metals market returns and the Brent returns; both the GARCH (1,1) and the GARCH (1,1) models with dummies, show a positive significant relationship between precious metal returns and oil returns, with all the coefficients being significant at the 1 per cent, and 5 per cent significance levels. This situation reflects that, in general when the oil markets are appreciating there is a trend of increasing returns for the gold market. In relation to the equity markets most of the coefficients appear to be insignificant, meaning that shocks in equity markets do not tend to generate major effects on gold markets and only to a minor extent on other precious metals markets. It is also found that all the coefficients for the ICSS model are statistically significant, with the characteristic that volatility persistence coefficients tend to reduce their value after including the dummy variables that correct the results for sudden shifts in conditional volatility.

These results are of importance to investors due to the fact that stock markets are influenced by shocks in oil and precious metals markets, while precious metals markets are seen as being more stable and secure assets. Therefore, the independent behaviour of precious metals regarding oil and equity markets during times of crises, and the constant upward trend that these markets are facing in current times, represent high valuable information for investors who would be able to design their investment strategies taking into account the use of precious metals in the composition of their portfolios. The initial results present evidence of the important implications that the new role of precious metal markets could play for investors. Thus, the author considers that this is a topic worthy of future research, where it is advisable to use an adjusted version of the EGARCH model and also to take into account different frequencies on the data analysis (weekly and monthly) that will provide more evidence in understanding precious metals markets.

CHAPTER VI

SUMMARY AND CONCLUSIONS

The general review of the work undertaken starts with a summary of the topics under study, by presenting in a clear way what were the main research motivations and objectives for attempting the analysis of the linkages between stock markets, currency markets, precious metals and oil markets with an emphasis on some selected emerging economies and also with reference to the world's most developed economies. The chapter continues with the outline of the study's major findings for the different markets and regions, and also with a careful discussion of the major implications of the findings. Finally, the chapter concludes by identifying some limitations associated with the research, and a discussion of some areas that need further attention, and that are considered of great importance to the better understanding of financial markets and their interlinkages.

6.1 Research Motivation and Main Objectives

In the recent past, where energy and non-energy commodities prices have first trended sharply upwards and have subsequently suffered an adjustment due to the current economic circumstances, it is plausible to think that after the world economy recovers, the upward trend in these markets will come back and will tend to persist for the coming years. This assumption is based on the fact that the demand for oil and precious metals has been and will continue to be deeply affected by the needs of emerging economies located in Asia (China and India in particular) and Latin America (Brazil, Chile, and Mexico).

The analysis that is presented in this thesis has been developed in order to provide empirical evidence of the relationship between equity, currency, precious metals and oil markets. An international approach has been followed, with a focus on emerging markets in Europe, Asia and Latin America, but without forgetting the importance of the G-7 that represents the most developed equity markets in the world. The main research is focused in finding out whether emerging economies and commodities markets are real alternatives for investors. Therefore, the initial stages of this thesis were based on the formulation of three particular hypotheses that demanded a clear answer and that can be summarised as follows:

1. First, this research questions whether global markets are becoming more integrated. While it is true that the existing literature has demonstrated that developed markets are the ones that show the existence of some level of integration, it is not possible to generalise this statement to every country, and in particular, special care should be taken when talking about market at different levels of development. Therefore, the initial hypothesis is that there is weak evidence demonstrating interlinkages between stock and currency markets in the G-7 economies, Eastern European, Asian and Latin American emerging economies.

2. The second hypothesis focuses on the analysis of the relationship between stock returns and exchange rates in the economies mentioned above during times of uncertainty. In this case, the main argument questions existing evidence according to which exchange rates changes do not affect stock returns. In order to offer a wide view of the true relationship between these markets, the current investigation introduced a variety of exchange rates, and also the time period under analysis includes a period of financial turmoil,

distress and uncertainty that offers a better view of the real behaviour of these two markets.

3. The third hypothesis relates to the analysis of commodities markets. The main interest is focused on the idea that these markets can present price stability properties, especially during times of financial distress. The author suspects that stock markets, precious metals and oil markets are not highly integrated, and so they behave quite independently.

On a general basis, it is possible to conclude that the general pattern followed for the equity, currency and precious metals markets that were included in this study do show a high degree of independence. This means that investors could clearly benefit from diversification; therefore, their investment strategies should be designed by taking account of potential opportunities derived from emerging economies and precious metals markets.

6.2 Main Findings and Implications

The main findings can be presented under three main headings: i) the results obtained for the emerging markets: Eastern Europe, East Asia and Latin America, ii) the results from a comparative point of view between the emerging economies, with the world's most developed markets represented by the G-7 economies, and iii) finally, the main results from the precious metals and oil markets analysis.

6.2.1 Emerging economies major findings

a) With regard to Eastern Europe, the bivariate analysis did not identify any country where exchange rates and stock prices were found to be cointegrated. These results can be explained by the need for these countries to progress in core areas like corporate and bank restructuring, and of course a deep reform of their legal and regulatory frameworks. In terms of the causality analysis it is not possible to infer any clear conclusion, as the main methodologies under use did not show consistency among the results. However, as a general statement, it could be said that it seems to be the case that exchange rates and stock prices are independent in this part of the world. In terms of the trivariate analysis, the results are also consistent with the ones obtained from the bivariate analysis, which confirms that the non-existence of a consistent relationship between exchange rates and stock prices seems to be a fact in these countries. The causality test indicates that there is evidence of unidirectional causal effects running from the exchange rates to the stock markets. Finally, when analysing volatility effects in these markets, the results show that volatility in stock returns and exchange rates tended to decrease after the countries joined the European Union, a situation that can be explained by the increase in stability regarding these markets after they joined the EU. In terms of spillover effects these are non-significant results, suggesting again the non-existence of integration between markets.

b) When analysing East Asia, the major findings indicate that for most of the markets there exists significant volatility persistence effects. There is also evidence of significant volatility spillovers between stock returns and exchange rates during the crisis. However, when looking at the results after the financial crisis, there is no significant evidence of spillover effects. The reduced volatility transmission from currency markets to stock returns in most of the markets may be an indication of the learning processes that took place in the region. Therefore, a high increase in risk management techniques took place in these countries in order to minimise companies' risk exposure. Also, the lack of significant spillover effects is an indication of the financial restructuration that took place in the markets after the financial turmoil. As it is possible to appreciate, the Asian countries interlinkages exhibit a different level of integration when compared to the East European countries, where the lack of integration on their markets is evident. This can be explained by the immaturity of these markets and also by the transformation process that their economies are undergoing, with the aim of adjusting to EU regulations. However, in the case of East Asia, the lack of integration appears to exist because of better management of risk exposure to currency fluctuations.

c) In the Latin American case, the results for the volatility spillovers coefficients present some degree of variation across countries and time, in relation to the various exchanges rate introduced in the study. Similar findings are encountered when analysing spillover effects from exchange rates to stock markets. The presence of significant coefficients indicates that volatility of the world's dominant currencies (US dollar, Japanese Yen, and British Pound) were a determinant on shocks in stock markets. The results are very interesting, as one could identify some instances where spillovers were bidirectional in nature between the two markets. These results imply that bidirectional spillovers can be taken as evidence of a high degree of integration between stock markets and the major currencies. These results are not found when looking at the linkages between stocks returns and exchange rates of neighbouring countries. Therefore, it seems that the level of integration would be more currency specific in this part of the world.

6.2.2 World developed markets versus Emerging economies

The results analysing volatility spillovers effects for the G-7 economies, show a large degree of consistency across countries and time periods. In the case of spillovers running from stock returns to exchange rates, the results are consistent with the major findings in the existing literature. So it can be concluded that shocks on stock markets are very important in determining volatility in the exchange rate markets, and also they confirm the high level of integration that exists between them. These results are not surprising, as the G-7 encompasses the most developed financial markets globally. In terms of volatility spillovers from exchange rates to stock markets, the results are less significant across countries and overtime. However, the results show a number of bilateral exchange rates, where significant spillovers were evident from exchange rates to stock returns.

The major findings reflect that these results are affected by the introduction of a large number of bilateral exchange rates, and this brings into question the generalised assumption that exchange rates will not generate effects on stock markets. The author's core expectation was to find evidence of exchange rates driven stock markets, and the results confirm her suspicions. Therefore, one can talk about a currency specific level of integration between these markets. Another important conclusion and a clear contribution derived from this research's findings is that the relationship between these financial markets is still not clear, and many more studies should be conducted in order to clarify and truly enlighten the real relationship that exists between these markets.

6.2.3 Precious Metals Markets

In relation to the volatility analysis conducted on precious metals, this research's major findings bring new and important results.

a) First, the analysis of precious metals show that there is clear evidence of volatility persistence between precious metals returns. In terms of volatility spillovers effects, the main findings are that there is some evidence of volatility spillovers running in a unidirectional way in some of the cases; in particular, gold tends to generate effects on all the markets, but there is little evidence of spillover effects in the case of the other precious metals influencing the gold market. Finally, the results from asymmetric spillover effects show that negative news has a stronger impact in these markets than positive news, a characteristic that is shared with the financial markets analysed.

b) Second, the analysis of equity markets in combination with precious metals and oil markets indicates that in terms of volatility persistence there are no significant coefficients from stock returns to precious metals returns, while the results are significant in the reverse direction. This means that shocks in precious metals markets impact on stock markets, but shocks affecting stock markets are not transmitted to precious metals and oil markets.

c) Third, when looking at precious metals behaviour and how they react during times of crisis, and in this particular case to the effects of the Asian crisis, the findings indicate that precious metals depreciation under conditions of stable and unstable markets situations tends to decrease the mean stock return and also increase market volatility. The results show that there is clear evidence of volatility persistence between precious metals returns, but that this persistence was not so obvious during the Asian financial crisis, where it seems that these markets were affected to a lesser extent by this shock than by what happened to the financial markets. In terms of volatility spillover effects, the main findings are that there is evidence of volatility spillovers running in a unidirectional way from gold to the rest of the metals; some evidence of bidirectional spillovers exists, but they are quite mixed and weak across the time periods. However there is little evidence that the other precious metals under study influence the gold market.

To conclude, the results for the emerging markets show that when analysing the relationship between exchange rates and stock prices they seem to be independent. There is no strong evidence of these two markets moving together either in the long-term or in the short-term. Overall, the individual pair wise analysis does not identify evidence of stock returns and exchange rates being cointegrated. These findings are not surprising as this author's a priori expectation was based in not finding a high level of integration and interdependence between the markets under study. Based on the general hypothesis that argues that financial markets are becoming more and more integrated, the results obtained throughout this research are quite challenging as they show evidence demonstrating that such a theory should be considered carefully.

The correlation between markets is very important for portfolio managers in the composition of their portfolios. Associating this statement with this research it is possible to explain markets connections as follows: if the results show that equity and currency markets are not cointegrated, implying that the markets are not moving together in the long-term, investors can build their investment portfolios wisely, trying to exploit the differences between countries. Applying these statements to this study's findings, it is possible to conclude that the results have revealed a clear pattern of no cointegration between the European equity and currency markets in the Euro zone. Therefore, one might conclude that from the point of view of investors, they can use the equity markets to diversify their portfolios. As the markets are not moving together, it would be possible to exploit the differences between them in the long-term and also in the short-term. The causality analysis also shows an interesting result where a unidirectional relationship is found running from stock returns to exchange rates. Overall, there is no evidence that stock returns in the European equity markets are causing any effect on the other markets (as has been demonstrated from the pair wise analysis). These findings allow one to state that an investor could diversify his/her portfolio using equity and currency markets in order to generate profits. This indicates that portfolio managers can obtain benefits in building their portfolios in the long term, diversifying between the emerging equity markets and the world's major markets included in this analysis.

Finally and in order to conclude, the present study has identified an interesting pattern with regard to equity market interlinkages. In globalised economies and after all the changes affecting European economies such as the introduction of the euro in the financial markets in 1999, - with the objective of eliminating transaction costs, facilitating capital flows and therefore allowing for an easy movement of capital between equity markets - , it would be reasonable to think that equity markets should become more integrated, a fact that, if it were to happen, would have direct repercussions for investors' decisions. For that reason, this thesis provides clear evidence that such an integration process is quite slow, and not homogeneous around the world, and as a consequence there are still many opportunities in the markets for investors in order to make profits.

6.3 Main Contributions to Existing Research

The major contributions of this thesis can be enumerated as follows:

a) At the initial stage of this study, it was possible to indentify some gaps and limitations in the existing studies analysing interlinkages between stock and currency markets. Most of the studies focus on the analysis of cointegration and causality relationships in these markets. Therefore, this thesis proposed some methodological improvements and also the addition of new variables that allow one to attempt an investigation that provides new evidence in the area. The study also implemented a comparative analysis between emerging and developed economies. Another feature that is worth mentioning is that this research introduced the analysis of these markets behaviour during times of uncertainty, where the Asian crisis and the introduction of the Euro were considered as major events that could generate shocks in the markets under study.

b) A second major contribution is related to the analysis of precious metals markets. In this regard, this thesis's contribution is very clear, as there is a somewhat surprising lack of research dealing with the analysis of the relationships that could exist between these markets, and in particular little has been done in the area of volatility issues.

c) A third area where this study adds to the literature is related to the relationships that exist between precious metals and the most developed stock markets in the world. Again, in this case this work is quite unique, as to the best of the author's knowledge there is no evidence of the existence of similar studies.

d) Fourth, this thesis also takes into account volatility effects that exist between core stock markets, precious metals and oil markets. In this case, it has been possible to provide a clear improvement in the methodology that was applied, by using the ICSS algorithm on the GARCH (1,1) standardized residuals where currency depreciation was included in the model. This kind of analysis is also very unique, as there is no current evidence of this technique having been applied to the analysis of volatility effects in the above-mentioned markets.

e) And finally, the whole thesis is a relevant work given the current trends of stock markets suffering from the consequences of a deep economic recession. This research has been able to identify future areas of efficient investment, where well designed strategies managing risk exposure can benefit from the allocation of capital in emerging economies, and precious metals markets.

Overall, it can be considered that the work that has been done in the present thesis has major implication for investors, as it has been able to identify potential areas of investment that should be considered when designing their portfolios. But more importantly, it has also brought out important areas of research that seem to be forgotten by academics and that are of great interest and importance to the whole economy.

6.4 Notes for Further Research

In conclusion, while the global economy is going through times of uncertainty and distress and where developed markets are appearing as less attractive, commodities markets, emerging and developing economies, and in particular Asian emerging markets are appearing as zones of great interest and high investment potential. Indeed, commodities are markets that need to be studied carefully and in more detail as they are clear options for new investment. Consequently, possible extensions of this work could focus on the analysis of commodities and the Asian emerging economies, using multivariate techniques where key indicators such as economic growth, interest rates and exchange rates should be included in future research, in order to get information on the reaction of these markets when changes in interest rates, unemployment, monetary policies, or currency depreciation/appreciation occur. Thus, it is obvious that this kind of research is of great relevance for practitioners and investors in order to understand markets connections, as this would allow them to design their investment strategies in a more efficient manner.

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APPENDIX

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105. FIGURE 11: GARCH(1,1): PLATINUM – FTSE 100 – BRENT
106. FIGURE 12: GARCH(1,1) PLATINUM – NIKKEI 225 – BRENT

APPENDIX A

EUROPEAN EQUITY MARKETS

TABLE 1.1: UNIT ROOT TEST

Type of Test		ADF		PP		KPSS	
Countries	**Variables**	**Levels**	**1st Diff.**	**Levels**	**1st Diff.**	**Levels**	**1st Diff.**
Czech Republic	CZI	-1.7585	-9.6892*	-1.6220	-46.0777*	0.8375	0.0999*
	CZE	-2.0775	-31.7775*	-2.0122	-40.6068*	0.4585*	n/a
Hungary	HGI	-1.1226	-28.8073*	-1.1030	-41.6523*	4.7000	0.0504*
	HGE	-0.5147	-44.1129*	-0.5190	-44.1146*	4.7484	0.0813*
Poland	POI	0.4208	-13.2113*	0.5106	-40.7275*	4.1117	0.3832*
	POI	1.4131	-15.9524*	1.3358	-42.3416*	3.6709	0.4841*
Slovakia	SLI	-0.9505	-11.6013*	-0.8230	-40.5091*	1.7710	0.3336*
	SLE	-0.3479	-8.4861*	-0.0087	-46.1630*	4.4851	0.2697*

*****1% significance level**,** CZI: Czech Republic Stock Prices, CZE: Czech Republic Exchange Rates, HGI: Hungary Stock Prices, HGE: Hungary Exchange Rate, POI: Poland Stock Prices, POE: Poland Exchange Rate, SLI: Slovakia Stock Prices, SLE: Slovakia Exchange Rate.

TABLE 1.2: LAGRANGE MULTIPLIER FOR SERIAL CORRELATION (LM TEST)

Type of Test		LM	
Countries	**Variables**	**LM-Statistic**	**p-values**
Czech Republic	CZI	0.7674	0.3811*
	CZE	2.0353	0.0152*
Hungary	HGI	3.8592	0.0212*
	HGE	1.4533	0.2281*
Poland	POI	0.4912	0.4835*
	POI	4.3621	0.0369*
Slovakia	SLI	0.3387	0.5606*
	SLE	0.5606	0.0537*

*****1% significance level**,** CZI: Czech Republic Stock Prices, CZE: Czech Republic Exchange Rates, HGI: Hungary Stock Prices, HGE: Hungary Exchange Rate, POI: Poland Stock Prices, POE: Poland Exchange Rate, SLI: Slovakia Stock Prices, SLE: Slovakia Exchange Rate.

TABLE 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**
Czech Republic	CZI	-1.6539	0.4547	-3.4335	-2.8628	-2.5675
	CZE	-1.9699	0.3004	-3.4335	-2.8628	-2.5675
Hungary	HGI	-2.1138	0.2393	-3.4335	-2.8628	-2.5675
	HGE	-1.7175	0.4222	-3.4335	-2.8628	-2.5675
Poland	POI	-1.7034	0.4294	-3.4335	-2.8628	-2.5675
	POI	-1.3645	0.6011	-3.4335	-2.8628	-2.5675
Slovakia	SLI	-1.6783	0.4422	-3.4335	-2.8628	-2.5675
	SLE	-1.0494	0.7373	-3.4335	-2.8628	-2.5675

*****1% significance level**,** CZI: Czech Republic Stock Prices, CZE: Czech Republic Exchange Rates, HGI: Hungary Stock Prices, HGE: Hungary Exchange Rate, POI: Poland Stock Prices, POE: Poland Exchange Rate, SLI: Slovakia Stock Prices, SLE: Slovakia Exchange Rate.

JOHANSEN COINTEGRATION TESTS

TABLE 1.4: CZECH REPUBLIC

Type of Test		**JOHANSEN COINTEGRATION TEST**				
Models	**No. of CE(s)**	**Trace Statistic**	**1% CV**	**Max-Eigen St**	**1% CV**	**Cointegration**
Model 2	None	9.0088	25.0781	7.3252	20.1612	No
	At most 1	1.6836	12.7608	1.6836	12.7608	No
Model 3	None	8.5929	19.9371	7.2779	18.5200	No
	At most 1	1.3149	6.6349	1.3149	6.6349	No
Model 4	None	9.2422	31.1539	7.2787	23.9753	No
	At most 1	1.9634	16.5539	1.9634	16.5539	No
Summary	Test	None No Intercept No Trend	None Intercept No Trend	Linear Intercept No Trend	Linear Intercept Trend	Quadratic Intercept Trend
Variables	Trace	0	0	0	0	0
	Max-Eig	0	0	0	0	0

*1% significance level

TABLE 1.5: HUNGARY

Type of Test		**JOHANSEN COINTEGRATION TEST**				
Models	**No. of CE(s)**	**Trace Statistic**	**1% CV**	**Max-Eigen St**	**1% CV**	**Cointegration**
Model 2	None	6.4833	25.0781	4.5045	20.1612	No
	At most 1	1.9788	12.7608	1.9788	12.7608	No
Model 3	None	4.6019	19.9371	4.3931	18.5200	No
	At most 1	0.2087	6.6349	0.2087	6.6349	No
Model 4	None	23.5664	31.1539	19.8665	23.9753	No
	At most 1	3.6999	16.5539	3.6999	16.5539	No
Summary	Test	None No Intercept No Trend	None Intercept No Trend	Linear Intercept No Trend	Linear Intercept Trend	Quadratic Intercept Trend
Variables	Trace	0	0	0	0	0
	Max-Eig	0	0	0	0	0

*1% significance level

TABLE 1.6:POLAND

Type of Test		JOHANSEN COINTEGRATION TEST				
Models	**No. of CE(s)**	**Trace Statistic**	**1% CV**	**Max-Eigen St**	**1% CV**	**Cointegration**
Model 2	None	14.7918	25.0781	13.1396	20.1612	No
	At most 1	1.6522	12.7608	1.6522	12.7608	No
Model 3	None	8.7422	19.9371	8.0634	18.5200	No
	At most 1	0.6788	6.6349	0.6788	6.6349	No
Model 4	None	11.4590	31.1539	8.0789	23.9753	No
	At most 1	3.3801	16.5539	3.3801	16.5539	No
Summary	Test	None No Intercept No Trend	None Intercept No Trend	Linear Intercept No Trend	Linear Intercept Trend	Quadratic Intercept Trend
Variables	Trace	0	0	0	0	0
	Max-Eig	0	0	0	0	0

*1% significance level

TABLE 1.7: SLOVAKIA

Type of Test		JOHANSEN COINTEGRATION TEST				
Models	**No. of CE(s)**	**Trace Statistic**	**1% CV**	**Max-Eigen St**	**1% CV**	**Cointegration**
Model 2	None	6.3133	25.0781	4.2836	20.1612	No
	At most 1	2.0297	12.7608	2.0297	12.7608	No
Model 3	None	2.2209	19.9371	2.0771	18.5200	No
	At most 1	0.1438	6.6349	0.1438	6.6349	No
Model 4	None	8.7433	31.1539	6.7107	23.9753	No
	At most 1	2.0326	16.5539	2.0326	16.5539	No
Summary	Test	None No Intercept No Trend	None Intercept No Trend	Linear Intercept No Trend	Linear Intercept Trend	Quadratic Intercept Trend
Variables	Trace	0	0	0	0	0
	Max-Eig	0	0	0	0	0

*1% significance level

TABLE 1.8: VAR RESIDUAL SERIAL CORRELATION LM TEST

Type of Test		LM	
Countries	**No. of Lags HQ criteria**	**LM-Statistic**	**p-values**
Czech Republic	2	8.1461	0.0864*
Hungary	1	8.5036	0.0748*
Poland	2	5.4575	0.2435*
Slovakia	3	9.6055	0.0476*

*1% significance level

TABLE 1.9: BIVARIATE MODEL LAGRANGE MULTIPLIER FOR SERIAL CORRELATION (LM TEST)

Type of Test		LM	
Countries	**Variables**	**LM-Statistic**	**p-values**
Czech Republic	DCZI	1.8206	0.1774
	DCZE	1.6724	0.1961
Hungary	DHGI	0.4632	0.4962
	DHGE	1.3838	0.2396
Poland	DPOI	4.0731	0.0437
	DPOE	1.0113	0.3147
Slovakia	DSLI	3.9353	0.0474
	DSLE	0.0652	0.7984

*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.

APPENDIX B

EUROPEAN EQUITY MARKETS II

TABLE 2.1: DATA SET FOR EACH COUNTRY

Countries	Variables	Sample period 1997-2006
Czech Republic	CZE CZI	1st January 1999 to 12th July 2006
Hungary	HGE HGI	1st January 1999 to 12th July 2006
Poland	POE POI	1st January 1999 to 12th July 2006
Slovakia	SLE SLI	1st January 1999 to 12th July 2006
Germany	GE	1st January 1999 to 12th July 2006
United Kingdom	UK	1st January 1999 to 12th July 2006
United States	US	1st January 1999 to 12th July 2006

*Data Source: DATASTREAM

TABLE 2.2: UNIT ROOT TEST: 1% Significance Level

Type of Test		ADF		PP		KPSS	
Countries	**Variables**	**Levels**	**1st Diff.**	**Levels**	**1st Diff.**	**Levels**	**1st Diff.**
Czech	CZE	0.5344	19.0384*	0.5386	44.1260*	4.7514	0.08002*
Republic	CZI	0.4182	13.2265*	0.4949	40.7338*	4.1173	0.3797*
Hungary	HGE	2.0405	31.8661*	1.9891	4.07551*	0.4542*	n/a
	HGI	0.3403	13.0366*	0.4010	41.5615*	3.9822	0.2861*
Poland	POE	1.5001	19.4770*	1.6241	46.1103*	0.8368	0.0992*
	POI	1.3379	16.1436*	1.2725	42.3800*	3.6773	0.4712*
Slovakia	SLE	1.1184	28.8191*	1.1007	41.6648*	4.7037	0.0505*
	SLI	0.0909	9.0546*	0.0185	46.1846*	4.4895	0.2682*
Germany	GE	1.3310	19.0267*	1.2744	44.4622*	2.0448	0.2176*
UK	UK	1.3108	16.0706*	1.2643	46.1370*	2.6750	0.2439*
US	US	2.7288	32.7127*	2.6060	45.1036*	0.8367	0.0558*

*1% significance level.

TABLE 2.3: UNIT ROOT SUMMARY TABLE

Type of Test		ADF		PP		KPSS	
Countries	**Variables**	**Levels**	**1st Diff.**	**Levels**	**1st Diff.**	**Levels**	**1st Diff.**
Czech Republic	CZE	No	Yes	No	Yes	No	Yes
	CZI	No	Yes	No	Yes	No	Yes
Hungary	HGE	No	Yes	No	Yes	Yes	n/a
	HGI	No	Yes	No	Yes	No	Yes
Poland	POE	No	Yes	No	Yes	No	Yes
	POI	No	Yes	No	Yes	No	Yes
Slovakia	SLE	No	Yes	No	Yes	No	Yes
	SLI	No	Yes	No	Yes	No	Yes
Germany	GE	No	Yes	No	Yes	No	Yes
United Kingdom	UK	No	Yes	No	Yes	No	Yes
United States	US	No	Yes	No	Yes	No	Yes

TABLE 2.4: LAGRANGE MULTIPLIER FOR SERIAL CORRELATION (LM TEST)

Type of Test		LM	
Countries	**Variables**	**LM-Statistic**	**p-values**
Czech Republic	CZE	2.5463	0.1107*
	CZI	2.4280	0.1193*
Hungary	HGE	20260	0.1580*
	HGI	1.4513	0.2284*
Poland	POE	4.4364	0.0353*
	POI	0.6205	0.4309*
Slovakia	SLE	2.9623	0.0114*
	SLI	0.0961	0.7565*
Germany	GE	0.6051	0.4367*
United Kingdom	UK	0.9367	0.3332*
United States	US	1.1425	0.2852*

TABLE 2.5: JOHANSEN COINTEGRATION TEST

Type of Test		JOHANSEN COINTEGRATION TEST (hungary & ge)				
Models	**No. of CE(s)**	**Trace Statistic**	**1% CV**	**Max-Eigen St**	**1% CV**	**Cointegration**
Model 2	None	26.4385	41.1950	18.8789	27.0678	No
	At most 1	7.5596	25.0781	6.7786	20.1612	No
	At most 2	0.7809	12.7607	0.7809	12.7607	No
Model 3	None	19.3187	35.4581	13.6595	25.8612	No
	At most 1	5.6591	19.9371	5.6591	18.5200	No
	At most 2	9.67E-07	6.6348	9.67E-07	6.6348	No
Model 4	None	26.4181	41.0814	12.1802	29.2615	No
	At most 1	12.3580	23.1523	5.7164	21.7442	No
	At most 2	5.6427	6.6348	1.3738	6.6348	No
Summary	Test	None No Intercept No Trend	None Intercept No Trend	Linear Intercept No Trend	Linear Intercept Trend	Quadratic Intercept Trend
Variables	Trace	0	0	0	0	0
	Max-Eig	0	0	0	0	0

*1% significance level.

TABLE 2.6: JOHANSEN COINTEGRATION TEST

Type of Test		JOHANSEN COINTEGRATION TEST (hungary & uk)				
Models	**No. of CE(s)**	**Trace Statistic**	**1% CV**	**Max-Eigen St**	**1% CV**	**Cointegration**
Model 2	None	18.7893	41.1950	11.7285	27.0678	No
	At most 1	7.0608	25.0781	4.8675	20.1621	No
	At most 2	2.1933	12.7607	2.1933	12.7607	No
Model 3	None	13.5587	35.4581	9.8382	25.8612	No
	At most 1	3.7305	19.9371	3.6266	18.5200	No
	At most 2	0.1038	6.6348	0.1038	6.6348	No
Model 4	None	38.1844	49.3627	27.1128	30.8339	No
	At most 1	11.0715	31.1538	8.0136	23.9753	No
	At most 2	3.0579	16.5538	3.0579	16.5538	No
Summary	Test	None No Intercept No Trend	None Intercept No Trend	Linear Intercept No Trend	Linear Intercept Trend	Quadratic Intercept Trend
Variables	Trace	0	0	0	0	0
	Max-Eig	0	0	0	0	0

*1% significance level.

TABLE 2.7: JOHANSEN COINTEGRATION TEST

Type of Test		JOHANSEN COINTEGRATION TEST (hungary & us)				
Models	**No. of CE(s)**	**Trace Statistic**	**1% CV**	**Max-Eigen St**	**1% CV**	**Cointegration**
Model 2	None	28.0149	4.1950	17.2342	2.70678	No
	At most 1	10.7806	25.0781	8.4220	20.1612	No
	At most 2	23.1485	12.7607	2.3485	12.7607	No
Model 3	None	23.0080	35.4581	6.6622	25.8612	No
	At most 1	6.3457	19.9371	6.1436	18.5200	No
	At most 2	0.2020	6.6348	0.2020	6.6348	No
Model 4	None	33.9658	49.3627	21.9445	30.8339	No
	At most 1	12.0212	31.1538	8.5746	23.9753	No
	At most 2	3.4466	16.5538	3.4466	16.5538	No
Summary	Test	None No Intercept No Trend	None Intercept No Trend	Linear Intercept No Trend	Linear Intercept Trend	Quadratic Intercept Trend
Variables	Trace	0	0	0	0	0
	Max-Eig	0	0	0	0	0

*1% significance level.

TABLE 2.8: JOHANSEN COINTEGRATION TEST

Type of Test		JOHANSEN COINTEGRATION TEST (poland & ge)				
Models	**No. of CE(s)**	**Trace Statistic**	**1% CV**	**Max-Eigen St**	**1% CV**	**Cointegration**
Model 2	None	26.6212	41.1950	16.1975	27.0678	No
	At most 1	9.4236	25.0781	8.2825	20.1612	No
	At most 2	1.1411	12.7607	1.1411	12.7607	No
Model 3	None	18.0571	35.4581	11.6807	25.8612	No
	At most 1	6.3763	19.9371	6.1053	18.5200	No
	At most 2	0.2710	6.6348	0.2710	6.6348	No
Model 4	None	21.6674	49.3627	13.1291	30.8339	No
	At most 1	8.5382	31.1538	6.1241	23.9753	No
	At most 2	2.4041	16.5538	2.4041	16.5538	No
Summary	Test	None No Intercept No Trend	None Intercept No Trend	Linear Intercept No Trend	Linear Intercept Trend	Quadratic Intercept Trend
Variables	Trace	0	0	0	0	0
	Max-Eig	0	0	0	0	0

*1% significance level.

TABLE 2.9: JOHANSEN COINTEGRATION TEST

Type of Test		JOHANSEN COINTEGRATION TEST (poland & uk)				
Models	**No. of CE(s)**	**Trace Statistic**	**1% CV**	**Max-Eigen St**	**1% CV**	**Cointegration**
Model 2	None	17.2481	41.1950	9.1904	27.0678	No
	At most 1	8.0577	25.0781	4.7863	20.1612	No
	At most 2	3.2713	12.7607	3.2713	12.7607	No
Model 3	None	11.5546	35.4581	7.2143	25.8612	No
	At most 1	4.3403	19.9371	4.0091	18.5200	No
	At most 2	0.3309	6.6348	0.3309	6.6348	No
Model 4	None	37.0236	49.3627	27.8138	30.8339	No
	At most 1	9.2098	31.1538	6.5575	23.9753	No
	At most 2	2.6522	16.5538	2.6522	16.5538	No
Summary	Test	None No Intercept No Trend	None Intercept No Trend	Linear Intercept No Trend	Linear Intercept Trend	Quadratic Intercept Trend
Variables	Trace	0	0	0	0	0
	Max-Eig	0	0	0	0	0

*1% significance level.

TABLE 2.10: JOHANSEN COINTEGRATION TEST

Type of Test		JOHANSEN COINTEGRATION TEST (poland & US)				
Models	**No. of CE(s)**	**Trace Statistic**	**1% CV**	**Max-Eigen St**	**1% CV**	**Cointegration**
Model 2	None	22.4381	41.1950	12.5843	27.0678	No
	At most 1	9.8537	25.0781	7.5856	20.1612	No
	At most 2	2.2681	12.7607	2.2681	12.7607	No
Model 3	None	17.3279	35.4581	11.5527	25.8612	No
	At most 1	5.7751	19.9371	5.1395	18.5200	No
	At most 2	0.6356	6.6348	0.6356	6.6348	No
Model 4	None	27.5175	49.3627	18.8355	30.8339	No
	At most 1	8.6820	31.1538	6.1048	23.9753	No
	At most 2	2.5771	16.5538	5.5771	16.5538	No
Summary	Test	None No Intercept No Trend	None Intercept No Trend	Linear Intercept No Trend	Linear Intercept Trend	Quadratic Intercept Trend
Variables	Trace	0	0	0	0	0
	Max-Eig	0	0	0	0	0

*1% significance level.

TABLE 2.11: JOHANSEN COINTEGRATION TEST

Type of Test		JOHANSEN COINTEGRATION TEST (czec rep. & ge)				
Models	**No. of CE(s)**	**Trace Statistic**	**1% CV**	**Max-Eigen St**	**1% CV**	**Cointegration**
Model 2	None	26.8349	41.1950	17.4609	27.0678	No
	At most 1	9.3739	25.0781	6.7948	20.1612	No
	At most 2	2.5791	12.7607	2.5791	12.7607	No
Model 3	None	17.1658	35.4581	11.1516	25.8612	No
	At most 1	6.0141	19.9371	4.9325	18.5200	No
	At most 2	1.0816	6.6348	1.0816	6.6348	No
Model 4	None	39.7184	49.3627	25.1734	30.8339	No
	At most 1	14.5450	31.1538	10.0550	23.9753	No
	At most 2	4.4900	16.5538	4.4900	16.5538	No
Summary	Test	None No Intercept No Trend	None Intercept No Trend	Linear Intercept No Trend	Linear Intercept Trend	Quadratic Intercept Trend
Variables	Trace	0	0	0	0	0
	Max-Eig	0	0	0	0	0

*1% significance level.

TABLE 2.12: JOHANSEN COINTEGRATION TEST

Type of Test		JOHANSEN COINTEGRATION TEST (czec rep. & uk)				
Models	**No. of CE(s)**	**Trace Statistic**	**1% CV**	**Max-Eigen St**	**1% CV**	**Cointegration**
Model 2	None	24.9688	41.1950	16.2239	27.0678	No
	At most 1	8.7449	25.0781	6.2398	20.1612	No
	At most 2	2.5050	12.7607	2.5050	12.7607	No
Model 3	None	18.6901	35.4581	15.7208	25.8612	No
	At most 1	2.9693	19.9371	2.9318	18.5200	No
	At most 2	0.0374	6.6348	0.0374	6.6348	No
Model 4	None	37.7443	49.3627	20.7188	30.8339	No
	At most 1	17.0254	31.1538	14.3495	23.9753	No
	At most 2	2.6759	16.5538	2.6759	16.5538	No
Summary	Test	None No Intercept No Trend	None Intercept No Trend	Linear Intercept No Trend	Linear Intercept Trend	Quadratic Intercept Trend
Variables	Trace	0	0	0	0	0
	Max-Eig	0	0	0	0	0

*1% significance level.

TABLE 2.13: JOHANSEN COINTEGRATION TEST

Type of Test		JOHANSEN COINTEGRATION TEST (czech rep. & us)				
Models	**No. of CE(s)**	**Trace Statistic**	**1% CV**	**Max-Eigen St**	**1% CV**	**Cointegration**
Model 2	None	34.2738	41.1950	25.6250	27.0678	No
	At most 1	8.6487	25.0781	6.1148	20.1611	No
	At most 2	2.5338	12.7607	2.5338	12.7607	No
Model 3	None	28.5452	35.4581	25.5131	25.8612	No
	At most 1	3.0321	19.9371	2.5977	18.5200	No
	At most 2	0.4344	6.6348	0.4344	6.6348	No
Model 4	None	42.0915	49.3627	25.7546	30.8339	No
	At most 1	16.3368	31.1538	14.2822	23.9753	No
	At most 2	2.0545	16.5538	2.0545	16.5538	No
Summary	Test	None No Intercept No Trend	None Intercept No Trend	Linear Intercept No Trend	Linear Intercept Trend	Quadratic Intercept Trend
Variables	Trace	1	0	0	0	0
	Max-Eig	1	0	0	0	0

*1% significance level.

TABLE 2.14: JOHANSEN COINTEGRATION TEST

Type of Test		JOHANSEN COINTEGRATION TEST (slovakia & ge)				
Models	**No. of CE(s)**	**Trace Statistic**	**1% CV**	**Max-Eigen St**	**1% CV**	**Cointegration**
Model 2	None	2522.219*	41.1950	1316.005*	27.0678	Yes
	At most 1	1206.214*	25.0781	1204.421*	20.1612	Yes
	At most 2	1.7930	12.7607	1.7930	12.7607	No
Model 3	None	2522.199*	35.4581	1316.005*	25.8612	Yes
	At most 1	1206.195*	19.9371	1204.421*	18.5200	Yes
	At most 2	1.7743	6.6348	1.7743	6.6348	No
Model 4	None	2525.190*	49.3627	1316.321*	30.8339	Yes
	At most 1	1208.869*	31.1538	1205.382*	23.9753	Yes
	At most 2	3.4868	16.5538	3.4868	16.5538	No
Summary	Test	None No Intercept No Trend	None Intercept No Trend	Linear Intercept No Trend	Linear Intercept Trend	Quadratic Intercept Trend
Variables	Trace	2	2	2	2	2
	Max-Eig	2	2	2	2	2

*1% significance level.

TABLE 2.15: JOHANSEN COINTEGRATION TEST

Type of Test		JOHANSEN COINTEGRATION TEST (slovakia & uk)				
Models	**No. of CE(s)**	**Trace Statistic**	**1% CV**	**Max-Eigen St**	**1% CV**	**Cointegration**
Model 2	None	27.5694	41.1950	16.6757	27.0678	No
	At most 1	10.8937	25.0781	8.9405	20.1612	No
	At most 2	1.9532	12.7607	1.9532	12.7607	No
Model 3	None	21.6854	35.4581	13.7613	25.8612	No
	At most 1	7.9240	19.9371	7.0108	18.5200	No
	At most 2	0.9132	6.6348	0.9132	6.6348	No
Model 4	None	35.2696	49.3627	23.4495	30.8339	No
	At most 1	11.8201	31.1538	7.0114	23.9753	No
	At most 2	4.8087	16.5538	4.8087	16.5538	No
Summary	Test	None No Intercept No Trend	None Intercept No Trend	Linear Intercept No Trend	Linear Intercept Trend	Quadratic Intercept Trend
Variables	Trace	0	0	0	0	0
	Max-Eig	0	0	0	0	0

*1% significance level.

TABLE 2.16: JOHANSEN COINTEGRATION TEST

Type of Test		JOHANSEN COINTEGRATION TEST (solovakia & us)				
Models	**No. of CE(s)**	**Trace Statistic**	**1% CV**	**Max-Eigen St**	**1% CV**	**Cointegration**
Model 2	None	28.1544	41.1950	16.3803	27.0678	No
	At most 1	11.7741	25.0781	8.9689	20.1612	No
	At most 2	2.8052	12.7607	2.8052	12.7607	No
Model 3	None	22.2139	35.4581	13.5824	25.8612	No
	At most 1	8.6314	19.9371	8.6050	18.5200	No
	At most 2	0.0264	6.6348	0.0264	6.6348	No
Model 4	None	35.7784	49.3627	20.9366	30.8339	No
	At most 1	14.8417	31.1538	10.1222	23.9753	No
	At most 2	4.7195	16.5538	4.7195	16.5538	No
Summary	Test	None No Intercept No Trend	None Intercept No Trend	Linear Intercept No Trend	Linear Intercept Trend	Quadratic Intercept Trend
Variables	Trace	0	0	0	0	0
	Max-Eig	0	0	0	0	0

*1% significance level.

TABLE 2.17: Error Correction Mechanism

Country	**Statistics**			**1% Critical Values**		
Slovakia	D(SLE)	D(SLI)	D(GE)	D(SLE)	D(SLI)	D(GE)
	-0.01	-0.16	-4.60*	1.88	-2.68	-2.76

TABLE 2.18: VAR RESIDUAL SERIAL CORRELATION LM TEST

VAR model implemented to decide the optimal numbers of lags to implement the Johansen Cointegration Test.

Type of Test		LM	
Countries	**No. of Lags HQ criteria**	**LM-Statistic**	**p-values**
Hungary & GE	2	15.5515	0.0769*
Hungary & UK	2	16.3123	0.0606*
Hungary & US	3	8.8163	0.4544*
Poland & GE	2	16.3769	0.0594*
Poland & UK	3	8.8494	0.4513*
Poland & US	3	17.5239	0.0411*
Czech Republic & GE	1	8.0839	0.5257*
Czech Republic & UK	2	8.3264	0.5016*
Czech Republic & US	3	9.0905	0.4290*
Slovakia & GE	0	21.6000	0.0102*
Slovakia & UK	1	15.6737	0.0740*
Slovakia & US	1	17.0314	0.0482*

TABLE 2.22: SUMMARY CAUSALITY TEST FOR GERMANY

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
	DGE $\Rightarrow$ DHGI	Accept Ho	Accept Ho
	DHGI $\Rightarrow$ DGE	Accept Ho	Accept Ho
	DGE $\Rightarrow$ DHGE	Accept Ho	Accept Ho
	DHGE $\Rightarrow$ DGE	Accept Ho	Accept Ho
Poland	DPOE $\Rightarrow$ DPOI	Reject Ho	Reject Ho
	DPOI $\Rightarrow$ DPOE	Accept Ho	Accept Ho
	DGE $\Rightarrow$ DPOI	Accept Ho	Accept Ho
	DPOI $\Rightarrow$ DGE	Accept Ho	Accept Ho
	DGE $\Rightarrow$ DPOE	Accept Ho	Accept Ho
	DPOE $\Rightarrow$ DGE	Accept Ho	Accept Ho
Czech Republic	DCZE $\Rightarrow$ DCZI	Reject Ho	Reject Ho
	DCZI $\Rightarrow$ DCZE	Accept Ho	Accept Ho
	DGE $\Rightarrow$ DCZI	Accept Ho	Accept Ho
	DCZI $\Rightarrow$ DGE	Accept Ho	Accept Ho
	DGE $\Rightarrow$ DCZE	Accept Ho	Accept Ho
	DCZE $\Rightarrow$ DGE	Accept Ho	Accept Ho
Slovakia	DSLE $\Rightarrow$ DSLI	Accept Ho	Accept Ho
	DSLI $\Rightarrow$ DSLE	Accept Ho	Accept Ho
	DGE $\Rightarrow$ DSLI	Accept Ho	Accept Ho
	DSLI $\Rightarrow$ DUK	Accept Ho	Accept Ho
	DGE $\Rightarrow$ DSLE	Accept Ho	Accept Ho
	DSLE $\Rightarrow$ DGE	Accept Ho	Accept Ho

TABLE 2.23: 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 2.24: SUMMARY CAUSALITY TEST TABLE FOR US

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
	DUS $\Rightarrow$ DHGI	Accept Ho	Accept Ho
	DHGI $\Rightarrow$ DUS	Accept Ho	Accept Ho
	DUS $\Rightarrow$ DHGE	Accept Ho	Accept Ho
	DHGE $\Rightarrow$ DUS	Reject Ho	Reject Ho
Poland	DPOE $\Rightarrow$ DPOI	Reject Ho	Reject Ho
	DPOI $\Rightarrow$ DPOE	Accept Ho	Accept Ho
	DUS $\Rightarrow$ DPOI	Reject Ho	Reject Ho
	DPOI $\Rightarrow$ DUS	Accept Ho	Accept Ho
	DUS $\Rightarrow$ DPOE	Reject Ho	Reject Ho
	DPOE $\Rightarrow$ DUS	Accept Ho	Accept Ho
Czech Republic	DCZE $\Rightarrow$ DCZI	Reject Ho	Reject Ho
	DCZI $\Rightarrow$ DCZE	Accept Ho	Accept Ho
	DUS $\Rightarrow$ DCZI	Reject Ho	Reject Ho
	DCZI $\Rightarrow$ DUS	Accept Ho	Accept Ho
	DUS $\Rightarrow$ DCZE	Accept Ho	Accept Ho
	DCZE $\Rightarrow$ DUS	Accept Ho	Accept Ho
Slovakia	DSLE $\Rightarrow$ DSLI	Accept Ho	Accept Ho
	DSLI $\Rightarrow$ DSLE	Accept Ho	Accept Ho
	DUS $\Rightarrow$ DSLI	Accept Ho	Accept Ho
	DSLI $\Rightarrow$ DUS	Accept Ho	Accept Ho
	DUS $\Rightarrow$ DSLE	Accept Ho	Accept Ho
	DSLE $\Rightarrow$ DUS	Accept Ho	Accept Ho

APPENDIX C

EUROPEAN EQUITY MARKETS III

TABLE 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 3.2: 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: 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 3.4: 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 3.5: 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 3.6: 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)

APPENDIX D

G-7 EQUITY MARKETS

Table 4.1 Descriptive Statistics Stock Returns

	Mean	SD	Skewness	Kurtosis	JB
1996-1998					
S&P/TSX Composite	0.000408	0.0092	-1.2067	11.7138	2568
CAC 40	0.000962	0.0133	-0.1264	5.6589	224
DAX 30	0.001027	0.0145	-0.3719	6.2860	357
MIB 30	5.24E-05	0.0127	-0.2050	6.1065	822
NIKKEI 225	-0.00048	0.0149	0.1413	5.7485	240
FTSE 100	0.000619	0.0101	-0.1328	4.8311	108
Dow Jones	0.00076	0.0109	-0.7291	9.0648	1222
1999-2001					
S&P/TSX Composite	0.000228	0.0133	-0.4666	6.2841	352
CAC 40	0.000145	0.0143	-0.1723	3.7704	22
DAX 30	-3.31E-05	0.0158	-0.1669	4.2393	52
MIB 30	-0.0002	0.0147	-0.2199	5.3724	183
NIKKEI 225	-0.00032	0.0151	0.0152	4.9564	120
FTSE 100	-0.00016	0.0127	-0.3770	4.5325	86
Dow Jones	0.000116	0.0123	-0.3880	5.7630	258
2002-2006					
S&P/TSX Composite	0.000425	0.008127	0.0097	5.6228	347
CAC 40	0.000152	0.0141	-0.0357	7.2778	958
DAX 30	0.000194	0.0161	-0.0582	6.7782	747
MIB 30	0.00021	0.0112	-0.1440	6.1939	538
NIKKEI 225	0.000391	0.0127	-0.2084	4.1589	79
FTSE 100	0.000153	0.0114	0.2547	11.4587	3504
Dow Jones	0.000172	0.0100	0.3669	6.9579	847

Table 4.2 Descriptive Statistics Exchange Rates 1996-1998

	Mean	SD	Skewness	Kurtosis	JB
CANADA					
C$/$	0.000165	0.0029	-0.0828	7.1026	530
C$/£	0.000253	0.0055	-0.0605	4.9201	116
C$/¥	5.29E-05	0.0087	0.7794	7.3918	682
C$/CHF	-6.22E-05	0.0071	0.6768	5.0271	187
C$/DM	-3.34E-05	0.0061	0.4390	4.1136	63
FRANCE					
FRANCS/$	0.000173	0.0052	-0.2988	4.1836	55
FRANCS/£	0.000261	0.0053	-0.2789	4.0171	42
FRANCS/¥	6.13E-05	0.0077	0.6667	6.7006	486
FRANCS/CHF	-5.38E-05	0.0029	0.0289	4.6822	89
FRANCS/DM	-2.50E-05	0.0011	-0.2162	6.0925	306
GERMANY					
DM/$	0.000198	0.0053	-0.2665	4.1385	50
DM/£	0.000286	0.0052	-0.2564	3.6515	22
DM/¥	8.63E-05	0.0077	0.6796	6.7852	508
DM/CHF	-2.88E-05	0.0029	0.0380	4.9698	122
ITALY					
LIRA/$	6.91E-05	0.0049	-0.1731	4.0160	36
LIRA/£	0.000157	0.0051	-0.2416	3.8240	29
LIRA/¥	-4.29E-05	0.0078	0.7519	6.8662	541
LIRA/CHF	-0.00016	0.0039	0.3086	5.4278	197
LIRA/DM	-0.00013	0.0027	0.1394	10.1224	1596
JAPAN					
¥/$	0.000112	0.0083	-1.0488	8.9635	1256
¥/£	0.0002	0.0087	-0.5002	5.9988	314
¥/CHF	-0.00012	0.0078	-0.5877	5.9964	325
¥/DM	-8.63E-05	0.0077	-0.6796	6.7852	508
UK					
£/$	-8.76E-05	0.0047	0.1766	5.6793	229
£/¥	-0.0002	0.0087	0.5002	5.9988	314
£/CHF	-0.00032	0.0060	0.2784	3.9091	36
£/DM	-0.00029	0.0052	0.2564	3.6515	22
US					
$/£	8.76E-05	0.0046	-0.1765	5.6793	229
$/¥	-0.00023	0.0062	0.45614	4.6274	109
$/CHF	-0.00011	0.0082	1.0487	8.9635	1256
$/DM	-0.0002	0.0052	0.2665	4.1385	50

Table 4.3 Descriptive Statistics Exchange Rates 1999-2001

	Mean	SD	Skewness	Kurtosis	JB
CANADA					
C$/€	0.000604	0.0073	-0.2090	3.6311	17
C$/$	6.08E-05	0.0036	-0.1017	3.6845	15
C$/£	-0.00013	0.0061	0.1749	3.7087	19
C$/¥	-0.00017	0.0079	0.0648	4.3551	56
C$/CHF	-0.0002	0.0076	0.2368	3.7611	24
EURO					
€/$	-0.00038	0.0066	0.2486	3.9753	38
€/£	-0.0002	0.0053	0.0808	4.0327	34
€/¥	0.000169	0.0090	-0.0593	4.1008	38
€/CHF	0.000118	0.0024	0.6117	12.3531	2792
JAPAN					
¥/€	-0.00017	0.0090	0.0593	4.1008	38
¥/$	0.00023	0.0071	-0.1587	4.8328	104
¥/£	4.37E-05	0.0081	0.0760	4.4216	62
¥/CHF	-1.97E-05	0.0100	-0.0175	4.5574	73
UK					
£/€	0.000185	0.0051	0.0059	3.8378	21
£/$	0.000193	0.0051	-0.0601	3.8565	22
£/¥	3.82E-05	0.0100	2.0150	19.3181	8299
£/CHF	-4.87E-05	0.0085	0.1817	3.9171	29
US					
$/€	0.000376	0.00664	-0.24884	3.9724	37
$/£	-0.00017	0.004915	0.150059	3.4898	10
$/¥	-0.00021	0.007	0.157536	5.1265	145
$/CHF	-0.00026	0.006686	0.273988	3.8228	31

Table 4.4 Descriptive Statistics Exchange Rates 2002-2006

	Mean	SD	Skewness	Kurtosis	JB
CANADA					
C$/€	-0.00042	0.0071	0.1276	3.0984	4
C$/$	-0.00027	0.0051	0.0323	3.3647	7
C$/£	-1.18E-05	0.0058	-0.0984	3.4803	14
C$/¥	-0.00018	0.0078	0.1178	3.5324	17
C$/CHF	-1.49E-05	0.0083	-0.0631	3.5365	15
FRANCE					
€/$	0.000302	0.0058	-0.1429	3.4419	14
€/£	5.99E-05	0.0038	0.0831	4.0029	54
€/¥	-0.00022	0.0055	0.3238	4.4597	133
€/CHF	-6.50E-05	0.0021	0.3025	4.2286	98
GERMANY					
€/$	0.000302	0.0058	-0.1429	3.4419	14
€/£	5.99E-05	0.0038	0.0831	4.0029	54
€/¥	-0.00022	0.0055	0.3238	4.4597	133
€/CHF	-6.50E-05	0.0021	0.3025	4.2286	98
ITALY					
€/$	0.000302	0.0058	-0.1429	3.4419	14
€/£	5.99E-05	0.0038	0.0831	4.0029	54
€/¥	-0.00022	0.0055	0.3238	4.4597	133
€/CHF	-6.50E-05	0.0021	0.3025	4.2286	98
JAPAN					
¥/€	0.000219	0.0055	-0.3238	4.4597	133
¥/$	-8.62E-05	0.0059	-0.2830	4.5441	136
¥/£	0.000167	0.0057	-0.5124	5.2745	314
¥/CHF	0.000164	0.0091	-0.2452	3.4915	24
UK					
£/€	-0.00026	0.0054	0.1466	4.0860	62
£/$	-0.00026	0.0054	0.0839	4.0850	59
£/¥	-0.00021	0.0089	0.0092	4.2362	75
£/CHF	-0.00018	0.0087	0.1027	3.3903	9
US					
$/€	-0.0003	0.005794	0.141897	3.4401	14
$/£	0.000244	0.005221	-0.12246	3.6344	24
$/¥	8.31E-05	0.005858	0.330416	4.5867	154
$/CHF	0.000236	0.006529	-0.03263	3.4612	11

Table 4.5 Augmented Dickey-Fuller Test Results

	1996-1998	1999-2001	2002-2006
Stock Returns			
S&P/TSX Composite	-6.36*	-19.91*	-34.10*
CAC 40	-9.05*	-26.47*	-9.79*
DAX 30	-6.55*	-27.13*	-8.53*
MIB 30	-16.68*	-11.95*	-13.64*
NIKKEI 225	-21.84*	-28.30*	-13.62*
FTSE 100	-7.02*	-17.68*	-11.89*
Dow Jones	-27.14*	-20.50*	-8.48*
Exchange Rates			
CANADA			
C$/$	-13.75*	n/a	n/a
C$/£	-19.72*	n/a	n/a
C$/¥	-11.56*	n/a	n/a
C$/CHF	-26.82*	n/a	n/a
C$/DM	-27.00*	n/a	n/a
FRANCE			
FRANCS/$	-27.26*	n/a	n/a
FRANCS/£	-27.90*	n/a	n/a
FRANCS/¥	-25.11*	n/a	n/a
FRANCS/CHF	-26.59*	n/a	n/a
FRANCS/DM	-24.45*	n/a	n/a
GERMANY			
DM/$	-10.57*	n/a	n/a
DM/£	-10.79*	n/a	n/a
DM/¥	-26.54*	n/a	n/a
DM/CHF	-11.04*	n/a	n/a
ITALY			
Lira/$	-27.28*	n/a	n/a
Lira/£	-15.45*	n/a	n/a
Lira/¥	-25.26*	n/a	n/a
Lira/CHF	-20.34*	n/a	n/a
Lira/DM	-29.39*	n/a	n/a
JAPAN			
¥/€	n/a	-26.54*	-14.21*
¥/$	-7.00*	-27.48*	-35.81*
¥/£	-11.43*	-26.23*	-12.42*
¥/CHF	-25.69*	-29.21*	-21.28*
¥/DM	-25.30*	n/a	n/a
UK			
£/€	n/a	-25.74*	-33.28*
£/$	-26.39*	-26.18*	-33.82*
£/¥	-11.43*	-16.55*	-35.06*
£/CHF	-27.29*	-24.96*	-34.11*
£/DM	-15.17*	n/a	n/a
US			
$/€	n/a	-10.54*	-6.72*
$/£	-26.39*	-13.30*	-34.85*
$/¥	-7.00*	-28.26*	-36.33*

$/CHF	-26.70*	-26.86*	-37.84*
$/DM	-27.28*	n/a	n/a

Note: * Indicates significant at 1% level

Table 4.6 Augmented Dickey-Fuller Test Results: Post Euro

	1999-2001	**2002-2006**
Exchange Rates		
CANADA		
C$/€	-25.26*	-34.07*
C$/$	-12.53*	-35.34*
C$/£	-27.57*	-33.82*
C$/¥	-28.01*	-28.90*
C$/CHF	-27.30*	-23.27*
FRANCE		
€/$	-10.57*	-6.73*
€/£	-10.79*	-17.64*
€/¥	-26.54*	-14.21*
€/CHF	-11.04*	-35.70*
€/$	-10.57*	-6.73*
GERMANY		
€/$	-10.57*	-6.73*
€/£	-10.79*	-17.64*
€/¥	-26.54*	-14.21*
€/CHF	-11.04*	-35.70*
ITALY		
€/$	-10.57*	-6.73*
€/£	-10.79*	-17.64*
€/¥	-26.54*	-14.21*
€/CHF	-11.04*	-35.70*

Note: * Indicates significant at 1% level

Table 4.7 Likelihood Ratio Test Results

Canada					
1996-1998	**C$/$**	**C$/£**	**C$/¥**	**C$/CHF**	**C$/DM**
Stock Returns	0.256	0.336	0.06	0.398	0.18
Exchange Rates	0.48	0.044	0.97	0.781	18.317*
1999-2001	**C$/€**	**C$/$**	**C$/£**	**C$/¥**	**C$/CHF**
Stock Returns	12.084	11.238	9.998*	10.868*	10.11*
Exchange Rates	0.057	1.258	0.152	0.794	0.19
2002-2006	**C$/€**	**C$/$**	**C$/£**	**C$/¥**	**C$/CHF**
Stock Returns	0.402	0.246	0.612	0.29	0.210
Exchange Rates	0	0.656	7.38*	0.07	0.016
France					
1996-1998	**FR/$**	**FR/£**	**FR/¥**	**FR/CHF**	**FR/DM**
Stock Returns	1.364	0.922	1.142	1.458	0.084
Exchange Rates	16.93	3.84	1.912	3.594	14.84*
1999-2001	**€/$**	**€/£**	**€/¥**	**€/CHF**	
Stock Returns	0.2022	0.0728	0.195	0.488	
Exchange Rates	2.28	0.492	1.092	0.022	
2002-2006	**€/$**	**€/£**	**€/¥**	**€/CHF**	
Stock Returns	7.706*	7.256	6.908*	2.734	
Exchange Rates	7.8488*	0.056	0.756	0.0256	
Germany					
1996-1998	**DM/$**	**DM/£**	**DM/¥**	**DM/CHF**	
Stock Returns	1.386	8.046*	5.64	6.142	
Exchange Rates	16.602*	2.99	2.718	6.158	
1999-2001	**€/$**	**€/£**	**€/¥**	**€/CHF**	
Stock Returns	12.441*	12.02*	14.864*	11.568*	
Exchange Rates	1.738	0.592	1.574	0.048	
2002-2006	**€/$**	**€/£**	**€/¥**	**€/CHF**	
Stock Returns	5.852	5.68	15.92*	4.484	
Exchange Rates	4.205	0.086	0.8	0.1006	
Italy					
1996-1998	**LIRA/$**	**LIRA/£**	**LIRA/¥**	**LIRA/CHF**	**LIRA/DM**
Stock Returns	1.56	2.12	2.11	1.94	3.81
Exchange Rates	4.95	0.13	0.25	2.49	5.52
1999-2001	**€/$**	**€/£**	**€/¥**	**€/CHF**	
Stock Returns	0.238	0.507	1.192	1.77	
Exchange Rates	1.962	0.414	3.092	0.916	
2002-2006	**€/$**	**€/£**	**€/¥**	**€/CHF**	
Stock Returns	1.42	1.158	1.432	0.372	
Exchange Rates	38.155*	0.14	1.058	0.042	
Japan					
1996-1998	**¥/$**	**¥/£**	**¥/CHF**	**¥/DM**	
Stock Returns	0.056	0.206	0.204	0.254	
Exchange Rates	0.284	1.664	17.536*	4.994	
1999-2001	**¥/€**	**¥/$**	**¥/£**	**¥/CHF**	
Stock Returns	13.73*	13.746*	14.554*	12.384*	
Exchange Rates	3.66	2.718	1.118	1.026	
2002-2006	**¥/€**	**¥/$**	**¥/£**	**¥/CHF**	

Stock Returns	11.028*	10.152*	10.284*	11.32*
Exchange Rates	2.266	2.142	4.073	3.78
UK				
1996-1998	**£/$**	**£/¥**	**£/CHF**	**£/DM**
Stock Returns	1.28	1.94	1.27	1.286
Exchange Rates	1.76	3.35	5.47	1.76
1999-2001	**£/€**	**£/$**	**£/¥**	**£/CHF**
Stock Returns	0.061	2.591	0.131	0.01
Exchange Rates	0.453	0.01	0.276	0.002
2002-2006	**£/€**	**£/$**	**£/¥**	**£/CHF**
Stock Returns	1.376	1.12	0.762	0.292
Exchange Rates	33.848*	5.076	0.403	23.294*
US				
1996-1998	**$/£**	**$/¥**	**$/CHF**	**$/DM**
Stock Returns	6.892*	6.612*	5.706	6.934*
Exchange Rates	3.608	0.006	1.022	4.783
1999-2001	**$/€**	**$/£**	**$/¥**	**$/CHF**
Stock Returns	0	0.088	0.102	0.004
Exchange Rates	1.132	0.401	1.932	2.324
2002-2006	**$/€**	**$/£**	**$/¥**	**$/CHF**
Stock Returns	5.202	4.946	3.202	5.382
Exchange Rates	43.93*	43.012*	0.693	5.969

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. Note: * Indicates significant at 1% level

Table 4.8 Diagnostic Test on EGARCH models

Canada					
1996-1998	**C$/$**	**C$/¥**	**C$/DM**	**C$/CHF**	**C$/£**
Stock Returns					
JB	389	757	395	429	324
LB(20)	50.584	53.727	54.751	53.283	53.897
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
LB²(20)	12.507	10.434	11.927	12.919	12.595
	(0.898)	(0.960)	(0.919)	(0.881)	(0.894)
Exchange Rates					
JB	46	187	74	245	67
LB(20)	19.539	24.336	18.246	12.319	28.708
	(0.487)	(0.228)	(0.571)	(0.905)	(0.094)
LB²(20)	15.77	8.0373	36.107	12.992	13.47
	(0.731)	(0.992)	(0.015)	(0.878)	(0.856)
Cross Products					
LB(20)	17.635	29.27	18.606	14.511	16.194
	(0.611)	(0.083)	(0.548)	(0.804)	(0.705)
LB²(20)	14.614	49.117	20.332	11.218	2.9102
	(0.798)	(0.000)*	(0.437)	(0.940)	(1.000)
1999-2001	**C$/$**	**C$/¥**	**C$/CHF**	**C$/£**	**C$/€**
Stock Returns					
JB	83	86	73	82	56
LB(20)	18.661	18.547	17.752	18.386	25.749
	(0.544)	(0.551)	(0.604)	(0.562)	(0.174)
LB²(20)	6.9292	7.6807	7.5534	7.2135	7.6796
	(0.997)	(0.994)	(0.991)	(0.996)	(0.994)
Exchange Rates					
JB	18	18	21	16	17
LB(20)	22.689	14.777	31.638	26.505	32.342
	(0304)	(0.789)	(0.047)	(0.150)	(0.040)
LB²(20)	44.719	12.831	15.091	17.999	25.543
	(0.001)*	(0.885)	(0.771)	(0.587)	(0.181)
Cross Products					
LB(20)	15.066	15.896	14.089	18.742	17.966
	(0.773)	(0.723)	(0.826)	(0.539)	(0.590)
LB²(20)	4.1503	11.937	4.692	9.877	12.113
	(1.000)	(0.918)	(1.000)	(0.970)	(0.912)
2002-2006	**C$/$**	**C$/¥**	**C$/CHF**	**C$/£**	**C$/€**
Stock Returns					
JB	22	25	28	23	28
LB(20)	15.884	14.465	13.859	14.316	12.92
	(0.724)	(0.806)	(0.838)	(0.814)	(0.881)
LB²(20)	18.499	18.248	19.627	19.883	13.238
	(0.555)	(0.571)	(0.481)	(0.465)	(0.867)
Exchange Rates					
JB	9	20	7	7	3
LB(20)	16.257	49.509	77.078	20.578	14.005
	(0.701)	(0.000)*	(0.000)*	(0.422)	(0.830)
LB²(20)	28.365	16.122	18.381	27.212	59.112

	(0.101)	(0.709)	(0.562)	(0.129)	(0.000)*
Cross Products					
LB(20)	21.431 (0.372)	16.748 (0.669)	23.474 (0.266)	20.657 (0.418)	32.503 (0.038)
LB²(20)	12.337 (0.904)	11.382 (0.936)	6.741 (0.997)	15.677 (0.736)	28.945 (0.089)

*LB²(32):53.005(0.011); LB²(9):18.074(0.034); LB(41):64.861(0.010); LB²(9):16.766(0.053)

Table 4.18 Diagnostic Test on EGARCH models

France					
1996-1998	**FR/$**	**FR/£**	**FR/¥**	**FR/CHF**	**FR/DM**
Stock Returns					
JB	11	4	7	10	7
LB(20)	23.11 (0.283)	23.531 (0.263)	19.37 (0.498)	21.582 (0.364)	22.482 (0.315)
LB²(20)	7.9367 (0.992)	7.8246 (0.993)	6.7154 (0.998)	7.6451 (0.994)	7.8243 (0.993)
Exchange Rates					
JB	19	39	114	44	66
LB(20)	12.361 (0.903)	14.973 (0.778)	15.39 (0.754)	12.926 (0.881)	76.764 (0.000)*
LB²(20)	36.008 (0.015)	20.254 (0.442)	12.692 (0.890)	17.608 (0.613)	13.205 (0.868)
Cross Products					
LB(20)	17.791 (0.601)	21.004 (0.397)	20.382 (0.434)	28.745 (0.093)	14.915 (0.781)
LB²(20)	23.717 (0.255)	30.86 (0.057)	10.219 (0.964)	22.426 (0.18)	46.381 (0.000)*
1999-2001	**€/$**	**€/£**	**€/¥**	**€/CHF**	
Stock Returns					
JB	4	7	5	7	
LB(20)	24.666 (0.215)	21.273 (0.381)	20.502 (0.427)	21.265 (0.382)	
LB²(20)	29.966 (0.070)	30.199 (0.067)	28.182 (0.105)	25.834 (0.171)	
Exchange Rates					
JB	44	28	26	392	
LB(20)	37.236 (0.011)	30.548 (0.061)	21.012 (0.396)	21.817 (0.351)	
LB²(20)	39.916 (0.005)*	39.213 (0.006)*	16.808 (0.665)	14.392 (0.810)	
Cross Products					
LB(20)	32.065 (0.043)	28.389 (0.101)	16.104 (0.710)	19.462 (0.492)	
LB²(20)	18.399 (0.561)	19.35 (0.499)	8.3721 (0.989)	4.3363 (1.000)	
2002-2006	**€/$**	**€/£**	**€/¥**	**€/CHF**	
Stock Returns					
JB	13	17	13	6	

LB(20)	25.928 (0.168)	22.238 (0.328)	24.27 (0.231)	22.211 (0.329)
LB²(20)	22.69 (0.304)	20.096 (0.452)	17.824 (0.599)	18 (0.616)
Exchange Rates				
JB	15	52	133	95
LB(20)	31.227 (0.052)	22.607 (0.308)	31.314 (0.051)	15.604 (0.741)
LB²(20)	20.226 (0.444)	23.067 (0.286)	13.627 (0.849)	12.875 (0.883)
Cross Products				
LB(20)	56.758 (0.000)*	33.204 (0.032)	35.872 (0.016)	26.591 (0.147)
LB²(20)	36.13 (0.015)	56.568 (0.000)*	18.915 (0.527)	10.732 (0.953)

*LB²(29):48.588(0.013);LB²(24):42.949(0.010),LB²(22):39.664(0.012);LB(13):27.359(0.011), LB²(20):20.027(0.067)

Table 4.9 Diagnostic Test on EGARCH models

Germany				
1996-1998	**DM/$**	**DM/£**	**DM/¥**	**DM/CHF**
Stock Returns				
JB	14	10	16	15
LB(20)	20.324 (0.438)	18.855 (0.531)	19.441 (0.493)	17.805 (0.600)
LB²(20)	17.356 (0.630)	14.312 (0.814)	14.403 (0.809)	10.094 (0.966)
Exchange Rates				
JB	45	32	122	78
LB(20)	15.335 (0.757)	15.316 (0.758)	18.458 (0.557)	9.9396 (0.969)
LB²(20)	15.131 (0.769)	16.535 (0.683)	10.94 (0.948)	7.8623 (0.993)
Cross Products				
LB(20)	17.878 (0.595)	16.525 (0.684)	18.333 (0.565)	24.856 (0.207)
LB²(20)	8.362 (0.989)	42.49 (0.000)*	4.6912 (1.000)	32.65 (0.037)
1999-2001	**€/$**	**€/£**	**€/¥**	**€/CHF**
Stock Returns				
JB	25	7	9	4
LB(20)	26.326 (0.155)	24.048 (0.240)	23.657 (0.258)	23.181 (0.280)
LB²(20)	14.727 (0.792)	22.581 (0.310)	21.721 (0.356)	24.475 (0.222)
Exchange Rates				
JB	43	28	30	386
LB(20)	36.744	30.946	21.015	22.57

	(0.013)	(0.056)	(0.936)	(0.310)
LB²(20)	35.205 (0.019)	35.908 (0.016)	16.443 (0.689)	16.11 (0.710)
Cross Products				
LB(20)	29.798 (0.073)	28.851 (0.091)	7.9922 (0.967)	12.198 (0.909)
LB²(20)	46.009 (0.001)*	44.686 (0.000)*	59.215 (0.000)	4.1369 (1.000)
2002-2006	**€/$**	**€/£**	**€/¥**	**€/CHF**
Stock Returns				
JB	13	19	13	9
LB(20)	21.871 (0.348)	18.607 (0.547)	21.222 (0.384)	18.232 (0.572)
LB²(20)	14.605 (0.799)	10.43 (0.960)	10.754 (0.952)	13.172 (0.870)
Exchange Rates				
JB	11	48	143	104
LB(20)	27.739 (0.116)	22.121 (0.334)	32.216 (0.041)	16.027 (0.715)
LB²(20)	24.533 (0.220)	22.368 (0.321)	11.979 (0.917)	13.763 (0.842)
Cross Products				
LB(20)	50.826 (0.000)*	35.423 (0.018)	28.179 (0.105)	29.039 (0.087)
LB²(20)	42.541 (0.002)*	19.792 (0.471)	25.965 (0.167)	13.963 (0.832)

*LB²(29)49.719(0.01); LB²(12)8.884(0.712); LB(29):48.757(0.012); LB²(2.112(0.953); LB(14):19.432(0.149); LB(14):6.907(0.938)

Table 4.10 Diagnostic Test on EGARCH models

Italy					
1996-1998	**LIRA/CHF**	**LIRA/¥**	**LIRA/DM**	**LIRA/£**	**LIRA/$**
Stock Returns					
JB	15	31	20	26	43
LB(20)	23.848 (0.249)	23.466 (0.266)	29.863 (0.0072)	23.745 (0.254)	22.535 (0.312)
LB²(20)	19.997 (0.458)	16.592 (0.679)	17.702 (0.607)	17.048 (0.650)	14.667 (0.795)
Exchange Rates					
JB	46	137	106	21	38
LB(20)	11.204 (0.941)	15.531 (0.745)	31.792 (0.046)	19.333 (0.500)	13.682 (0.846)
LB²(20)	19.695 (0.477)	6.613 (0.989)	18.171 (0.576)	19.550 (0.486)	37.219 (0.011)
Cross Products					
LB(20)	24.965 (0.203)	10.677 (0.954)	29.421 (0.080)	29.74 (0.074)	12.336 (0.904)
LB²(20)	8.8149	0.5807	8.7528	4.9999	0.6451

	(0.985)	(1.000)	(0.986)	(1.000)	(1.000)
1999-2001	**€/CHF**	**€/¥**	**€/£**	**€/$**	
Stock Returns					
JB	6	9	6	5	
LB(20)	27 (0.142)	23.386 (0.270)	23.145 (0.282)	23.009 (0.288)	
LB²(20)	16.578 (0.680)	18.114 (0.580)	16.437 (0.689)	19.109 (0.515)	
Exchange Rates					
JB	411	31	28	48	
LB(20)	22.291 (0.325)	20.469 (0.429)	28.594 (0.096)	30.995 (0.055)	
LB²(20)	15.365 (0.755)	16.068 (0.712)	40.263 (0.005)*	41.967 (0.003)*	
Cross Products	**€/CHF**	**€/¥**	**€/£**	**€/$**	
LB(20)	23.862 (0.248)	13.011 (0.877)	20.214 (0.445)	29.864 (0.072)	
LB²(20)	10.566 (0.957)	23.052 (0.286)	42.596 (0.000)*	23.923 (0246)	
2002-2006	**€/CHF**	**€/¥**	**€/£**	**€/$**	
Stock Returns					
JB	43	86	85	58	
LB(20)	16.12 (0.709)	18.992 (0.522)	17.646 (0.611)	16.745 (0.669)	
LB²(20)	10.368 (0.961)	7.4098 (0.995)	9.1597 (0.981)	8.4719 (0.988)	
Exchange Rates					
JB	93	136	51	11	
LB(20)	17.629 (0.612)	31.613 (0.048)	21.434 (0.372)	28.688 (0.094)	
LB²(20)	12.27 (0.906)	13.515 (0.854)	20.009 (0.457)	20.979 (0.398)	
Cross Products	**€/CHF**	**€/¥**	**€/£**	**€/$**	
LB(20)	21.918 (0.345)	34.941 (0.020)	19.785 (0.471)	48.811 (0.000)*	
LB²(20)	16.934 (0.657)	15.265 (0.761)	11.048 (0.945)	40.239 (0.000)*	

Table 4.11 Diagnostic Test on EGARCH models

Japan				
1996-1998	**¥/$**	**¥/£**	**¥/CHF**	**¥/DM**
Stock Returns				
JB	19	19	20	18
LB(20)	22.284	21.886	22.615	21.775
	(0325)	(0.347)	(0.308)	(0.353)
LB²(20)	21.559	21.049	19.74	20.219
	(0.365)	(0.394)	(0.474)	(0.444)
Exchange Rates				
JB	326	90	62	123
LB(20)	19.902	16.514	24.144	16.816
	(0.464)	(0.684)	(0.236)	(0.665)
LB²(20)	7.9373	16.626	33.145	15.829
	(0.992)	(0.677)	(0.033)	(0.727)
Cross Products				
LB(20)	33.631	26.711	25.479	31.28
	(0.029)	(0.144)	(0.184)	(0.052)
LB²(20)	21.444	36.965	56.363	60.027
	(0.371)	(0.012)	(0.000)*	(0.000)*
1999-2001	**¥ /€**	**¥/$**	**¥/£**	**¥/CHF**
Stock Returns				
JB	53	47	49	47
LB(20)	26.779	19.037	18.436	18.984
	(0.142)	(0.519)	(0.559)	(0.523)
LB²(20)	16.558	16.617	16.666	16.984
	(0.681)	(0.678)	(0.675)	(0.654)
Exchange Rates				
JB	27	38	39	24
LB(20)	19.029	23.154	13.439	18.985
	(0.520)	(0.281)	(0.858)	(0.523)
LB²(20)	15.846	15.85	10.015	16.984
	(0.726)	(0.726)	(0.968)	(0.654)
Cross Products				
LB(20)	29.685	15.131	25.552	27.177
	(0.075)	(0.769)	(0.181)	(0.130)
LB²(20)	8.7263	8.3058	13.934	25.255
	(0.986)	(0.990)	(0.834)	(0.192)
2002-2006	**¥/€**	**¥/$**	**¥/£**	**¥/CHF**
Stock Returns				
JB	49	56	58	59
LB(20)	18.175	9.7344	10.083	9.7879
	(0.576)	(0.973)	(0.967)	(0.972)
LB²(20)	11.799	9.5823	8.9081	9.1307
	(0.923)	(0.975)	(0.984)	(0.981)
Exchange Rates				
JB	133	138	210	14
LB(20)	33.128	14.661	38.73	108.15

	(0.033)	(0.0795)	(0.007)*	(0.081)
LB²(20)	14.095 (0.826)	15.632 (0.739)	19.803 (0.470)	21.138 (0.389)
Cross Products				
LB(20)	22.665 (0.306)	11.788 (0.923)	26.826 (0.140)	23.449 (0.267)
LB²(20)	6.4011 (0998)	4.5495 (1.000)	7.5342 (0.995)	8.6938 (0.986)

*LB²(17):21.662(0.198); LB²(47):71.638(0.012); LB(19):35.643(0.012)

Table 4.12 Diagnostic Test on EGARCH models

UK				
1996-1998	**£/$**	**£/¥**	**£/CHF**	**£/DM**
Stock Returns				
JB	10	8	6	7
LB(20)	47.888 (0.000)*	47.738 (0.000)*	44.158 (0.001)*	45.919 (0.000)*
LB²(20)	58.783 (0.01)	11.777 (0.924)	12.154 (0.911)	11.437 (0.934)
Exchange Rates				
JB	76	86	95	29
LB(20)	24.07 (0.239)	18.808 (0.534)	13.424 (0.858)	14.581 (0.800)
LB²(20)	17.066 (0.649)	17.252 (0.637)	23.698 (0.256)	18.187 (0.575)
Cross Products				
LB(20)	26.58 (0.148)	26.051 (0.164)	25.491 (0.183)	34.752 (0.021)
LB²(20)	10.934 (0.948)	15.851 (0.726)	16.253 (0.701)	8.8589 (0.984)
1999-2001	**£/€**	**£/$**	**£/¥**	**£/CHF**
Stock Returns				
JB	234	202	207	206
LB(20)	26.745 (0.143)	30.979 (0.055)	25.967 (0.167)	29.358 (0.081)
LB²(20)	5.7629 (0.999)	6.2182 (0.999)	5.4999 (0.999)	6.4189 (0.998)
Exchange Rates				
JB	8	24	3223	22
LB(20)	24.57 (0.218)	23.766 (0.253)	29.275 (0.082)	16.863 (0.662)
LB²(20)	36.393 (0.014)	32.442 (0.039)	30.984 (0.055)	9.0466 (0.982)
Cross Products				
LB(20)	26.884 (0.139)	31.666 (0.047)	21.115 (0.390)	18.832 (0.533)
LB²(20)	7.9564 (0.992)	15.329 (0.757)	4.0625 (1.000)	5.4335 (0.999)

2002-2006	£/€	£/$	£/¥	£/CHF
Stock Returns				
JB	23	15	18	18
LB(20)	26.756 (0.142)	24.823 (0.208)	28.599 (0.096)	25.534 (0.182)
LB²(20)	21.107 (0.391)	25.827 (0.172)	20.965 (0.399)	20.784 (0.410)
Exchange Rates				
JB	67	41	40	10
LB(20)	24.17 (0.235)	23.881 (0.248)	14.056 (0.826)	24.817 (0.209)
LB²(20)	37.431 (0.010)	8.4694 (0.988)	8.8236 (0.985)	11.119 (0.943)
Cross Products				
LB(20)	15.163 (0.767)	21.101 (0.391)	26.346 (0.155)	17.58657 (0.619)
LB²(20)	14.253 (0.817)	21.698 (0.357)	36.9 (0.012)	9.869 (0.994)

*LB(36):58.783(0.01); LB(35):54.471(0.01); LB(26):44.940(0.012); LB(33):54.145(0.012)

Table 4.13 Diagnostic Test on EGARCH models

US				
1996-1998	**$/£**	**$/¥**	**$/CHF**	**$/DM**
Stock Returns				
JB	65	68	83	59
LB(20)	21.725	23.438	19.656	19.921
	(0.356)	(0.268)	(0.480)	(0.463)
LB²(20)	11.428	13.012	11.334	14.469
	(0.934)	(0.877)	(0.937)	(0.806)
Exchange Rates				
JB	107	343	170	62
LB(20)	21.159	19.364	12.969	14.482
	(0.388)	(0.498)	(0.879)	(0.805)
LB²(20)	21.159	8.499	12.15	40.929
	(0.780)	(0.988)	(0.911)	(0.004)*
Cross Products				
LB(20)	21.05	20.279	12.649	24.885
	(0.394)	(0.441)	(0.892)	(0.206)
LB²(20)	4.575	2.4032	9.0539	13.222
	(1.000)	(1.000)	(0.982)	(0.868)
1999-2001	**$/€**	**$/£**	**$/¥**	**$/CHF**
Stock Returns				
JB	76	81	96	71
LB(20)	19.532	19.67	20.675	21.004
	(0.488)	(0.479)	(0.416)	(0.397)
LB²(20)	11.639	14.04	15.032	12.9
	(0.928)	(0.828)	(0.775)	(0.882)

Exchange Rates				
JB	33	8	53	30
LB(20)	31.226	20.37	21.298	26.351
	(0.052)	(0.435)	(0.380)	(0.155)
LB²(20)	30.887	40.126	17.674	17.541
	(0.057)	(0.005)*	(0.609)	(0.618)
Cross Products				
LB(20)	31.403	35.834	31.644	51.048
	(0.050)	(0.016)	(0.047)	(0.123)
LB²(20)	21.925	17.642	70.464	27.469
	(0.345)	(0.611)	(0.000)*	(0.123)
2002-2006	**$/€**	**$/£**	**$/¥**	**$/CHF**
Stock Returns				
JB	2	2	2	2
LB(20)	30.322	30.579	31.15	30.37
	(0.065)	(0.061)	(0.053)	(0.064)
LB²(20)	37.394	36.853	33.944	37.26
	(0.01)	(0.012)	(0.027)	(0.011)
Exchange Rates				
JB	7	24	165	9
LB(20)	27.634	18.196	16.158	27.059
	(0.118)	(0.578)	(0.707)	(0.134)
LB²(20)	26.3	79.138	15.104	22.776
	(0.156)	(0.000)*	(0.770)	(0.300)
Cross Products				
LB(20)	13.342	27.081	28.998	9.7734
	(0.862)	(0.133)	(0.088)	(0.972)
LB²(20)	21.508	43.29	27.996	22.778
	(0.368)	(0.000)*	(0.110)	(0.300)

*LB²(6)5.044; LB(9):18.533(0.029); LB(4):7.545(0.01);
LB²(16):7.66(0.958);LB(5):6.097(0.297); LB(5):1.5454(0.908)

APPENDIX E

ASIAN EQUITY MARKETS

Table 5.1 Descriptive Statistics

		Mean ($x10^3$)	SD	Skewness	Kurtosis	JB
Stock Returns						
Hong Kong	Total sample	0.082	0.0169	0.17	14.63	14002
	Crises	0.369	0.0075	-0.88	8.09	474
	Post-crises	2.52	0.0135	-0.26	6.47	1008
South Korea	Total sample	0.278	0.0217	-0.13	6.15	1035
	Crises	0.400	0.0050	1.88	15.99	2988
	Post-crises	2.81	0.0118	-0.36	7.69	1841
Singapore	Total sample	0.078	0.0140	0.36	13.95	12467
	Crises	-1.10	0.0290	0.44	9.10	620
	Post-crises	4.27	0.0194	-0.39	6.08	825
Taiwan	Total sample	-0.018	0.0160	-0.06	5.59	698
	Crises	-0.800	0.0316	0.27	4.19	28
	Post-crises	0.002	0.0003	-3.06	229.43	4194538
Thailand	Total sample	0.099	0.0071	-0.54	419.26	17933710
	Crises	-0.900	0.0162	-0.09	4.58	41
	Post-crises	0.017	0.0040	0.13	17.74	17774
Exchange Rates						
		Mean ($x10^3$)	**SD**	**Skewness**	**Kurtosis**	**JB**
Hong Kong	Total sample	0.002	0.0004	-3.16	171.70	2949788
	Crises	0.009	0.0005	-3.15	71.79	77932
	Post-crises	0.002	0.0003	-3.06	229.43	4194538
South Korea	Total sample	0.044	0.0106	0.01	139.86	1938493
	Crises	0.800	0.0251	-0.08	28.20	10371
	Post-crises	-0.023	0.0027	-0.22	6.18	844
Singapore	Total sample	0.048	0.0039	-0.94	18.86	26410
	Crises	1.00	0.0175	2.01	26.39	9197
	Post-crises	-0.126	0.0039	-0.06	6.35	920
Taiwan	Total sample	0.067	0.0034	1.15	33.60	97464
	Crises	-0.800	0.0230	0.85	9.79	801
	Post-crises	0.017	0.0161	-0.04	5.78	631
Thailand	Total sample	0.155	0.0082	3.31	90.14	790400
	Crises	-0.300	0.0124	-0.40	154.14	373107
	Post-crises	0.237	0.0023	-0.51	7.66	1859

Table 5.2 Augmented Dickey Fuller Test Results

	Variables	Total Sample	Crises	Post crises
Hong Kong	E	-14.4	-10.9	-12.0
	S	-24.4	-21.0	-42.8
South Korea	E	-7.1	-0.4	-15.2
	S	-35.2	-13.5	-20.7
Singapore	E	-9.9	-9.8	-13.3
	S	-44.3	-20.9	-42.9
Taiwan	E	-9.5	-17.5	-19.2
	S	-22.1	-16.6	-12.0
Thailand	E	-9.4	-15.8	-11.9
	S	-11.1	-10.7	-15.6

1% critical values

Table 5.3 Likelihood Ratio Test for EGARCH Model Selection for Conditional Variance Equations

	Stock Returns			Exchange Rates		
Country	**Total Sample**	**Crises**	**Post Crises**	**Total Sample**	**Crises**	**Post Crises**
Hong Kong	12.6*	12.0*	17.3*	895.8*	7.4*	3.7
South Korea	0.4	19.8*	4.9	41.0*	0.6	0.7
Singapore	1.1	0.0	1.1	1.0	12.5*	18.9*
Taiwan	8.0*	0.04	800.9*	84.2*	0.0	18.3*
Thailand	159.1*	0.0	9.7*	22.1*	2.1	17.6*

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 5.4 Diagnostics on Standardised Residuals: Total Sample

	Hong Kong	South Korea	Singapore	Taiwan	Thailand
Stock return equation					
Jarque-Bera	198	504	1035	221	107533
LB(20)	36.43	21.29	40.546	23.535	134.4
	(0.014)	(0.380)	(0.004)*	(0.263)	(0.000)*
$LB^2(20)$	23.89	15.14	11.1	17.294	4.6008
	(0.247)	(0.768)	(0.944)	(0.634)	(1.000)
Exchange rate equation					
Jarque-Bera	940888	2457	1100	491680	24317
LB(20)	22.82	91.38	22.63	31.89	56.9
	(0.297)	(0.000)	(0.307)	(0.044)	(0.000)**
$LB^2(20)$	2.55	67.47	24.24	2.68	4.09
	(1.000)	(0.000)	(0.232)	(1.000)	(1.000)

*LB(24)=42.780(0.010); ** LB(43)=67.64(0.01)

Table 5.5 Diagnostics on Standardised Residuals: Crisis Period

	Hong Kong	South Korea	Singapore	Taiwan	Thailand
Stock return equation					
Jarque-Bera	165	4157	55	32	17
LB(20)	19.15	26.87	17.82	22.51	13.26
	(0.512)	(0.139)	(0.599)	(0.313)	(0.866)
LB²(20)	19.514	1.63	19.75	11.17	9.99
	(0.489)	(1.000)	(0.473)	(0.942)	(0.968)
Exchange rate equation					
Jarque-Bera	1146	220	106	131	462742
LB(20)	10.81	36.96	22.89	34.22	16.39
	(0.951)	(0.012)	(0.294)	(0.025)	(0.692)
LB²(20)	12.51	15.01	10.01	13.21	0.93
	(0.897)	(0.776)	(0.968)	(0.868)	(1.000)

Table 5.6Diagnostics on Standardised Residuals: Post Crisis Period

	Hong Kong	South Korea	Singapore	Taiwan	Thailand
Stock return equation					
Jarque-Bera	161	917	547	1333647	11785
LB(20)	23.24	25.55	16.74	18.51	33.30
	(0.277)	(0.181)	(0.670)	(0.554)	(0.031)
LB²(20)	21.28	9.79	15.46	0.65	4.67
	(0.381)	(0.972)	(0.750)	(1.000)	(1.000)
Exchange rate equation					
Jarque-Bera	1966851	653	335	137	153
LB(20)	19.16	23.16	55.15	27.18	23.40
	(0.512)	(0.281)	(0.000)*	(0.130)	(0.270)
LB²(20)	1.48	10.19	25.84	17.18	15.70
	(1.000)	(0.965)	(0.171)	(0.641)	(0.735)

APPENDIX F

LATIN AMERICAN EQUITY MARKETS

Table 6.1 Descriptive Statistics Stock Return

Stock Indices *	Mean	SD	Skewness	Kurtosis	JB
1998					
Merval	-0.001908	0.0288	-0.5002	6.4864	132
Bovespa	-0.001854	0.0363	0.0441	7.2298	180
IGPA Gen	-0.00122	0.0115	0.3701	4.8870	41
CSE Index	n/a	n/a	n/a	n/a	n/a
IPC	-0.001021	0.0222	0.6056	9.8558	487
IBC	-0.002466	0.0336	1.1081	11.4543	767
IBEX 35	0.001075	0.0197	-0.3973	5.6594	77
1999-2001					
Merval	-0.000544	0.0256	0.4044	7.6183	663
Bovespa	0.000893	0.0249	1.9831	29.4984	21656
IGPA Gen	0.000556	0.0070	-0.0579	5.3085	161
CSE Index	n/a	n/a	n/a	n/a	n/a
IPC	0.000592	0.0191	0.0137	4.3738	57
IBC	0.000456	0.0180	1.0025	10.4508	1798
IBEX 35	-0.000325	0.0151	-0.2076	4.1193	43
2002-2006					
Merval	0.001501	0.0206	-0.1443	6.7135	699
Bovespa	0.000941	0.0174	-0.2239	3.7560	39
IGPA Gen	0.000684	0.0056	0.1899	6.6485	677
CSE Index	0.00191	0.0154	-0.0937	17.0443	10086
IPC	0.000995	0.0120	-0.0056	5.3720	283
IBC	0.001685	0.0148	1.8533	23.9751	22836
IBEX 35	0.000427	0.0122	0.0238	6.5292	638

*Stock Indices: Argentina (Merval), Brazil (Bovespa), Chile (IGPA Gen), Colombia (CSE Index), Mexico (IPC), Venezuela (IBC), Spain (IBEX 35)

Table 6.2 Descriptive Statistics Exchange Rates 1998

	Mean	SD	Skewness	Kurtosis	JB
ARGENTINA					
Argentine Peso/ Brazilian Real	-0.000328	0.0005	0.0000	33.8355	9548
Argentine Peso/ Chilean Peso	0.000294	0.0042	1.5439	15.3122	1618
Argentine Peso/Colombian Peso	-0.000677	0.0072	-1.5360	26.7642	5766
Argentine Peso/Mexican Peso	-0.000884	0.0101	-0.5039	9.1249	387
Argentine Peso/Venezuelan Bolivar	-0.000466	0.0024	1.5624	18.4654	2500
Argentine Peso/ Canadian Dollar	-0.000328	0.0009	0.6970	12.1685	864
Argentine Peso/Japanese Yen	0.000105	0.0045	0.6266	4.3583	34
Argentine Peso/US Dollar	-0.000343	0.0041	0.1940	5.4497	62
Argentine Peso/UK Pound	0.000638	0.0114	0.9528	6.2739	144
Argentine Peso/Peseta	0.000329	0.0057	0.2220	4.8028	35
BRAZIL					
Brazilian Real/Argentine Peso	0.000328	0.0009	-0.6970	12.1685	864
Brazilian Real/Chilean Peso	0.000622	0.0042	1.5497	15.0520	1555
Brazilian Real/ Colombian Peso	-0.000349	0.0072	-1.6579	26.8142	5805
Brazilian Real/Mexican Peso	-0.000556	0.0101	-0.4634	9.0536	377
Brazilian Real/Venezuelan Bolivar	-0.000138	0.0024	1.7292	18.9503	2675
Brazilian Real/Canadian Dollar	-1.47E-05	0.0041	0.1516	5.4523	61
Brazilian Real/Japanese Yen	0.000966	0.0114	0.9202	6.0561	128
Brazilian Real/US Dollar	0.000328	0.0007	-1.0504	10.4432	601
Brazilian Real/UK Pound	0.000433	0.0046	0.7520	4.6478	50
Brazilian Real/Peseta	0.000657	0.0056	0.2423	4.8265	36
CHILE					
Chilean Peso/Argentine Peso	-0.000294	0.0042	-1.5439	15.3122	1618
Chilean Peso/Brazilian Real	-0.000622	0.0042	-1.5497	15.0520	1555
Chilean Peso/Colombian Peso	-0.000971	0.0079	-1.6220	19.1891	2737
Chilean Peso/Mexican Peso	-0.001178	0.0116	-0.3534	7.0242	168
Chilean Peso/Venezuelan Bolivar	-0.00076	0.0048	-1.1520	11.4184	765
Chilean Peso/Canadian Dollar	-0.000636	0.0062	-0.5758	6.5358	139
Chilean Peso/Japanese Yen	0.000345	0.0123	0.7485	5.9719	111
Chilean Peso/US Dollar	-0.000294	0.0041	-1.6074	16.2371	1863
Chilean Peso/UK Pound	-0.000189	0.0059	-0.3412	8.4914	307
Chilean Peso/Peseta	3.57E-05	0.0071	-0.4180	4.8491	41
MEXICO					
Mexican Peso/Argentine Peso	0.000884	0.0101	0.5039	9.1249	387
Mexican Peso/Brazilian Real	0.000556	0.0101	0.4634	9.0536	377
Mexican Peso/Chilean Peso	0.001178	0.0116	0.3534	7.0242	168
Mexican Peso/Colombian Peso	0.000207	0.0121	0.0680	7.1030	169
Mexican Peso/Venezuelan Bolivar	0.000418	0.0102	0.4539	8.6870	333
Mexican Peso/Canadian Dollar	0.000541	0.0102	0.1693	6.9462	158
Mexican Peso/Japanese Yen	0.001523	0.0145	0.4051	5.3927	64
Mexican Peso/US Dollar	0.000884	0.0101	0.5130	9.1372	389
Mexican Peso/UK Pound	0.000989	0.0107	0.6822	7.9181	262
Mexican Peso/Peseta	0.001214	0.0115	0.4749	6.9739	168
VENEZUELA					
Venezuelan Bolivar/Argentine Peso	0.000466	0.0024	-1.5624	18.4654	2500
Venezuelan Bolivar/Brazilian Real	0.000138	0.0024	-1.7292	18.9503	2675
Venezuelan Bolivar/Chilean Peso	0.00076	0.0048	1.1520	11.4184	765
Venezuelan Bolivar/Colombian Peso	-0.000211	0.0075	-1.3571	22.4022	3854
Venezuelan Bolivar/Mexican Peso	-0.000418	0.0102	-0.4539	8.6870	333
Venezuelan Bolivar/Canadian Dollar	0.000123	0.0049	-0.1511	5.1371	47
Venezuelan Bolivar/Japanese Yen	0.001104	0.0114	0.9453	6.0416	129
Venezuelan Bolivar/US Dollar	0.000466	0.0023	-1.7686	20.3143	3136
Venezuelan Bolivar/UK Pound	0.00057	0.0051	0.7050	4.9109	57
Venezuelan Bolivar/Peseta	0.000795	0.0059	0.2692	5.0549	45
SPAIN					
Peseta/Argentine Peso	-0.000329	0.0057	-0.2220	4.8028	35
Peseta/Brazilian Real	-0.000657	0.0056	-0.2423	4.8265	36
Peseta/Chilean Peso	-3.57E-05	0.0071	0.4180	4.8491	41
Peseta/Colombian Peso	0.004149	0.0644	15.4274	239.0042	568860

Peseta/Mexican Peso	-0.001214	0.0115	-0.4749	6.9739	168
Peseta/Venezuelan Bolivar	0.000795	0.0059	0.2692	5.0549	45
Peseta/Canadian Dollar	-0.000672	0.0065	-0.3084	3.7826	10
Peseta/Japanese Yen	0.000309	0.0112	0.7238	4.9367	59
Peseta/US Dollar	-0.000329	0.0056	-0.2282	4.9138	39
Peseta/UK Pound	-0.000225	0.0073	0.2812	4.9902	43

Table 6.3 Descriptive Statistics Exchange Rates 1999-2001

	Mean	SD	Skewness	Kurtosis	JB
ARGENTINA					
Argentine Peso/ Brazilian Real	-0.000905	0.0123	-1.4371	21.0500	10078
Argentine Peso/ Chilean Peso	0.000467	0.0058	0.2467	24.2531	13633
Argentine Peso/Colombian Peso	-0.000554	0.0054	-0.1694	14.6112	4071
Argentine Peso/Mexican Peso	8.55E-05	0.0061	0.3505	14.6138	4084
Argentine Peso/Venezuelan Bolivar	-0.000428	0.0018	-0.2182	13.9139	3599
Argentine Peso/ Canadian Dollar	-6.93E-05	0.0038	0.1280	4.3961	61
Argentine Peso/Japanese Yen	-0.000234	0.0072	0.0128	5.4393	180
Argentine Peso/US Dollar	-3.46E-06	0.0014	0.7550	29.1979	20773
Argentine Peso/UK Pound	-0.000185	0.0052	0.1951	3.6097	16
Argentine Peso/Euro	0.000394	0.0069	-0.1041	4.3974	60
BRAZIL					
Brazilian Real/Argentine Peso	0.000905	0.0123	1.4371	21.0500	10078
Brazilian Real/Chilean Peso	0.001372	0.0145	1.1541	13.6133	3559
Brazilian Real/ Colombian Peso	0.000351	0.0131	1.3230	16.5796	5774
Brazilian Real/Mexican Peso	0.00099	0.0132	1.8838	28.2685	19690
Brazilian Real/Venezuelan Bolivar	0.000476	0.0122	1.3597	20.7954	9776
Brazilian Real/Canadian Dollar	0.000835	0.0124	1.1972	18.8928	7792
Brazilian Real/Japanese Yen	0.000671	0.0139	0.9655	9.8435	1525
Brazilian Real/US Dollar	0.000901	0.0122	1.4672	21.3356	10402
Brazilian Real/UK Pound	0.00072	0.0129	1.1223	17.5260	6517
Brazilian Real/Euro	0.001298	0.0136	1.0523	15.3162	4710
CHILE					
Chilean Peso/Argentine Peso	-0.000467	0.0058	-0.2467	24.2531	13633
Chilean Peso/Brazilian Real	-0.001372	0.0145	-1.1541	13.6133	3559
Chilean Peso/Colombian Peso	-0.001021	0.0076	-0.1044	9.4687	1264
Chilean Peso/Mexican Peso	-0.000381	0.0089	0.0964	9.8755	1427
Chilean Peso/Venezuelan Bolivar	-0.000895	0.0057	-0.2583	25.9726	15928
Chilean Peso/Canadian Dollar	-0.000536	0.0068	-0.0947	14.1952	3782
Chilean Peso/Japanese Yen	-0.000701	0.0088	0.0511	8.9223	1058
Chilean Peso/US Dollar	-0.00047	0.0057	-0.2113	26.5957	16801
Chilean Peso/UK Pound	-0.000652	0.0077	-0.2554	9.3477	1223
Chilean Peso/Euro	-7.34E-05	0.0090	0.0474	7.9821	749
MEXICO					
Mexican Peso/Argentine Peso	-8.55E-05	0.0061	-0.3505	14.6138	4084
Mexican Peso/Brazilian Real	-0.00099	0.0132	-1.8838	28.2685	19690
Mexican Peso/Chilean Peso	0.000381	0.0089	-0.0964	9.8755	1427
Mexican Peso/Colombian Peso	-0.000639	0.0078	-0.1485	11.2994	2081
Mexican Peso/Venezuelan Bolivar	-0.000514	0.0060	-0.4625	15.0934	4438
Mexican Peso/Canadian Dollar	-0.000155	0.0067	-0.4309	11.9419	2434
Mexican Peso/Japanese Yen	-0.000319	0.0095	0.1727	6.3591	344
Mexican Peso/US Dollar	-8.90E-05	0.0059	-0.3496	15.9708	5090
Mexican Peso/UK Pound	-0.00027	0.0079	0.1680	8.5175	922
Mexican Peso/Euro	0.000308	0.0085	-0.0456	6.0155	275
VENEZUELA					
Venezuelan Bolivar/Argentine Peso	0.000428	0.0018	0.2193	13.9312	3615
Venezuelan Bolivar/Brazilian Real	-0.000476	0.0122	-1.3606	20.8241	9821
Venezuelan Bolivar/Chilean Peso	0.000885	0.0057	0.2599	25.8924	15839
Venezuelan Bolivar/Colombian Peso	-0.000127	0.0053	-0.1575	14.8603	4252
Venezuelan Bolivar/Mexican Peso	0.00052	0.0060	0.4599	15.0926	4443
Venezuelan Bolivar/Canadian Dollar	0.000364	0.0037	0.1223	3.7968	21
Venezuelan Bolivar/Japanese Yen	0.000207	0.0072	0.1167	5.4070	177
Venezuelan Bolivar/US Dollar	0.000424	0.0012	1.6488	19.9372	8994
Venezuelan Bolivar/UK Pound	0.000244	0.0052	0.1725	3.6602	17
Venezuelan Bolivar/Euro	0.000827	0.0069	-0.0864	4.3778	58
SPAIN					
Euro/Argentine Peso	-0.000377	0.0069	0.2617	4.0012	39
Euro/Brazilian Real	0.001272	0.0135	0.9139	15.0087	4500
Euro/Chilean Peso	8.48E-05	0.0090	-0.0289	7.9631	751
Euro/Colombian Peso	0.000927	0.0081	-0.0667	4.0318	33

Euro/Mexican Peso	0.000289	0.0084	-0.2082	5.3358	172
Euro/Venezuelan Bolivar	0.000803	0.0068	-0.2622	3.9114	34
Euro/Canadian Dollar	-0.000564	0.0073	0.1958	3.5974	16
Euro/Japanese Yen	-0.00018	0.0092	0.1095	3.9446	29
Euro/US Dollar	-0.000381	0.0067	0.2696	3.9996	39
Euro/UK Pound	-0.000195	0.0055	0.2431	4.3547	63

Table 6.4 Descriptive Statistics Exchange Rates 2002-2006

	Mean	SD	Skewness	Kurtosis	JB
ARGENTINA					
Argentine Peso/ Brazilian Real	0.000987	0.0213	4.6529	72.4489	247328
Argentine Peso/ Chilean Peso	0.000772	0.0210	5.1964	85.9022	351657
Argentine Peso/Colombian Peso	0.00095	0.0199	6.0769	102.7253	508427
Argentine Peso/Mexican Peso	0.000788	0.0199	6.4689	112.5684	613196
Argentine Peso/Venezuelan Bolivar	6.83E-05	0.0257	1.9244	77.2046	278127
Argentine Peso/ Canadian Dollar	0.00119	0.0197	6.1411	108.5820	569157
Argentine Peso/Japanese Yen	0.001013	0.0200	5.9707	102.0545	501453
Argentine Peso/US Dollar	0.000929	0.0192	6.7500	119.6719	694902
Argentine Peso/UK Pound	0.001182	0.0200	6.0744	104.6116	527552
Argentine Peso/Euro	0.000612	0.0202	6.0246	100.6488	487654
BRAZIL					
Brazilian Real/Argentine Peso	-0.00099	0.0213	-4.6507	72.3902	246710
Brazilian Real/Chilean Peso	-0.000215	0.0142	-0.0871	8.2087	1367
Brazilian Real/ Colombian Peso	-3.75E-05	0.0112	-0.2730	11.2622	3451
Brazilian Real/Mexican Peso	-0.000205	0.0100	-0.5446	12.4380	4543
Brazilian Real/Venezuelan Bolivar	-0.000919	0.0180	-2.3150	53.0405	127116
Brazilian Real/Canadian Dollar	0.000207	0.0108	-0.1894	10.7560	3035
Brazilian Real/Japanese Yen	2.66E-05	0.0111	-0.1241	9.8137	2340
Brazilian Real/US Dollar	-5.80E-05	0.0100	-0.2266	13.1965	5243
Brazilian Real/UK Pound	0.000193	0.0114	-0.3045	10.0937	2551
Brazilian Real/Euro	-0.000373	0.0119	0.0112	9.1990	1934
CHILE					
Chilean Peso/Argentine Peso	-0.000775	0.0210	-5.1940	85.8325	350780
Chilean Peso/Brazilian Real	0.000215	0.0142	0.0871	8.2087	1367
Chilean Peso/Colombian Peso	0.000178	0.0093	0.0197	16.2251	8804
Chilean Peso/Mexican Peso	1.07E-05	0.0103	0.1827	10.6550	2956
Chilean Peso/Venezuelan Bolivar	-0.000704	0.0170	-2.2505	51.0485	117222
Chilean Peso/Canadian Dollar	0.000422	0.0101	0.0674	13.2870	5327
Chilean Peso/Japanese Yen	0.000242	0.0104	0.2676	11.2501	3440
Chilean Peso/US Dollar	0.000157	0.0079	0.2223	26.6252	28103
Chilean Peso/UK Pound	0.000408	0.0096	0.2084	15.3793	7722
Chilean Peso/Euro	-0.000157	0.0092	-0.2989	15.6126	8025
COLOMBIA					
Colombian Peso/Argentine Peso	-0.00094	0.0196	-6.2056	107.1390	562322
Colombian Peso/Brazilian Real	4.23E-05	0.0110	0.3395	11.2263	3483
Colombian Peso/Chilean Peso	-0.000198	0.0092	-0.0197	16.4927	9307
Colombian Peso/Mexican Peso	-0.000159	0.0069	-0.1713	6.2428	544
Colombian Peso/Venezuelan Bolivar	-0.000863	0.0152	-2.6055	75.4045	269407
Colombian Peso/Canadian Dollar	0.000236	0.0070	-0.0659	5.0084	207
Colombian Peso/Japanese Yen	6.36E-05	0.0074	0.2770	5.4154	314
Colombian Peso/US Dollar	-2.45E-05	0.0047	0.2456	9.6286	2259
Colombian Peso/UK Pound	0.00022	0.0068	-0.0464	4.9462	194
Colombian Peso/Euro	-0.000334	0.0075	0.2021	4.2070	83
MEXICO					
Mexican Peso/Argentine Peso	-0.000786	0.0199	-6.4668	112.4829	611741
Mexican Peso/Brazilian Real	0.000205	0.0100	0.5446	12.4380	4543
Mexican Peso/Chilean Peso	-1.07E-05	0.0103	-0.1827	10.6550	2956
Mexican Peso/Colombian Peso	0.000167	0.0070	0.1786	6.1810	516
Mexican Peso/Venezuelan Bolivar	-0.000715	0.0157	-3.0165	72.9130	247853
Mexican Peso/Canadian Dollar	0.000411	0.0069	0.2689	4.0989	75
Mexican Peso/Japanese Yen	0.000231	0.0077	0.4271	3.9566	83
Mexican Peso/US Dollar	0.000147	0.0050	0.4525	4.4619	149
Mexican Peso/UK Pound	0.000398	0.0074	0.2392	4.2128	86
Mexican Peso/Euro	-0.000168	0.0078	0.3201	4.0244	73
VENEZUELA					
Venezuelan Bolivar/Argentine Peso	-7.08E-05	0.0257	-1.9234	77.1418	277428
Venezuelan Bolivar/Brazilian Real	0.000919	0.0180	2.3150	53.0405	127116
Venezuelan Bolivar/Chilean Peso	0.000704	0.0170	2.2505	51.0485	117222
Venezuelan Bolivar/Colombian Peso	0.000882	0.0157	2.8485	71.0965	235036
Venezuelan Bolivar/Mexican Peso	0.000715	0.0157	3.0165	72.9130	247853
Venezuelan Bolivar/Canadian Dollar	0.001126	0.0159	2.8513	70.1792	228793
Venezuelan Bolivar/Japanese Yen	0.000946	0.0164	2.6340	62.8997	181992
Venezuelan Bolivar/US Dollar	0.000861	0.0152	3.4346	86.2320	351062
Venezuelan Bolivar/UK Pound	0.001112	0.0162	3.0231	71.4827	237897
Venezuelan Bolivar/Euro	0.001112	0.0162	3.0231	71.4827	237897
SPAIN					

Euro/Argentine Peso	-0.00061	0.0199	-6.1700	104.6999	537439
Euro/Brazilian Real	-0.000368	0.0118	-0.1001	9.1826	1959
Euro/Chilean Peso	0.000145	0.0090	0.2107	15.5108	8024
Euro/Colombian Peso	-0.000334	0.0074	0.2169	3.9727	58
Euro/Mexican Peso	-0.000162	0.0078	0.2522	4.1485	81
Euro/Venezuelan Bolivar	0.00054	0.0158	2.7721	72.0483	245718
Euro/Canadian Dollar	0.000401	0.0070	-0.1329	3.1036	4
Euro/Japanese Yen	0.000257	0.0056	-0.3498	4.4584	126
Euro/US Dollar	0.000306	0.0059	-0.1031	3.4633	13
Euro/UK Pound	8.27E-05	0.0039	0.1308	4.1549	68

Table 6.5 Augmented Dickey-Fuller Test Results

	1998	1999-2001	2002-2006
Stock Returns			
Merval	-14.60*	-24.70*	-10.66*
Bovespa	-16.05*	-20.20*	-25.14*
IGPA Gen	-3.46*	-18.64*	-8.47*
CSE Index	n/a	n/a	-8.03*
IPC	-14.86*	-22.83*	-32.55*
IBC	-11.00*	-22.91*	-20.54*
IBEX 35	-14.25*	-26.71*	-8.47*
Exchange Rates			
ARGENTINA			
Argentine Peso/ Brazilian Real	-7.01*	-9.52*	-7.23*
Argentine Peso/ Chilean Peso	-14.40*	-10.50*	-8.45*
Argentine Peso/Colombian Peso	-12.53*	-26.64*	-7.84*
Argentine Peso/Mexican Peso	-18.03*	-20.76*	-7.97*
Argentine Peso/Venezuelan Bolivar	-8.55*	-19.52*	-9.11*
Argentine Peso/ Canadian Dollar	-14.05*	-12.48*	-8.18*
Argentine Peso/Japanese Yen	-11.68*	-16.89*	-7.78*
Argentine Peso/US Dollar	-15.32*	-8.89*	-8.19*
Argentine Peso/UK Pound	-13.55*	-27.69*	-7.77*
Argentine Peso/Peseta	-15.51*	n/a	n/a
Argentine Peso/Euro	n/a	-26.97*	-6.49*
BRAZIL			
Brazilian Real/Argentine Peso	-14.05*	-9.52*	-7.23*
Brazilian Real/Chilean Peso	-14.14*	-8.25*	-19.32*
Brazilian Real/ Colombian Peso	-12.53*	-9.22*	-8.51*
Brazilian Real/Mexican Peso	-18.03*	-8.90*	-14.29*
Brazilian Real/Venezuelan Bolivar	-8.43*	-9.28*	-11.22*
Brazilian Real/Canadian Dollar	-14.99*	-9.45*	-8.00*
Brazilian Real/Japanese Yen	-13.49*	-24.53*	-19.06*
Brazilian Real/US Dollar	-12.76*	-9.51*	-7.53*
Brazilian Real/UK Pound	-11.84*	-16.07*	-16.07*
Brazilian Real/Peseta	-15.49*	n/a	n/a
Brazilian Real/Euro	n/a	-21.81*	-24.81*
CHILE			
Chilean Peso/Argentine Peso	-14.40*	-10.50*	-8.44*
Chilean Peso/Brazilian Real	-14.14*	-8.25*	-19.32*
Chilean Peso/Colombian Peso	-12.17*	-25.78*	-11.54*
Chilean Peso/Mexican Peso	-16.17*	-20.44*	-27.21*
Chilean Peso/Venezuelan Bolivar	-9.21*	-10.76*	-7.90*
Chilean Peso/Canadian Dollar	-15.39*	-10.57*	-28.51*
Chilean Peso/Japanese Yen	-13.26*	-30.10*	-28.14*
Chilean Peso/US Dollar	-14.09*	-10.61*	-30.01*
Chilean Peso/UK Pound	-11.55*	-28.69*	-26.82*
Chilean Peso/Peseta	-15.43*	n/a	n/a

Chilean Peso/Euro	n/a	-15.09*	-27.76*

Table 6.6 Augmented Dickey-Fuller Test Results

	1998	1999-2001	2002-2006
COLOMBIA			
Colombian Peso/Argentine Peso	n/a	n/a	-8.72*
Colombian Peso/Brazilian Real	n/a	n/a	-8.76*
Colombian Peso/Chilean Peso	n/a	n/a	-11.74*
Colombian Peso/Mexican Peso	n/a	n/a	-19.57*
Colombian Peso/Venezuelan Bolivar	n/a	n/a	-11.47*
Colombian Peso/Canadian Dollar	n/a	n/a	-8.28*
Colombian Peso/Japanese Yen	n/a	n/a	-34.63*
Colombian Peso/US Dollar	n/a	n/a	-24.13*
Colombian Peso/UK Pound	n/a	n/a	-31.74*
Colombian Peso/Euro	n/a	n/a	-34.11*
MEXICO			
Mexican Peso/Argentine Peso	-18.03*	-26.63*	-7.97*
Mexican Peso/Brazilian Real	-18.03*	-23.16*	-32.54*
Mexican Peso/Chilean Peso	-16.17*	-26.10*	-37.32*
Mexican Peso/Colombian Peso	-13.01*	-27.15*	-34.83*
Mexican Peso/Venezuelan Bolivar	-18.29*	-25.96*	-13.41*
Mexican Peso/Canadian Dollar	-7.22*	-21.04*	-36.02*
Mexican Peso/Japanese Yen	-16.12*	-25.82*	-35.62*
Mexican Peso/US Dollar	-17.96*	-25.87*	-36.82*
Mexican Peso/UK Pound	-17.36*	-25.64*	-36.56*
Mexican Peso/Peseta	-6.50*	-27.03*	-36.76*
Mexican Peso/Euro			
VENEZUELA			
Venezuelan Bolivar/Argentine Peso	-8.55*	-19.48*	-9.10*
Venezuelan Bolivar/Brazilian Real	-8.43*	-9.09*	-11.22*
Venezuelan Bolivar/Chilean Peso	-9.21*	-10.11*	-7.90*
Venezuelan Bolivar/Colombian Peso	-12.09*	-4.95*	-13.42*
Venezuelan Bolivar/Mexican Peso	-18.29*	-20.95*	-10.08*
Venezuelan Bolivar/Canadian Dollar	-14.64*	-20.20*	-10.02*
Venezuelan Bolivar/Japanese Yen	-13.88*	-27.60*	-12.69*
Venezuelan Bolivar/US Dollar	-8.25*	-6.42*	-10.06*
Venezuelan Bolivar/UK Pound	-13.91*	-26.48*	-9.97*
Venezuelan Bolivar/Peseta	-15.59*	n/a	n/a
Venezuelan Bolivar/Euro	n/a	-25.98*	-9.22*
SPAIN			
Peseta/Argentine Peso	-15.51*	n/a	n/a
Peseta/Brazilian Real	-15.49*	n/a	n/a
Peseta/Chilean Peso	-15.43*	n/a	n/a
Peseta/Colombian Peso	-15.49*	n/a	n/a
Peseta/Mexican Peso	-17.86*	n/a	n/a
Peseta/Venezuelan Bolivar	-15.59*	n/a	n/a
Peseta/Canadian Dollar	-15.01*	n/a	n/a
Peseta/Japanese Yen	-15.01*	n/a	n/a
Peseta/US Dollar	-15.44*	n/a	n/a
Peseta/UK Pound	-13.35*	n/a	n/a
Euro/Argentine Peso	n/a	-26.10*	-8.80*
Euro/Brazilian Real	n/a	-22.16*	-25.18*
Euro/Chilean Peso	n/a	-28.14*	-28.13*
Euro/Colombian Peso	n/a	-24.82*	-23.50*
Euro/Mexican Peso	n/a	-26.02*	-37.32*

Euro/Venezuelan Bolivar	n/a	-25.32*	-9.74*
Euro/Canadian Dollar	n/a	-25.42*	-34.07*
Euro/Japanese Yen	n/a	-26.57*	-33.57*
Euro/US Dollar	n/a	-25.63*	-36.70*
Euro/UK Pound	n/a	-20.67*	-33.82*

Note: * Indicates significant at 1% level

Table 6.7 Likelihood Ratio Test Results

ARGENTINA											
1998	**A.Peso/B.Real**	**A.Peso/Ch.Peso**	**A.Peso/Co.Peso**	**A.Peso/M.Peso**	**A.Peso/Bolivar**	**A,Peso/C$**	**A.Peso/¥**	**A.Peso/$**	**A.Peso/£**	**A.Peso/Pta**	**A.Peso/€**
Stock Returns	0.067	0.08	0.153	0.443	0.204	0.084	0.027	0.06	0.038	0.07	n/a
Exchange Rates	12.38	15.91	1.148	3.18	3.85	3.33	0.076	0.226	0.112	0.79	n/a
1999-2001											
Stock Returns	29.58	4.05	2.56	4.038	3.33	3.21	2.96	2.99	3.44	n/a	3.17
Exchange Rates	1.014	3.51	6.82	0.32	3.75	2.72	0.618	5.024	33.71	n/a	2.701
2002-2006											
Stock Returns	6.91	0.936	4.89	7.894	1.264	5.518	4.87	5.91	4.61	n/a	3.87
Exchange Rates	10.03	40.92	8.93	276.69	8.14	746.76	3.13	38.38	6.75	n/a	554.5
BRAZIL	**Real/A.Peso**	**Real/Ch.Peso**	**Real/Co.Peso**	**Real/M.Peso**	**Real/Bolivar**	**Real/C$**	**Real/¥**	**Real/$**	**Real/£**	**Real/Pta**	**Real/€**
1998											
Stock Returns	3.80	6.08	4.39	4.63	4.45	4.27	4.24	3.66	4.55	4.02	n/a
Exchange Rates	3.88	20.74	0.66	5.20	2.61	0.47	0.79	0.62	0.13	3.88	n/a
1999-2001											
Stock Returns	8.85	6.21	9.62	3.17	8.18	7.78	7.58	8.79	8.48	n/a	6.88
Exchange Rates	0.57	1.63	5.32	10.39	0.60	0.43	0.06	0.50	1.27	n/a	0.90
2002-2006											
Stock Returns	7.72	4.49	10.90	7.2	8.72	6.14	8.74	4.75	8.76	n/a	4.93
Exchange Rates	4.96	0.99	0.62	0.004	230.47	0.446	0.27	0.04	3.36	n/a	0.18
CHILE	**Ch.Peso/A.Peso**	**Ch.Peso/Real**	**Ch.Peso/Co.Peso**	**ChPeso/M.Peso**	**ChPeso/Bolivar**	**Ch Peso/C$**	**Ch Peso/¥**	**ChPeso/$**	**ChPeso/£**	**ChPeso/Pta**	**Ch.Peso/€**
1998											
Stock Returns	6.81	6.77	9.07	2.97	6.01	5.28	8.24	3.38	7.32	7.38	n/a
Exchange Rates	14.19	15.36	10.89	8.29	1.64	1.87	0.008	12.83	1.94	7.16	n/a
1999-2001											
Stock Returns	21.44	20.47	4.25	27.97	22.06	20.84	22.30	21.71	21.42	n/a	3.728
Exchange Rates	2.67	0.002	0.99	0.266	3.65	3.004	32.722	6.012	2.59	n/a	0.6
2002-2006											
Stock Returns	0.47	0.002	0.166	0.068	0.442	0.122	0.232	0.128	0.064	n/a	0.122
Exchange Rates	51.42	0.198	8.36	5.57	4.10	19.32	4343	9.94	11.25	n/a	0.068

*Note: H_0: EGARCH (1,1), H_1: EGARCH(2,1) The 5% critical value for the LR test distributed as with 2 degrees of freedom is 5.99.

Table 6.8 Likelihood Ratio Test Results

MEXICO	**M.Peso/A.Peso**	**M.Peso./Real**	**M.Peso/Ch.Peso**	**M.Peso/Co.Peso**	**M.Peso/Bolivar**	**M.Peso/C$**	**M.Peso/¥**	**M.Peso/$**	**M.Peso/£**	**M.Peso/Pta**	**M.Peso/€**
1998											
Stock Returns	50.76	50.11	57.04	43.12	50.06	53.75	43.02	50.129	1.150	27.54	n/a
Exchange Rates	3.37	6.60	57.04	1.245	1.25	1.51	0.015	4.31	7.62	4.16	n/a
1999-2001											
Stock Returns	0.48	1.402	0.69	1.40	0.83	0.62	0.98	0.69	1.00	n/a	0.64
Exchange Rates	0.30	9.42	1.88	0.57	6.49	11.89	1.06	4.94	0.004	n/a	12.24
2002-2006											
Stock Returns	3.46	4.66	2.83	4.24	3.24	3.31	3.29	3.11	3.90	n/a	3.55
Exchange Rates	19.87	0.05	0.04	3.40	141.93	3.44	1.35	0.006	0.03	n/a	0.15
VENEZUELA	**Bolivar/A.Peso**	**Bolivar/Real**	**Bolivar/Ch.Peso**	**Bolivar/Co.Peso**	**Bolivar/M.Peso**	**Bolivar/C$**	**Bolivar/¥**	**Bolivar/$**	**Bolivar/£**	**Bolivar/Pta**	**Bolivar/€**
1998											
Stock Returns	0.06	0.21	1.66	1.51	24.18	0.03	1.08	0.01	4.15	2.5	n/a
Exchange Rates	1.7	1.35	1.61	39.82	0.54	16.21	0.01	10.96	5.92	3.22	n/a
1999-2001											
Stock Returns	0.81	0.97	0.63	0.65	0.81	0.734	0.23	0.33	0.85	n/a	0.83
Exchange Rates	2.33	0.41	6.87	11.27	16.33	15.73	0.33	32.08	1.09	n/a	0.88
2002-2006											
Stock Returns	1.82	0.81	4.13	1.71	0.59	3.51	2.65	2.42	2.29	n/a	2.92
Exchange Rates	1773.4	252.18	3.472	253.416	111.06	214.80	10.70	237.33	75.53	n/a	567.12
SPAIN	**Pta/A.Peso**	**Pta/Real**	**Pta/Ch.Peso**	**Pta/Co.Peso**	**Pta/M.Peso**	**Pta/Bolivar**	**Pta/C$**	**Pta/¥**	**Pta/$**	**Pta/£**	
1998											
Stock Returns	0.94	0.73	0.35	79.53	2.37	0.66	0.76	0.03	0.92	0.49	
Exchange Rates	2.26	2.19	3.17	28.51	4.48	5.54	0.65	0.10	1.81	540.00	
1999-2001	**€/A.Peso**	**€/Real**	**€/Ch.Peso**	**€/Co.Peso**	**€/M.Peso**	**€/Bolivar**	**€/C$**	**€/¥**	**€/$**	**€/£**	
Stock Returns	1.58	3.55	2.63	2.69	2.43	1.44	1.72	2.26	1.41	2.63	
Exchange Rates	3.79	4.26	1.85	2.26	8.45	0.66	0.25	1.09	1.12	0.22	
2002-2006											
Stock Returns	1.69	1.55	0.37	0.88	1.73	1.40	1.01	1.75	1.21	1.10	
Exchange Rates	628.36	2.48	3.09	2.466	0.35	410.48	5.63	0.00	0.14	0.10	

*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.

A.Peso: Argentine Peso, B.Real: Brazilian Real, Ch.Peso: Chilean Peso, Co.Peso: Colombian Peso, M.Peso: Mexican Peso, Bolivar: Venezuelan Bolivar, C$: Canadian Dollar, ¥: Japanese Yen, $: US Dollar, £: British Pound, Pta: Spanish Peseta, €: Euro.

Table 6.9: Diagnostic Tests :Argentina

BRAZL 1998		Real/A.Peso	Real/Ch.Peso	Real/Co.Peso	Real/M.Peso	Real/Bolivar	Real/C$	Real/¥	Real/$	Real£	Real/Pta
Stock Returns	JB	5	3	4	3	4	2	4	5	3	3
	LB(20)	22.392	21.522	22.452	16.48	22.359	20.332	22.999	20.87	22.489	21.693
		(0.30)	(0.367)	(0.317)	(0.686)	(0.321)	(0.437)	(0.289)	(0.405)	(0.315)	(0.357)
	LB²(20)	21.158	20.303	20.762	18.605	20.482	18.904	19.722	18.573	20.303	19.276
		(0.388)	(0.439)	(0.411)	(0.548)	(0.428)	(0.528)	(0.475)	(0.550)	(0.439)	(0.504)
Exchange Rates	JB	869	102	3042	180	72	8	4	1483	41	17
	LB(20)							26.315			
		15.109	21.709	21.45	23.841	33.868	15.669	(0.156)	12.231	13.814	16.825
		(0.770)	(0.357)	(0.371)	(0.249)	(0.027)	(0.737)		(0.908)	(0.840)	(0.664)
	LB²(20)	3.3429	11.934	2.1166	13.74	10.943	12.371	12.96	2.3189	11.636	18.773
		(1.000)	(0.918)	(1.000)	(0.843)	(0.948)	(0.903)	(0.879)	(1.000)	(0.928)	(0.537)
Cross Products	LB(20)	15.282	18.569	7.8701	19.247	13.578	25.401	29.177	11.686	13.744	15.527
		(0.760)	(0.550)	(0.993)	(0.506)	(0.851)	(0.187)	(0.084)	(0.926)	(0.843)	(0.746)
	LB²(20)	0.3624	11.431	0.5489	7.1416	18.821	20.972	24.282	0.2089	11.613	15.317
		(1.000)	(0.934)	(1.000)	(0.996)	(0.534)	(0.399)	(0.230)	(1.000)	(0.929)	(0.758)
1999-2001		**Real/A.Peso**	**Real/Ch.Peso**	**Real/Co.Peso**	**Real/M.Peso**	**Real/Bolivar**	**Real/C$**	**Real/¥**	**Real/$**	**Real£**	**Real/€**
Stock Returns	JB	74	63	63	173	72	85	92	73	74	133
	LB(20)	25.943	24.567	26.313	27.228	25.404	26.414	24.969	25.706	23.582	27.952
		(0.168)	(0.219)	(0.156)	(0.129)	(0.186)	(0.153)	(0.203)	(0.176)	(0.261)	(0.100)
	LB²(20)	6.4366	8.4334	4.8138	5.1357	6.2247	5.6554	6.5295	6.1113	5.8771	4.1555
		(0.998)	(0.989)	(1.000)	(1.000)	(0.999)	(0.999)	(0.998)	(0.999)	(0.999)	(1.000)
Exchange Rates	JB	261	510	183	416	223	93	37	252	97	163
	LB(20)	9.3431	18.394	16.552	13.15	13.222	9.7492	15.4	11.116	15.282	18.086
		(0.979)	(0.561)	(0.682)	(0.871)	(0.868)	(0.972)	(0.753)	(0.943)	(0.760)	(0.582)
	LB²(20)	26.056	15.321	28.991	11.862	25.114	23.429	9.3243	29.254	17.237	21.731
		(0.164)	(0.758)	(0.088)	(0.921)	(0.197)	(0.268)	(0.979)	(0.083)	(0.638)	(0.355)
Cross Products	LB(20)	15.453	15.313	15.987	15.886	15.707	14.045	21.263	15.038	18.34	16.931
		(0.750)	(0.758)	(0.717)	(0.724)	(0.735)	(0.828)	(0.382)	(0.774)	(0.565)	(0.657)
	LB²(20)	1.4359	0.5354	2.9844	0.2057	1.4787	0.6873	0.7014	1.6761	1.1927	0.8954
		(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)
2002-2006											
Stock Returns	JB	16	10	8	21	19	23	21	14	17	7
	LB(20)	14.316	21.361	22.432	19.005	17.461	23.552	22.276	29.908	19.85	21.038
		(0.814)	(0.376)	(0.318)	(0.522)	(0.623)	(0.262)	(0.326)	(0.071)	(0.467)	(0.395)
	LB²(20)	16.853	16.498	18.778	14.585	16.313	19.013	16.652	21.069	19.512	21.412
		(0.662)	(0.685)	(0.536)	(0.800)	(0.697)	(0.521)	(0.675)	(0.393)	(0.489)	(0373)
Exchange Rates	JB	375	562	30	110	89145	66	43	81	34	184
	LB(20)	20.802	28.603	23.814	20.937	32.143	21.468	26.978	32.449	24.532	15.346
		(0.409)	(0.096)	(0.251)	(0.401)	(0.042)	(0.370)	(0.136)	(0.039)	(0.0220)	(0.756)
	LB²(20)	26.755	14.965	13.515	36.826	1.7714	17.319	15.935	14.35	24.801	20.827
		(0.142)	(0.778)	(0.854)	(0.012)	(1.000)	(0.632)	(0.721)	(0.812)	(0.209)	(0.407)
Cross Products	LB(20)	45.467	25.04	32.562	21.926	30.853	32.75	42.657	39.254	23.892	21.038

	(0.000)	(0.200)	(0.038)	(0.345)	(0.057)	(0.036)	(0.000)	(0.006)	(0.247)	(0.395)
$LB^2(20)$	4.3289	17.249	15.234	9.5104	7.6056	14.174	17.265	20.507	16.233	21.412
	(1.000)	(0.637)	(0.763)	(0.976)	(0.994)	(0.822)	(0.636)	(0.427)	(0.702)	(0.373)

Table 6.10: Diagnostic Tests :Brazil

BRAZIL	Real/A.Peso	Real/Ch.Peso	Real/Co.Peso	Real/M.Peso	Real/Bolivar	Real/C$	Real/¥	Real/$	Real£	Real/Pta
1998										
Stock Returns										
JB	5	3	4	3	4	2	4	5	3	3
LB(20)	22.392	21.522	22.452	16.48	22.359	20.332	22.999	20.87	22.489	21.693
	(0.30)	(0.367)	(0.317)	(0.686)	(0.321)	(0.437)	(0.289)	(0.405)	(0.315)	(0.357)
LB²(20)	21.158	20.303	20.762	18.605	20.482	18.904	19.722	18.573	20.303	19.276
	(0.388)	(0.439)	(0.411)	(0.548)	(0.428)	(0.528)	(0.475)	(0.550)	(0.439)	(0.504)
Exchange Rates										
JB	869	102	3042	180	72	8	4	1483	41	17
LB(20)							26.315			
	15.109	21.709	21.45	23.841	33.868	15.669	(0.156)	12.231	13.814	16.825
	(0.770)	(0.357)	(0.371)	(0.249)	(0.027)	(0.737)		(0.908)	(0.840)	(0.664)
LB²(20)	3.3429	11.934	2.1166	13.74	10.943	12.371	12.96	2.3189	11.636	18.773
	(1.000)	(0.918)	(1.000)	(0.843)	(0.948)	(0.903)	(0.879)	(1.000)	(0.928)	(0.537)
Cross Products										
LB(20)	15.282	18.569	7.8701	19.247	13.578	25.401	29.177	11.686	13.744	15.527
	(0.760)	(0.550)	(0.993)	(0.506)	(0.851)	(0.187)	(0.084)	(0.926)	(0.843)	(0.746)
LB²(20)	0.3624	11.431	0.5489	7.1416	18.821	20.972	24.282	0.2089	11.613	15.317
	(1.000)	(0.934)	(1.000)	(0.996)	(0.534)	(0.399)	(0.230)	(1.000)	(0.929)	(0.758)
1999-2001	**Real/A.Peso**	**Real/Ch.Peso**	**Real/Co.Peso**	**Real/M.Peso**	**Real/Bolivar**	**Real/C$**	**Real/¥**	**Real/$**	**Real£**	**Real/€**
Stock Returns										
JB	74	63	63	173	72	85	92	73	74	133
LB(20)	25.943	24.567	26.313	27.228	25.404	26.414	24.969	25.706	23.582	27.952
	(0.168)	(0.219)	(0.156)	(0.129)	(0.186)	(0.153)	(0.203)	(0.176)	(0.261)	(0.100)
LB²(20)	6.4366	8.4334	4.8138	5.1357	6.2247	5.6554	6.5295	6.1113	5.8771	4.1555
	(0.998)	(0.989)	(1.000)	(1.000)	(0.999)	(0.999)	(0.998)	(0.999)	(0.999)	(1.000)
Exchange Rates										
JB	261	510	183	416	223	93	37	252	97	163
LB(20)	9.3431	18.394	16.552	13.15	13.222	9.7492	15.4	11.116	15.282	18.086
	(0.979)	(0.561)	(0.682)	(0.871)	(0.868)	(0.972)	(0.753)	(0.943)	(0.760)	(0.582)
LB²(20)	26.056	15.321	28.991	11.862	25.114	23.429	9.3243	29.254	17.237	21.731
	(0.164)	(0.758)	(0.088)	(0.921)	(0.197)	(0.268)	(0.979)	(0.083)	(0.638)	(0.355)
Cross Products	**Real/A.Peso**	**Real/Ch.Peso**	**Real/Co.Peso**	**Real/M.Peso**	**Real/Bolivar**	**Real/C$**	**Real/¥**	**Real/$**	**Real£**	**Real/€**
LB(20)	15.453	15.313	15.987	15.886	15.707	14.045	21.263	15.038	18.34	16.931
	(0.750)	(0.758)	(0.717)	(0.724)	(0.735)	(0.828)	(0.382)	(0.774)	(0.565)	(0.657)
LB²(20)	1.4359	0.5354	2.9844	0.2057	1.4787	0.6873	0.7014	1.6761	1.1927	0.8954
	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)
2002-2006										
Stock Returns										
JB	16	10	8	21	19	23	21	14	17	7
LB(20)	14.316	21.361	22.432	19.005	17.461	23.552	22.276	29.908	19.85	21.038
	(0.814)	(0.376)	(0.318)	(0.522)	(0.623)	(0.262)	(0.326)	(0.071)	(0.467)	(0.395)
LB²(20)	16.853	16.498	18.778	14.585	16.313	19.013	16.652	21.069	19.512	21.412
	(0.662)	(0.685)	(0.536)	(0.800)	(0.697)	(0.521)	(0.675)	(0.393)	(0.489)	(0373)

Exchange Rates										
JB	375	562	30	110	89145	66	43	81	34	184
LB(20)	20.802	28.603	23.814	20.937	32.143	21.468	26.978	32.449	24.532	15.346
	(0.409)	(0.096)	(0.251)	(0.401)	(0.042)	(0.370)	(0.136)	(0.039)	(0.0220)	(0.756)
$LB^2(20)$	26.755	14.965	13.515	36.826	1.7714	17.319	15.935	14.35	24.801	20.827
	(0.142)	(0.778)	(0.854)	(0.012)	(1.000)	(0.632)	(0.721)	(0.812)	(0.209)	(0.407)
Cross Products										
LB(20)	45.467	25.04	32.562	21.926	30.853	32.75	42.657	39.254	23.892	21.038
	(0.000)	(0.200)	(0.038)	(0.345)	(0.057)	(0.036)	(0.000)	(0.006)	(0.247)	(0.395)
$LB^2(20)$	4.3289	17.249	15.234	9.5104	7.6056	14.174	17.265	20.507	16.233	21.412
	(1.000)	(0.637)	(0.763)	(0.976)	(0.994)	(0.822)	(0.636)	(0.427)	(0.702)	(0.373)

Table 6.11: Diagnostic Tests :Chile

CHILE 1998	**Ch.Peso/A.Peso**	**Ch.Peso/Real**	**Ch.Peso/Co.Peso**	**ChPeso/M.Peso**	**ChPeso/Bolivar**	**Ch Peso/C$**	**Ch Peso/¥**	**ChPeso/$**	**ChPeso/£**	**ChPeso/Pta**
Stock Returns										
JB	2	2	2	5	2	5	3	6	3	2
LB(20)	67.655	67.631	60.315	60.781	67.649	72.697	67.819	74.448	67.643	67.855
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
LB²(20)	19.226	19.188	17.906	18.374	19.672	14.346	20.435	18.469	20.681	20.442
	(0.507)	(0.510)	(0.594)	(0.563)	(0.479)	(0.813)	(0.431)	(0.557)	(0.416)	(0.431)
Exchange Rates										
JB	259	228	1865	80	95	250	4	283	31	25
LB(20)	14.154	15.229	14.914	16.848	17.18	22.504	24.905	13.62	25.717	11.047
	(0.823)	(0.763)	(0.781)	(0.663)	(0.641)	(0.314)	(0.205)	(0.849)	(0.175)	(0.945)
LB²(20)	14.596	13.553	4.9063	11.921	11.221	5.0375	8.6098	14.505	19.443	8.5588
	(0.799)	(0.852)	(1.000)	(0.919)	(0.940)	(1.000)	(0.987)	(0.804)	(0.493)	(0.987)
Cross Products										
LB(20)	17.735	16.672	20.284	20.621	9.5908	18.446	25.516	14.478	10.037	25.106
	(0.605)	(0.674)	(0.440)	(0.420)	(0.975)	(0.558)	(0.182)	(0.805)	(0.967)	(0.197)
LB²(20)	3.4851	9.1627	27.514	2.034	6.7822	0.785	24.532	4.9403	2.513	9.6908
	(1.000)	(0.981)	(0.121)	(1.000)	(0.997)	(1.000)	(0.220)	(1.000)	(1.000)	(0.973)
1999-2001	**Ch.Peso/A.Peso**	**Ch.Peso/Real**	**Ch.Peso/Co.Peso**	**ChPeso/M.Peso**	**ChPeso/Bolivar**	**Ch Peso/C$**	**Ch Peso/¥**	**ChPeso/$**	**ChPeso/£**	**Ch.Peso/€**
Stock Returns										
JB	58	57	63	61	56	61	55	55	66	59
LB(20)	94.732	97.168	109.57	76.808	86.952	92.019	105.22	92.355	100.64	110.72
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
LB²(20)	15.572	15.984	24.993	40.095	19.001	16.25	16.584	15.328	17.79	25.825
	(0.743)	(0.718)	(0.202)	(0.005)	(0.522)	(0.701)	(0.680)	(0.757)	(0.601)	(0.172)
Exchange Rates										
JB	6412	590	788	870	7402	998	293	3917	588	177
LB(20)	14.382	20.227	27.22	19.758	13.518	15.008	34.386	12.918	14.108	20.338
	(0.811)	(0.444)	(0.129)	(0.473)	(0.854)	(0.776)	(0.024)	(0.881)	(0.825)	(0.437)
LB²(20)	15.839	12.712	93.76	13.553	14.349	19.084	20.802	28.969	21.028	15.154
	(0.727)	(0.889)	(0.000)	(0.852)	(0.812)	(0.516)	(0.409)	(0.088)	(0.396)	(0.768)
Cross Products										
LB(20)	28.192	13.703	39.735	41.352	33.757	19.832	10.85	24.401	15.604	17.494
	(0.105)	(0.845)	(0.005)	(0.003)	(0.028)	(0.468)	(0.950)	(0.225)	(0.741)	(0.621)
LB²(20)	5.6517	0.8168	4.1042	11.477	5.7488	4.6745	9.0028	4.9834	7.8388	12.392
	(0.999)	(1.000)	(1.000)	(0.933)	(0.999)	(1.000)	(0.983)	(1.000)	(0.983)	(0.902)
2002-2006										
Stock Returns	**Ch.Peso/A.Peso**	**Ch.Peso/Real**	**Ch.Peso/Co.Peso**	**ChPeso/M.Peso**	**ChPeso/Bolivar**	**Ch Peso/C$**	**Ch Peso/¥**	**ChPeso/$**	**ChPeso/£**	**Ch.Peso/€**
JB	681	686	607	650	541	673	685	624	482	631
LB(20)	102.43	89.439	98.62	98.977	104.15	97.625	100.43	100.77	99.29	106.97
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
LB²(20)	14.003	11.898	15.32	12.33	15.541	14.238	14.964	14.659	14.639	13.044
	(0.830)	(0.920)	(0.758)	(0.904)	(0.745)	(0.818)	(0.778)	(0.796)	(0.797)	(0876)

Exchange Rates										
JB	4952	409	1879	1425	145481	716	449	4444	2351	2826
LB(20)	19.323	38.863	22.304	25.025	23.192	14.92	14.761	17.32	17.961	20.723
	(0.501)	(0.007)	(0.324)	(0.200)	(0.279)	(0.781)	(0.790)	(0.632)	(0.590)	(0.414)
LB²(20)	14.662	13.802	13.764	17.775	1.4314	13.325	12.318	9.2539	12.954	6.3291
	(0.795)	(0.840)	(0.842)	(0.602)	(1.000)	(0.863)	(0.905)	(0.980)	(0.879)	(0.998)
Cross Products										
LB(20)	14.263	30.113	20.8	44.128	3.2548	24.251	21.525	24.543	15.879	19.379
	(0.817)	(0.068)	(0.409)	(0.001)	(1.000)	(0.232)	(0.367)	(0.219)	(0.724)	(0.497)
LB²(20)	7.3076	2.0714	8.2808	2.174	0.1216	11.033	27.638	7.981	47.003	2.6706
	(0.996)	(1.000)	(0.990)	(1.000)	(1.000)	(0.945)	(0.118)	(0.992)	(0.000)	(1.000)

Table 6.12: Diagnostic Tests :Columbia

COLOMBIA 2002-2006	Co.Peso/A.Peso	Co.Peso/Real	Co.Peso/Ch.Peso	Co.Peso/M.Peso	Co.Peso/Bolivar	Co.Peso/C$	Co.Peso/¥	Co.Peso/$	Co.Peso/£	Co.Peso/€
Stock Returns										
JB	439	459	471	443	444	441	435	433	451	384
LB(20)	121.47	122.39	111.58	120.54	121.13	119.91	118.67	114.37	118.54	118.34
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
LB²(20)	8.7838	8.4812	9.5085	8.6398	8.6889	9.0821	8.8424	8.9108	8.748	8.4169
	(0.985)	(0.988)	(0.976)	(0.987)	(0.986)	(0.982)	(0.985)	(0.984)	(0.986)	(0.989)
Exchange Rates										
JB	1860	31	2697	123	409469	73	204	1336	124	51
LB(20)	28.021	37.604	30.096	13.411	25.203	22.332	11.214	70.431	31.514	15.734
	(0.109)	(0.010)	(0.068)	(0.859)	(0.194)	(0.323)	(0.341)	(0.000)	(0.049)	(0.733)
LB²(20)	7.1205	16.423	12.836	20.223	1.7832	11.4	15.884	5.5515	9.0831	15.107
	(0.996)	(0.690)	(0.884)	(0.444)	(1.000)	(0.935)	(0.724)	(0.999)	(0.982)	(0.770)
Cross Products										
LB(20)	10.149	20.122	21.954	19.564	9.9955	20.359	16.938	19.771	17.733	22.91
	(0.965)	(0.450)	(0.343)	(0.485)	(0.968)	(0.436)	(0.657)	(0.472)	(0.605)	(0.293)
LB²(20)	1.8382	2.6526	17.742	2.9959	0.4762	1.7723	1.4139	7.6329	1.5619	3.6701
	(1.000)	(1.000)	(0.604)	(1.000)	(1.000)	(1.000)	(1.000)	(0.994)	(1.000)	(1.000)

Table 6.13: Diagnostic Tests : Mexico

MEXICO	M.Peso/A.Peso	M.Peso.Real	M.Peso/Ch.Peso	M.Peso/Co.Peso	M.Peso/Bolivar	M.Peso/C$	M.Peso/¥	M.Peso/$	M.Peso/£	M.Peso/Pta
1998										
Stock Returns										
JB	18	21	20	16	25	17	23	19	13	17
LB(20)	18.699	18.686	19.139	16.86	19.688	22.463	17.671	18.469	16.526	19.023
	(0.541)	(0.542)	(0.513)	(0.662)	(0.478)	(0.316)	(0.609)	(0.557)	(0.684)	(0.520)
$LB^2(20)$	22.013	22.11	23.342	25.116	24.618	27.004	21.852	22.069	29.635	22.307
	(0.340)	(0.335)	(0.272)	(0.197)	(0.216)	(0.135)	(0.349)	(0.337)	(0.197)	(0.324)
Exchange Rates										
JB	183	95	203	77	88	23	0.73	182	8	12
LB(20)	24.805	26.457	19.796	11.047	22.465	16.658	22.791	26.046	16.493	25.318
	(0.209)	(0.151)	(0.471)	(0.354)	(0.316)	(0.675)	(0.299)	(0.164)	(0.686)	(0.190)
$LB^2(20)$	13.559	13.005	12.675	15.534	11.727	21.081	15.537	13.059	15.282	13.203
	(0.852)	(0.877)	(0.891)	(0.745)	(0.925)	(0.392)	(0.745)	(0.875)	(0.760)	(0.869)
Cross Products										
LB(20)	24.56	21.938	8.1769	19.649	25.503	13.63	24.672	23.25	11.236	19.281
	(0.219)	(0.344)	(0.991)	(0.480)	(0.183)	(0.849)	(0.214)	(0.277)	(0.940)	(0.504)
$LB^2(20)$	19.759	18.091	9.4409	18.907	25.603	17.711	14.533	19.443	14.091	26.69
	(0.473)	(0.581)	(0.977)	(0.528)	(0.179)	(0.606)	(0.802)	(0.493)	(0.826)	(0.144)
1999-2001	**M.Peso/A.Peso**	**M.Peso.Real**	**M.Peso/Ch.Peso**	**M.Peso/Co.Peso**	**M.Peso/Bolivar**	**M.Peso/C$**	**M.Peso/¥**	**M.Peso/$**	**M.Peso/£**	**M.Peso/€**
Stock Returns										
JB	25	36	24	21	30	27	33	31	25	29
LB(20)	35.547	42.211	40.061	43.363	36.972	39.418	40.471	35.291	36.266	42.642
	(0.017)	(0.003)	(0.005)	(0.002)	(0.012)	(0.006)	(0.004)	(0.019)	(0.014)	(0.002)
$LB^2(20)$	22.442	20.512	20.593	27.451	22.049	24.382	21.343	22.013	24.506	20.401
	(0.317)	(0.426)	(0.421)	(0.123)	(0.338)	(0.226)	(0.377)	(0.340)	(0.221)	(0.433)
Exchange Rates										
JB	2566	422	947	1848	1806	735	213	2543	959	70
LB(20)	13.167	14.813	19.558	19.866	16.002	17.913	19.671	14.721	24.856	28.986
	(0.870)	(0.787)	(0.486)	(0.466)	(0.716)	(0.593)	(0.479)	(0.792)	(0.207)	(0.088)
$LB^2(20)$	6.9929	12.446	10.059	6.4078	3.9519	7.1675	39.141	5.9	11.349	33.162
	(0.997)	(0.900)	(0.967)	(0.998)	(1.000)	(0.996)	(0.006)	(0.999)	(0.937)	(0.032)
Cross Products										
LB(20)	20.096	14.933	18.896	19.961	18.407	13.581	25.028	21.134	14.558	18.333
	(0.452)	(0.780)	(0.529)	(0.460)	(0.561)	(0.851)	(0.200)	(0.389)	(0.801)	(0.565)
$LB^2(20)$	2.2587	1.822	4.3228	8.5144	2.5099	4.0253	15.493	2.4189	4.1956	29.284
	(1.000)	(1.000)	(1.000)	(0.988)	(1.000)	(1.000)	(0.748)	(1.000)	(1.000)	(0.082)
2002-2006										
Stock Returns	**M.Peso/A.Peso**	**M.Peso.Real**	**M.Peso/Ch.Peso**	**M.Peso/Co.Peso**	**M.Peso/Bolivar**	**M.Peso/C$**	**M.Peso/¥**	**M.Peso/$**	**M.Peso/£**	**M.Peso/€**
JB	37	46	37	37	40	37	38	34	37	31
LB(20)	17.433	17.737	15.406	16.007	16.443	16.843	15.972	13.523	16.274	16.085

	(0.625)	(0.605)	(0.753)	(0.716)	(0.689)	(0.663)	(0.718)	(0.854)	(0.699)	(0.711)
$LB^2(20)$	42.858	40.488	37.51	48.937	43.554	42.014	41.679	42.035	44.793	43.373
	(0.002)	(0.004)	(0.010)	(0.000)	(0.002)	(0.003)	(0.003)	(0.003)	(0.001)	(0.002)
Exchange Rates										
JB	238	110	1278	132	577497	28	127	74	65	22
LB(20)	20.516	21.261	28.792	11.344	11.68	12.475	12.694	16.106	24.442	26.12
	(0.426)	(0.382)	(0.092)	(0.937)	(0.927)	(0.899)	(0.890)	(0.710)	(0.224)	(0.162)
$LB^2(20)$	15.333	35.921	17.131	17.464	0.5694	19.529	10.352	14.176	19.731	16.137
	(0.757)	(0.016)	(0.644)	(0.623)	(1.000)	(0.488)	(0.961)	(0.821)	(0.475)	(0.708)
Cross Products										
LB(20)	22.985	13.012	17.593	27.66	18.396	30.753	28.595	31.866	9.8981	59.19
	(0.290)	(0.877)	(0.614)	(0.118)	(0.561)	(0.059)	(0.096)	(0.045)	(0.970)	(0.000)
$LB^2(20)$	13.044	4.8079	1.3524	20.64	0.4933	2.8359	12.898	7.5668	9.2143	4.5321
	(0.876)	(1.000)	(1.000)	(0.419)	(1.000)	(1.000)	(0.882)	(0.994)	(0.980)	(1.000)

Table 6.14: Diagnostic Tests :Venezuela

VENEZUELA	**Bolivar/A.Peso**	**Boliar/Real**	**Bolivar/Ch.Peso**	**Bolivar/Co.Peso**	**Bolivar/M/Peso**	**Bolivar/C$**	**Bolivar/¥**	**Bolivar/$**	**Bolivar/£**	**Bolivar/Pta**
1998										
Stock Returns										
JB	330	342	384	628	51	541	641	269	473	657
LB(20)	20.7	20.973	19.498	24.251	29.87	25.742	24.444	21.074	23.198	24.13
	(0.415)	(0.399)	(0.490)	(0.232)	(0.072)	(0.174)	(0.224)	(0.393)	(0.279)	(0.237)
LB²(20)	2.9108	1.8107	2.1931	1.6105	7.5449	1.83	1.397	2.9816	1.7549	1.3839
	(1.000)	(1.000)	(1.000)	(1.000)	(0.994)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)
Exchange Rates										
JB	40	17	98	2540	62	26	3	49	14	6
LB(20)	12.621	34.473	16.966	23.857	24.29	23.305	22.056	21.147	6.8154	13.409
	(0.893)	(0.023)	(0.655)	(0.249)	(0.230)	(0.274)	(0.337)	(0.389)	(0.997)	(0.859)
LB²(20)	24.235	20.526	8.728	6.0583	11.813	30.265	15.011	17.688	9.5753	10.818
	(0.232)	(0.425)	(0.986)	(0.999)	(0.922)	(0.066)	(0.776)	(0.608)	(0.975)	(0.951)
Cross Products										
LB(20)	28.206	15.847	19.146	12.385	15.949	28.272	35.31	30.33	17.012	9.5874
	(0.105)	(0.726)	(0.512)	(0.902)	(0.720)	(0.103)	(0.019)	(0.065)	(0.652)	(0.975)
LB²(20)	10.641	3.391	10.039	0.6052	2.9555	12.71	18.303	17.304	6.0626	7.926
	(0.955)	(1.000)	(0.967)	(1.000)	(1.000)	(0.889)	(0.567)	(0.633)	(0.999)	(0.992)
1999-2001	**Bolivar/A.Peso**	**Boliar/Real**	**Bolivar/Ch.Peso**	**Bolivar/Co.Peso**	**Bolivar/M/Peso**	**Bolivar/C$**	**Bolivar/¥**	**Bolivar/$**	**Bolivar/£**	**Bolivar/€**
Stock Returns										
JB	2060	2082	2009	2032	1922	1977	2187	1998	1845	2081
LB(20)	35.074	33.178	34.988	35.855	31.668	35.508	36.832	35.863	34.806	35.694
	(0.020)	(0.032)	(0.020)	(0.016)	(0.047)	(0.018)	(0.012)	(0.016)	(0.021)	(0.017)
LB²(20)	20.355	19.58	19.32	20.278	21.106	20.636	19.036	20.167	20.7	19.573
	(0.436)	(0.484)	)0.501)	(0.441)	(0.391)	(0.419)	(0.520)	(0.4448)	(0.415)	(0.485)
Exchange Rates										
JB	1894	317	7312	3947	1194	8	58	1180	11	45
LB(20)	33.471	19.039	15.11	32.035	13.496	16.642	19.23	31.916	19.73	27.445
	(0.030)	(0.519)	(0.770)	(0.043)	(0.855)	(0.670)	(0.507)	(0.044)	(0.475)	(0.123)
LB²(20)	6.9087	33.901	10.546	4.2793	6.1997	14.945	8.776	13.047	23.803	23.481
	(0.997)	(0.027)	(0.957)	(1.000)	(0.999)	(0.780)	(0.985)	(0.875)	(0.251)	(0.266)
Cross Products	**Bolivar/A.Peso**	**Boliar/Real**	**Bolivar/Ch.Peso**	**Bolivar/Co.Peso**	**Bolivar/M/Peso**	**Bolivar/C$**	**Bolivar/¥**	**Bolivar/$**	**Bolivar/£**	**Bolivar/€**
LB(20)	15.013	17.734	20.878	18.047	24.947	13.487	14.765	10.212	13.332	11.374
	(0.776)	(0.605)	(0.404)	(0.584)	(0.203)	(0.856)	(0.790)	(0.964)	(0.863)	(0.936)
LB²(20)	7.097	16.569	31.966	14.672	42.419	2.8423	2.7455	1.2317	14.55	13.164

	(0.996)	(0.681)	(0.044)	(0.795)	(0.002)	(1.000)	(1.000)	(1.000)	(0.802)	(0.870)
2002-2006										
Stock Returns										
JB	14321	13658	12934	10350	9258	11580	13197	10223	10875	11928
LB(20)	42.766	45.66	46.543	43.872	51.625	47.23	46.475	51.453	46.25	53.696
	(0.002)	(0.001)	(0.001)	(0.002)	(0.000)	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)
$LB^2(20)$	1.7661	1.6531	1.7649	2.2114	3.4101	2.2685	1.8996	2.999	2.3626	1.8247
	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)
Exchange Rates										
JB	135145	152735	106106	1352745	616176	463312	423796	3915436	307315	439685
LB(20)	90.132	27.414	22.664	24.169	9.3375	14.297	15.335	11.497	12.08	11.17
	(0.000)	(0.124)	(0.306)	(0.235)	(0.979)	(0.815)	(0.757)	(0.932)	(0.913)	(1.000)
$LB^2(20)$	131.92	0.7065	1.8774	0.4377	0.6351	0.8019	0.4136	0.6003	0.7774	0.5123
	(0.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)
Cross Products										
LB(20)	61.357	2.1598	1.9411	5.7218	2.5167	8.0333	2.2149	8.3912	3.7709	2.9044
	(0.000)	(1.000)	(1.000)	(0.999)	(1.000)	(0.992)	(1.000)	(0.989)	(1.000)	(1.000)
$LB^2(20)$	18.919	0.0397	0.0273	0.2271	0.1877	0.1316	0.0378	0.2463	0.0738	0.0497
	(0.527)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)

Table 6.15: Diagnostic Tests :Spain

SPAIN	**Pta/A.Peso**	**Pta/Real**	**Pta/Ch.Peso**	**Pta/Co.Peso**	**Pta/M.Peso**	**Pta/Bolivar**	**Pta/C$**	**Pta/¥**	**Pta/$**	**Pta/£**
1998										
Stock Returns										
JB	2	2	3	77	0.62	2	0.45	2	2	2
LB(20)	21.738	21.703(0.357	21.409	37.801	19.265	21.072	18.954	21.568	21.886(0.	21.394
	(0.355)	)	(0.373)	(0.009)	(0.505)	(0.393)	(0.525)	(0.364)	347)	(0.374)
LB²(20)	23.768	23.547	21.187	193.02	29.987	23.74	20.559	24.859	23.882	23.601
	(0.253)	(0.263)	(0.386)	(0.000)	(0.070)	(0.254)	(0.423)	(0.207)	(0.248)	(0.260)
Exchange Rates										
JB	21	17	4	342266	7	9	4	27	23	5
LB(20)	18.417	18.202	13.089	9.2876	37.091	12.349	20.105	9.9806	19.471	19.469
	(0.560)	(0.574)	(0.874)	(0.979)	(0.011)	(0.904)	(0.451)	(0.969)	(0.491)	(0.492)
LB²(20)	14.061	16.412	12.876	0.1961	9.3664	11.778	11.244	11.692	14.389	22.168
	(0.827)	(0.691)	(0.883)	(1.000)	(0.978)	(0.924)	(0.940)	(0.926)	(0.810)	(0.331)
Cross Products										
LB(20)	19.536	15.744	31.047	190.15	21.012	8.5618	20.035	19.213	18.117	24.129
	(0487)	(0.732)	(0.055)	(0.000)	(0.396)	(0.987)	(0.456)	(0.508)	(0.580)	(0.237)
LB²(20)	23.932	8.8237	15.995	113.05	72.163	15.065	8.9971	71.245	18.951	29.016
	(0.245)	(0.985)	(0.717)	(0.000)	(0.000)	(0.773)	(0.983)	(0.000)	(0.525)	(0.087)
1999-2001	**€/A.Peso**	**€/Real**	**€/Ch.Peso**	**€/Co.Peso**	**€/M.Peso**	**€/Bolivar**	**€/C$**	**€/¥**	**€/$**	**€/£**
Stock Returns										
JB	2	3	2	6	5	2	3	5	3	5
LB(20)	22.034	22.555	19.625	21.997	22.994	22.178	22.745	22.815	22.207	22.556
	(0.339)	(0.311)	(0.502)	(0.341)	(0.289)	(0.331)	(0.301)	(0.298)	(0.329)	(0.311)
LB²(20)	23.366	16.477	20.58	21.738	18.751	23.639	21.272	18.314	22.389	18.554
	(0.271)	(0.687)	(0.422)	(0.355)	(0.538)	(0.259)	(0.381)	(0.567)	(0.320)	(0.551)
Exchange Rates										
JB	49	39	102	21	38	40	19	26	40	55
LB(20)	42.825	28.856	27.995	25.777	25.605	42.953	41.307	11.733	42.756	24.417
	(0.002)	(0.091)	(0.110)	(0.173)	(0.179)	(0.002)	(0.003)	(0.925)	(0.002)	(0.225)
LB²(20)	30.029	22.396	10.325	13.643	24.746	20.539	23.902	10.752	24.535	11.953
	(0.069)	(0.319)	(0.962)	(0.848)	(0.211)	(0.425)	(0.247)	(0.952)	(0.220)	(0.918)
Cross Products	**€/A.Peso**	**€/Real**	**€/Ch.Peso**	**€/Co.Peso**	**€/M.Peso**	**€/Bolivar**	**€/C$**	**€/¥**	**€/$**	**€/£**
LB(20)	37.332	19.231	13.229	27.166	30.218	43.717	37.732	28.367	38.743	22.237
	(0.011)	(0.507)	(0.867)	(0.131)	(0.066)	(0.002)	(0.010)	(0.101)	(0.007)	(0.328)
LB²(20)	40.935	58.794	9.2621	7.0933	8.5367	38.92	30.985	12.64	39.456	38.228
	(0.004)	(0.000)	(0.980)	(0.996)	(0.988)	(0.007)	(0.055)	(0.892)	(0.006)	(0.008)
2002-2006										
Stock Returns										

JB	79	62	65	65	77	77	80	77	63	77
LB(20)	18.819	17.901	21.246	18.976	18.808	19.354	21.038	16.296	18.034	16.545
	(0.534)	(0.594)	(0.501)	(0.523)	(0.534)	(0.499)	(0.724)	(0.698)	(0.585)	(0.682)
LB²(20)	29.897	27.245	31.868	36.751	29.416	31.544	28.721	27.826	34.489	27.824
	(0.072)	(0.129)	(0.045)	(0.013)	(0.080)	(0.048)	(0.093)	(0.114)	(0.023)	(0.114)
Exchange Rates										
JB	7200	50	2959	31	48	316009	4	118	9	47
LB(20)	44.025	29.773	16.185	25.168	26.375	38.334	15.467	27.512	29.79	17.818
	(0.001)	(0.074)	(0.705)	(0.195)	(0.154)	(0.008)	(0.749)	(0.121)	(0.073)	(0.599)
LB²(20)	720.17	12.042	5.5246	24.438	12.165	10.305	53.582	16.908	19.155	25.68
	(0.000)	(0.915)	(0.999)	(0.224)	(0.910)	(0.962)	(0.000)	(0.659)	(0.512)	(0.177)
Cross Products										
LB(20)	70.824	66.714	21.741	18.942	68.4	27.992	23.86	20.558	56.368	21.318
	(0.000)	(0.000)	(0.355)	(0.526)	(0.000)	(0.110)	(0.249)	(0.424)	(0.000)	(0.379)
LB²(20)	128.09	51.546	1.522	27.29	37.551	21.598	3.0345	23.063	29.664	35.818
	(0.000)	(0.000)	(1.000)	(0.127)	(0.010)	(0.363)	(1.000)	(0.286)	(0.075)	(0.016)

APPENDIX G

PRECIOUS METALS MARKETS AND THE G-7 EQUITY MARKETS

TABLE 7.1: Descriptive Statistics Stock Returns

	Mean	SD	Skewness	Kurtosis	JB
1995-2006					
S&P/TSX Composite	0.000358	0.0094	-0.7059	9.4888	5749
CAC 40	0.000345	0.0135	-0.1080	5.9068	1108
DAX 30	0.000369	0.0149	-0.1689	6.2272	1373
MIB 30	0.000333	0.0135	-0.1097	6.0301	1203
NIKKEI 225	-4.33E-05	0.0139	-0.0259	5.1865	624
FTSE 100	0.000226	0.0106	-0.1976	6.2149	1368
Dow Jones	0.000377	0.0104	-0.2513	7.7645	2992
1995-June 1997					
S&P/TSX Composite	0.000652	0.0056	-0.6371	6.5221	380
CAC 40	0.000644	0.0100	-0.1630	3.9388	27
DAX 30	-0.00091	0.0084	0.2432	4.3997	59
MIB 30	0.000477	0.0122	0.2234	4.3261	53
NIKKEI 225	6.73E-05	0.0125	0.0937	5.3677	153
FTSE 100	0.000626	0.0061	-0.2018	3.3343	7
Dow Jones	0.001067	0.0073	-0.3743	4.8146	104
July 1997-1998					
S&P/TSX Composite	0.000173	0.0104	-1.1045	9.8534	1126
CAC 40	0.001021	0.0150	-0.2350	4.7557	72
DAX 30	0.001061	0.0167	-0.4105	5.0705	108
MIB 30	0.001547	0.0180	-0.2322	4.4308	49
NIKKEI 225	-0.000644	0.0168	0.1624	4.8557	77
FTSE 100	0.000684	0.0114	-0.0857	4.2899	37
Dow Jones	0.000678	0.0120	-0.6988	8.4702	692
1999-2006					
S&P/TSX Composite	0.00033	0.0100	-0.5478	8.3101	2554
CAC 40	0.000163	0.0140	-0.0798	5.9644	766
DAX 30	0.000132	0.0158	-0.0787	5.8040	685
MIB 30	8.04E-05	0.0126	-0.1566	6.6067	1139
NIKKEI 225	0.000105	0.0135	-0.1193	4.8653	307
FTSE 100	2.68E-05	0.0113	-0.2025	6.0828	840
Dow Jones	0.000147	0.0107	-0.0462	6.7601	1229

Table 7.2: Descriptive Statistics Precious Metals

	Mean	SD	Skewness	Kurtosis	JB
1995-2006					
Gold	0.000162	0.0086	0.1703	10.5384	7424
Platinum	-0.000315	0.0136	0.6427	19.1193	34091
Silver	0.000307	0.0174	-0.6741	12.9421	13124
1995-June 1997					
Gold	-0.000207	0.0044	0.3319	6.4210	329
Platinum	4.91E-05	0.0101	2.3290	33.2392	25353
Silver	-7.95E-05	0.0143	0.6299	10.4756	1557
July 1997-1998					
Gold	-0.000481	0.0069	0.0639	4.1675	30
Platinum	-4.20E-05	0.0155	0.6264	10.0941	1127
Silver	-2.13E-05	0.0175	0.2059	6.3548	248
1999-2006					
Gold	0.000379	0.0097	0.1240	9.2690	3420
Platinum	0.000541	0.0142	-1.0640	20.1818	26040
Silver	0.000453	0.0181	-1.0566	14.1642	11216

Table 7.3: Augmented Dickey-Fuller Test

	1995-2006	1995-June 1997	July 1997-1998	1999-2006
Stock Returns				
S&P/TSX Composite	-39.25*	-20.88*	-20.23*	-33.02*
CAC 40	-13.73*	-15.09*	-21.52*	-21.60*
DAX 30	-14.27*	-27.01*	-17.42*	-15.20*
MIB 30	-11.13*	-24.40*	-5.01*	-15.39*
NIKKEI 225	-41.68*	-26.91*	-18.79*	-46.81*
FTSE 100	-13.91*	-24.35*	-16.56*	-15.17*
Dow Jones	-41.02*	-15.83*	-22.83*	-33.62*
Precious Metals				
Gold	-22.48*	-25.69*	-21.17*	-18.09*
Platinum	-43.40*	-10.44*	-17.95*	-35.48*
Silver	-62.19*	-8.16*	-22.55*	-52.05*

*1% significance level

Table 7.4: Likelihood Ratio Test Stock Returns-Precious Metals

	1995-2006	1995-June 1997	July 1997-1998	1999-2006
S&P/TSX Composite-Gold	0.344	0.016	0.42	2.16
S&P/TSX Composite-Platinum	0.254	0.41	0.34	2.02
S&P/TSX Composite-Silver	0.504	0.54	0.1	2.29
CAC 40-Gold	6.81*	5.61	1.02	7.81*
CAC 40-Platinum	7.28*	3.54	0.962	8.5*
CAC 40-Silver	6.89*	3.672	1.094	8.31*
DAX 30-Gold	22.04*	8.12*	4.35	14.77*
DAX 30-Platinum	24.47*	7.81*	5.04	16.73*
DAX 30-Silver	24.56*	8.01*	4.68	16.81*
MIB 30-Gold	0.776	2.154	0.118	6.644*
MIB 30-Platinum	0.8	1.09	0.096	6.76*
MIB 30-Silver	0.824	0.75	0.124	6.66*
NIKKEI 225-Gold	8.07*	2.79	3.07	23.16*
NIKKEI 225-Platinum	8.72*	2.69	1.93	23.35*
NIKKEI 225-Silver	8.48*	3.21	5.05	23.23*
FTSE 100-Gold	1.6	0.236	0.824	2.274
FTSE 100-Platinum	1.66	0.284	0.038	2.312
FTSE 100-Silver	1.6	0.266	0.006	2.48
Dow Jones-Gold	6.4*	11.92*	2.49	1.78
Dow Jones-Platinum	6.52*	9.36*	2.65	1.62
Dow Jones-Silver	6.68*	9.26*	2.73	1.64

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.

Table 7.5: Likelihood Ratio Test Precious Metals-Stock Returns*

	1995-2006	1995-June 1997	July 1997-1998	1999-2006
Gold -S&P/TSX Composite	0.154	1.51	29.26*	27.63*
Platinum-S&P/TSX Composite	5.25	0.46	7.13*	4.19
Silver-S&P/TSX Composite	0.078	0.00	175.32*	119.71*
Gold- CAC 40	35.5*	0.718	0.326	32.05*
Platinum-CAC 40	9.242*	0.038	0.254	4.21
Silver-CAC 40	191.532*	14.43*	0.688	132.69*
Gold-DAX 30	36.98*	0.326	0.326	32.94*
Platinum-DAX 30	7.88*	0.044	0.24	3.48
Silver-DAX 30	191.02*	15.276*	0.72	129.12*
Gold-MIB 30	34.6*	0.724	0.364	25.93*
Platinum-MIB 30	9.14*	0.02	0.288	4.31
Silver-MIB 30	182.602*	14.562*	0.618	126.83*
Gold-NIKKEI 225	25.52*	0.418	0.372	24.89*
Platinum-NIKKEY 225	8.63*	0.03	0.27	3.67
Silver-NIKKEY 225	178.12*	16.286*	0.25	124.15*
Gold-FTSE 100	38.68*	0.89	0.388	34.92*
Platinum-FTSE 100	8.58*	0.008	0.294	4.02
Silver-FTSE 100	190.94*	13.77*	0.302	132.22*
Gold-Dow Jones	31.82*	0.48	0.676	32.51*
Platinum-Dow Jones	8.99*	0.002	0.08	4.22
Silver-Dow Jones	182.42**	16.35*	0.22	128.21*

*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.

Table 7.6: Diagnostic Test on EGARCH models

	1995-2006			1995-June 1997			July 1997-1998			1999-2006		
Canada												
Stock Returns	S-Gold	S-Platinum	S-Silver	S-Gold	S-Platinum	S-Silver	S-Gold	S-Platinum	S-Silver	S-Gold	S-Platinum	S-Silver
JB	1071	1169	1134	109	119	120	487	428	454	206	216	215
LB(20)	47.902	50.422	49.472	34.801	34.125	32.454	45.096	50.804	49.627	19.685	20.635	20.601
	(0.000)*	(0.000)*	(0.000)*	(0.021)	(0.025)	(0.039)	(0.001)*	(0.000)*	(0.000)*	(0.478)	(0.419)	(0.421)
LB^2(20)	8.2302	7.6437	9.1782	12.082	13.346	12.77	5.6233	7.6326	7.4712	12.883	13.056	13.307
	(0.990)	(0.994)	(0.981)	(0.913)	(0.862)	(0.887)	(0.999)	(0.994)	(0.995)	(0.882)	(0.875)	(0.864)
Precious Metals	Gold-S	Platinum-S	Silver-S	Gold-S	Platinum-S	Silver-S	Gold-S	Platinum-S	Silver-S	Gold-S	Platinum-S	Silver-S
JB	2979	1500	6479	225	155	571	38	45	98	1408	1453	7172
LB(20)	27.605	16.152	37.707	11.639	15.858	36.046	20.321	19.178	24.181	25.33	11.99	28.61
	(0.119)	(0.707)	(0.01)	(0.928)	(0.725)	(0.015)	(0.438)	(0.510)	(0.235)	(0.189)	(0.916)	(0.096)
LB^2(20)	21.191	8.8491	4.3797	25.748	11.536	22.004	20.287	14.942	32.614	15.925	9.5636	4.3493
	(0.386)	(0.985)	(1.000)	(0.174)	(0.931)	(0.340)	(0.440)	(0.780)	(0.037)	(0.721)	(0.975)	(1.000)
Cross Products												
LB(20)	30.43	23.33	32.037	15.925	22.643	9.5188	17.604	12.062	17.382	31.01	20.376	36.462
	(0.063)	(0.273)	(0.043)	(0.721)	(0.307)	(0.976)	(0.613)	(0.914)	(0.628)	(0.055)	(0.435)	(0.014)
LB^2(20)	0.6422	9.9602	3.447	15.205	17.702	4.0504	4.3876	1.0662	16.711	0.997	114.96	2.3441
	(1.000)	(0.969)	(1.000)	(0.765)	(0.607)	(1.000)	(1.000)	(1.000)	(0.672)	(1.000)	(0.000)	(1.000)
France												
Stock Returns	S-Gold	S-Platinum	S-Silver	S-Gold	S-Platinum	S-Silver	S-Gold	S-Platinum	S-Silver	S-Gold	S-Platinum	S-Silver
JB	76	69	71	24	16	16	13	11	14	52	47	48
LB(20)	32.927	32.66	31.902	24.577	24.61	23.27	31.987	33.762	30.394	18.458	18.23	17.949
	(0.034)	(0.037)	(0.044)	(0.218)	(0.217)	(0.276)	(0.043)	(0.026)	(0.064)	(0.557)	(0.572)	(0.591)
LB^2(20)	28.953	26.959	27.719	28.547	26.873	25.71	11.215	12.364	11.533	34.801	32.163	32.573
	(0.089)	(0.136)	(0.116)	(0.097)	(0.139)	(0.176)	(0.940)	(0.903)	(0.931)	(0.021)	(0.042)	(0.038)
Precious Metals	Gold-S	Platinum-S	Silver-S	Gold-S	Platinum-S	Silver-S	Gold-S	Platinum-S	Silver-S	Gold-S	Platinum-S	Silver-S
JB	2253	1468	7403	194	157	593	42	47	102	1162	1249	7019
LB(20)	29.211	16.397	31.84	14.539	15.441	32.647	18.163	19.014	21.457	22.597	12.283	23.049
	(0.084)	(0.692)	(0.045)	(0.802)	(0.751)	(0.037)	(0.577)	(0.521)	(0.371)	(0.309)	(0.906)	(0.286)
LB^2(20)	20.168	8.0838	4.3957	27.18	11.636	20.331	17.674	14.855	33.083	13.125	10.071	4.2372
	(0.447)	(0.991)	(1.000)	(0.130)	(0.928)	(0.437)	(0.609)	(0.785)	(0.033)	(0.872)	(0.967)	(1.000)
Cross Products												
LB(20)	29.677	23.09	30.152	23.27	22.503	14.452	21.831	16.357	30.394	20.563	22.103	29.015
	(0.075)	(0.284)	(0.067)	(0.276)	(0.314)	(0.807)	(0.350)	(0.694)	(0.064)	(0.423)	(0.335)	(0.087)
LB^2(20)	0.6263	35.475	74.836	3.2541	10.141	8.0354	51.826	14.835	12.884	0.5136	64.118	48.73
	(1.000)	(0.018)	(0.000)*	(1.000)	(0.966)	(0.992)	(0.000)*	(0.786)	(0.882)	(1.000)	(0.000)*	(0.000)*

* LB(20) and LB^2(20) : In the cases where the coefficient is not significant is enough with increasing the number of lags and the coefficients become fine.

Table 7.7 : Diagnostic Test on EGARCH models

	1995-2006			**1995-June 1997**			**July 1997-1998**			**1999-2006**		
Germany												
Stock Returns	S-Gold	S-Platinum	S-Silver	S-Gold	S-Platinum	S-Silver	S-Gold	S-Platinum	S-Silver	S-Gold	S-Platinum	S-Silver
JB	94	95	96	28	29	28	6	6	7	47	51	50
LB(20)	23.878	24.256	23.746	20.478	20.49	21.078	29.799	30.727	29.941	21.986	22.177	22.191
	(0.248)	(0.231)	(0.254)	(0.428)	(0.428)	(0.393)	(0.073)	(0.059)	(0.071)	(0.341)	(0.331)	(0.330)
LB²(20)	34.217	33.404	33.858	31.847	32.538	32.218	22.352	22.125	22.026	35.537	35.142	35.067
	(0.025)	(0.030)	(0.027)	(0.061)	(0.038)	(0.041)	(0.322)	(0.334)	(0.339)	(0.017)	(0.019)	(0.020)
Precious Metals	Gold-S	Platinum-S	Silver-S	Gold-S	Platinum-S	Silver-S	Gold-S	Platinum-S	Silver-S	Gold-S	Platinum-S	Silver-S
JB	2256	1493	7225	246	152	577	44	46	92	1177	1276	7092
LB(20)	27.848	16.525	32.765	11.649	15.291	33.348	17.743	18.202	21.753	22.849	12.435	24.197
	(0.113)	(0.684)	(0.036)	(0.928)	(0.759)	(0.031)	(0.604)	(0.574)	(0.354)	(0.296)	(0.900)	(0.234)
LB²(20)	20.734	8.1311	4.3352	26.024	10.849	22.87	17.862	15.144	33.326	14.128	9.5252	4.2405
	(0.413)	(0.991)	(1.000)	(0.165)	(0.950)	(0.295)	(0.597)	(0.768)	(0.031)	(0.824)	(0.976)	(1.000)
Cross Products												
LB(20)	38.27	23.44	35.069	22.777	22.014	27.477	23.476	13.956	22.425	27.958	29.206	31.309
	(0.008)*	(0.268)	(0.020)	(0.300)	(0.340)	(0.122)	(0.266)	(0.833)	(0.318)	(0.110)	(0.084)	(0.051)
LB²(20)	1.9285	11.687	17.88	24.216	0.9345	46.635	30.807	12.365	6.4189	1.9547	9.2439	26.16
	(1.000)	(0.926)	(0.595)	(0.233)	(1.000)	(0.001)*	(0.058)	(0.903)	(0.998)	(1.000)	(0.980)	(0.161)
Italy												
Stock Returns	S-Gold	S-Platinum	S-Silver	S-Gold	S-Platinum	S-Silver	S-Gold	S-Platinum	S-Silver	S-Gold	S-Platinum	S-Silver
JB	240	254	240	25	21	22	3	2	3	103	106	107
LB(20)	26.026	26.828	26.026	17.322	19.644	18.632	28.145	27.429	28.031	16.092	16.756	16.803
	(0.165)	(0.140)	(0.165)	(0.632)	(0.480)	(0.546)	(0.106)	(0.124)	(0.109)	(0.711)	(0.669)	(0.666)
LB²(20)	21.266	21.548	21.266	12.632	12.871	11.265	27.768	28.003	27.578	12.865	12.176	12.047
	(0.382)	(0.366)	(0.382)	(0.893)	(0.883)	(0.939)	(0.115)	(0.109)	(0.120)	(0.883)	(0.910)	(0.914)
Precious Metals	Gold-S	Platinum-S	Silver-S	Gold-S	Platinum-S	Silver-S	Gold-S	Platinum-S	Silver-S	Gold-S	Platinum-S	Silver-S
JB	2324	1551	2324	213	161	22	41	46	103	1119	1316	7474
LB(20)	30.176	16.891	30.176	14.861	15.96	34.612	17.261	18.165	21.868	22.857	12.598	25.205
	(0.067)	(0.660)	(0.067)	(0.784)	(0.719)	(0.022)	(0.636)	(0.577)	(0.348)	(0.296)	(0.894)	(0.194)
LB²(20)	20.715	7.7196	20.715	27.1	11.289	23.208	17.442	15.377	34.057	13.84	9.6315	4.0524
	(0.414)	(0.994)	(0.414)	(0.132)	(0.938)	(0.279)	(0.624)	(0.754)	(0.026)	(0.839)	(0.974)	(1.000)
Cross Products												
LB(20)	35.759	18.383	35.759	23.04	10.169	21.547	20.617	17.154	32.695	28.467	25.252	38.69
	(0.016)	(0.562)	(0.016)	(0.287)	(0.965)	(0.366)	(0.420)	(0.643)	(0.036)	(0.099)	(0.192)	(0.007)*
LB²(20)	1.563	8.6148	1.563	20.079	1.9086	19.582	12.014	18.645	8.1558	1.0599	3.3146	17.162
	(1.000)	(0.987)	(1.000)	(0.453)	(1.000)	(0.484)	(0.916)	(0.545)	(0.991)	(1.000)	(1.000)	(0.642)

* LB(20) and LB²(20) : In the cases where the coefficient is not significant there is only need of adding more lags and the coefficients become fine.

Table 7.8 : Diagnostic Test on EGARCH models

	1995-2006			**1995-June 1997**			**July 1997-1998**			**1999-2006**		
Japan												
Stock Returns	S-Gold	S-Platinum	S-Silver	S-Gold	S-Platinum	S-Silver	S-Gold	S-Platinum	S-Silver	S-Gold	S-Platinum	S-Silver
JB	430	475	480	311	344	325	21	6	6	117	116	121
LB(20)	9.2276	8.6475	8.6268	16.402	17.076	15.978	16.731	17.378	17.03	8.9625	8.523	8.4713
	(0.980)	(0.987)	(0.987)	(0.691)	(0.648)	(0.718)	(0.670)	(0.628)	(0.651)	(0.983)	(0.988)	(0.988)
$LB^2(20)$	10.866	9.716	9.737	5.5449	5.6498	6.3459	23.146	24.205	22.168	18.93	17.736	19.115
	(0.950)	(0.973)	(0.973)	(0.999)	(0.999)	(0.998)	(0.282)	(0.234)	(0.331)	(0.526)	(0.605)	(0.514)
Precious Metals	Gold-S	Platinum-S	Silver-S	Gold-S	Platinum-S	Silver-S	Gold-S	Platinum-S	Silver-S	Gold-S	Platinum-S	Silver-S
JB	2781	1534	6968	243	153	544	39	45	97	1376	1342	6657
LB(20)	27.825	16.405	35.218	12.619	15.622	33.721	20.218	18.318	22.283	25.213	12.025	28.849
	(0.114)	(0.691)	(0.019)	(0.893)	(0.740)	(0.028)	(0.444)	(0.566)	(0.325)	(0.193)	(0.915)	(0.091)
$LB^2(20)$	21.539	8.4573	4.4437	26.936	11.003	23.237	18.669	14.868	32.204	16.037	10.477	4.5077
	(0.366)	(0.988)	(1.000)	(0.137)	(0.946)	(0.277)	(0.543)	(0.784)	(0.041)	(0.714)	(0.959)	(1.000)
Cross Products												
LB(20)	33.738	10.768	20.294	11.086	12.636	18.492	27.736	31.413	17.383	31.802	7.2531	23.996
	(0.028)	(0.952)	(0.440)	(0.944)	(0.892)	(0.555)	(0.116)	(0.050)	(0.628)	(0.045)	(0.996)	(0.243)
$LB^2(20)$	10.352	9.5029	2.8882	10.332	7.7845	8.7577	1.8577	28.343	13.599	16.829	5.3342	5.0117
	(0.961)	(0.976)	(1.000)	(0.962)	(0.993)	(0.986)	(0.997)	(0.102)	(0.850)	(0.664)	(1.000)	(1.000)
UK												
Stock Returns	S-Gold	S-Platinum	S-Silver	S-Gold	S-Platinum	S-Silver	S-Gold	S-Platinum	S-Silver	S-Gold	S-Platinum	S-Silver
JB	134	121	134	8	6	5	2	3	3	160	153	191
LB(20)	25.101	25.353	25.179	30.588	29.142	29.079	44.207	43.167	42.754	14.509	14.687	15.598
	(0.198)	(0.188)	(0.195)	(0.061)	(0.085)	(0.086)	(0.001)*	(0.002)*	(0.002)*	(0.804)	(0.794)	(0.741)
$LB^2(20)$	22.017	21.648	20.832	27.865	27.058	25.77	16	15.18	15.468	20.023	20.186	17.865
	(0.340)	(0.360)	(0.407)	(0.113)	(0.134)	(0.174)	(0.717)	(0.766)	(0.749)	(0.456)	(0.446)	(0.596)
Precious Metals	Gold-S	Platinum-S	Silver-S	Gold-S	Platinum-S	Silver-S	Gold-S	Platinum-S	Silver-S	Gold-S	Platinum-S	Silver-S
JB	2346	1506	6851	205	162	576	40	47	100	1228	1341	6571
LB(20)	25.796	16.71	32.218	14.183	15.63	33.54	17.02	18.572	21.978	23.64	12.64	24.007
	(0.173)	(0.672)	(0.041)	(0.821)	(0.739)	(0.029)	(0.652)	(0.550)	(0.342)	(0.258)	(0.892)	(0.242)
$LB^2(20)$	23.247	7.8685	4.8847	27.823	11.166	22.618	17.839	15.402	32.746	16.328	9.577	4.5703
	(0.277)	(0.993)	(1.000)	(0.114)	(0.942)	(0.308)	(0.598)	(0.753)	(0.036)	(0696)	(0.975)	(1.000)
Cross Products												
LB(20)	28.836	18.418	28.298	26.126	32.113	18.233	30.384	17.564	33.568	19.261	10.146	17.756
	(0.091)	(0.560)	(0.103)	(0.162)	(0.042)	(0.572)	(0.064)	(0.616)	(0.029)	(0.505)	(0.965)	(0.603)
$LB^2(20)$	0.5646	4.6775	3.145	7.4426	9.3828	3.4381	13.913	10.767	35.088	0.4486	3.6424	1.0646
	(1.000)	(1.000)	(1.000)	(0.995)	(0.978)	(1.000)	(0.835)	(0.952)	(0.020)	(1.000)	(1.000)	(1.000)

* LB(20) and $LB^2(20)$: In the cases where the coefficient is not significant there is only need of adding more lags and the coefficients become fine.

Table 7.9 : Diagnostic Test on EGARCH models

	1995-2006			**1995-June 1997**			**July 1997-1998**			**1999-2006**		
US												
Stock Returns	S-Gold	S-Platinum	S-Silver	S-Gold	S-Platinum	S-Silver	S-Gold	S-Platinum	S-Silver	S-Gold	S-Platinum	S-Silver
JB	337	329	331	51	46	48	70	71	68	111	100	101
LB(20)	22.048	22.029	21.982	18.31	18.501	18.704	25.988	26.26	25.684	17.305	17.883	17.85
	(0.338)	(0.339)	(0.341)	(0.567)	(0.554)	(0.541)	(0.166)	(0.157)	(0.177)	(0.633)	(0.595)	(0.597)
LB²(20)	8.9215	9.2453	9.0978	12.776	12.044	11.171	8.9561	8.7364	8.5482	12.368	13.148	13.267
	(0.984)	(0.980)	(0.982)	(0.887)	(0.915)	(0.942)	(0.983)	(0.986)	(0.986)	(0.903)	(0.871)	(0.866)
Precious Metals	Gold-S	Platinum-S	Silver-S	Gold-S	Platinum-S	Silver-S	Gold-S	Platinum-S	Silver-S	Gold-S	Platinum-S	Silver-S
JB	3001	1517	7235	251	152	609	37	45	103	1572	1401	7027
LB(20)	27.854	16.563	34.539	12.502	16.456	33.714	19.088	18.197	22.196	24.768	12.623	25.78
	(0.113)	(0.681)	(0.023)	(0.898)	(0.688)	(0.028)	(0.516)	(0.574)	(0.330)	(0.210)	(0.893)	(0.173)
LB²(20)	22.127	8.0428	4.4506	27.581	11.041	22.563	17.664	15.109	32.826	15.463	9.6617	4.3131
	(0.334)	(0.992)	(1.000)	(0.120)	(0.945)	(0.311)	(0.610)	(0.770)	(0.035)	(0.749)	(0.974)	(1.000)
Cross Products												
LB(20)	29.197	31.565	25.183	25.592	15.089	27.501	15.928	18.306	18.816	20.021	41.159	29.886
	(0.084)	(0.048)	(0.195)	(0.180)	(0.771)	(0.122)	(0.705)	(0.567)	(0.534)	(0.457)	(0.004)*	(0.072)
LB²(20)	6.2807	37.927	4.2465	16.484	7.6088	91.607	11.712	4.6055	9.3534	3.3659	109.65	2.5813
	(0.998)	(0.009)*	(1.000)	(0.686)	(0.994)	(0.000)*	(0.926)	(1.000)	(0.978)	(1.000)	(0.000)*	(1.000)

* LB(20) and LB²(20) : In the cases where the coefficient is not significant there is only need of adding more lags and the coefficients become fine.

APPENDIX H

PRECIOUS METALS MAREKTS AND THE ASIAN CRISIS

Table 8.1: Descriptive Statistics Precious Metals Returns

	Mean	SD	Skewness	Kurtosis	JB
1995- July 2007					
Gold	0.000168	0.0086	0.1096	10.2094	7112
Palladium	0.000258	0.0215	0.0967	9.6825	6110
Platinum	0.000345	0.0134	-0.6478	19.2013	36113
Silver	0.00029	0.0173	-0.6922	12.8068	13410
1995-June 1997					
Gold	-0.00021	0.0044	0.3319	6.4210	329
Palladium	0.000312	0.0164	1.0173	11.9374	2275
Platinum	4.91E-05	0.0101	2.3290	33.2392	25353
Silver	-7.95E-05	0.0143	0.6299	10.4756	1557
July 1997-1998					
Gold	-0.00038	0.0072	-0.0111	3.9738	15
Palladium	0.001321	0.0275	0.2410	6.2832	180
Platinum	-0.00048	0.0149	-0.1976	4.4165	35
Silver	0.000173	0.0183	0.2691	6.1449	166
1999-July 2007					
Gold	0.000374	0.0097	0.0639	9.0372	3399
Palladium	4.64E-05	0.0217	-0.0873	9.8476	4373
Platinum	0.000569	0.0139	-1.0661	20.4116	28681
Silver	0.000419	0.0179	-1.0660	13.9877	11677

Table 8.2: Augmented Dickey-Fuller Test

	1995-July 2007	1995-June 1997	July 1997-1998	1999-July 2007
Precious Metals				
Gold	-14.11*	-12.34*	-44.47*	-63.55*
Palladium	-25.69*	-4.97*	-10.44*	-8.16*
Platinum	-18.08*	-5.03*	-16.26*	-19.18*
Silver	-18.37*	-14.62*	-36.78*	-53.698

*1% significance level

Table 8.3: Likelihood Ratio Precious Metals

Precious Metals	1995-July 2007	1995-June 1997	July 1997-1998	1999-July 2007
Gold-Palladium	29.68**	0.77*	0.31*	96.43**
Palladium-Gold	1.83*	13.64**	34.95**	0.00*
Gold-Platinum	28.16**	0.39*	0.34*	75.14**
Platinum-Gold	4.00*	2.22*	0.84*	5.28*
Gold-Silver	32.1**	1.99*	1.04*	79.41**
Silver-Gold	116.15**	20.43**	2.10*	28.29**
Palladium-Platinum	6.14**	0.01*	16.35**	1.43*
Platinum-Palladium	1.01*	3.48*	1.02*	0.17*
Palladium-Silver	2.13*	15.74**	45.33**	1.19*
Silver-Palladium	99.39**	23.22**	1.92*	10.82**
Platinum-Silver	3.16*	0.10*	0.01*	1.57*
Silver-Platinum	104.84**	20.63**	2.2*	25.01**

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.

Table 8.4: Diagnostic on EGARCH residuals: 1995-July 2007

Precious Metals	Gold-Palladium	Gold-Platinum	Gold-Silver	Palladium-Platinum	Palladium-Silver	Platinum-Silver
JB						
LB(20)	27.689	26.788	25.015	65.144	56.077	16.978
	(0.117)	(0.141)	(0.201)	(0.000)	(0.000)	(0.654)
LB²(20)	20.252	20.717	15.466	3.1955	3.8736	12.796
	(0.442)	(0.414)	(0.749)	(1.000)	(1.000)	(0.886)
ARCH-LM	0.93	0.95	0.72	0.16	0.19	0.60
	(0.55)	(0.53)	(0.81)	(1.00)	(1.00)	(0.92)
	Palladium-Gold	Platinum-Gold	Silver-Gold	Platinum-Palladium	Silver-Palladium	Silver-Platinum
JB						
LB(20)	60.22	17.823	27.532	17.105	26.806	27.562
	(0.000)	(0.599)	(0.121)	(0.646)	(0.141)	(0.120)
LB²(20)	4.2919	6.0518	7.151	7.7502	7.8512	7.5869
	(1.000)	(0.999)	(0.996)	(0.993)	(0.993)	(0.994)
ARCH-LM	0.21	0.30	0.35	0.38	0.39	0.37
	(1.00)	(1.00)	(1.00)	(0.99)	(0.99)	(0.99)
Cross Products						
LB(20)	80.705	25.096	23.581	3.4841	33.653	22.614
	(0.000)	(0.198)	(0.261)	(1.000)	(0.029)	(0.308)
LB²(20)	91.473	21.068	1.3085	0.0365	2.3852	1.3525
	(0.000)	(0.383)	(1.000)	(1.000)	(1.000)	(1.0000

Table 8.5: Diagnostic on EGARCH residuals: 1995-June 1997

Precious Metals	Gold-Palladium	Gold-Platinum	Gold-Silver	Palladium-Platinum	Palladium-Silver	Platinum-Silver
JB						
LB(20)	14.64	15.21	10.73	13.31	15.79	12.56
	(0.797)	(0.764)	(0.953)	(0.864)	(0.730)	(0.895)
LB²(20)	19.08	18.47	26.22	7.29	5.57	10.06
	(0.516)	(0.557)	(0.159)	(0.996)	(0.999)	(0.967)
ARCH-LM	0.92	0.97	1.22	0.35	0.32	0.56
	(0.57)	(0.50)	(0.23)	(1.00)	(1.00)	(0.94)
	Palladium-Gold	Platinum-Gold	Silver-Gold	Platinum-Palladium	Silver-Palladium	Silver-Platinum
JB						
LB(20)	15.62	21.60	29.44	13.28	28.30	29.27
	(0.740)	(0.363)	(0.079)	(0.865)	(0.102)	(0.083)
LB²(20)	8.25	14.03	22.19	10.03	12.05	22.03
	(0.990)	(0.829)	(0.331)	(0.968)	(0.914)	(0.339)
ARCH-LM	0.38	0.67	1.06	0.62	0.56	1.05
	(0.99)	(0.86)	(0.39)	(0.90)	(0.94)	(0.40)
Cross Products						
LB(20)	23.08	21.27	26.48	16.52	27.09	19.69
	(0.285)	(0.382)	(0.151)	(0.684)	(0.133)	(0.478)
LB²(20)	1.27	8.75	1.73	0.52	24.20	2.99
	(1.000)	(0.986)	(1.000)	(1.000)	(0.234)	(1.000)

Table 8.6: Diagnostic on EGARCH residuals: July 1997-1998

Precious Metals	Gold-Palladium	Gold-Platinum	Gold-Silver	Palladium-Platinum	Palladium-Silver	Platinum-Silver
JB						
LB(20)	18.86	18.18	19.62	45.89	48.51	15.93
	(0.531)	(0.576)	(0.482)	(0.001)	(0.000)	(0.721)
LB²(20)	17.91	18.06	17.03	53.04	74.09	17.20
	(0.593)	(0.584)	(0.651)	(0.000)	(0.000)	(0.640)
ARCH-LM	1.08	1.07	0.89	2.81	3.48	0.87
	(0.37)	(0.38)	(0.61)	(0.00)	(0.00)	(0.63)
	Palladium-Gold	Platinum-Gold	Silver-Gold	Platinum-Palladium	Silver-Palladium	Silver-Platinum
JB						
LB(20)	48.32	25.57	47.38	26.20	25.94	22.74
	(0.000)	(0.180)	(0.001)	(0.159)	(0.168)	(0.302)
LB²(20)	66.18	16.12	41.40	16.33	42.84	42.43
	(0.000)	(0.709)	(0.003)	(0.696)	(0.002)	(0.002)
ARCH-LM	3.35	0.79	1.86	0.80	2.18	2.19
	(0.00)	(0.73)	(0.01)	(0.71)	(0.00)	(0.00)
Cross Products						
LB(20)	21.57	31.05	20.15	19.11	37.03	16.99
	(0.364)	(0.055)	(0.449)	(0.515)	(0.012)	(0.654)
LB²(20)	7.42	16.82	23.41	9.10	13.26	16.83
	(0.995)	(0.665)	(0.269)	(0.982)	(0.866)	(0.773)

Table 8.7: Diagnostic on EGARCH residuals: 1999-July 2007

Precious Metals	Gold-Palladium	Gold-Platinum	Gold-Silver	Palladium-Platinum	Palladium-Silver	Platinum-Silver
JB						
LB(20)	26.32	26.07	31.23	58.13	49.11	12.73
	(0.156)	(0.164)	(0.052)	(0.000)	(0.000)	(0.889)
LB²(20)	15.47	15.31	17.83	2.46	3.35	13.12
	(0.749)	(0.758)	(0.598)	(1.000)	(1.000)	(0.872)
ARCH-LM	0.71	0.70	0.85	0.12	0.16	0.60
	(0.82)	(0.83)	(0.65)	(1.00)	(1.00)	(0.92)
	Palladium-Gold	Platinum-Gold	Silver-Gold	Platinum-Palladium	Silver-Palladium	Silver-Platinum
JB						
LB(20)	55.36	13.20	16.38	11.58	18.53	18.73
	(0.000)	(0.869)	(0.693)	(0.930)	(0.553)	(0.539)
LB²(20)	3.31	7.82	18.69	9.66	25.91	19.84
	(1.000)	(0.993)	(0.592)	(0.974)	(0.169)	(0.468)
ARCH-LM	0.16	0.35	0.92	0.46	1.25	0.97
	(1.00)	(1.00)	(0.56)	(0.98)	(0.20)	(0.49)
Cross Products						
LB(20)	98.53	25.86	36.85	5.95	48.54	24.61
	(0.000)	(0.170)	(0.012)	(0.999)	(0.000)	(0.217)
LB²(20)	63.32	20.15	2.71	0.05	2.70	3.24
	(0.000)	(0.449)	(1.000)	(1.000)	(1.000)	(1.000)

Table 8.8: Diagnostic on GARCH(1,1) residuals: 1995-July 2007

Precious Metals	Gold-Palladium	Gold-Platinum	Gold-Silver	Palladium-Platinum	Palladium-Silver	Platinum-Silver
JB						
LB(20)	27.69	33.22	28.70	29.69	42.73	13.10
	(0.117)	(0.032)	(0.094)	(0.075)	(0.002)	(0.873)
LB²(20)	33.94	27.12	14.62	32.90	343.47	11.77
	(0.027)	(0.132)	(0.798)	(0.035)	(0.000)	(0.924)
ARCH-LM	1.52	1.25	0.73	1.63	18.87	0.58
	(0.06)	(0.20)	(0.80)	(0.04)	(0.00)	(0.93)
	Palladium-Gold	Platinum-Gold	Silver-Gold	Platinum-Palladium	Silver-Palladium	Silver-Platinum
JB						
LB(20)	35.53	14.29	21.01	11.34	26.15	14.13
	(0.017)	(0.815)	(0.397)	(0.937)	(0.161)	(0.824)
LB²(20)	5.80	9.46	24.13	16.38	42.36	41.47
	(0.999)	(0.977)	(0.237)	(0.693)	(0.002)	(0.008)
ARCH-LM	0.28	0.45	1.16	0.81	1.90	2.01
	(1.00)	(0.98)	(0.28)	(0.71)	(0.01)	(0.00)
Cross Products						
LB(20)	54.97	26.01	17.59	35.29	26.40	40.88
	(0.000)	(0.165)	(0.614)	(0.019)	(0.153)	(0.004)
LB²(20)	4.17	8.14	2.43	15.80	259.36	7.16
	(1.000)	(0.991)	(1.000)	(0.729)	(0.000)	(0.996)

Table 8.9: Diagnostic on GARCH(1,1) residuals: 1995-June 1997

Precious Metals	Gold-Palladium	Gold-Platinum	Gold-Silver	Palladium-Platinum	Palladium-Silver	Platinum-Silver
JB						
LB(20)	15.68	14.13	11.79	17.75	17.46	26.43
	(0.736)	(0.824)	(0.923)	(0.604)	(0.623)	(0.152)
LB²(20)	16.91	34.37	16.19	12.78	3.48	9.90
	(0.659)	(0.024)	(0.705)	(0.887)	(1.000)	(0.970)
ARCH-LM	0.82	1.56	0.84	0.60	0.17	0.80
	(0.70)	(0.06)	(0.66)	(0.91)	(1.00)	(0.72)
	Palladium-Gold	Platinum-Gold	Silver-Gold	Platinum-Palladium	Silver-Palladium	Silver-Platinum
JB						
LB(20)	16.14	23.45	20.63	20.18	32.23	13.13
	(0.708)	(0.267)	(0.420)	(0.447)	(0.041)	(0.872)
LB²(20)	3.34	12.81	13.65	7.74	12.05	15.78
	(1.000)	(0.886)	(0.848)	(0.993)	(0.915)	(0.730)
ARCH-LM	0.14	0.59	0.69	0.39	0.59	0.81
	(1.00)	(0.92)	(0.84)	(0.99)	(0.92)	(0.71)
Cross Products						
LB(20)	18.51	15.90	12.25	26.34	34.63	25.76
	(0.554)	(0.723)	(0.907)	(0.155)	(0.022)	(0.174)
LB²(20)	0.98	20.68	2.93	7.86	27.24	10.79
	(1.000)	(0.426)	(1.000)	(0.993)	(0.129)	(0.951)

Table 8.10: Diagnostic on GARCH(1,1) residuals: July 1997-1998

Precious Metals	Gold-Palladium	Gold-Platinum	Gold-Silver	Palladium-Platinum	Palladium-Silver	Platinum-Silver
JB						
LB(20)	17.52	15.63	29.36	32.97	27.66	10.52
	(0.619)	(0.739)	(0.081)	(0.034)	(0.118)	(0.958)
LB²(20)	20.43	18.10	15.72	27.52	19.36	17.49
	(0.431)	(0.581)	(0.734)	(0.121)	(0.499)	(0.621)
ARCH-LM	0.96	0.83	0.78	1.94	1.18	0.93
	(0.51)	(0.67)	(0.74)	(0.01)	(0.27)	(0.55)
	Palladium-Gold	Platinum-Gold	Silver-Gold	Platinum-Palladium	Silver-Palladium	Silver-Platinum
JB						
LB(20)	31.28	12.36	37.79	18.23	20.57	20.78
	(0.052)	(0.903)	(0.009)	(0.572)	(0.423)	(0.410)
LB²(20)	17.86	17.12	36.42	18.52	38.63	42.89
	(0.597)	(0.645)	(0.014)	(0.553)	(0.007)	(0.002)
ARCH-LM	1.02	0.89	1.85	1.09	1.93	2.20
	(0.43)	(0.60)	(0.02)	(0.35)	(0.01)	(0.00)
Cross Products						
LB(20)	17.95	31.83	17.82	19.16	39.29	14.46
	(0.591)	(0.045)	(0.600)	(0.512)	(0.006)	(0.806)
LB²(20)	17.14	56.48	16.33	22.09	6.33	11.82
	(0.644)	(0.000)	(0.696)	(0.336)	(0.998)	(0.922)

Table 8.11: Diagnostic on GARCH(1,1) residuals: 1999-July 2007

Precious Metals	Gold-Palladium	Gold-Platinum	Gold-Silver	Palladium-Platinum	Palladium-Silver	Platinum-Silver
JB						
LB(20)	26.65	31.54	25.98	24.98	36.47	11.57
	(0.145)	(0.048)	(0.166)	(0.202)	(0.014)	(0.930)
LB²(20)	7.48	11.02	18.71	22.84	2.86	13.58
	(0.995)	(0.946)	(0.541)	(0.297)	(1.000)	(0.851)
ARCH-LM	0.35	0.51	0.89	1.10	0.14	0.80
	(1.00)	(0.96)	(0.60)	(0.34)	(1.00)	(0.72)
	Palladium-Gold	Platinum-Gold	Silver-Gold	Platinum-Palladium	Silver-Palladium	Silver-Platinum
JB						
LB(20)	35.49	10.93	13.28	13.82	29.04	7.73
	(0.018)	(0.948)	(0.865)	(0.839)	(0.087)	(0.993)
LB²(20)	3.32	11.39	19.40	23.43	19.72	20.80
	(1.000)	(0.935)	(0.496)	(0.268)	(0.476)	(0.409)
ARCH-LM	0.16	0.63	0.95	1.31	1.01	1.06
	(1.00)	(0.90)	(0.52)	(0.16)	(0.45)	(0.38)
Cross Products						
LB(20)	78.75	28.98	14.22	37.47	22.99	23.75
	(0.000)	(0.088)	(0.819)	(0.010)	(0.290)	(0.253)
LB²(20)	24.41	18.33	2.99	17.05	8.02	5.01
	(0.225)	(0.566)	(1.000)	(0.650)	(0.992)	(1.000)

APPENDIX I

PRECIOUS METALS MARKETS, EQUITY MARKETS AND OIL PRICES

Figure 1: Crude Brent Oil & Crude Oil – WTI Spot Cushing

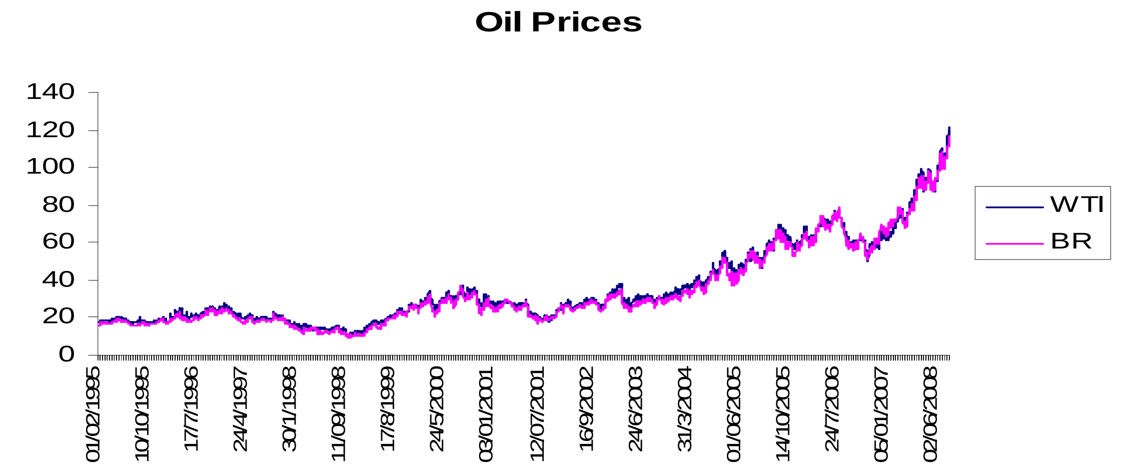

Figure 2: Dow Jones, FTSE-100 & Nikkei 225

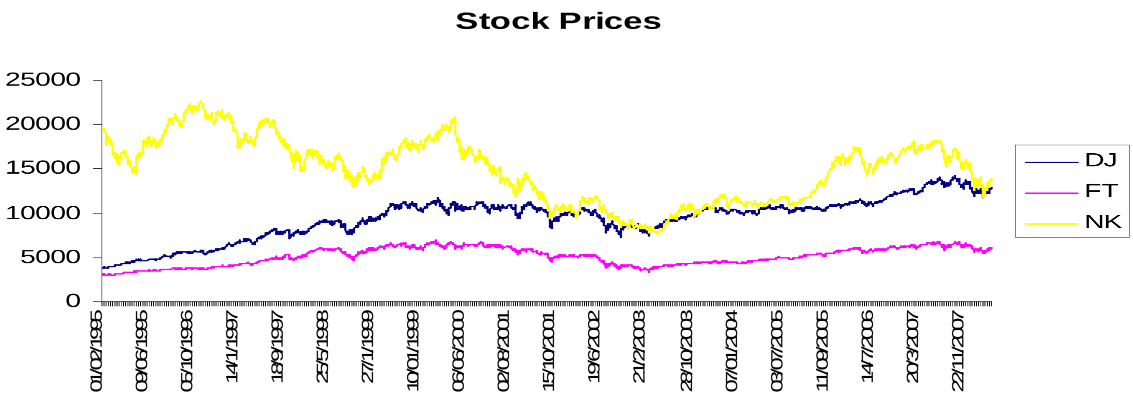

Figure 3: Gold, Silver and Platinum

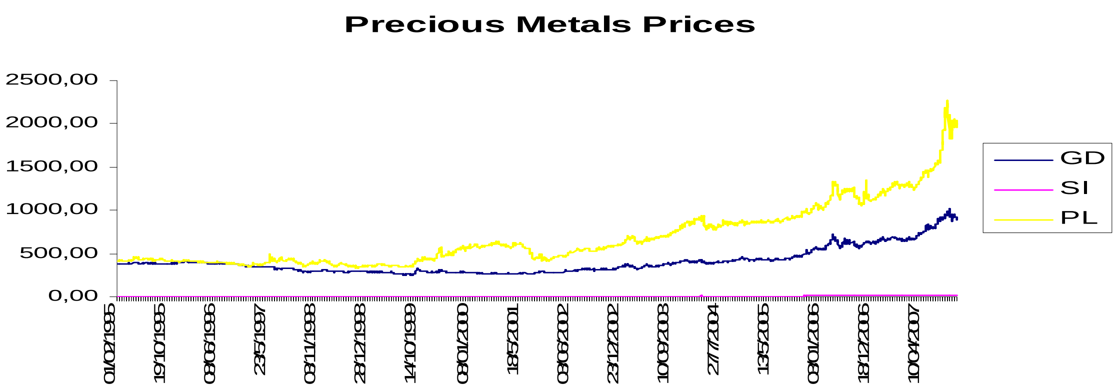

Table 9.1: Descriptive Statistics

	GOLD	SILVER	PLATINUM	DOW	FTSE	NIKKEI	BRENT
Mean	0.000243	0.000356	0.000445	0.000349	0.000198	-0.000101	0.000570
Std. Dev.	0.008931	0.017309	0.013689	0.010342	0.010788	0.013954	0.022474
Skewness	-0.105000	-0.534531	-0.627836	-0.247420	-0.198963	-0.084421	-0.113218
Kurtosis	10.204	1.073	1.785	7.452	6.113	5.161	6.172
Jarque-Bera	7519	8837	32155	2905	1426	680	1464

Table 9.2: Unit Roots

	GOLD	SILVER	PLATINUM	DOW	FTSE	NIKKEI	BRENT
ADF	-58.18*	-13.04*	-13.13*	-43.14*	-14.71*	-43.77*	-21.87*

*1% significance level.

Table 9.3: Precious Metals Break Points*

Gold Series	Silver Series	Platinum Series
May 9, 1995	March 29, 1995	March 27, 1995
December 29, 1995	May 9, 1995	May 9, 1995
March 1, 1996	October 2, 1995	March 4, 1996
December 31, 1996	December 2, 1996	February 11, 1997
March 4, 1997	December 8, 1997	May 28, 1997
May 16, 1997	December 16, 1997	August 24, 1998
July 2, 1997	May 29, 1998	September 21, 1998
October 9, 1998	March 15, 1999	December 10, 1998
September 17, 1999	September 27, 1999	December 18, 1998
October 5, 1999	September 30, 1999	January 22, 1999
December 8, 1999	June 21, 2000	January 27, 1999
February 2, 2000	January 1, 2001	September 23, 1999
February 8, 2000	May 14, 2001	November 18, 1999
July 19, 2000	August 14, 2002	January 26, 2000
January 26, 2001	July 14, 2003	February 29, 2000
March 13, 2001	January 2, 2004	August 7, 2000
May 17, 2001	April 12, 2004	July 13, 2001
September 7, 2001	May 10, 2004	October 16, 2001
September 18, 2001	March 8, 2005	June 3, 2001
January 31, 2002	December 5, 2005	April 9, 2004
August 8, 2002	April 14, 2006	May 17, 2004
January 31, 2003	June 14, 2006	December 7, 2004
July 22, 2004	October 3, 2006	October 28, 2005
December 5, 2005	February 25, 2008	May 5, 2006
May 5, 2006	March 19, 2008	June 19, 2006
October 3, 2006		October 30, 2006
November 1, 2007		November 16, 2006
March 3, 2008		November 21, 2006
March 17, 2008		March 14, 2007
		September 26, 2007
		November 15, 2007
		January 22, 2008

*Break points calculated using the ICSS algorithm for each of the series. The ICSS algorithm for the individual series overestimate the number of points where sudden changes in volatility occur.

Table 9.4: Stock and Oil Markets Break Points

Stock and Oil Markets Break Points*			
Dow Jones Industrials	FTSE 100	Nikkei 225	Crude Oil Brent
December 14, 1995	May 28, 1995	October 2, 1995	July 3, 1995
January 8, 1996	July 31, 1998	December 3, 1996	December 29, 1995
November 29, 1996	September 10, 1998	January 30, 1997	December 13, 1996
October 14, 1997	January 21, 1999	October 20, 1997	January 22, 1998
March 7, 2002	December 31, 1999	January 15, 1998	March 16, 1999
October 18, 2002	February 6, 2000	August 25, 1998	March 3, 2000
January 4, 2003	November 9, 2000	November 3, 1998	February 13, 2001
May 13, 2003	April 9, 2001	February 27, 2001	September 12, 2001
May 17, 2005	September 21, 2001	April 17, 2001	January 16, 2002
June 7, 2007	December 7, 2001	March 19, 2002	November 29, 2004
	June 10, 2002	December 16, 2002	January 12, 2005
	October 16, 2002	December 8, 2004	May 13, 2005
	January 23, 2003	April 12, 2005	
	April 7, 2003	November 29, 2005	
	July 11, 2003	August 15, 2006	
	August 13, 2003	July 25, 2007	
	April 28, 2006	January 14, 2008	
	June 14, 2006		
	February 23, 2007		
	March 14, 2007		
	July 16, 2007		

*Break points calculated using the ICSS algorithm for each of the series. The ICSS algorithm for the individual series overestimate the number of points where sudden changes in volatility occur, same situation was found in the case of the precious metals indices. Another problem is that each series are presenting a different number of break points that happened at different days during the period of analysis, therefore and in order to get a common number of break points we we decide to use the standardized residuals of the GARCH(1,1) (equation 9) that will allow us to get the appropriate number of break points to improve our variance equation (equation 10).

Table 9.5: GARCH(1,1) Residuals Break Points*

Gold-Dow Jones Ind.-Brent	**Gold-FTSE 100-Brent**	**Gold-Nikkei 225-Brent**
March 28, 1995 (obs.63)	March 28, 1995 (obs.63)	March 28, 1995 (obs.63)
March 29, 1995 (obs.64)	March 29, 1995 (obs.64)	March 29, 1995 (obs.64)
December 30, 1995 (obs.522)	August 15, 1995 (obs.163)	December 30, 1995 (obs.522)
May 28, 2001(obs.1672)	November 2, 1995 (obs.220)	May 28, 2001 (obs.1672)
September 5, 2001(obs.1744)	February 29,1996 (obs.305)	September 5, 2001 (obs.1744)
September 12, 2001(obs.1749)	July 31, 1996 (obs.414)	September 10, 2001 (obs.1747)
	December 12, 1996 (obs.522)	
Silver-Dow Jones Ind.-Brent	**Silver-FTSE 100-Brent**	**Silver-Nikkei 225-Brent**
September 29, 1999 (obs.1239)	September 29, 1999 (obs.1239)	September 29, 1999 (obs.1239)
May 7, 2001 (obs.1657)	July 5, 2001 (obs.1657)	May 7, 2001 (obs.1657)
July 7, 2003 (obs.2222)	July 4, 2003 (obs.2221)	July 7, 2003 (obs.222)
Platinum-Dow Jones Ind.-Brent	**Platinum-FTSE 100-Brent**	**Platinum-Nikkei 225-Brent**
May 31, 1996 (obs.371)	May 31, 1996 (obs.371)	May 31, 1996 (obs.371)
February 10, 1997 (obs.552)	February 10, 1997 (obs.552)	February 10, 1997 (obs.552)
August 27, 2002 (obs.1998)	August 27, 2002 (obs.1998)	August 27, 2002 (obs.1998)

*The ICSS algorithm using the GARCH(1,1) standardized residuals have the advantage of reducing the number of Points where sudden changes in volatility occurs and also have the quality of providing a common break point for our mean equation, allowing us to reduce the number of dummy variables that should be introduce in the GARCH(1,1) variance equation..

Figure 4: GARCH (1,1) Gold- Dow Jones Industrials-Brent

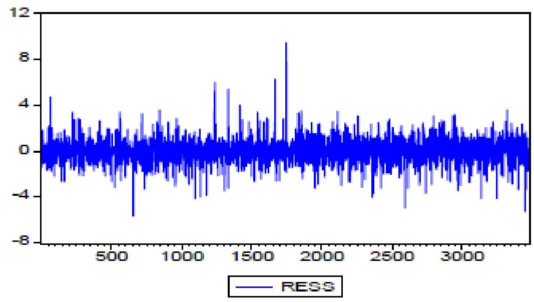

Figure 5: GARCH (1,1) Gold- FTSE 100-Brent

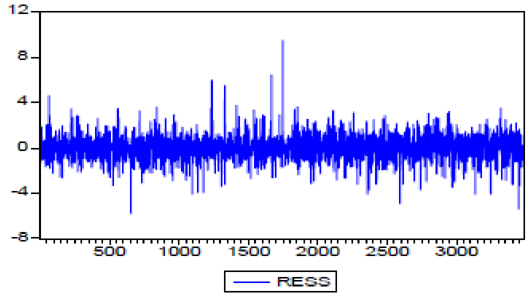

Figure 6: GARCH (1,1) Gold- Nikkei 225-Brent

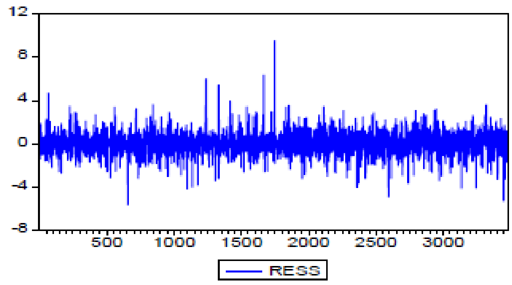

Figure 7: GARCH (1,1) Silver-Dow Jones Industrials-Brent

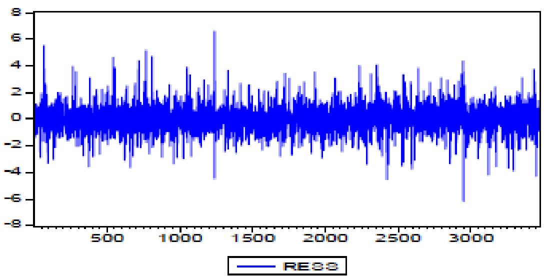

Figure 8: GARCH (1,1) Silver- FTSE 100-Brent

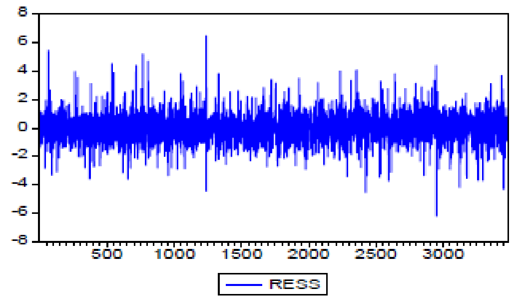

Figure 9: GARCH (1,1) Silver-Nikkei 225-Brent

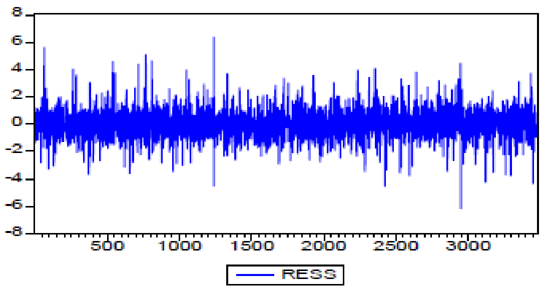

Figure 10: GARCH (1,1) Platinum- Dow Jones-Brent

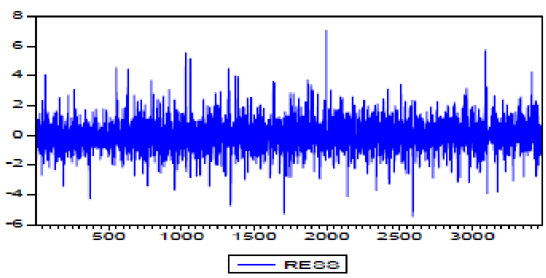

Figure 11: GARCH (1,1) Platinum-FTSE 100-Brent

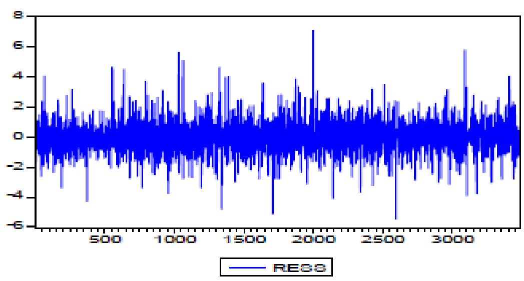

Figure 12: GARCH (1,1) Platinum-Nikkei 225-Brent