2011

How short and long term interdependencies have changed due to the global financial crisis

Lungowe Andala
Edith Cowan University

How Short and Long Term Interdependencies have changed due to the Global Financial Crisis

By

Lungowe Andala

A Thesis submitted in Partial Fulfillment of the Requirements for the

Award of

Bachelor of Business (Finance) Honours

Faculty of Business and Law

Edith Cowan University

Date Submitted: 9th June, 2011

USE OF THESIS

ABSTRACT

This study investigates how short and long term interdependencies have changed among ten countries grouped into countries from the same region (close geographical proximity) as a result of the recent Global Financial Crisis. A number of econometrics methodologies are employed in doing the analysis. Johansen's cointegration methodology is carried out to assess whether the stock markets have long run interdependencies and whether these interdependencies have changed as a result of the Global Financial Crisis. For the stock markets not cointegrated Granger Causality is carried out to analyze short run interdependencies between pairs of stock markets.

Furthermore, generalized Impulse Response Function (GIRF) analysis is carried out to assess the speed at which shocks are fully incorporated by a stock market. Generalized Forecast Error Variance Decompositions (GFEVD) is used to assess the most endogenous, least endogenous and most exogenous stock markets. Using Johansen's cointegration method, there is no change in the level of integration and long run interdependencies among the American stock markets, evidenced by the number of cointegrating vectors staying the same in all sample periods. For the European stock markets, the level of integration and long run interdependencies increase in comparison to before the crisis. In contrast the level of integration and interdependencies decrease for the Asian stock markets in comparison to before the crisis with no cointegration being present during the GFC and after.

Evidence of Granger causality is found between the European stock markets before the crisis but none is found between the Asian stock markets during the GFC and in the post GFC

period. The GIRF generally shows a change in responses and a change in the speed at which stock markets incorporate shocks to other stock markets during the GFC period. The GIRF graphs show that the stock markets take longer to fully incorporate the effects of shocks during the GFC in comparison to the pre GFC sample period and post GFC sample period. Lastly the GFEVD analysis finds that there is an increase in the contribution of other markets in explaining shocks to each individual market implying an increase in interdependencies as is found by Worthington & Higgs (2004) as a result of the Asian crisis of 1997 and Masih & Masih (1997) as a result of the October 1987 Crash.

DECLARATION

I certify that this thesis does not, to the best of my knowledge and belief:

(i) Incorporate without acknowledgment any material previously submitted for a degree or diploma in any institution of higher degree or diploma in any institution of higher education;

(ii) Contain any material previously published or written by another person except where due reference is made in the text of this thesis; or

(iii) Contain any defamatory material.

(iv) Contain any data that has not been collected in a manner consistent with ethics approval.

The Ethics Committee may refer any incidents involving requests for ethics approval after data collection to the relevant Faculty for action.

Signed......................................

Date....11/08/2011..............

ACKNOWLEDGEMENTS

I would like to thanks my supervisor Professor David Allen for his invaluable help, patience, expert guidance and encouragement. I am extremely grateful for introducing me to the world of econometrics. Many doors of opportunities await as a result. Thank you.

I wish to express my profound appreciation to the honors coordinator, Margaret Giles for her extraordinary understanding and patience with me and reaching out a helping hand when I needed it the most. A special thanks to Peter Standen for his patience and understanding and to Ghialy Yap for her help in my last semester.

Most of all I am especially grateful to my family and friends for their support through the trying times and helping me pull through what seemed to be bleakest of times. I will always be grateful to my parents for their financial and moral support, never ceasing to encourage me. A very special thank you to my partner, Peter Revill for his love, moral support, motivation and faith in me. Not forgetting to the Lord Almighty for all his done for me.

A special and heart felt thank you to all.

Table of Contents

LIST OF TABLES

LIST OF FIGURES

CHAPTER ONE: GENERAL INTRODUCTION

This Chapter gives a brief introduction to the concept and ideas that led to this research being carried out. This is then followed by sections that outline the background and causes of the Global Financial Crisis (GFC) and the purpose and justification of carrying out this research. This is then followed by a description of the significance and contributions of this research and lastly concluding with the research questions that have been answered in the Empirical Findings Chapter.

1.1 Introduction

With the increasing use of advanced information technology and financial deregulation, leading to increased international stock market investments, equity markets are becoming more integrated and interdependent, resulting in stronger linkages among equity markets around the globe (Gerrits & Yuce, 1999).

Jalolov & Miyakoshi (2005) point out that "recent rapid financial deregulation throughout the world has promoted a great deal of trading in financial assets that has attracted international investors". This deregulation has resulted in a large volume of direct investment by advanced countries in emerging countries and vice-versa. Thus, it is expected that developed and emerging countries are becoming more integrated, linked and interdependent. Similarly, developed countries are becoming more interdependent for the same reasons.

Consequently, we can logically assume that due to integration and interdependencies among international stock markets, shocks (good or bad) in one or more financial markets can be transmitted to other financial markets. The magnitude of the effect of shocks depends on how strongly integrated and interdependent equity markets are, and the degree of co-movement among them.

An important concept that goes hand in hand with interdependencies among stock markets is international portfolio diversification. Modern portfolio theory (MPT) developed by Markowitz (1952) advocates that international portfolio diversification is beneficial as long as returns in the international stock markets are less than perfectly correlated with the domestic market returns. As pointed out by Gerrits & Yuce (1999), the presence or lack of interdependencies among international stock markets provides evidence for the limits or benefits of international portfolio diversification, respectively. Thus, if stock markets are interdependent, it is implied that the benefits of diversification are minimal or indeed do disappear (Lim, Lee, & Liew, 2003). As a result, the effectiveness of diversification depends on the degree of co-movements and interdependence among equity markets.

Due to interdependencies among countries, a number of international financial equity markets were greatly affected by the Subprime Crisis that originated in the United States of America in 2007 (Gorton, 2008) and escalated into Global Financial Crisis (GFC) by the end of 2008 (Poole, 2010). As pointed out by Edey (2009), "equity prices .... fell to levels between 30 and 50 per cent, lower than they had been at the start of 2008" while other developing economies were affected indirectly via trade and capital flows (Craig, n.d.). Thus, the Global Financial Crisis (GFC) had a significant effect on international equity markets and more so for those that had strong ties and linkages with the U.S.A. As a result, the financial crisis of 2007-2009 is viewed as the worst financial disruption since the Great Depression of 1929-1933 (Wheelock, 2010). Thus, it is expected that interdependencies and linkages among international stock markets have changed due to this phenomenal event.

As a result, my research investigates the effect of the Global Financial Crisis on short and long term interdependencies among equity markets of ten countries ranked as having the highest GDP in the world in 2009 by the World Bank. This is in order to ascertain the impact, if any, of the Global Financial Crisis (GFC) on these interdependencies among various leading stock markets.

1.2 Background of the Global Financial Crisis:

From the beginning of 2001 to mid-2003, the Federal Reserve of the U.S.A eased monetary policy, reducing interest rates from 6% to 1% (Federal Reserve, n.d.). This is supported by White (2009) who reports that the Federal Reserve lowered its target federal funds (interbank overnight) interest rate from 6.25% at the beginning of 2001 to 1.75% at the end of the year and further pushed it down to a record low of 1% in 2003. The easing of monetary policy was carried out in fear of a recession and deflation due to the dot-com bubble bursting and the 9/11 attack (White, 2009).

White (2009) also points out that capital inflows and the supply of loanable funds to the U.S market pushed the U.S. real interest rates down and therefore, expansion of monetary policy was not the only factor that led to lower interest rates. However, the lowering of short term interest rates by 525 basis points between 2001 and 2004 led to cheap credit (White, 2009).

By lowering short term interest rates so dramatically, one year adjustable mortgage rates that are dependent on short term interest rates declined significantly in comparison to 30 year fixed mortgage rates. This is supported by (Freddie Mac, n.d.) who show that in 2001 the 30 year fixed mortgage rate (annual average) was 6.97% which was lowered to an annual average of 5.84% by 2004. In contrast, the 1 year adjustable mortgage rate in 2001 was 5.82% which was reduced to 2.77% by 2004.

As can be seen the lowering of short term interest rates by the Federal Reserve led to a decline in one year adjustable mortgage rates which made one year adjustable mortgages more attractive for mortgage borrowers as compared to the 30 year fixed rate mortgages. As reported by White (2009), "The share of new mortgages with adjustable rates, only one-fifth in 2001, had more than doubled by 2004".

As a result, low interest rates led to the growth in one year adjustable rate mortgages that in turn led to increased demand for housing and pushed house prices up. The large demand for housing encouraged housing construction in the U.S.A and this created a housing boom.

Alongside the boom, the U.S Government was pushing for and supporting house ownership by U.S citizens. As pointed by Yandle (2010), there was political effort to expand mortgage lending to consumers/ subprime borrowers who could not meet normal standards of creditworthiness. This is further supported by Poole (2010) who states that "congress and the Bush administration pushed the giant mortgage intermediaries, Fannie Mae and Freddie Mac, to accumulate subprime mortgages" as previously they had only dealt in prime mortgages.

Similarly, Listokin, Wyly, Keating, Rengert, & Listokin (2000) declare that the housing financial industry was looking to new markets such as low to moderate-income (LMI) households for house ownership and this provision was stimulated by policy makers. This is also supported by Calomiris (2009) who points out that subsidies for mortgage leverage and government policies that expanded access to credit were key factors that caused the Global

Financial Crisis (GFC). It should be noted that the housing boom, easy credit conditions for borrowing and stimulants from the US Government made mortgage lenders lower their underwriting standards in order to provide subprime mortgages to these subprime borrowers (Gorton, 2008).

As a result of these factors, there was too much optimism in the housing market with subprime borrowers taking out Adjustable Rate Mortgages (ARM's) at a low cost for a chance of home ownership, leading to the growth of the subprime mortgage market.

The subprime mortgages had to be financed somehow and their risk had to be spread. As pointed out by Gorton (2008), securitization is the main method of financing for subprime originators. As a result, securitisation was carried out leading to an increase in the number of financial derivatives, namely; Mortgage Backed Securities (MBS) and Collateralized Debt Obligations (CDOs). These derivatives were sold to institutions and investors around the globe, enabling foreign investors to invest in the U.S. housing market that was booming (Poole, 2010). The distribution of these financial derivatives internationally is what tied international investors to the U.S.A.

However, once interest rates began to rise in the U.S.A and interest rates on loans began to increase, it became increasingly difficult for subprime borrowers to repay their mortgages and refinance. This led to defaults by the subprime borrowers and thus, housing foreclosures. On the other hand, the housing bubble burst and house prices also began to decline. Furthermore, derivatives based on subprime mortgages began to decrease in value and therefore foreign institutions and investors who invested in these derivatives reported significant losses in early 2007 (Gorton, 2008). This led to the downgrading of investors and institutions by credit rating agencies (Wheelock, 2010).

As a result of these events, markets cut off financial funding to several financial entities (Poole, 2010) and liquidity dried up. This is because the distribution of the derivatives led to asymmetric information, in that no one knew which investors and banks were holding these toxic subprime mortgage backed securities (Gorton, 2008). As stated by Naude (2009), "securities containing bad subprime mortgages were distributed across the financial system and institutions did not know where they were. This created counterparty risk". Thus, due to the existence of asymmetric information and counterparty risk, lending between financial entities ceased and this naturally led to a liquidity problem. This was the beginning of the subprime crisis.

From this point on, the subprime crisis escalated into the Global Financial Crisis (GFC) which led to the collapse of many institutions, significant declines in stock markets, declines in lending and widened credit spreads. Many banks and institutions filed for bankruptcy and Governments all around the world intervened by bailing out and guaranteeing bank deposits, providing stimulus packages and injecting liquidity and money into the systems in order to resuscitate them (Wheelock, 2010).

A combination of these events and loss in consumer confidence impacted global economies negatively either through losses via direct investment in the toxic assets or indirectly via trade and lending/borrowing (wholesale funds widened spreads). As a result, "the financial crisis of 2007-09 is widely viewed as the worst financial disruption since the Great Depression of 1929-33" (Wheelock, 2010).

1.3 Research Purpose

The purpose of this research is to investigate the effect of the Global Financial Crisis (GFC) on interdependencies, if any, among equity markets of ten countries ranked as having the highest GDP in the world in 2009 by the World Bank. The ten equity markets in question are: the USA, Japan, China, Germany, the UK, France, Italy, Brazil, Spain and Canada. These countries will be grouped into countries of the same region i.e. America (USA, Canada and Brazil), Europe (UK, Germany, France, Italy and Spain) and Asia (China and Japan). The analyses will be carried out for each group to assess whether interdependencies, if any, among stock markets of these groups have changed due to this phenomenal event. This analysis will be carried out using econometric methods and both short run and long run interdependencies will be assessed in order to provide more insight into changes in interdependencies. This will be done for the benefit of both short and long term investors.

1.4 Rationale/Justification

Research based on interdependencies among stock markets of the same region has been carried out. Furthermore, research on changes in interdependencies among stock markets due to the Global Financial Crisis has been carried out. Due to the Global Financial Crisis (GFC) being a fairly recent event, not much research has been carried out based on this event and thus my research will contribute to this limited research.

Furthermore, there is a gap based on research carried out based on the post crisis sample period. Adding this sample period will provide better insight into how interdependencies have changed due to this phenomenal event in comparison to research that only has the Pre-crisis period and during the crisis period. My research will use all three sample periods.

Furthermore, there is a gap in the literature involving both short and long term interdependencies among the stock markets of the ten countries with the highest GDP as ranked by the World Bank in 2009. My research looks to fill this gap by carrying out my analysis based on these countries.

1.5 Significance

This research will provide new information about how interdependencies among stock markets have changed due to the Global Financial Crisis (GFC). This information will be useful for investors, portfolio managers and financial institutions looking to diversify internationally in both the short and long term. By providing empirical evidence based on a fairly recent event, valuable information is being provided about whether short and long run relationships among the equity markets exist and whether these interdependencies have changed due to the Global Financial Crisis (GFC). This information will be essential for both short and long term investors to base their investment and diversification decisions.

Furthermore, investors will benefit from the results provided by the short run analyses such that if causality exists among different stock markets, investors or investment institutions can formulate short term profit investment strategies even in turbulent times. The generalised impulse response analysis and generalised forecast error variance decompositions will provide information on which stock markets are least affected by other stock markets and which ones are most influenced and affected by other stock markets.

The stock markets with the least effect from other stock markets are more beneficial for international portfolio diversification than those that are more affected and influenced by other stock markets. The information provided by the long run analyses will be very useful such that if cointegration exists, diversification among the stock markets that are cointegrated is limited or not beneficial because the stock markets move closely together in the long run and share common trend patterns.

1.6 Research Questions

This paper will attempt to answer the following questions by applying several econometrics methods:

1. Are the stock markets in each region cointegrated in the pre-Global Financial Crisis (GFC) period?
2. If yes, are the stock markets in each region still cointegrated during and after the Global Financial Crisis (GFC) and if so has the level of integration (number of cointegrating vectors) increased, decreased or stayed the same during and after the Global Financial Crisis (GFC)?
3. For each region, has there been a change in the stock markets that are important in the long run equilibrium relationship due to the Global Financial Crisis (GFC)?
4. For each region, have the stock markets that bear the burden of adjusting short run disequilibrium back to the long run equilibrium (cointegrating) relationship changed due to the Global Financial Crisis (GFC)?
5. If no cointegration is present in either one of the sub-periods, does bi-variate Granger Causality exist between the stock markets and what are the directions of the Granger Causality relationships?
6. If no cointegration is present in more than one of the sub-periods, do the directions and number of Granger Causal relationships change as a result of the Global Financial Crisis (GFC)?

7. In the presence or absence of cointegration, have the response patterns of each stock market to shocks in another stock market changed and have the most and least affected stock markets in each region changed due to the Global Financial crisis (GFC)?

1.7 Conclusion

This research has a significant role in educating investors and firms about linkages and interdependencies among international or regional stock markets and how these interdependencies have changed due to the Global Financial Crisis (GFC). Furthermore, this study contributes to the limited research carried out based on the Global Financial Crisis (GFC) and the existing gaps that exist based on this phenomenal event. Thus, the empirical results founded from answering the above research questions provide valuable insight on the benefits or limits of international portfolio diversification and portfolio selection and whether the benefits or limits still exist as a result of the Global Financial Crisis (GFC). If international stock markets move together or are highly interdependent or integrated, the benefits of international diversification may be overstated but if low or no interdependence exists, then international portfolio diversification can be very fruitful.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction:

This Chapter assesses research carried out that is relevant to my research, starting with a brief summary of the focus of previous studies that are relevant to mine.

A vast number of studies have been carried out on short run and long run relationships between and among different countries' equity markets using the methodologies mentioned in the research questions. Researchers have focused on interdependencies among stock markets of close geographical proximity such as European Interdependencies, Asian interdependencies and American Interdependencies.

Others have focused on how interdependencies have changed among stock markets due to financial crises such as the October 1987 Crash, the Asian crisis of 1997-1998 and the Global Financial Crisis of 2007 – 2009.

Following this brief introduction, the Literature Review is organised as follows.

- Literature on Interdependencies among stock markets of close geographical proximity
  - Literature on European Interdependencies
  - Literature on Asian Interdependencies
  - Literature on American Interdependencies
- Literature on how Interdependencies have Changed due to Financial Crises
  - Literature on the October 1987 Crash

- Literature on the Asian 1997-1998 Asian Crisis

- Literature on the Global Financial Crisis and Interdependencies

The results to these pieces of research are presented below.

2.2 Literature on Interdependencies and close geographical proximity

2.2.1 Literature on European Interdependencies

Vast amounts of research have focused on interdependencies among stock markets from the same regions or continents and find that stock markets that are of close geographical proximity or that are from the same continent are interdependent.

Eun & Shim (1989) being one of the early researchers, analyse the short run aspects of interdependencies among nine stock markets by using correlation analysis, impulse response analysis and forecast error variance decompositions. The nine stock market indices are Australia, Canada, France, Germany, Hong Kong, Japan, Switzerland, the United Kingdom and the United States of America.

The Pair-wise correlation analysis results show that intra-regional correlations (countries from the same regions) are highly interdependent as compared to inter-regional correlations (countries from different regions). It is concluded that the intra-regional stock markets are interdependent in the short run. Using forecast error variance decompositions it is shown that stock markets are not completely exogenous and are influenced by innovations in other stock markets and are thus interdependent. The impulse response analysis provides evidence to show that the transmission of shocks from the USA to the other stock markets is instant and speedy occurring by day one thereafter tapering off.

Furthermore, it is found that all stock markets respond to most of the effect of the shocks by day one.

Corhay, Rad, & Urbain (1993) investigate the existence of long run interdependencies among European price indices of France, Germany, Italy, the Netherlands and the UK using Engle-Granger's and Johansen's cointegration methods over a sample period of 1st March 1975 to 20th September 1991. Using Engle-Granger's method, significant bi-variate cointegration relationships are found between the stock markets except for Italy. When the Johansen-Juselius method is used, evidence of one cointegrating vector among the European stock markets is found but the Italian stock market does not influence the long run equilibrium relationship. These results imply that long run interdependencies exist among European stock markets and thus portfolio diversification among European stock markets would not be beneficial with the exception of Italy.

Similarly, when Cheung & Lai (1999) investigate interdependencies among three European Monetary System countries of France, Germany and Italy using Johansen's cointegration over a sample period from April 1979 to June 1992, the presence of one cointegrating vector is found. Furthermore, it is found that Italy belongs to or influences the long run equilibrium relationship providing contradictory results to that of Corhay et al (1993) who find that Italy does not influence the long run relationship. Thus, this result provides evidence of long run interdependencies among European stock markets implying that portfolio diversification among these stock markets would not be beneficial in the long run because these stock markets move closely together and share common stochastic trends.

A possible reason explaining Cheung et al (1999) and Corhay et al (1993) contradicting results could be due to different sample periods used by these researchers and the inclusion of Netherlands and the UK by Cheung et al (1999).

King & Serletis (1997) find the presence of cointegration among ten European Union stock markets of Belgium, Denmark, France, Germany, Greece, Ireland, Italy, the Netherlands, Spain and the UK. Similarly, Gerrits & Yuce (1999) find that the European stock markets of Germany, the UK and Netherlands influence each other in the short and long run using. Using bi-variate cointegration (Engle-Granger) it is found that only Germany and the Netherlands are cointegrated. The Granger causality results provide evidence of bi-variate causality running from Germany to the UK and from the UK to the Netherlands. Furthermore, uni-variate Granger Causality is found, running from the Netherlands to Germany.

These results imply that diversification benefits between Germany and the Netherlands in the long run would not be beneficial but diversification between Germany and the UK or the Netherlands and the UK would be beneficial because they are not cointegrated or do not share common stochastic trends. The presence of Granger Causality implies that the stock markets are interdependent in the short run and thus diversification would not be beneficial. On the other hand, the presence of Granger Causality implies that one can predict the movement of the stock market that is being Granger caused (being led) by assessing the movements of the stock market that is leading, thus short run profit strategies can be formulated.

Erdinc & Milla (2009) investigate whether a long run relationship exists among stock markets of three European Union countries of France, Germany and the UK and using the Johansen-Juselius cointegration method, the presence of one cointegrating vector among these stock markets is found. This suggests that these stock markets move close together in the long run and share two (n - r= 3 – 1 = 2) common stochastic trends implying that international portfolio diversification among these stock markets is not beneficial in the long run.

A limitation in using the Engle-Granger method is that it is not able to identify more than one cointegrating vector among a k-dimensional set of variables where k>2 thus, the Johansen-Juselius cointegration method that caters for the presence of more than one cointegrating vector in the multivariate case is more informative (Corhay et al (1993), Masih & Masih (2004).

Similarly, Masih & Masih (2004) assess how interdependencies among European stock markets of France, Germany, Netherlands, Italy and the UK changed due to the October 1987 Crash find the presence of one cointegrating vector in the pre- and post-crash period implying no change in long run interdependencies (or the level of integration). The presence of cointegration in both periods provides evidence for the limits of portfolio diversification among the stock markets. The influence of each stock market to the long run cointegrating relationship is assessed and in the pre-crash period it is found that all the stock markets significantly influence the cointegrating relationship but in the post-crash period all markets except Italy influences the long run equilibrium relationship. The result that Italy does not influence the long run relationship is supported by Corhay et al (1993) and Cheung et al (1999).

Granger causality using VECM is assessed and it is found that the number of Granger causal relationships decreased in the post-crash period. In the pre-crash period, causality runs from Germany to the other stock markets except Italy, from the Netherlands to the UK and from France to Italy. In the post-crash period the only causal relationships that remain are from Germany to France and from the UK to Germany. The finding of Granger Causality running from Germany to the UK (and vice-versa) and from the Netherlands to the UK has been documented by Gerrits et al (1999).

Further evidence is found that in the pre-crash period, the French and German markets bear the burden of adjusting short run disequilibrium back to the long run equilibrium (cointegrating relationship) but in the post-crash period the burden of short run adjustment falls on France and Italy only and not the German market anymore. The Forecast Error Variance Decomposition (FEVD) results provide evidence that in the post-crash period, the British and Dutch markets are the most exogenous stock markets with British and Dutch markets explaining 63.18% and 56.94% of their own forecast error variance, respectively. In comparison the Italian, German and French markets explain only 32.37%, 36.60% and 9.29% of their own forecast variance after the same time horizon, respectively.

Worthington, Katsuura & Higgs (2003) assessing interdependencies among nine countries that adopted the Euro in 1991 namely, Austria, Belgium, Finland, France, Germany, Ireland, Italy, Luxembourg, Netherlands and Spain and among four countries that did not adopt the Euro (UK, Greece, Sweden and Denmark) find that both sets of stock markets are cointegrated in the long run after the adoption of the Euro. Using VECM to asses Granger causality, significant Granger causal relationships are found between both sets of stock markets with the larger stock markets (i.e. France, UK, Germany, Switzerland) having the most influence but having lower causality relationships with the middle sized (Belgium, Spain and Netherlands) and smaller sized (Ireland, Luxembourg, Finland and Norway) equity markets.

Similarly, Menezes, Dionsio & Mendes (2010) using Granger causality find that the UK is a regional leader in Europe among the European countries of Germany, France and Italy because it leads more stock markets than any of the other European stock markets. The UK Granger causes Germany and Italy, Germany Granger causes France only, France Granger causes the UK only and Italy Granger causes France only. The finding of Granger causality running from the UK to Germany has been documented by Gerrits et al (1999) and Masih et al (2004) but Menezes et al (2010) only find the presence of uni-variate causality between the two stock markets while Gerrits et al (1999) finds the presence of bi-variate Granger Causality between the two stock markets. The finding of Granger causality from Germany to France has been documented by Masih et al (2004). This implies that interdependencies are present among the European Union countries and diversification is not beneficial but short term profit strategies can be formulated.

The above results suggest that portfolio diversification among countries of close geographical proximity is not beneficial.

2.2.2 Literature on Asian Interdependencies

Worthington & Higgs (2004) analyse short run interdependencies among APEC stock markets and using Granger causality it is found that Japan Granger causes China. In contrast, Kashefi (2008) investigates short run interdependencies among the USA, Australia, China, Hong Kong, South Korea, Japan, New Zealand, Singapore and Taiwan and using Granger causality it is found that Japan does not Granger cause China or vice-versa. Using pairwise cointegration (Engle-Granger), no evidence of pairwise cointegration is found between any of the stock markets showing that Japan and China do not share a long run cointegrating relationship. Worthington et al's (2004) finding implies that profit strategies can be made because movements in Japan can be used to predict movements in China while Kashefi's (2008) finding implies that portfolio diversification between Japan and China in the short and long run is beneficial because no short or long run interdependencies exist between them.

Jeyanthi (2010) examines the existence of cointegration and causality between the stock prices of the BRIC countries (Brazil, Russia India and China) and the US and Japan. Using the Engle-Granger cointegration method, no evidence of pairwise cointegration is found among any of these stock markets implying that Japan and China do not share a long run equilibrium relationship as is found by Kashefi (2008). The Granger causality results show no evidence of Granger causality present between China and Japan as is found by Worthington et al (2004). Jeyanthi's (2010) result implies that short and long run diversification would be beneficial between China and Japan because they are not interdependent in the short or long run.

Similarly, Azad (2009) using Engle-Granger's cointegration to analyse long run interdependencies and Toda and Yamamoto (1995) Granger causality test among China, Japan and South Korea find that cointegration is present among the three stock markets in the long run over a sample period of July 1996 to December 2006. This implies that long run portfolio diversification among these stock markets would not be beneficial. The Granger causality results show bi-directional causality between Japan and South Korea but no Granger causality between Japan and China as was found by Jeyanthi et al (2010).

A limitation of Azad's (2009) analysis is that the Engle Granger test is used for more than two variables and if more than two variables are used in this analysis, a serious bias occurs. This is because depending on the choice of the dependent variable different estimates and results of the cointegration vector are obtained (Alexander (2001); Masih & Masih (2004)). Furthermore, the Engle-Granger test assumes at most one cointegrating vector being present when there can be more than one present, in this case there can be at most two cointegrating vectors. Li (n.d.), on the other hand using an asymmetric GARCH-BEKK model and likelihood ratio tests over a sample period of 1992 to 2010 finds unidirectional causality from China to Japan.

Another important finding assessing interdependencies between Japan and China is that correlations are low between Japan and China implying that interdependencies between developed and developing stock markets are low (Worthington & Higgs (2004); Lamba (2005) and Fadhlaoui, Bellalah, Dherry, & Zouaouii (2009).

Other researchers such as Raju & Khanapuri (2009) and Marimuthu (2010) have documented the isolation of China as a stock market and China not being influenced or influencing other stock markets in terms of forecast error variance decompositions and Granger causality.

2.2.3 Literature on American Interdependencies

Eun & Shim (1989) use a group of stock markets from different continents and find that short run interdependencies among stock markets of the same region are higher than those not from the same stock region. Thus, it is found that correlations between the USA and Canada are higher than between USA (or Canada) and other stock markets from different regions, implying that interdependencies between stock markets of the same region are higher than those that are not of the same region.

Using Forecast Error Variance Decomposition (FEVD) it is found that the USA significantly accounts for the forecast error variance of Canada and the rest of the other stock markets but Canada or any other stock markets do not significantly cause fluctuations in the USA. This result implies that the USA has high influence on Canada and the other stock markets but not vice-versa showing the dominance of the USA as a stock market.

Masih & Masih (1997) investigate interdependencies among the stock markets of USA, Japan, France, Canada, Germany and the UK due to the October 1987 Crash and find the presence of one cointegrating vector in both the pre and post-crash period implying the presence of long run interdependencies. When the USA is normalised upon, it is found that each market is significant in the long run cointegrating relationship implying that Canada is significant in the long run equilibrium relationship. In the pre-crash and post-crash period the Granger causality results show no evidence of Granger causality between the USA and Canada. The Forecast error variance decomposition (FEVD) results show that in the post-crash period there is an increase in the contribution of other markets in explaining shocks to each individual market implying an increase in interdependencies as is found by Worthington & Higgs (2004) as a result of the Asian crisis of 1997.

In contrast, Cheung & Lai (1999) assessing cointegration among Canada, Germany, Japan, the UK and the USA over a sample period of April 1979 to June 1992, find no evidence of cointegration implying that these stock markets and thus Canada and the USA are not interdependent and thus do not move closely together in the long run. In contrast, Kasa

(1992) using a sample period from January 1974 to August 1990 finds the presence of cointegration among the stock markets of USA, Japan, England, Canada and Germany implying interdependencies being present between the USA and Canada though it is found that Canada has the lowest influence in the long run cointegrating relationship. The difference in results between Cheung et al (1999) and Kasa (1992) could be due to different sample periods used.

Worthington & Higgs (2004) find no significant influence running from Canada to the USA or vice-versa in the short run, implying no short run interdependencies present between Canada and the USA. However, using generalised forecast error variance decompositions (GFEVD) it is found that the USA significantly affects Canada and they also find an increase in the contribution of each market in explaining the forecast error variance of other markets in the post-crisis period of the Asian Crisis of 1997. This result supports Masih & Masih's (1997) finding of an increase in the contribution of each market in explaining the forecast error variance of other stock markets as a result of the October 1987 crash.

The limitation in using forecast error variance decomposition (FEVD) and impulse response function (IRF) analysis is that they both use orthogonolisation implying that changing the ordering of the variables produces different results. Thus, if a variable is ordered first in the variance decomposition (FEVD) analysis and impulse response function (IRF) analysis the first variable will have an impact on all other variables and so will the second variable but the second variable will have no impact on the first variable and the third variable will affect itself and the variables after it but it will have no impact on the second or first variable (Climent, Meneu & Pardo, 2001, pg. 4). To overcome this problem, the generalised impulse response function (GIRF) and generalised forecast error variance decomposition (GFEVD) analyses which were discovered by Pesaran & Shin (1997) and used by Worthington et al (2004) is preferable because changing the ordering of the variables does not produce different results (Yang et al (2002)) because all variables are shocked at once to assess responses by all other variables and this is supported by Worthington et al (2004).

Liu, Chang, Lin, & Lai (2005) assessing short and long run interdependencies among the US and ten of its major trading partners (Canada, Japan, Mexico, Germany, the UK, Taiwan, South Korea, France, Singapore and Hong Kong) find no evidence of cointegration among the 11 stock markets using Johansen's multivariate cointegration method. This result implies that no long run interdependencies exist between the USA and Canada. Using forecast error variance decompositions (FEVD), it is found that intra-regional interdependencies are higher than inter-regional interdependencies especially for the American (USA, Canada, Mexico) and European stock markets due to close geographical proximity. This finding is similar to that of Eun & Shim (1989) and Metin & Muradoglu (2001) who find that stock markets of close geographic proximity are highly interdependent.

Furthermore, it is also found that the USA is the most influential stock market as is found by Eun & Shim (1989) and the USA explains a higher forecast error variance of Canada as compared to that of Mexico (Latin-American), implying higher interdependencies between Canada and the USA as compared to the USA and the Latin American stock market.

In assessing the diversification potential in Latin American stock markets, from the viewpoint of a US investor or portfolio manager, Maniam, Chatterjee, & Mehta (1999) use correlation analysis on stock market data from Brazil, Argentina, Chile, Venezuela, Peru and the US with a sample period from 5th July 1989 to 31st December 1997 . It is found that pair-wise correlations and thus short run interdependencies between the USA and Brazil and USA and Argentina are low and significant implying that diversification between the USA and Brazil would be beneficial in the short run. Furthermore, evidence of limited diversification benefits between the rest of the Latin American stock markets and the USA exist.

Similarly, Fernandez-Serrano & Sosvilla-Rivero (2003) assess long run interdependencies between the USA and the Latin American stock markets of Argentina, Brazil, Chile, Mexico, Peru and Venezuela using Engle-Granger bi-variate method and Johansen-Juselius cointegration method. Evidence of cointegration is present in the long run between Brazil and the USA implying that long run portfolio diversification would not be beneficial between the USA and Brazil because of the presence of long run interdependencies but when the Johansen cointegration test is used in a bi-variate sense, no evidence of cointegration is found between the USA and Brazil. Thus, this evidence provides mixed results on whether interdependencies exist between the USA and Brazil. This result is similar to that of Jeyanthi (2010) who find no evidence of pairwise cointegration between Brazil and the USA as is found by Fernandez-Serano et al (2003) who also use the Engle-Granger bi-variate cointegration method.

Using a number of regions, Metin &n Muradoglu (2001) support the finding that intra-regional or stock markets that are geographically close are highly interdependent. They group 16 emerging countries into stock markets from the same region of European, Asian, and Latin American and find the presence of long run interdependencies among stock markets from the same region using Johansen's cointegration in a bi-variate sense. This result implies that stock markets in the same continent or of close geographical proximity are interdependent in the long run.

2.3 Literature on how Interdependencies have changed due to Financial Crises

Researchers have also focused on how interdependencies among stock markets have changed due to major financial crises such as the October 1987 Crash and the Asian 1997-1998 Crisis but the results provided do not reach a consensus on how financial downturns have affected interdependencies among stock markets.

2.3.1 Literature on the 1987 October Crash

Researchers have focused on the effects of the October 1987 Crash on relationships and interdependencies among different international and regional stock markets from a range of continents. Malliaris & Urrutia (1992) focus on how short run interdependencies (lead-lag relationships) have changed between six stock price indices of New York, Tokyo, London, Hong Kong, Singapore and Australia before (May 1 1987 to 30 September 1987), during (October 1 1987 to October 31 1987) and after (November 1 1987 to march 31 1988) the October 1987 crash. Using the Engle-Granger two step cointegration method, the results show that the null hypothesis of no cointegration was rejected more often during the crash and post-crash period compared to the pre-crash period implying an increase in long run interdependencies during and after the crash.

Assessing Granger causality using an error correction model for the cointegrated stock prices and a standard VAR for stock prices not cointegrated, no lead-lag relationships are detected in the pre and post-crash period contradicting Eun & Shim's (1989) finding of USA having leading information and being the most influential for European and Asian stock markets in the pre-crash period. These results could be solely due to a difference in sample periods used. In contrast, during the crash sample period, a dramatic increase in lead-lad relationships is found with 20 out of the 30 lead-lag relationships being significant at 5%. This result implies that interdependencies increased temporarily during the crisis period and thus, diversification benefits among these stock markets during the crash period were limited.

Similarly, Arshanapalli & Doukas (1993) assess how short run and long run linkages among stock price indices of the USA, Japan, France, the UK and Germany have changed due to the October 1987 crisis dividing their sample period(January 1980 to May 1990) into pre-crash period (January 1980 to September 1987) and post-crash period (November 1987 to May 1990). Using Engle-Granger's bi-variate cointegration method, they find no evidence of cointegration among the stock markets at 5% significance level in the pre-crash period but in the post-crash period the French, German and UK stock markets are cointegrated with the USA but Japan is not.

The pre-crash period result implies that portfolio diversification in the long run is beneficial because the stock markets do not share a common trend and do not move closely together but this result is in contrast to the substantial amount of interdependence among national stock markets found by Eun and Shim (1989) in the pre-crash period. The post-crash period result implies an increase and strengthening in long run interdependencies with the exception of Japan. This result implies that long run portfolio diversification between the USA and the stock markets of France, Germany and the UK would not be beneficial but portfolio diversification between the USA and Japan would be beneficial.

Using the error correction model to analyse Granger causality only in the post-crash period, it is found that innovations in the US Granger cause the French, German and UK markets but innovations in the three European markets do not impact the US stock market.

This result is in line with Eun & Shim's (1989) finding that the US market is the most influential on European markets but the European markets cannot significantly explain movements in the US market but contradicts Malliaris et al's (1992) finding of no influence from the US on any of the stock markets in the post-crash period in the Granger causal sense.

As a result, if there are innovations in the US market, one can predict movements in the European countries because innovations/movements in the US precede or Granger Cause movements in the European stock markets. Another implication is that short run international portfolio diversification would not be beneficial as the stock markets are interdependent in the short run.

Masih & Masih (1997) investigate the effect of the October 1987 crash on short and long term interdependencies among the US, Japan, the UK, Germany, Canada and France dividing the sample period into pre-crash period (January 1979 to September 1987) and post-crash period (November 1987 to June 1994). Using the Johansen's multivariate cointegration method to test for the presence of cointegration unlike Arshanapalli et al (1993) and Malliaris et al (1992) who use the Engle-Granger bi-variate cointegration methodology, evidence of one cointegrating vector is found in both the pre and post-crash sample periods.

This implies that the stock price indices share 5 ($n - r = 6 - 1 = 5$) common stochastic trends and move close together in the long run and thus portfolio diversification among these stock markets in the long run would not be beneficial. Furthermore, this result implies that the level of integration remained constant in the pre and post-crash periods. This result is inconsistent with that of Malliaris et al (1992) and Arshanapalli et al (1993) who find that interdependencies increased in the post-crash period.

Using VECM to assess Granger Causality it is found that the US market is unaffected by innovations from other markets and does not affect other markets (completely exogenous) in the pre-crash period while in the post-crash period the US market Granger causes both France and British stock markets. Furthermore, the German stock market Granger causes France and the UK. The result that USA contains leading information about the European markets is supported by Eun and Shim (1989) and Arshanapalli & Doukas (1993). Masih et al (1997) also find a feedback relationship between Japan and the UK but no relationship between Japan and the USA. The result that no relationship exists between Japan and USA is consistent with that of Arshanapalli & Doukas (1993). Furthermore, the finding that Germany Granger causes France and the UK has been documented by Gerrits et al (1999), Masih et al (2004) and Menezes et al (2010).

Using Forecast Error Variance Decompositions (FEVD) to ascertain the change in the extent to which stock markets explain forecast error variance in other stock markets, an increase in the contribution of other markets explaining shocks/ forecast error variance of each individual market in the post-crash period is found. Thus, it is concluded that the crash increased interactions and interdependencies among the stock markets and this finding is consistent with that of Malliaris et al (1992) and Arshanapalli et al (1993).

As can be seen there are a number of contradictory results on the effect of the October 1987 Crash on interdependencies among stock markets. This could be due to different sample periods used to analyse interdependencies and also due to different methods used to do the same analyses.

2.3.2 Literature on the Asian 1997-1998 Financial Crisis

Other researchers have focussed on the effects of the Asian 1997-1998 financial crisis on interdependencies among Asian stock markets and contradictory results have been found about whether interdependencies changed due to the Asian Crisis.

Yang, Kolari & Min (2002) focus on how long run relationships among the US, Japan and ten Asian emerging stock markets (Hong Kong, India, Indonesia, Korea, Malaysia, Philippines, Pakistan, Singapore, Thailand, and Taiwan) have changed due to the Asian Crisis. The sample periods are divided into pre-crisis period (January 2 1995 to December 31 1996), during the crisis period (July 1 1997 to June 30 1998) and post-crisis period (July 1 1998 to May 15 2001). In the pre-crisis period no evidence of cointegration is found but during the crisis and in post-crisis period the presence of two cointegrating vectors is found. This implies that long run integration and interdependencies among these stock markets intensified during the crisis and in the post-crisis period in comparison to the pre-crisis period. As a result, it can be concluded that the Asian crisis changed the degree of integration and interdependence among the stock markets.

These results are computed with the stock price indices expressed in local currency but when the stock price indices are converted and denominated in US dollars; Yang et al (2002) find the presence of one cointegrating vector in the pre-crisis period instead of no cointegration being present. Yang et al (2002) state that Hung & Cheung (1995) find that exchange rate adjustment can affect the number of cointegrating vectors.

Worthington, Katsuura & Higgs (2003) find contradictory results to that of Yang et al (2002) in regards to how long run interdependencies changed due to the Asian crisis. Johansen's multivariate cointegration and VAR procedures are used to analyse interdependencies with three developed markets (Hong Kong, Japan and Singapore) and six emerging markets (Indonesia, Korea, Malaysia, the Philippines, Taiwan and Thailand) using sample periods before the crisis and the period since the Asian crisis. Using the Johansen-Juselius approach, Worthington et al (2003) find evidence of one cointegrating vector/relationship in all sample periods, suggesting that long run relationships did not intensify but stayed the same in the pre-crisis period and during the crisis period which contradicts Yang et al's (2002) finding of intensified integration and interdependencies among the Asian stock markets during the crisis period.

Using Granger causality to analyse short run interdependencies, 16 significant Granger causal relationships are found in the pre-crisis period but only 8 are significant in the post crisis period implying a decrease in short run interdependencies due to the Asian crisis. The above empirical results found by Worthington et al (2003) imply that in the long run international portfolio diversification would not be beneficial because these stock markets share common long run stochastic trends or move closely together. In contrast, in the short run as shown by the Granger causality results, stock market interdependencies reduced during and after the crisis showing beneficial opportunities of international portfolio diversification.

Chatterjee, Ayadi & Maniam (2003) investigate the impact of the Asian Financial Crisis on interdependencies and using the Johansen-Juselius multivariate cointegration method, similar results to that of Worthington et al (2003) on long run interdependencies are found. Using the same Asian stock markets as Worthington et al (2003) except Japan over the pre-crisis period and during the crisis and post-crisis periods combined, evidence of one cointegrating vector is found in both sample periods which is consistent with Worthington et al's (2003) finding of no change in long run relationships.

Other researchers have focussed on the impact of the Asian Financial Crisis not only on Asian stock markets but other international stock markets from different continents.

Daly (2003) investigates how both the static (short run) and dynamic (long run) interdependencies of the stock markets of Indonesia, Malaysia, the Philippines, Singapore, Thailand and three advanced stock markets of Australia, Germany and the United States of America have changed due to the Asian crisis. Using correlation analysis to analyse short run interdependencies, evidence of an increase in interdependencies (correlations) between stock markets over the post-crisis period was found, implying an increase in short run interdependencies among the stock markets.

The finding that correlations among international stock markets increased due to the Asian Financial Crisis is supported by Lamba (1999) who finds that correlations increased among international stock markets of India, Hong Kong, USA, UK, Singapore and Japan due to the Asian Financial crisis of 1997-1998. This result is inconsistent with that of Worthington et al (2003) who use Granger Causality instead of correlation analysis to assess short run interdependencies and find that interdependencies reduced after the Asian crisis.

Daly's (2003) finding implies that short run international portfolio diversification would not have been beneficial in the post-crisis period because there was an increase in interdependencies between the stock markets. To assess long run interdependencies, the Johansen-Juselius multivariate cointegration (among the Asian markets only, among the developed markets only and a combination of Asian and developed) is carried out. Evidence of no cointegration is found between the stock markets of the advanced markets and the markets of Southeast Asia. Furthermore, no cointegration is found among the advanced countries both in the pre and post crisis periods. Thus the results imply no significant increase in long run relationships due to the Asian crisis in either the developed or developing stock markets. Thus, it can be concluded that portfolio diversification benefits were not reduced due to the Asian Financial crisis. This result is inconsistent with Yang et al (2002) who find that long run relationships among Asian stock markets had strengthened and integration had increased due to the Asian crisis.

The above results show that there have been contradictory results about how interdependencies have changed due to the Asian Financial Crisis. Some results show strengthened interdependencies among stock markets due to the crisis, others have shown weakened interdependencies or no change in interdependencies at all.

2.4 Literature on the Global Financial Crisis and Interdependencies

A significant amount of research has been carried out on how financial crises have changed interdependencies among stock markets but not much research has been carried out on the effects of the Global Financial Crisis (GFC) on interdependencies among international stock markets because this is a fairly recent event. The findings below lean towards an increase or strengthening in interdependencies due to this event.

Gklezakou & Mylonakis (2009) analyse the interdependencies among South Eastern European stock markets of Romania, Bulgaria, Croatia, Slovenia and Turkey with the addition of Greece and Germany as developed stock markets, using two sub-periods of pre-crisis period (1st November 2000 to 19th July 2007) and during the crisis period (20th July 2007 to 20th February 2009). Utilising pair-wise correlation coefficient analysis to analyse short run interdependencies, it is found that correlations among developing stock markets are low but increase during the GFC. When the two developed stock markets are added the same result is found but evidence that correlations are higher between developed countries than between developed and developing stock markets is shown. The finding that correlations are higher between developed stock markets than between developed and developing stock markets is supported by Worthington et al (2004), Fadhlaoui et al (2009) and Jeyanthi (2010).

Overall, evidence is provided that interdependencies increased due to the financial crisis. The Granger Causality tests show that Germany is the leading stock market as it Granger causes all the other stock markets while it is not Granger caused by any of the stock markets. It is concluded that interdependencies increased and strengthened due the financial crisis. A limitation of this research is that effects on long run relationships are not investigated as this would be beneficial for long term investors.

Similarly, Cheung, Fung , & Tsai (2010) examine the impact of the 2007-2009 Global Financial Crisis (GFC) on interrelationships among global stock markets namely the USA, the UK, Hong Kong, Japan, Australia, Russia and China using the pre-crisis period (January 2003 to June 2007) and during the crisis period (July 2007 to April 2009). Concentrating on interdependencies between the USA and the other stock markets, using a VAR model, it is found that bivariate short run causal relationships have been strengthened during the crisis. The finding that short run interdependencies have increased and been strengthened is in line with Gklezakou et al (2009) who finds an increase in short run interdependencies.

Using Johansen's cointegration technique and VECM, it is found that bivariate long run cointegrating relationships have been strengthened between the USA and the other stock markets during the crisis. Overall, these results imply that interdependencies have increased and been strengthened due to the Global financial Crisis.

2.5 Conclusion

As can be seen a vast number of researchers have investigated interdependencies among stock markets from the same regions. Most of the researchers have found similar results while others have found contradicting results on the same countries. This could be attributed to different sample periods used as well as different methods used to analyse short or long run interdependencies.

Generally, it has been found that stock markets that are of close geographical proximity or of the same region are highly interdependent and correlated than those that are not. This can be attributed to having similar economies, being trade partners or less trade restrictions among these countries (Maniam, Chatterjee & Mehta, 1999). Furthermore, evidence is also found that interdependencies among developed countries are higher than interdependencies between developed and developing countries of the same region. This could be attributed to openness of trade of the developing stock markets.

Evidence using forecast error variance decompositions (FEVD) emphasise these points but also show that all stock markets are not fully exogenous but are affected by other stock markets to some degree, some more than others.

Furthermore, research based on how interdependencies have changed due to financial crises such as the October 1987 Crash and the Asian 1997-1998 Crisis have been carried out but there has been no consensus on the effect of financial downturns on interdependencies. Some researchers have found increased interdependencies while others have found decreased interdependencies or no change at all in interdependencies. While interdependencies among stock markets have been widely explored, a limited amount of research has focused on the impacts of the Global Financial Crisis (GFC) on both short and long term interdependencies among stock markets. This is because the Global Financial Crisis (GFC) is a fairly recent event. With the limited research that has been done, a limited amount of researchers have dissected sample periods into the pre-crisis period, during the crisis period and post-crisis period. Doing this would provide better insight into how interdependencies have changed due to this phenomenal event.

Furthermore, there is a gap in the literature involving both short and long term interdependencies using the stock markets of the ten countries with the highest GDP in the world in 2009 as ranked by the World Bank in 2009. My research looks to fill this gap. Investigation into both short and long term interdependencies will be beneficial for both short term and long term investors in providing information on the limits or benefits of portfolio diversification among stock markets of the same region. I will also add to the limited amount of research done based on such a phenomenal event considered the worst financial disruption since the Great Depression of 1929-1933 (Wheelock, 2009).

CHAPTER THREE: ECONOMETRICS METHODOLOGY

3.1 Introduction

The aim of this study is to investigate how short and long term interdependencies, if any, have changed due to the Global Financial Crisis (GFC). Thus, to identify how these interdependencies have changed, quantitative analysis using Econometrics methods will be utilized. This Chapter will outline a detailed description of these econometrics methods. The econometric methods are chosen on the basis of the methods used by the authors in the literature review as these methods are relevant to my research.

3.2 Unit Root (Stationarity tests):

In this research, the first analysis that will be carried out before any other regressions are carried out are tests for stationarity or unit root tests on both price index levels and first log differences of the price indices (returns). This is because a pre-requisite for one of the methods, cointegration, is that the variables must have a unit root and must be integrated of the same order (Engle & Granger (1987); Dickey, Jansen & Thornton, 1991) otherwise spurious regressions and results occur (Alexander (2001); Gujarati & Porter (2009). Spurious results can be very misleading to investors that base investment decisions on these results and can lead to bad investment decisions being made.

There are a number of approaches used to examine the stationarity of time series data. The most popular are the Augmented Dickey Fuller (ADF) test, and the Kwiatowski, Phillips, Schmidt and Shin (KPSS) and thus these two methods will be utilized to test for stationarity.

3.2.1 Augmented Dickey Fuller (ADF) Test:

The Augmented Dickey Fuller (ADF) test is a refinement of the original Dickey & Fuller (1979) test. The original Dickey Fuller test is represented as shown below:

$$\Delta y_t = \delta y_{t-1} + u_t$$

Where y_t denotes the price index level at time period t and $\Delta y_t = y_t - y_{t-1}$ (stock return). δ is the estimated slope coefficient and u_t is the error term.

The Dickey-Fuller tests' main assumption is that the error terms (u_t) are independently distributed or not correlated. This is not always the case as trends that exist in financial time series are sometimes due to serial correlation (Harris (1992); Gujarati & Porter (2009)). Thus, the ADF test in 1981 was developed to take care of serial correlation in the error terms by adding the lagged difference terms of the dependent variable (Δy_t) (Gujarati and Porter,2009, p. 757) to the original Dickey Fuller (DF) test as shown below:

$$\Delta y_t = \delta y_{t-1} + \sum_{i=1}^{m} \alpha_i \Delta y_{t-i} + u_t$$

Where m = number of lags sufficient to get rid of serial correlation (Alexander, 2001, p. 327).

In implementing the ADF test, some decisions based on whether to test for a unit root only, test for a unit root with a constant or test for a unit root with a constant and a time trend have to be made.

In order to know what options to choose, one can base their decision by inspecting the time series graphs of the price indices and stock returns data as "such plots give an initial clue about the likely nature of the time series variables" (Gujarati & Porter, 2009, p. 749). The three mainly used options when testing for unit root using the ADF test are:

1. Test for a unit root:

$$\Delta y_t = \delta y_{t-1} + \sum_{i=1}^{m} \alpha_i \Delta y_{t-i} + \varepsilon_t$$

2. Test for unit root with drift

$$\Delta y_t = \beta_o + \delta y_{t-1} + \sum_{i=1}^{m} \alpha_i \Delta y_{t-i} + \varepsilon_t$$

3. Test for unit root with drift and a deterministic trend:

$$\Delta y_t = \beta_o + \beta_1 t + \delta y_{t-1} + \sum_{i=1}^{m} \alpha_i \Delta y_{t-i} + \varepsilon_t$$

Where β_o is the drift term, t is the linear trend term and m is the lag length of the autoregressive process. The other variables are the same as mentioned in the ADF formula mentioned previously.

The first formula corresponds to modelling a random walk without a drift term (constant/intercept). The second formula corresponds to modelling a random walk with a drift and the third corresponds to modelling a random walk with drift and a deterministic time trend.

Unit root tests also provide information on what order of integration the time series are. Daily return data are generated by stationary process while daily price data are generated by a stochastic non-stationary process (Alexander (2001); Gujarati & Porter (2009). Thus, if the Stock Price Indices (levels) are non-stationary and the stock returns (first differences) are stationary, it is concluded that the stock price indices are integrated of order one (I(1)); (Kasa (1992), Arshanapalli & Doukas (1993), Masih & Masih (1997); Alexander (2001); Gujarati & Porter (2009).

3.1.1.1 Limitations of Unit Root tests:

Gujarati & Porter (2009, p. 758) declare that the varieties of testing for unit roots (unit root, unit root with drift and unit root with drift and time trend) all produce different estimates/results and as a result, if one chooses the wrong option that does not correspond to the true model or an option that does not characterise the price indices, the results can be misleading. This limitation is supported by Harris (1992).

Gujarati & Porter (2009) also report that the power of the ADF test is low in that it tends to accept the null hypothesis of unit root. This is because if the (δ) coefficient is close to but not exactly one, the unit root test declares the time series non-stationary though clearly it is stationary but close to non-stationary. Also unit root tests may not detect structural breaks and changes and this is supported by Gujarati & Porter (2009, p.759) who points out that Perron (1989) argued that standard tests that have unit root as the null hypothesis may not be reliable when structural changes are present .

3.2.2 Kwiatowski, Phillips, Schmidt and Shin (KPSS) Test:

Kwiatkowski, Phillips, Schmidt, & Shin (1992) declare that "standard unit root tests fail to reject the null hypothesis of a unit root for many economic time series" (p. 159). The KPSS test proposed by Kwiatowski et al in 1992 was created to overcome the low power of the ADF test. Kwiatowski et al (1992) report that "the test is a Lagrange Multiplier test of the hypothesis that a random walk has zero variance (stationary)". Kwiatowski et al (1992) firstly start by regressing the dependent variable (y_t) on a constant or constant and time trend as shown below:

$$y_t = \beta t + r_t + \varepsilon_t$$

Where βt is the deterministic trend, r_t is the random walk i.e. $r_t = r_{t-1} + u_t$ and ε_t is the stationary error. From this regression they get the residuals ε_t where t= 1,2,...., T and compute the partial sum process of the residuals as:

$$S_t = \sum_{i=1}^{t} \varepsilon_i \text{ for all t.}$$

The partial sum of the residuals is in turn used to calculate the Lagrange multiplier one-sided test statistic used to test for stationarity as shown below:

$$LM = \sum_{t=1}^{T} \frac{S_t^2}{\hat{\sigma}_\varepsilon^2}$$

Where $\hat{\sigma}_\varepsilon^2$ is the estimated error variance from the regression.

3.3 Lag Length Selection:

An important decision one has to make in carrying out unit root tests, cointegration and Granger causality is selecting the optimal lag length. This is in order to include enough lags so that the error terms are not serially correlated (Harris, 1992); Gujarati & Porter (2009). One approach to selecting the optimal number of lags is called testing down in which the software program tests down from high lag orders. One just has to put in a generous number of lags and the software program automatically reduces the number lags until the t-value on the longest remaining lag is significant. An alternative approach that will be used in this research is to use the lag length selection Information Criteria called the Akaike Information Criteria (AIC) and the Schwartz Bayesian Information Criterion (SBIC). The AIC criterion is defined as:

$$\ln AIC = \left(\frac{2k}{n}\right) + \ln\left(\frac{RSS}{n}\right)$$

The SBIC criterion is defined as:

$$\ln SBIC = \left(\frac{k}{n}\right)\ln n + \ln\left(\frac{RSS}{n}\right)$$

Where k = number of parameters in the model, n = number of observations and RSS = Residual Sum of Squares.

The appropriate lag length in Microfit is the one that maximises both the Information Criteria.

3.4 Vector Autoregressive (VAR) Models:

Vector Autoregressive (VAR) models will be utilised in doing my analysis of cointegration and Granger causality. The vector autoregression model is "a multiple time series generalization of the autoregressive model" (Maddala, 2001, p. 544). An Autoregressive (AR) model regresses a dependent variable on its own past values (lags) while the Vector autoregressive (VAR) model regresses a dependent variable on its own past lag values and lag values of other independent variables (Gujarati & Porter, 2009). A bivariate Vector autoregressive (VAR) model can be shown as:

$$x1_t = \alpha_{11}x1_{,t-1} + \alpha_{12}x2_{,t-1} + \varepsilon_{1t}$$

$$x2_t = \alpha_{21}x1_{,t-1} + \alpha_{22}x2_{,t-1} + \varepsilon_{2t}$$

A VAR model can also describe the evolution of a set of k variables or more than two variables over a same sample period (t = 1, 2, ..., T) as a linear function of only their past values and lag values of other independent variables. A VAR model with p lags written in matrix notation is shown below:

$$x_t = c + A_1 x_{t-1} + A_2 x_{t-2} + ... + A_p x_{t-p} + \varepsilon_t$$

Where x_t and its lagged values are a k x 1 vector of variables, c is a k x 1 vector of constants, and ε_t is a k x 1 vector of error terms. A_i is a k x k matrix (for every i = 1, ..., p) of coefficients to be estimated.

A VAR model has its advantages, in that it is easy to use and one does not need to worry about determining which variables are endogenous or exogenous because all the variables are considered endogenous (Gujarati & Porter, 2009). With its advantages come its limitations too. A problem emphasised by Maddala (2001) is that there is over-parameterization in VAR models. For example, if one has four variables and considers six lags for each variable, then each equation would have 24 parameters to be estimated and thus, 96 parameters to be estimated overall. Thus, it gets very messy.

3.5 Cointegration

The concept of cointegration was developed by Engle and Granger (1987) and asserts that if individual time series are integrated of order one (non-stationary) but one or more linear combinations of these variables is stationary then the time series variables are cointegrated. This implies that the time series variables move closely together in the long run and are said to share a common stochastic long term trend and thus should never drift apart (Alexander (2001); Dickey, Jansen, & Thornton (1991) .

The Johansen (1990) and Johansen & Juselius test (1991) test will be used in preference of the Engle-Granger method (1987). This is because if more than two variables are used in the analysis; the Engle-Granger method can suffer from a serious bias. This is because depending on the choice of the dependent variable different estimates and results of the cointegration vector are obtained (Alexander (2001); Masih & Masih (2004)).

Furthermore, the Engle-Granger method only allows estimating one cointegration vector when there can be up to n-1 cointegration vectors present (Alexander, 2001, p. 355; Masih & Masih (2004)) where n is the number of variables (i.e. stock markets) in the system. Thus, an alternative approach that is suitable for all these limitations is the Johansen (1988, 1991) and Johansen & Juselius (1990) multivariate cointegration test.

3.5.1 The Johansen-Juselius Cointegration Test:

As demonstrated by Johansen and Juselius (1988, 1990, 1991), the Johansen-Juselius test can be expressed as a general VAR model as shown below:

$$\Delta X_t = \mu + \sum_{i=1}^{k-1} \Gamma_i \Delta X_{t-i} + \Pi X_{t-k} + \varepsilon_t$$

Where X_t is a n x 1 column vector of variables integrated of order one, Δ represents the difference operator, k represents the optimal lag length to get rid of serial correlation, $\Gamma_i = \left(\sum_{j=1}^{i} \beta_j\right) - I_n$ and $\Pi = (\sum_{i=1}^{k} \beta_i) - I_n$ are coefficient matrices and I is an n x n identity matrix, μ is an n x 1 vector of constants if needed and u_t is a n x 1 column vector of innovations.

Cointegration among the variables X_t is determined by identifying the rank of the n x n matrix Π (Johansen (1990) and Johansen & Juselius (1991)). If the rank (r) of the matrix Π is zero, then no cointegration exists among the variables (stock markets) X_t and ΔX_t is stationary (Hendry & Juselius, 2001).

If the rank r (the number of stationary linear combinations of the variables X_t) is equal to n (the number of variables or number of column vectors of X_t) this means the coefficient matrix Π is full rank and the variables X_t are stationary (Johansen and Juselius, 1990).

If the rank of the coefficient matrix Π lies between zero and n (less than full rank), the number of variables being investigated will be non-stationary but r linear combination of the variables are stationary and cointegration is present. The rank (r) of the coefficient matrix, Π equates to the number of cointegrating vectors present (Johansen and Juselius, 1990).

3.5.1.1 Testing for the rank of the Matrix:

The rank (r) of a matrix is equal to the number of non-zero eigenvalues and the eigenvalues are denoted by λ_i (Johansen & Juselius (1990); Johansen (1991). Thus if the variables are not cointegrated, the rank (r) of Π will not be significantly different from zero i.e. $\lambda_i \approx 0$ (Johansen, (1991)).

Johansen & Juselius (1988, 1990 and 1991) provide two likelihood ratio tests to determine the rank of the coefficient matrix, called the trace test and the maximum eigenvalue test and they are represented as follows:

$$\lambda_{trace}(r) = -T \sum_{i=r+1}^{n} \ln\left(1 - \hat{\lambda}_i\right)$$

$$\lambda_{\max}(r, r+1) = -T \ln\left(1 - \hat{\lambda}_{r+1}\right)$$

Where T is the sample size, n is the number of variables in the system and the eigenvalues of Π are real numbers such that $\hat{\lambda}_1 > \hat{\lambda}_2 > ..... > \lambda_n > 0$.

The trace test has a null hypothesis of at most (less than or equal to) r cointegrating vectors against the alternative hypothesis of more than r cointegrating vectors. The maximum eigenvalue test has the null hypothesis of r cointegrating vectors against the alternative of r+1 cointegrating vectors.

Even if a long run cointegrating equilibrium relationship is found and exists, it can be so that in the short run there is disequilibrium or the price series drift apart (Engle & Granger (1987); Gujarati & Porter (2009). The size of the disequilibrium value equates to the error term from the cointegration regression and the number of disequilibrium terms equates to the number of cointegrating vectors present (Alexander (2001); Gujarati & Porter, 2009, p. 764). In the case that disequilibrium exists in the short run, Engle & Granger (1987) assert that the cointegrating relationship can be expressed as an Error Correction Model (ECM) or Vector Error Correction Model (VECM) and this model is used to correct any short run disequilibrium. Thus, in the presence of cointegration, the coefficient matrix Π is expressed as two matrices as shown below:

$$\Pi = \alpha * \beta'$$

Thus, the VECM can be shown as:

$$\Delta X_t = \mu + \sum_{i=1}^{k-1} \Gamma_i \Delta X_{t-i} + (\alpha * \beta') X_{t-k} + \varepsilon_t$$

Where α is a k x r matrix that provides evidence on whether the dependent variable bears the burden of correcting short run disequilibrium and the size of the alpha coefficient indicates the speed of adjustment of the dependent variable from the short run disequilibrium back to the long run cointegrating equilibrium relationship.

β' is a r x k matrix that contains the r cointegrating vectors/relationships that make $\beta' X_t$ stationary even if X_t themselves are non-stationary (Johansen (1988) and Johansen & Juselius (1990)).

If cointegration is found, the parameters of interest will be the speed of adjustment coefficient and the cointegrating vector/s. This is in order to assess which stock markets bear the burden of adjusting short run disequilibrium and the speed at which the stock markets adjust back to the long run equilibrium from the short run disequilibrium. The cointegrating vector/s help assess which stock markets are the most important or significant to the long run cointegrating (equilibrium) relationship.

3.6 Granger Causality:

The concept of Granger Causality discovered by Granger (1969) implies that there is a lead-lag relationship present between variables. That is, if X Granger causes Y then changes in X cause preceding movements/changes in Y. This implies that predictions of Y can be improved if lagged variables of X are included as explanatory variables (Granger (1969); Alexander (2001, p. 344)). Granger Causality can be represented as follows:

$$\Delta Y_t = \sum_{i=1}^{p} b_{1i} \Delta X_{t-i} + \sum_{j=1}^{p} c_{1j} \Delta Y_{t-j} + u_{1t}$$

$$\Delta X_t = \sum_{i=1}^{p} b_{2i} \Delta Y_{t-i} + \sum_{j=1}^{p} c_{2j} \Delta X_{t-j} + u_{2t}$$

Where p is the number of lags sufficient to get rid of serial correlation. If only b_{1i} is significant then unidirectional causality runs from X to Y and if only b_{2i} is significant then uni-variate Granger causality runs from Y to X. If both b_{1i} and b_{2i} are significant then bi-variate Granger causality runs from X to Y and from Y to X.

As pointed out by Alexander (2001, p. 345), the Granger-Causality test from X to Y is an F-test for the joint significance of $b_{11},.....,b_{1p}$ in an Ordinary Least Squares (OLS) Regression and similarly the Granger Causality test from Y to X is an F-test for the joint significance of $b_{21},....,b_{2p}$.

3.7 Generalised Impulse Response Function (GIRF) Analysis and Generalised Forecast Error Variance Decompositions (GFEVD):

Impulse response function (IRF) analysis uses a graph to map out the response of a market to a unit random shock to the residuals in another market for several periods in the future (Warne (2008); Gujarati & Porter (2009). Impulse response functions are exhibited as graphs so that one can assess how long the effects of the shock last into the future and also shows us the size of the response (Wang, 2008, p. 96). Forecast error variance decompositions are derived from impulse responses.

Forecast error variance decomposition (FEVD) analysis shows the percentage of forecast error variance of a variable accounted for by shocks to another market and a percentage accounted for by shocks to the given market (Worthington & Higgs, 2004). Forecast error variance decomposition analysis "provides a measure of the overall relative importance of the markets in generating fluctuations in both its own market and other markets" (Worthington & Higgs, 2004). As a result, forecast error variance decomposition shows us which stock markets are most affected or least affected by other stock markets or shows which stock markets are the most or least interdependent.

A VAR model as shown below is considered:

$$y_t = a_o + a_1 t + \sum_{i=1}^{p} \Phi_i y_{t-i} + u_t$$

Where y_t is a m x 1 vector of jointly determined dependent variables in the system, a_0 = constant, t = time trend and the error term u_t.

The above VAR model can be expressed as an infinite Moving Average Representation as shown below:

$$y_t = \sum_{j=0}^{\infty} A_j u_{t-j}$$

Where A_j are coefficient matrices .

Sims (1980) approach to assess the impulse response of a variable in the VAR system at time t+N to shocks (errors) to another variable in the VAR system at time t is done by Cholesky decomposition. The process of isolating the effect of shocks on a variable of interest from the influence of all other shocks is called orthogonolisation (Pesaran & Shin (1997); Wang(2008). Orthogonolisation is achieved by Cholesky Decomposition of $\sum$ (the covariance matrix of the shocks/ errors u_t) (Pesaran & Shin, 1997). Cholesky decomposition is achieved as shown below:

$\sum = PP'$ Where P is a lower triangular matrix. The moving average representation can be re-written as follows:

$$y_t = \sum_{j=0}^{\infty} (A_j P)(P^{-1} u_{t-j}) = \sum_{j=0}^{\infty} A_j^* \varepsilon_{t-j} \text{ where } A_j^* = A_j P \text{ and } \varepsilon_t = P^{-1} u_t$$

As a result, the new errors obtained via Cholesky decomposition are contemporaneously uncorrelated. Thus, the orthogonalized impulse response function of a unit shock to the orthogonalized error of i at time t on the j-th variable at time t+N is:

$OI_{ij,N} = e_j' A_N P e_i$ where i,j = 1,2,...,m

From the Impulse response function, the orthogonalized forecast error variance decomposition is obtained as follows:

$$\theta_{ij,N} = \frac{\sum_{l=0}^{N} \left(e_i' A_l P e_j \right)^2}{\sum_{l=0}^{N} e_i' A_l \sum A_l' e_i}$$

Where i,j = 1,2,....,m, P= Cholesky decomposition of $\sum$ (the covariance matrix) making the errors (shocks) uncorrelated, e_i is the error of the i-th variable in the vector of variables in the VAR model and A_l where i = 0,1,2 ; are the coefficient matrices in the moving average representation.

By construction $\sum_{j=1}^{m} \theta_{ij,N} = 1$ (adds up to 100%) due to the zero covariance or correlations between the orthogonalized shocks (errors).

As pointed out by Pesaran & Shin (1997), Yang et al (2002), Friedman et al (2005) and Wang (2008, p. 97), a limitation of using impulse response and forecast error variance decomposition analyses is the limitation of orthogonolisation in that different results are obtained depending on the ordering of the variables.

This means that if a variable is ordered first in the above analyses, this variable will have an impact on all the other variables and the variable ordered second will have an effect on itself and the variables ordered after it but the second variable will have no effect on the first variable and the third variable will have an effect on itself and the variables ordered after it but it will have no effect on the 1st or 2nd variable.

To overcome this limitation, the generalised impulse response function (GIRF) analysis and the generalised forecast error variance decomposition (GFEVD) analysis was discovered by Pesaran & Shin in 1997. The generalised version does not require orthogonolisation and changing the ordering of the variables does not produce different results (Pesaran & Shin, 1997). Thus, one can assess the effect each variable has on all the other variables.

The generalised impulse response function (GIRF) of a unit shock to the i-th equation in the VAR model on the j-th variable at horizon N is:

$$GI_{ij,N} = \frac{e_j^{'} A_N \Sigma e_i}{\sqrt{\sigma_{ii}}} \quad \text{i,j = 1,2,...,m}$$

Where $\Sigma = (\sigma_{ij})$ is the non-zero covariance between the non-orthogonalized errors/shocks of i and j and $\sqrt{\sigma_{ii}}$ is defined as the unit shock on the i-th variable. The above equation basically states that a generalised impulse response is equal to a unit shock to the i-th variable on the j-th variable with the size of the response depending on the lagged coefficients present in the VAR model and the multiplicative effect of the correlations between the error terms. Thus, the size of the response depends upon the estimated coefficients. In this study where different sample periods are compared, an increase or decrease in the values appearing on the vertical axis of a GIRF graph shows higher (lower) estimates of the coefficients in the VAR model and thus does not symbolise a larger (smaller) response by a variable, it just indicates a change in the nature of the estimated coefficients in the VAR model. Thus, the important effect to note down when comparing these graphs is to assess how strongly a variable initially responds and this is where the values in the vertical axis can come into play by subtracting the point of origin of the graph from the peak or subtracting the trough of the graph from the origin of the response in each sample period to give you a fair idea of whether the responses are stronger or not rather than assessing an increase (decrease) in the values on the vertical axis as an increase (decrease) in the responses of the variables.

The Generalised Forecast Error Variance Decomposition (GFEVD) is represented below:

$$\psi_{ij,N} = \frac{\sigma_{ii}^{-1}\sum_{l=0}^{N}\left(e_i' A_l \sum e_j\right)^2}{\sum_{l=0}^{N} e_i' A_l \sum A_l' e_i}$$

Where i,j = 1,2,....,m, e_i is the selection vector or error of the i-th variable in the vector of variables, $\sum_{l=0}^{N} A_l \Sigma A_l'$ is the total forecast error variance , $\Sigma = (\sigma_{ij})$is the non-zero covariance between the shocks of i and j and A_l where i = 0,1,2 are the coefficient matrices in the infinite moving average representation. The sum of the generalised forecast error variance decompositions does not add up to 100% ($\sum_{j=1}^{m} \psi_{ij,N} \neq 1$) because of the contemporaneous correlations between the shocks/errors (Pesaran & Pesaran, 2009). As a result, one cannot assess the total percentage of forecast error variance explained by all the other foreign stock markets combined in contrast to the orthogonalized forecast error variance decompositions that add up to 100% as a result of the errors not being correlated. Thus the contemporaneous correlations acts as a multiplicative factor making the GFEVD add up to more than a 100%.

3.8 Conclusion

The above methodologies were chosen on the basis of the methodologies used in research that is relevant to mine. They are characterised by their strengths and limitations that have been outlined under each description of each method. The importance and relevance of using these methods is that they directly answer and are most suited to answer the research questions that this study sought to answer. The combination of these sophisticated methods provides comprehensive results as will be seen in the Empirical findings Chapter.

CHAPTER FOUR: RESEARCH DESIGN AND DATA SELECTION

4.1 Introduction

The following Chapter gives an outline of the dataset used, what database the stock price indices were collected, how the price indices and returns were calculated and what statistics/econometrics software package was used to carry out my analysis. Furthermore, the dissection of the sample period into the appropriate sample periods of Pre-GFC, during the GFC and post-GFC has been outlined. Lastly, the theoretical framework section describes and provides details about the steps taken to do the analyses required and the order in which the analyses were carried out.

4.2 Data

To analyse how interdependencies among regional stock markets have changed due to the Global Financial Crisis (GFC), ten equity markets of the United States of America (U.S.A), Japan, China, Germany, The United Kingdom (UK), France, Italy, Brazil, Spain and Canada have been chosen. These equity markets are a mix of developed and developing stock markets and have been grouped into stock markets from the same region. The groups are American stock markets (USA, Canada and Brazil), European (Germany, UK, France, Italy, and Spain) stock markets and Asian stock markets (China and Japan) countries. The analysis has been carried out based on the groups and how interdependencies have changed for each group due to the GFC. These countries were selected on the basis of the highest Gross Domestic Product (GDP) measured in U.S dollars in 2009 as ranked by the World Bank and stated as being the ten largest economies in the world by the World Bank. Table 1 below shows the World Banks' ranking:

Table 1: Gross Domestic Product (GDP) 2009

Ranking	Economy	Millions of US dollars
1	United States	14,119,000
2	Japan	5,068,996
3	China	4,985,461
4	Germany	3,330,032
5	France	2,649,390
6	United Kingdom	2,174,530
7	Italy	2,112,780
8	Brazil	1,573,409
9	Spain	1,460,250
10	Canada	1,336,068

World Development Indicators database, World Bank.

Retrieved from: http://siteresources.worldbank.org/DATASTATISTICS/Resources/GDP.pdf on the 20th of November, 2010

The data set used to represent the ten equity markets are price indices for each of the ten countries. The dataset was downloaded from a database called DataStream over a sample period, running from 23/08/2000 to 09/05/2011. The raw data is comprised of market price indices of the ten countries and the price indices are all denominated in a common currency of the US dollar. For each stock market index a representative sample of stocks covering a minimum of 75%-80% of total market capitalisation makes it possible for DataStream to calculate the individual countries market price indices. These price indices are the main indicators of stock market performance and thus, capture stock market movements in these ten countries. Daily data is used in this research, the reason being that daily data captures interactions that may only last a few days which can be lost if weekly or monthly data is used (Eun & Shim, 1989).

DataStream calculates its own aggregate market price indices for each country. The price indices are calculated by market value using a representative list of shares. The market price index for each country as calculated by DataStream is shown below:

$$I_t = I_{t-1} * \frac{\sum_{1}^{n}(P_t * N_t)}{\sum_{1}^{n}(P_{t-1} * N_t * f)}$$

Where:

I_t = Index value on day t

I_{t-1} = Index value on previous working day

P_t = unadjusted price on day t

P_{t-1} = unadjusted price on previous working day

N_t = number of shares in issue on day t

f = adjustment factor for a capital action occurring on day t

n = number of constituents in index.

The software package used to do the analyses is Microfit and the price indices for the ten equity markets were converted into equity returns via taking the first log differences of the price indices. The first log differences (returns) were calculated as shown below:

$$R_t = \ln\left(\frac{P_t}{P_{t-1}}\right)$$

Where R_t is the return for each country at time t, ln is the logarithm function, P_t is today's price and P_{t-1} is yesterday's price.

My analysis divides the full sample period into three sample periods: Pre GFC, during GFC and post GFC. The Pre-GFC sample period has been set from 23/08/2000 to 31/07/2007, during GFC sample period has been set to start from 01/08/2007 to 30/06/2009 and the Post GFC sample period runs from 01/08/2009 to 09/05/2011. By sub-dividing the full sample period into sub-periods, I have obtained a clear picture of how interdependencies have changed during and after the Global Financial Crisis (GFC).

4.3 Theoretical Framework:

Before any analyses were carried out, time series plots of the data were graphed in order to assist in making decisions on what deterministic components to include in the unit root tests and the cointegration test. Graphing the time series plots was then followed by the usual summary statistics and pair-wise correlation coefficients to assess the features of each stock market and pairs of the stock markets in all three sample periods. A brief overview of any changes in the summary statistics and pair-wise correlations has been outlined.

The first analysis carried out was the unit root tests that were carried out on both stock price indices and their first differences. This is because a pre-requisite of cointegration, which is the analysis that follows the unit root tests, is that the variables must have a unit root and be integrated of the same order (Engle & Granger (1987); Dickey, Jansen & Thornton, 1991) otherwise spurious regressions and results occur (Alexander (2001); Gujarati & Porter (2009). Spurious results can be very misleading to investors that base investment decisions on these results and can lead to bad investment decisions being made.

The unit root tests were then followed by selecting the optimal lag length to use in the cointegration test. The selection of the appropriate lag length was done via using the Vector Autoregressive (VAR) lag length selection information criteria. The Johansen multivariate cointegration test was then carried out to test for the presence of cointegration among the groups of stock markets from the same region (close geographical proximity). This test was used to investigate whether the number of cointegrating vectors has changed due to the Global Financial Crisis (GFC). Assessing this provides information about whether long run interdependencies increased, decreased or stayed the same due to the Global Financial crisis (GFC).

Furthermore, if cointegration was found, the stock markets that were important to the long run cointegrating (equilibrium) relationship were assessed in the sample periods where cointegration was present. This was done in order to investigate any changes in the stock markets important to the long run equilibrium due to the Global Financial Crisis (GFC). This analysis was carried out via analysing the significance of each coefficient in the cointegrating vector/s after normalizing on a chosen stock market. The choice of the normalized variable in each region was based on the country with the highest GDP in that region as ranked by the World Bank in 2009.

Thereafter, the Vector Error Correction Model (VECM) was used to assess which stock market/s in the cointegrating relationship bears the burden of adjusting short run disequilibrium back to the long run equilibrium (cointegrating) relationship. This was investigated in the sample periods where cointegration was present for each region and this analysis was achieved by assessing which alpha coefficients (error correction terms) were significant. This analysis was carried out in the sample periods where cointegration was found and this was done in order to find out if there was a change in the stock markets that bear the burden of correcting short run disequilibrium due to the Global Financial Crisis (GFC).

An important theorem established by Engle & Granger (1987) is the Granger Representation theorem which has the implication that if two variables X_t and Y_t are cointegrated and each is integrated of order 1 (I (1)), then a unique channel of Granger causality must be present i.e. uni-variate or bi-variate Granger causality must exist (Engle & Granger (1987). This concept can be applied to a case with more than two variables. Thus, if two or more variables are cointegrated then there must be some Granger causal flow present among these variables to keep them in step with each other (Engle & Granger (1987); Gujarati & Porter, p. 787, Alexander (2001)). Granger causality tests were not carried out in the sample periods where cointegration was present though the presence of Granger causality was mentioned in accordance to the Granger Representation Theorem.

In the cases where no cointegration was found, a VAR model in first differences was used to carry out Granger causality tests to assess if short run inetrdependencies were present between pairs of stock markets. The implication of the presence of Granger causality is that predictions of the movement of the country that is being Granger caused can be improved by assesing the movement of the leading stock market.

The level of influence of a stock market on other stock markets from the same region has been assessed via Generalised Impulse Response Function (GIRF) analysis and Generalised Forecast Error Variance Decompositions (GFEVD) analysis. Generalised impulse response function (GIRF) analyses was used to asses whether there were changes in the response patterns of each stock market in each region due to the Global Financial Crisis (GFC). The results provided by the GIRF analysis gave an idea of whether the stock markets were more or less interdependent due to the GFC. This was assesed such that if the stock markets responded more (less) to a shock, this implied an increase (decrease) in interdependencies and if no response occured then the conclusion drawn was hat that particular stock market was not imapcted or affected by shocks to another stock market.

The GIRF analysis also provided evidence of how long it took the stock markets to fully incorporate the effect of the shock (speed of incoporation) in each sample period. This assisted in identifying any changes in the speed of incorporation of shocks during the GFC and in the post GFC sample period. Full incorporation occurs when the GIRF graphs level off/ taper off. Lastly, Generalised forecast error variance decomposition (GFEVD) analysis was carried out to assess any changes in the stock markets least and most affected by other stock markets in each region as a result of the Global Financial Crisis (GFC). The GFEVD analysis also provided information on the most exogenous stock markets with the most exogenous considered as the market with the highest percentage of forecast error variance accounted for by its own shocks (Climent, Meneu & Pardo, 2001).

CHAPTER FIVE: EMPIRICAL RESULTS

5.1 Introduction

The following Chapter presents the empirical findings for each region in each sample period. Furthermore, the answers to the research questions are provided and this is supported by reasons and justifications for the empirical findings and the implications of the findings for investors.

First thing first, time series plots of the stock price indices and the stock returns for the Pre-GFC sample period, during the GFC sample period and Post-GFC sample period are presented in the Appendix. These plots provide a visualisation of the nature of the data and having an idea of the characteristics of the data is important especially given the time series methodologies used in this study.

This data analysis starts with a brief overview of the main characteristics of the data.

5.2 Descriptive Statistics and Correlation Coefficients

As can be seen from the time series graphs, in the Pre-GFC sample period the trends look quadratic in nature for some of the stock price indices but some exhibit more of an upward trend. In contrast, during the GFC sample period the stock price indices exhibit a general downward trend for all the stock markets due to the impact of the Global financial crisis (GFC). Furthermore, Volatility in all the stock returns that can be seen in the time series plots of the stock returns during the GFC sample period appears to increase from about October 2008.

This is because this time period was considered the peak of the GFC with the collapse of a major institution Lehman Brothers and the bailout of a major insurance company AIG (Wheelock, 2010) and thus it can be seen via the increased volatility of the stock returns. In the post-GFC sample period the stock price indices do not appear to have very visible trends though some (USA, Canada, Brazil, UK, France and Germany) seem to have a slight upward trend. Furthermore, the time series plots of returns for Germany, France, UK, Italy and Spain, all have a spike in volatility around the 1st of May 2010 and this can be attributed to the Sovereign debt crisis that occurred in Europe in 2010 that led to the loss in confidence in the euro and in the debt markets (Financial Stability review, 2010). Japan had a large surge in volatility around the month of March 2011 which can be attributed to the tsunami and earthquake that occurred in Japan that had a devastating impact on its economy. The Global Financial Crisis from here on will be referred to as the GFC.

Summary statistics for the stock returns in the pre GFC period, during the GFC period and in the post GFC period are provided in Table 2(Panels A, B and C, respectively) below.

Table 2: Summary Statistics for Daily Market Returns

Panel A: Pre GFC Sample Period						
Market	Mean	Maximum	Minimum	Standard Deviation	Skewness	Kurtosis – 3
USA	-0.6540E-5	0.053666	-0.052109	0.010548	0.15553	3.0657
Japan	-0.3922E-5	0.055359	-0.074926	0.013144	-0.21863	1.9757
China	0.3814E-3	0.094400	-0.091526	0.013875	0.15778	5.9057
Germany	0.2437E-3	0.053777	-0.063306	0.011880	-0.33717	2.3036
France	0.2562E-3	0.055239	-0.064771	0.012152	-0.16895	2.3183
United Kingdom	0.2063E-3	0.047459	-0.047236	0.010436	-0.26069	2.4784
Italy	0.2233E-3	0.068055	-0.069068	0.010888	-0.39966	3.7865

Brazil	0.7305E-3	0.12993	-0.081721	0.017588	-0.11752	3.2345
Spain	0.4790E-3	0.051504	-0.053065	0.011458	-0.12314	1.5728
Canada	0.3521E-3	0.042061	-0.077098	0.010001	-0.60104	3.5274
Panel B: During the GFC Sample Period						
Market	Mean	Maximum	Minimum	Standard Deviation	Skewness	Kurtosis – 3
USA	-0.8866E-3	0.10902	-0.094087	0.021857	-0.099931	4.0620
Japan	-0.7720E-3	0.10698	-0.087620	0.020046	-0.018656	2.9575
China	-0.5065E-3	0.090255	-0.080613	0.024153	0.0012981	1.3359
Germany	-0.0010028	0.16261	-0.086207	0.021797	0.79378	8.7933
France	-0.0011807	0.10647	-0.10694	0.022948	0.17488	4.5588
United Kingdom	-0.0012393	0.11817	-0.10390	0.024494	0.039202	4.0674
Italy	-0.0014062	0.11255	-0.10901	0.023535	0.15768	4.2065
Brazil	-0.4766E-3	0.14036	-0.16226	0.032865	-0.36690	4.0765
Spain	-0.0010353	0.10365	-0.095485	0.022177	.0059811	4.0491
Canada	-0.7333E-3	0.095188	-0.13536	0.025232	-0.58389	4.0150
Panel C: Post GFC Sample Period						
Market	Mean	Maximum	Minimum	Standard Deviation	Skewness	Kurtosis – 3
USA	0.8223E-3	0.043274	-0.040259	0.010447	-0.31425	2.0008
Japan	0.2134E-3	0.074329	-0.088393	0.012729	-0.61258	8.7941

China	-0.2251E-4	0.049071	-0.071805	0.015368	-0.72808	2.4167
Germany	0.7598E-3	0.055750	-0.042351	0.014411	-0.19555	.55920
France	0.6361E-3	0.094752	-0.052029	0.015906	0.11536	2.5182
United Kingdom	0.7125E-3	0.073129	-0.048569	0.014101	-0.0036019	1.7184
Italy	0.3412E-3	0.10523	-0.060419	0.017038	0.053933	3.1631
Brazil	0.7428E-3	0.069110	-0.064514	0.016257	-0.21958	1.8564
Spain	0.2119E-3	0.13237	-0.073871	0.018501	0.35033	5.8935
Canada	0.9436E-3	0.042626	-0.045693	0.013173	-0.32926	.53422

Note: **Panel A**: shows the summary statistics in the pre GFC sample period. **Panel B**: shows the summary statistics during the GFC sample period and **Panel C:** Shows the summary statistics in the post GFC sample period. If the Kurtosis value is greater than zero this implies non-normally distributed stock returns.

In the pre-GFC sample period (Panel A), the summary statistics show that mean returns for each stock market are positive. In contrast, during the GFC (Panel B) all the mean returns are negative showing the negative impact the GFC had on stock markets. In the post-GFC sample period (Panel C), all the stock returns are positive except that of China implying an overall recovery in stock markets in this period. This supported by Dietrich (2011) who points out that in the last few months of 2010, stock markets stabilized with gains being made except for China's Shanghai Stock Market Index that ended 2010 at negative sixteen per cent (-16%).

With regards to volatility, all the stock markets are most volatile during the GFC sample period in comparison to the Pre GFC and post-GFC sample periods. Furthermore, in the post-GFC sample period volatility decreases in comparison to during the GFC but is still higher than the Pre-GFC sample period volatility, implying the waning effects of the GFC. The most volatile stock market Pre and during the GFC is Brazil but this changes to Spain followed by Italy in the post-GFC sample period. This could be attributed to the fears of Italy and Spain defaulting due to their large budget deficits (deficit to GDP ratios of 11.4% for Spain and 5.3% for Italy) and extremely high debt to GDP ratios (50% for Spain and 115% for Italy), causing loss in confidence in these European countries (Wolverson, 2010).

The results of skewness in each sample period show that the stock returns are not normally distributed and do not have a bell shaped distribution because they all have skewness greater than zero, implying the return distributions have thicker tails than a normal distribution (Pesaran & Pesaran , 2009). Furthermore, in each sample period all the return series are leptokurtic which indicates that these return series are highly peaked and have fatter tails relative to a normal distribution. The result that returns do not follow a normal distribution has been documented by Fama (1965).

Table 3 provides pair-wise cross correlation coefficients for each of the ten stock markets daily returns in the pre GFC period (Panel A), during the GFC period (Panel B) and in the post GFC period (Panel C). Overall, if correlations are compared in the Pre GFC sample period, during the GFC and in the post GFC sample period, the results show a general increase in correlations between stock markets and this is more pronounced for correlations between China and the rest of the stock markets.

This result is attributed to the fact that correlations are a positive function of volatility (Forbes & Rigobon, 2002). In contrast, correlations between Japan and other stock markets, with the exception of China, decrease in the post GFC period. Furthermore, correlations are higher between countries of close geographical proximity than between countries that are not from the same region or continent.

Table 3: Pair-wise Correlation Coefficients between Daily Stock Returns

Panel A: Pre GFC Period									
Market	USA	Japan	China	Germany	France	UK	Italy	Brazil	Spain
Japan	0.10694 (4.4895)*								
China	0.022731 (2.1588)*	0.095009 (2.9438)*							
Germany	0.54449 (14.0165)*	0.20568 (7.2222)*	0.043606 (1.7214)						
France	0.45614 (12.1828)*	0.21414 (7.5490)*	0.023080 (1.3781)	0.88844 (30.9025)*					
UK	0.41376 (12.0913)*	0.20282 (7.1717)*	0.030201 (-0.040283)	0.76672 (25.9138)*	0.84069 (27.1888)*				
Italy	0.42849 (9.9713)*	0.17940 (7.3132)*	0.037487 (1.9870)*	0.85188 (29.0677)*	0.88334 (30.5311)*	0.77760 (24.7881)*			
Brazil	0.36044 (12.4132)*	0.14955 (5.0567)*	0.075948 (1.8265)	0.39917 (13.0844)*	0.36692 (12.3142)*	0.35771 (12.1413)*	0.35387 (10.7652)*		
Spain	0.40486 (10.0124)*	0.18677 (7.3627)*	0.026300 (1.1058)	0.81912 (28.6278)*	0.86741 (30.9499)*	0.74523 (24.6415)*	0.84587 (29.3978)*	0.38133 (12.1002)*	
Canada	0.59923 (16.6106)*	0.19927 (7.2735)*	0.048229 (1.1224)	0.53544 (15.9603)*	0.49786 (15.1899)*	0.49159 (15.9608)*	0.49280 (14.5844)*	0.39469 (13.0079)*	0.46514 (13.7481)*
Panel B: During the GFC									
Market	USA	Japan	China	Germany	France	UK	Italy	Brazil	Spain
Japan	-0.025989 (-1.9672)								

China	0.031362 (-1.3602)	**0.30449 (4.7579)***							
Germany	**0.62275 (9.3157)***	0.15448 (1.0730)	**0.17074 (2.9654)***						
France	**0.52715 (7.8718)***	0.27216 (1.4409)	**0.19574 (3.6379)***	**0.83617 (17.2117)***					
UK	**0.52570 (7.7008)***	0.26142 (1.0744)	**0.17141 (3.3159)***	**0.78373 (14.8628)***	**0.93414 (16.6663)***				
Italy	**0.49144 (8.0511)***	0.27925 (1.2617)	**0.19522 (3.8172)***	**0.80504 (16.4948)***	**0.95974 (18.2580)***	**0.90335 (15.4119)***			
Brazil	**0.66829 (8.9704)***	0.15561 (-0.36406)	**0.20995 (2.8112)***	**0.73447 (11.6398)***	**0.74270 (11.5039)***	**0.75145 (12.1826)***	**0.71360 (10.7867)***		
Spain	**0.50064 (6.1709)***	0.27356 (1.5277)	**0.17093 (3.1999)***	**0.80865 (14.9633)***	**0.95532 (17.0960)***	**0.90539 (15.3160)***	**0.93989 (16.1996)***	**0.69770 (9.9672)***	
Canada	**0.72073 (11.4141)***	0.22383 (0.25833)	0.10941 (1.3162)	**0.66843 (12.0983)***	**0.71522 (11.6336)***	**0.72170 (11.7499)***	**0.70264 (11.6336)***	**0.75382 (12.7897)***	**0.69668 (9.5490)***
Panel C: Post GFC Sample Period									
Market	USA	Japan	China	Germany	France	UK	Italy	Brazil	Spain
Japan	-0.021474 (-1.1634)								
China	0.17678 (1.0152)	**0.23140 (3.4430)**							
Germany	**0.71240 (8.3776)***	0.10805 (1.5166)	**0.23812 (2.4179)***						
France	**0.67374 (7.7362)***	0.11637 (1.9008)	**0.24577 (3.1725)***	**0.95379 (18.5761)***					

UK	**0.65254 (8.0278)***	**0.10226 (2.0674)**	**0.27316 (2.9699)***	**0.89178 (14.3535)***	**0.90544 (14.7425)***				
Italy	**0.65618 (7.7935)***	0.095281 (1.3267)	**0.24079 (2.9567)***	**0.92553 (17.0869)***	**0.96202 (17.8598)***	**0.87559 (14.1677)***			
Brazil	**0.70837 (8.6788)***	-0.0078861 (-0.39169)	**0.25309 (2.8811)***	**0.71185 (9.5176)***	**0.68505 (9.1820)***	**0.70436 (10.0696)***	**0.67471 (8.4138)***		
Spain	**0.62434 (7.1474)***	0.073544 (1.3461)	**0.21078 (2.9797)***	**0.87306 (15.8251)***	**0.92476 (16.5606)***	**0.81895 (12.7236)***	**0.93844 (16.1954)***	**0.63743 (7.7095)***	
Canada	**0.76459 (11.2072)***	0.080673 (1.3032)	**0.29827 (2.7490)***	**0.77270 (10.6722)***	**0.73563 (11.3306)***	**0.76619 (11.0602)***	**0.70760 (10.6344)***	**0.76445 (11.3463)***	**0.64952 (9.2635)***

Note: Panel A: Reports pair-wise correlations in the Pre GFC sample period. **Panel B:** Reports pair-wise correlations in the Pre GFC sample period **Panel C:** Reports pair-wise correlations in the Pre GFC sample period. The top half of the correlation coefficient table is left blank because the correlation coefficients at the top half are exactly the same as the correlation coefficients at the bottom half. * and bolded imply significant correlation coefficients at 5% using Pesaran and Timmermann (1992) statistic for a non-parametric test which has the null hypothesis that X and Y (stock markets in my case) are distributed independently

This result is more pronounced for the European and North American Stock markets. This finding is similar to that of Eun & Shim (1989), Metin & Murdoglu (2001) and Climent, Meneu & Pardo (2001) and Worthington & Higgs (2004) who also find that intra-regional or stock markets that have close geographical proximity are highly interdependent as compared to those that are not (inter-regional). Thus, the correlation results generally show an increase in correlations due to the GFC.

Assessing the significance of the correlation coefficients, Table 3 shows that in the pre GFC sample period, correlations between stock returns were highly significant as compared to during the GFC and in the post GFC sample period. A noticeable result is that in the pre GFC sample period (Panel A) correlations between Japan and the rest of the stock markets were all significant but during the GFC sample period the only significant association is with China, implying a reduction in association with the other stock markets as a result of the GFC.

The exact opposite of Japan's case happens to China with China having only one significant association with Italy in the pre GFC sample period but during the GFC period (Panel B) and in the post GFC period (Panel C) China's association with other countries significantly increases, more so in the post GFC sample period. Furthermore, correlations between the European stock markets remain significant during the GFC and in the post GFC sample period though they are not as highly significant as they were in the Pre GFC sample period. Correlations between the American stock markets also remain significant during the GFC and in the post GFC sample period though the correlations are not as highly significant as in the Pre GFC period. Thus, there has been a decrease in the levels of significance as a result of the GFC.

5.3 Unit Root Tests:

The Augmented-Dickey Fuller (ADF) and Kwiatowski, Phillips, Schmidt & Shin (KPSS) tests are used to carry out unit root tests on both the price indices and stock returns in all three sample periods.

In the Pre-GFC period and during GFC period all stock price indices exhibit a downward or upward trend, thus stock price indices will be tested with a constant and trend. In the Post-GFC sample period both the ADF and KPSS test are tested with a constant only and with a constant and trend because some of the time series plots of the price indices do not appear to have a very visible trend with some appearing to be random walks without drift (Japan, China, Italy and Spain) while others have slightly visible trends in them which could be attributed to a drift term in the random walk rather than a time trend but nonetheless they are still tested with a trend term included.

In all sample periods, all stock return series do not exhibit an upward or downward trend thus, the stock returns will be tested with a constant only. The results are shown in tables 4, 5 and 6 for both the ADF and the KPSS tests.

As shown in Table 4, in all three sample periods, the ADF test with a constant and a trend for all price indices shows that we cannot reject the null hypothesis of a unit root (non-stationary) at the 5% significance level.

As a confirmatory test, the KPSS results (Table 4) for all price indices in the three sample periods indicate that the null hypothesis of stationary can be rejected at the 5% significance levels. Thus, the KPSS test confirms the results of the ADF test for the price indices and it can be concluded that the stock price indices are non-stationary.

Table 4: Unit Root Tests for Stock Price Indices with Constant and Trend

	Pre-GFC Period		During GFC Period		Post-GFC Period	
Index	ADF (constant and trend)	KPSS (constant and trend)	ADF (constant and trend)	KPSS (constant and trend)	ADF (constant and trend)	KPSS (constant and trend)
USA	-3.1613	4.7601*	-1.7932	0.64390*	-2.4740	0.69195*
Japan	-3.3190	4.3958*	-1.6771	0.51799*	-2.5980	0.44245*
China	3.3415	3.2038*	-1.0599	1.0808*	-2.1557	0.81526*
Germany	-1.7464	5.1406*	-1.8112	0.82041*	-1.8298	1.1228*
France	-2.2281	5.3044*	-1.9072	0.67799*	-2.1473	0.78609*
UK	-2.1536	5.3792*	-1.4998	0.65585*	-2.7534	0.70564*
Italy	-2.6213	4.9641*	-1.5909	0.66787*	-1.9397	0.84523*
Brazil	0.16431	5.5146*	-1.6240	0.90513*	-3.0779	0.39563*
Spain	-1.7985	5.0532*	-1.8063	0.71160*	-1.8725	0.84187*
Canada	-2.9420	5.2310*	-1.8684	0.78406*	-3.2191	0.76326*

Note: The above ADF test is based on the following formula with a constant and a trend:

$\Delta X_t = a_0 + a_1 T + \phi X_{t-1} + \sum_{i=1}^{p} \gamma_i \Delta X_{t-i} + u_t$ .The ADF test statistic is the t-ratio of ϕ . T = time trend, a_o = constant and p is lags sufficient to get rid of serial correlation. Microfit provides AIC and SBIC criteria for selecting the optimal lag length. * Denotes rejection of the null hypothesis at the 5% significance level. The null hypothesis of the ADF test is unit root (non-stationary) against the alternative of stationary. The null hypothesis for the KPSS test is stationary against the alternative hypothesis of non-stationary. In the Pre GFC period the 5% critical value for the ADF test with a constant and trend = -3.4148, during the GFC sample period the 5% critical value for ADF test with constant and a trend = -3.4208 and in the post GFC sample period the 5% critical value for the ADF test with a constant and a trend = -3.4210. The 5% critical value for the KPSS test with a trend is the same in all three sample periods = 0.148.

Table 5: Unit Root test for Stock price Indices with Constant only (Post GFC)

	Post GFC Period	
Index	ADF (constant)	KPSS (constant):
USA	-1.3085	5.2720*
Japan	-2.2029	2.5316*
China	-2.0863	1.5354*
Germany	-1.1808	3.4086*
France	-2.1041	1.1792*
UK	-2.0641	4.1318*
Italy	-1.8866	1.2366*

Brazil	-2.8148	3.5687*
Spain	-1.7197	1.8542*
Canada	-1.2993	5.7968*

Note: The above ADF test is based on the following formula with a constant only: $\Delta X_t = a_0 + \phi X_{t-1} + \sum_{i=1}^{p} \gamma_i \Delta X_{t-i} + u_t$.

The ADF test statistic is the t-ratio of ϕ . T = time trend, a_0 = constant and p is lags sufficient to get rid of serial correlation. Microfit provides AIC and SBIC criteria for selecting the optimal lag length. * Denotes rejection of the null hypothesis at the 5% significance level. The null hypothesis of the ADF test is unit root (non-stationary) against the alternative of stationary. The null hypothesis for the KPSS test is stationary against the alternative hypothesis of non-stationary. In the Pre GFC period the 5% critical value for the ADF test with a constant only = -2.8636, during the GFC sample period the 5% critical value for ADF test with constant only = -2.8676 and in the post GFC sample period the 5% critical value for the ADF test with a constant only = -2.8678. The 5% critical value for the KPSS test with a co is the same in all three sample periods = 0.461.

Table 6: Unit Root Test for Stock Returns with Constant only

	Pre-GFC Period		During GFC Period		Post GFC Period	
Index	ADF (constant)	KPSS (constant)	ADF (constant)	KPSS (constant)	ADF (constant)	KPSS (constant)
USA	-31.3732*	0.077608	-19.1583*	0.11505	-22.3055*	0.067751
Japan	-30.5493*	0.13012	-11.6266*	0.094837	-19.3584*	0.037090
China	-17.4181*	0.19674	-10.0623*	0.23828	-22.0554*	0.059857
Germany	-13.5486*	0.060981	-16.6155*	0.13778	-21.2071*	0.081176
France	-14.6838*	0.075076	-10.3954*	0.12475	-21.6302*	0.092010
UK	-14.6472*	0.068843	-10.9218*	0.15911	-22.6832*	0.062721
Italy	-13.0912*	0.095555	-10.3638*	0.13797	-21.3250*	0.095730
Brazil	-29.4650*	0.060746	-16.4278*	0.20565	-20.6531*	0.13314
Spain	-30.7028*	0.072747	-10.2092*	0.14498	-20.5218*	0.096461
Canada	-21.1856*	0.14571	-9.9092*	0.14718	-19.9982*	0.041555

Note: The above ADF test is based on the following formula with a constant only: $\Delta X_t = a_0 + \phi X_{t-1} + \sum_{i=1}^{p} \gamma_i \Delta X_{t-i} + u_t$ with the ADF test statistic is the t-ratio of ϕ . T = time trend, a_0 = constant and p is lags sufficient to get rid of serial correlation. Microfit provides AIC and SBIC criteria for selecting the optimal lag length. * Denotes rejection of the null hypothesis at the 5% significance level. The null hypothesis of the ADF test is unit root (non-stationary) against the alternative of stationary. The null hypothesis for the KPSS test is stationary against the alternative hypothesis of non-stationary. In the Pre GFC period the 5% critical value for the ADF test with a constant only = -2.8636, during the GFC sample period the 5% critical value for ADF test with constant only = -2.8676 and in the post GFC sample period the 5% critical value for the ADF test with a constant only = -2.8678. The 5% critical value for the KPSS test with a co is the same in all three sample periods = 0.461.

In the post GFC sample period where the price indices are tested with a constant only (Table 5), the ADF test result show that the null hypothesis of a unit root fails to be rejected at 5% concluding that the price indices are non-stationary. The KPSS test confirms the ADF test results with its null hypothesis of stationary being rejected.

In terms of the stock returns (Table 6) in all sample periods, the ADF test with a constant indicates that the null hypothesis of unit root (non-stationary) can be rejected for all the stock returns at the 5% significance level. The KPSS test results also confirm the ADF results in that for all stock returns, the null hypothesis of stationary fails to be rejected at the 5% significance level. It is concluded that all the stock returns are stationary.

In summary, the test results indicate that all price indices have a unit root (non-stationary) and all the stock returns are stationary. Thus, it can be concluded that stock price indices are non-stationary and integrated of the same order, one I(1). The finding that stock price indices are integrated of order one is similar to that of a number of researchers such as Kasa (1992), Corhay, Rad & Urbain (1993), Arshanapalli & Doukas (1993), Masih & Masih (1997), Worthington, Katsuura & Higgs (2003) but to mention a few.

5.4 Cointegration Test

It has been found that each of the level series (stock prices) have a unit root (non-stationary) while the first log differences of the levels (stock returns) are stationary and thus it is concluded that the stock price indices are non-stationary and are integrated of the same order, one (I(1)). Both results fulfil the pre-requisite for cointegration testing and thus cointegration tests can be carried out.

5.4.1 Lag Length Selection

Before running the Johansen (1988, 1991) and Johansen & Juselius (1990) cointegration test, one has to select the optimal lag length so that no serial correlation is present (Harris (1992), Gujarati & Porter (2009)). Selection of the optimal lag length is carried out by using the Akaike Information Criteria (AIC) and the Schwartz-Bayesian Information Criteria (SBIC) and choosing the lag length that maximises the Information Criteria. From here on the ten stock markets are grouped into countries from the same region (close geographical proximity) resulting in three VAR models for each sub-period. The three models will be:

- American stock markets (USA, Brazil and Canada)
- European stock markets (Germany, France, UK, Italy and Spain) and;
- Asian stock markets (Japan and China).

The results of the optimal lag length selected by the Information criteria are shown in Tables 7, 8 and 9, with the SBIC always choosing a conservative number relative to the AIC. In all sample periods the AIC result is chosen over the SBIC result because the SBIC result has more cases with serial correlation still present in comparison to the AIC result.

In Table 7 for the American stock markets, in the Pre-crisis period (Panel A) the optimal lag length chosen by the AIC is four, the optimal lag length chosen by the AIC during the GFC crisis period (Panel B) is five and the optimal lag length chosen in the post GFC period (Panel C) is two. When serial correlation is tested in all sample periods using the lags chosen by the AIC, no serial correlation exists in any of the sample periods.

Table 7: VAR Lag Length Selection (American Stocks Markets)

Panel A: Pre GFC Sample Period										
	VAR(1)	VAR(2)	VAR(3)	VAR(4)	VAR(5)	VAR(6)	VAR(7)	VAR(8)	VAR(9)	VAR(10)
AIC	-17425.1	-17384.9	-17378.7	**-17375.1***	-17379.2	-17382.8	-17386.1	-17388.3	-17394.7	-17400.7
SBIC	-17449.8	**-17434.4**	-17452.9	-17474.0	-17502.9	-17531.2	-17559.2	-17586.1	-17617.3	-17648.0
Panel B: During the GFC Sample Period										
	VAR(1)	VAR(2)	VAR(3)	VAR(4)	VAR(5)	VAR(6)	VAR(7)	VAR(8)	VAR(9)	VAR(10)
AIC	-6248.0	-6193.2	-6192.9	-6189.8	**-6189.2***	-6194.7	-6197.9	-6197.9	-6195.5	-6198.6
SBIC	-6267.0	**-6231.1**	-6249.8	-6265.7	-6284.0	-6308.5	-6330.7	-6349.6	-6366.2	-6388.3
Panel C: Post GFC Sample Period										
	VAR(1)	VAR(2)	VAR(3)	VAR(4)	VAR(5)	VAR(6)	VAR(7)	VAR(8)	VAR(9)	VAR(10)
AIC	-5247.0	**-5228.1***	-5230.3	-5232.3	-5233.8	-5237.5	-5240.9	-5246.2	-5251.8	-5257.3
SBIC	**-5265.8**	**-5265.8***	-5286.8	-5307.6	-5327.9	-5350.4	-5372.6	-5396.8	-5421.2	-5445.5

Note: A VAR model for the American stock market includes the USA, Brazil and Canada. AIC stands for Akaike Information criteria and SBIC stands for Schwartz-Bayesian Information criteria. **Panel A** shows the results for the optimal lag length chosen for the American stock markets in the pre GFC period, **Panel B** shows the results for the optimal lag length chosen for the American VAR model during the GFC and **Panel C** shows the results of the optimal lag length chosen for the American VAR model in the post GFC sample period. The lag length denoted by * is the optimal lag length chosen by each of the Information criteria. Microfit chooses the lag length that maximises the information criteria.

Table 8: VAR Lag Length Selection (European Stock Markets) Table

Panel A: Pre GFC Sample Period										
	VAR(1)	VAR(2)	VAR(3)	VAR(4)	VAR(5)	VAR(6)	VAR(7)	VAR(8)	VAR(9)	VAR(10)
AIC	-28678.9	-28611.6	-28609.4	-28607.4	**-28604.2***	-28611.6	-28620.6	-28627.5	-28631.6	-28636.8
SBIC	**-28747.5**	-28749.0	-28815.4	-28882.2	-28947.6	-29023.8	-29101.5	-29177.0	-29249.8	-29323.7
Panel B: During the GFC Sample Period										
	VAR(1)	VAR(2)	VAR(3)	VAR(4)	VAR(5)	VAR(6)	VAR(7)	VAR(8)	VAR(9)	VAR(10)
AIC	-9656.7	**-9634.2***	-9634.4	-9644.3	-9647.9	-9657.5	-9657.2	-9669.6	-9681.8	-9693.1
SBIC	**-9709.4**	-9739.5	-9792.5	-9855.0	-9911.3	-9973.6	-10026.0	-10091.1	-10155.9	-10219.9
Panel C: Post GFC Sample Period										
	VAR(1)	VAR(2)	VAR(3)	VAR(4)	VAR(5)	VAR(6)	VAR(7)	VAR(8)	VAR(9)	VAR(10)
AIC	-8204.6	**-8204.0***	-8215.4	-8226.6	-8235.6	-8248.8	-8257.4	-8266.3	-8271.3	-8285.4
SBIC	**-8256.9**	-8308.5	-8372.2	-8435.7	-8497.0	-8562.5	-8623.3	8684.5	-8741.8	-8808.1

Note: A VAR model for the European stock market includes the Germany, France, The UK, Italy and Spain. AIC stands for Akaike Information criteria and SBIC stands for Schwartz-Bayesian Information criteria. **Panel A** shows the results for the optimal lag length chosen for the European stock markets in the pre GFC period, **Panel B** shows the results for the optimal lag length chosen for the European VAR model during the GFC and **Panel C** shows the results of the optimal lag length chosen for the European VAR model in the post GFC sample period. The lag length denoted by * is the optimal lag length chosen by each of the Information criteria. Microfit chooses the lag length that maximises the information criteria.

Table 9: VAR Lag Length Selection (Asian Stock Markets)

Panel A: Pre GFC Sample Period										
	VAR(1)	VAR(2)	VAR(3)	VAR(4)	VAR(5)	VAR(6)	VAR(7)	VAR(8)	VAR(9)	VAR(10)
AIC	-12868.3	-12871.2	-12870.4	-12865.1	-12859.1	-12857.5	**-12854.8***	-12858.2	-12860.9	-12864.0
SBIC	**-12879.3**	-12893.2	-12903.3	-12909.1	-12914.0	-12923.4	-12931.8	-12946.1	-12959.8	-12973.9
Panel B: During the GFC Sample Period										
	VAR(1)	VAR(2)	VAR(3)	VAR(4)	VAR(5)	VAR(6)	VAR(7)	VAR(8)	VAR(9)	VAR(10)
AIC	-4322.8	**-4319.9***	-4320.5	-4320.5	-4322.0	-4324.8	-4326.4	-4326.6	-4329.2	-4332.1
SBIC	**-4331.2**	-4336.7	-4345.7	-4354.3	-4364.2	-4375.4	-4385.4	-4394.1	-4405.0	-4416.4
Panel C: Post GFC Sample Period										
	VAR(1)	VAR(2)	VAR(3)	VAR(4)	VAR(5)	VAR(6)	VAR(7)	VAR(8)	VAR(9)	VAR(10)
AIC	-3697.4	-3699.9	**-3695.6***	-3698.5	-3701.8	-3704.5	-3708.2	-3710.9	-3712.7	-3715.5
SBIC	**-3705.7**	-3716.6	-3720.7	-3732.0	-3743.6	-3754.7	-3766.8	-3777.8	-3788.0	-3799.1

Note: A VAR model for the European stock market includes the Japan and China. AIC stands for Akaike Information criteria and SBIC stands for Schwartz-Bayesian Information criteria. **Panel A** shows the results for the optimal lag length chosen for the Asian stock markets in the pre GFC period, **Panel B** shows the results for the optimal lag length chosen for the Asian VAR model during the GFC and **Panel C** shows the results of the optimal lag length chosen for the Asian VAR model in the post GFC sample period. The lag length denoted by * is the optimal lag length chosen by each of the Information criteria. Microfit chooses the lag length that maximises the information criteria.

In Table 8 for the European stock markets the optimal lag length chosen in the pre GFC period (Panel A) is five , the optimal lag length chosen by the AIC during the GFC (Panel B) is two and the optimal lag length chosen by the AIC for the post GFC sample period (Panel C) is two. When serial correlation is tested in all sample periods using the lags chosen by the AIC, the presence of serial correlation is found only during the GFC for all stock markets except Germany at 5%.

In Table 9 for the Asian stock markets, the optimal lag length chosen by the AIC in the pre GFC period (Panel A) is seven, the optimal lag length chosen by the AIC during the GFC period (Panel B) is two and in the post GFC (Panel C) the optimal lag length chosen by the AIC is two. Testing for the presence of serial correlation using these chosen lags, no serial correlation is present in any of the stock markets in the pre GFC period and post GFC period but during the GFC period, Japan has the presence of serial correlation at 5% while China does not. The presence of serial correlation could be attributed to omitted variables.

5.5 Cointegration Results

With the optimal lag length to be used in carrying out cointegration known, the next task in carrying out the Johansen cointegration test is to choose which models are appropriate to use from five models provided by Microfit. The selection of which model/s to use is determined by assessing the time series plots of the stock price indices in the Appendix. The five models are listed below:

Model 1: No Intercepts or Trends

Model 2: Restricted Intercepts and no Trends

Model 3: Unrestricted Intercepts and no Trends

Model 4: Unrestricted Intercept and Restricted Trends

Model 5: Unrestricted Intercepts and Unrestricted Trends

Model 1 asserts that the data has no intercepts or trends. Model 2 assumes that no linear deterministic trends are present in the data but the cointegrating vector/s contains an intercept. Model 3 asserts that there is a linear trend in the data but no trend in the cointegrating vector/s. Model 4 assumes that the data contains a linear trend and the cointegrating vector/s contain a deterministic trend. Model 5 assumes that a quadratic trend exists in the data. These assertions will be further demonstrated as equations in the notes under each Table of results. The cointegration tests are carried out for each group of stock markets (American, European and Asian) over all three sample periods of Pre GFC, During the GFC and Post GFC. For each region, the results in each sample period is displayed and interpreted before moving on to the cointegration results of another region.

5.5.1 Cointegration results (American Stock Markets)

The cointegration results for the American stock markets are presented first with the results in the pre GFC period, during the GFC period and post the GFC period being presented in Tables 10, 11 and 12, respectively with the interpretation of the results made after each table is presented.

In the Pre-GFC sample period, the time series plots (Appendix) for the American stock markets show that the USA and Canada appear to have quadratic trends but Brazil appears to start trending upwards from about the beginning of 2003. Thus, Model 5 and Model 4 are selected to carry out the analysis. Reasons being that Model 5 asserts a quadratic trend in the data and a weak visible quadratic trend is present for the USA and Canada and Model 4 asserts a trend in the Case of Brazil which starts to trend upwards from the end of 2003. Model 4 asserts a trend in data and this model also applies to USA and Canada in that for most of the sample period (after beginning of 2003) Canada and Brazil trend up. The results of the cointegration test for the American stock markets are presented below:

Table 10: The Johansen-Juselius Cointegration Test: Pre GFC Period (American Stock Markets)

Panel A: Unrestricted Intercept and Unrestricted trend (Model 5)					
Rank		Trace Test	95% Critical Value	Maximum Eigenvalue Test	95% Critical Value
r = 0	r >= 1	33.7566	39.3300	20.4052	24.3500
r <=1	r >=2	13.3515	23.8300	13.3318	18.3300
r <=2	r = 3	0.019608	11.5400	0.019608	11.5400
Panel B: Unrestricted Intercept and Restricted Trend (Model 4)					
Rank		Trace Test	95% Critical Value	Maximum Eigenvalue Test	95% Critical Value
r = 0	r >= 1	48.3492	42.3400	23.5362	25.4200
r <=1	r >=2	24.8130	25.7700	13.8456	19.2200
r <=2	r = 3	10.9674	12.3900	10.9674	12.3900

Note: The Johansen-Juselius cointegration test is represented by the following equation:

$\Delta y_t = a_0 + a_1 t - \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + e_t$ where the number of cointegrating vectors is equal to the rank of the coefficient matrix Π . The rank of the coefficient matrix is tested using the Trace and Maximum eigenvalue test. There are 1806 observations from 29 August 2000 to 31 July 2007 (sample period).The variables included in the cointegration test for all Panels are the USA, Brazil and Canada. The VAR lag order of 4 as selected by the AIC is used in all Panels. **Panel A** is based on a cointegration equation tested with Unrestricted Intercept and Unrestricted Trend (Model 5) which asserts that $a_0 \neq 0$ and $a_1 \neq 0$ thus implying a constant and time trend being present in the VECM but not in the cointegrating relationship of Πy_{t-1}. The time trend present in the VECM is due to a quadratic trend that exists in the levels of the time series data.**Panel B** is based on the cointegration equation tested with Unrestricted Intercept and Restricted Trend (Model 4) which asserts that $a_0 \neq 0$ and $a_1 = \Pi \gamma$ thus the equation used in the above analysis is represented as follows:

$\Delta y_t = a_0 - \Pi(y_{t-1} - \gamma_t) + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + e_t$ implying a time trend being present in the levels of the times series data and a time trend ((γ_t) being present in the cointegrating relationship i.e. $\Pi(y_{t-1} - \gamma_t)$.

The results in Table 10, shows no cointegration present in Model 5 (Panel A). The results for Model 4 (Panel B) however provide evidence of the presence of one cointegrating vector using the Trace test but no cointegration present using the maximum eigenvalue test at 5%. The Trace test result is chosen in preference over the Maximum eigenvalue test result. This is because the finding of the presence of cointegration among the American stock markets is expected because Canada and Brazil are close trading partners with the USA, more so for Canada who has strong economic and political ties with the USA (Iseman (2011), Ek & Fergusson (2010), U.S. Department of State (2010) and Gibley (2011)). The finding of one cointegrating vector implies that these stock markets are cointegrated. This result implies that these stock markets share two common stochastic trends ($n - r = 3 - 1 = 2$) in the long run and thus move closely together and should never drift apart. Furthermore, this result implies that there is one linear combination of these stock markets that is stationary.

During the GFC sample period as can be seen, the time series plots (Appendix) show that Canada appears to be a random walk up until May 2008 where it starts to trend downwards. The USA appears to have a general downward trend and Brazil appears to have a weak upward trend from the beginning of the sample period up until end of May 2008 where it starts to trend down. As can be seen for all stock markets, they appear to have a quadratic trend from about July 2008 to the end of the sample period. Thus cointegration is tested with a trend and a quadratic trend (Model 3, Model 4 and Model 5) to incorporate the trends present in the stock markets. The results are presented on the next page. During the GFC (Table 11), using Model 4 (Panel A) and Model 5 (Panel B) the presence of one cointegrating vector is found with only the maximum eigenvalue test but not the trace test at 5%.

Table 11: The Johansen-Juselius Cointegration Test: During the GFC (American Stock Markets)

Panel A: Unrestricted Intercept and Restricted Trend (Model 4)					
Rank		Trace Test	95% Critical Value	Maximum Eigenvalue Test	95% Critical Value
r = 0	r >= 1	39.3565	42.3400	26.9082	25.4200
r <=1	r >=2	12.4483	25.7700	8.4375	19.2200
r <=2	r = 3	4.0109	12.3900	4.0109	12.3900
Panel B: Unrestricted Intercept and Unrestricted Trend (Model 5)					
Rank		Trace Test	95% Critical value	Maximum Eigenvalue Test	95% Critical Value
r = 0	r >= 1	38.8438	39.3300	26.9023	24.3500
r <=1	r >=2	11.9416	23.8300	8.4199	18.3300
r <=2	r= 3	3.5217	11.5400	3.5217	11.5400
Panel C: Unrestricted Intercept and No Trend (Model 3)					
Rank		Trace Test	95% Critical Value	Maximum Eigenvalue Test	95% Critical Value
r = 0	r >= 1	25.4836	31.5400	20.8790	21.1200
r <=1	r >=2	4.6047	17.8600	4.0151	14.8800
r <=2	r = 3	0.58952	8.0700	0.58952	8.0700

Note: The Johansen-Juselius cointegration relationship is represented by the following equation:

$\Delta y_t = a_0 + a_1 t - \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + e_t$ where the number of cointegrating vectors is equal to the rank of the coefficient matrix Π . The rank of the coefficient matrix is tested using the Trace and Maximum eigenvalue tests. The VAR lag order of 5 as selected by the AIC is used in all Panels. The variables included in the cointegration test for all Panels are the USA, Brazil and Canada. There are 500 observations from 1-August-07 to 30-June-09 (sample period) **Panel A** is based on the cointegration equation tested with Unrestricted Intercept and Restricted Trend (Model 4) which asserts that $a_0 \neq 0$ and $a_1 = \Pi \gamma$ thus the equation used in the above analysis is represented as follows: $\Delta y_t = a_0 - \Pi(y_{t-1} - \gamma_t) + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + e_t$ implying a time trend being present in the levels of the times series data and a time trend ((γ_t) being present in the cointegrating relationship i.e. $\Pi(y_{t-1} - \gamma_t)$. **Panel B** is based on a cointegration equation tested with Unrestricted Intercept and Unrestricted Trend (Model 5) which asserts that $a_0 \neq 0$ and $a_1 \neq 0$ thus implying a constant and time trend being present in the VECM but not in the cointegrating relationship of Πy_{t-1}. The time trend present in the VECM is due to a quadratic trend that exists in the levels of the time series data. **Panel C:** is based on a cointegration equation tested with Unrestricted Intercept and No Trend (Model 3) which asserts that $a_0 \neq 0$ and $a_1 = 0$ thus the equation used in the above analysis is represented as follows:

$\Delta y_t = a_0 - \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + e_t$ implying a time trend being present in the levels of the times series data but no trend or intercept being present in the cointegrating relationship i.e. Πy_{t-1}.

Using Model 3 (Panel C) no cointegration is found. Model 4(Panel A) and Model 5's (Panel B) results are chosen in preference to Model 3's (Panel C) result as per the explanation given in the Pre GFC sample period in that cointegration among the American stock markets is expected because of the strong trade ties among these American stock markets. As a result, it is concluded that one linear combination of these stock markets is stationary in the long run or two (n –r = 3-1 = 2) common stochastic trends are present and thus in the long run these stock markets move closely together in step and should never drift apart.

In the Post GFC sample period, the American stock markets in the time series plots (Appendix) appear to have a slight upward trend which is more pronounced for the USA and Canada thus the cointegration tests will involve a trend using Model 4 and Model 3. The results are presented below:

Table 12: The Johansen-Juselius Cointegration Test: Post GFC Period (American Stock Markets)

Panel A: Unrestricted Intercept and No Trend (Model 3)					
Rank		Trace Test	95% Critical value	Maximum Eigenvalue Test	95% Critical Value
r = 0	r >= 1	35.5032	31.5400	23.6635	21.1200
r <=1	r >=2	11.8397	17.8600	11.4474	14.8800
r <=2	r= 3	0.39232	8.0700	0.39232	8.0700
Panel B: Unrestricted Intercept and Restricted Trend (Model 4)					

Rank		Trace Test	95% Critical value	Maximum Eigenvalue Test	95% Critical Value
r = 0	r >= 1	57.1299	42.3400	40.6444	25.4200
r <=1	r >=2	16.4856	25.7700	12.8398	19.2200
r <=2	r = 3	3.6457	12.3900	3.6457	12.3900

Note:: The Johansen-Juselius cointegration test is represented by the following equation:

$\Delta y_t = a_0 + a_1 t - \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + e_t$ where the number of cointegrating vectors is equal to the rank of Π. The rank of the coefficient matrix is tested using the Trace and Maximum eigenvalue tests. A VAR order of 2 as selected by the AIC is used in all Panels. There are 484 observations from 01-Jul-09 to 09-May-11 (sample period).The variables included in the cointegration tests in all Panels are the USA, Brazil and Canada. **Panel A** is based on a cointegration equation tested with Unrestricted Intercept and No Trend (Model 3) which asserts that $a_0 \neq 0$ and $a_1 = 0$ thus the equation used in the above analysis is represented as follows:

$\Delta y_t = a_0 - \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + e_t$ implying a time trend being present in the levels of the times series data but no trend or intercept being present in the cointegrating relationship i.e. Πy_{t-1}. **Panel B** is based on the cointegration equation tested with Unrestricted Intercept and Restricted Trend (Model 4) which asserts that $a_0 \neq 0$ and $a_1 = \Pi \gamma$ thus the equation used in the above analysis is represented as follows: $\Delta y_t = a_0 - \Pi(y_{t-1} - \gamma_t) + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + e_t$ implying a time trend being present in the levels of the times series data and a time trend ((γ_t) being present in the cointegrating relationship i.e. $\Pi(y_{t-1} - \gamma_t)$.

In the post GFC sample period (Table 12), both the Trace test and Maximum eigenvalue test for Model 3 (Panel A) and Model 4 (Panel B) show the presence of one cointegrating vector at the 5% significance level. Thus, it is concluded that one cointegrating vector is present among the American stock markets in the Post-GFC sample period implying that these stock markets are interdependent and move closely together in the long run and should never drift apart.

As can be seen from the cointegration results, in the case of the American stock markets, the number of cointegrating vectors has not changed during the GFC and post the GFC in comparison to the Pre GFC sample period. One cointegrating vector is present in all three sample periods. This implies that the level of integration and thus long run interdependencies among the American stock markets did not change but stayed the same due to the GFC. This result can also be interpreted as no change in the level of integration among these stock markets. The finding of no change in long run interdependencies due to financial crises such as October 1987 Crash and the Asian Crisis has been documented by Masih & Masih (1997) and Worthington, Katsuura & Higgs (2004).

5.5.2 Cointegration results (European Stock Markets)

The cointegration results for the European stock markets in the pre GFC sample period, during the GFC period and in the post the GFC period are presented in Tables 13, 14 and 15, respectively with the interpretation of the results made after each table is presented.

The time series plots of the European stock markets (Appendix) in the Pre-GFC sample period appear to have weak quadratic trends, except for Spain which appears to have more of an upward trend thus Model 5, Model 4 and Model 3 have been used in the cointegration analysis. All stock markets have the appearance of a downward trend from the beginning of the sample to about mid-2002 and then an upward trend for most of the sample period from 2002 to the end of the sample period. Thus, the justification for using Models 3 and 4 is to incorporate these trends. The results are presented below:

Table 13: The Johansen-Juselius Cointegration Test: Pre GFC (European Stock Markets)

Panel A: Unrestricted Intercept and Unrestricted Trend (Model 5)					
Rank		Trace Test	95% Critical Value	Maximum Eigenvalue Test	95% Critical Value
r = 0	r >= 1	72.8455	82.2300	32.6050	37.0700
r <=1	r >=2	40.2405	58.9300	21.5616	31.0000
r <=2	r >= 3	18.6790	39.3300	10.7318	24.3500
r <=3	r >=4	7.9471	23.8300	6.0734	18.3300
r <= 4	r = 5	1.8737	11.5400	1.8737	11.5400

Panel B: Unrestricted Intercept and Restricted Trend (Model 4)					
Rank		Trace Test	95% Critical value	Maximum Eigenvalue Test	95% Critical Value
r = 0	r >= 1	83.9297	87.1700	32.9042	37.8600
r <=1	r >=2	51.0254	63.0000	22.8285	31.7900
r <=2	r>= 3	28.1970	42.3400	14.1031	25.4200
r <=3	r >=4	14.0939	25.7700	8.5511	19.2200
r <= 4	r = 5	5.5428	12.3900	5.5428	12.3900
Panel C: Unrestricted Intercept and No Trend (Model 3)					
Rank		Trace Test	95% Critical value	Maximum Eigenvalue Test	95% Critical Value
r = 0	r >= 1	70.2033	70.4900	30.8271	33.6400
r <=1	r >=2	39.3761	48.8800	17.9151	27.4200
r <=2	r>= 3	21.4610	31.5400	13.9144	21.1200
r <=3	r >=4	7.5466	17.8600	5.8575	14.8800
r <= 4	r = 5	1.6891	8.0700	1.6891	8.0700

Note: The Johansen-Juselius cointegration test is represented by the following equation:

$\Delta y_t = a_0 + a_1 t - \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + e_t$ where the number of cointegrating vectors is equal to the rank of the coefficient matrix Π . The rank of the coefficient matrix is tested using the Trace and Maximum eigenvalue test. The VAR lag order of 5 as selected by the AIC is used in all panels. The variables included in the cointegration test in all Panels are Germany, France, the UK, Italy and Spain. There are 1805 observations from 30-Aug-00 to 31-Jul-07(sample period). **Panel A** is based on a cointegration equation tested with Unrestricted Intercept and Unrestricted Trend (Model 5) which asserts that $a_0 \neq 0$ and $a_1 \neq 0$ thus implying a constant and time trend being present in the VECM but not in the cointegrating relationship of Πy_{t-1} . The time trend present in the VECM is due to a quadratic trend that exists in the levels of the time series data. **Panel B** is based on the cointegration equation tested with Unrestricted Intercept and Restricted Trend (Model 4) which asserts that $a_0 \neq 0$ and $a_1 = \Pi \gamma$ thus the equation used in the above analysis is represented as follows: $\Delta y_t = a_0 - \Pi(y_{t-1} - \gamma_t) + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + e_t$ implying a time trend being present in the levels of the times series data and a time trend ((γ_t) being present in the cointegrating relationship i.e. $\Pi(y_{t-1} - \gamma_t)$. **Panel C** is based on a cointegration equation tested with Unrestricted Intercept and No Trend (Model 3) which asserts that $a_0 \neq 0$ and $a_1 = 0$ thus the equation used in the above analysis is represented as follows:

$\Delta y_t = a_0 - \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + e_t$ implying a time trend being present in the levels of the times series data but no trend or intercept being present in the cointegrating relationship i.e. Πy_{t-1}.

The results in Table 13 show no evidence of cointegration being present in the pre GFC sample period using the trace or maximum eigenvalue tests in none of the Models (Panel A, B or C). Thus, it is concluded that cointegration is not present among the European stock markets in the pre-GFC period, implying that these stock markets do not share a common stochastic trend and thus do not move closely together in the long run but move independently.

This result is unexpected because the European stock markets are of close geographical proximity, they are close trading partners and they are all part of the European Union. Furthermore, all countries except the UK use the Euro and as a result have similar economic and monetary policy and so it is expected that cointegration should be present. This result contradicts that of King & Serletis (1997), Cheung & Lai (1999) and Erdinc & Milla (2009) who find the presence of cointegration among European stock markets.

For the European stock markets during the GFC sample period (Table 14), the time series plots show that the stock markets generally have a downward trend thus Model 4 and Model 3 are used as the most appropriate models to test for cointegration. The results are presented below:

Table 14: The Johansen-Juselius Cointegration Test: During the GFC (European Stock Markets)

Panel A: Unrestricted Intercept and Restricted Trend (Model 4)				
Rank	Trace Test	95% Critical	Maximum	95% Critical

			value	Eigenvalue Test	Value
r = 0	r >= 1	84.6050	87.1700	38.6250	37.8600
r <=1	r >=2	45.9800	63.0000	24.0306	31.7900
r <=2	r>= 3	21.9494	42.3400	11.5289	25.4200
r <=3	r >=4	10.4205	25.7700	8.1251	19.2200
r <= 4	r = 5	2.2954	12.3900	2.2954	12.3900
Panel B: Unrestricted Intercept and No Trend (Model 3)					
Rank		Trace Test	95% Critical value	Maximum Eigenvalue Test	95% Critical Value
r = 0	r >= 1	76.9849	70.4900	36.5315	33.6400
r <=1	r >=2	40.4534	48.8800	21.7746	27.4200
r <=2	r>= 3	18.6788	31.5400	10.3088	21.1200
r <=3	r >=4	8.3700	17.8600	7.6592	14.8800
r <= 4	r = 5	0.71081	8.0700	0.71081	8.0700

Note: The Johansen-Juselius cointegration relationship is represented by the following equation:

$\Delta y_t = a_0 + a_1 t - \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + e_t$ where the number of cointegrating vectors is equal to the rank of the coefficient matrix Π . The rank of the coefficient matrix is tested using the Trace and Maximum eigenvalue tests A VAR lag order of 2 as selected by the AIC is used in all Panels. The variables included in the cointegration test in all panels are Germany, France, the UK, Italy and Spain. There are 500 observations from 01-Aug-07 to 30-Jun-09 (sample period). **Panel A** is based on the cointegration equation tested with Unrestricted Intercept and Restricted Trend (Model 4) which asserts that $a_0 \neq 0$ and $a_1 = \Pi \gamma$ thus the equation used in the above analysis is represented as follows: $\Delta y_t = a_0 - \Pi(y_{t-1} - \gamma_t) + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + e_t$ implying a time trend being present in the levels of the times series data and a time trend ((γ_t) being present in the cointegrating relationship i.e. $\Pi(y_{t-1} - \gamma_t)$. **Panel B** is based on a cointegration equation tested with Unrestricted Intercept and No Trend (Model 3) which asserts that $a_0 \neq 0$ and $a_1 = 0$ thus the equation used in the above analysis is represented as follows:

$\Delta y_t = a_0 - \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + e_t$ implying a time trend being present in the levels of the times series data but no trend or intercept being present in the cointegrating relationship i.e. Πy_{t-1}.

In Table 14 (during the GFC period), Model 4 (Panel A) provides evidence of no cointegration being present using the trace test but using the maximum eigenvalue test one cointegrating vector exists at 5%. Model 3 (Panel B) provides stronger results than Model 4 (Panel A), with the presence of one cointegrating vector at 5% using both the Trace test and the Maximum eigenvalue test. As a result, it can be concluded that one cointegrating vector is present during the GFC sample period; implying one linear combination of these stock markets is stationary in the long run. An implication of this is that the stock markets share four (n – r = 5 – 1 = 4) common stochastic trends in the long run and move closely together.

In the Post GFC sample period , the time series plots (Appendix) show that Germany, France and UK from the beginning of the sample period to about the beginning of September 2009 appear to be random walks with no trend but then start to trend up from then on. Thus, Model 2 and Model 3 apply to the characteristics of Germany, France and UK. Italy and Spain on the other hand appear to be random walks without drift and trend, thus Model 1 (No Intercept or Trend) applies to Italy and Spain. As a result Model 1, 2 and 3 have been used to analyse cointegration, and the results are presented below:

Table 15: The Johansen-Juselius Cointegration Test: Post GFC (European Stock Markets)

Panel A: Restricted Intercept and No Trend (Model 2)					
Rank		Trace Test	95% Critical value	Maximum Eigenvalue Test	95% Critical Value
r = 0	r >= 1	76.2057	75.9800	34.5841	34.4000
r <=1	r >=2	41.6217	53.4800	18.5914	28.2700
r <=2	r>= 3	23.0302	34.8700	13.3790	22.0400
r <=3	r >=4	9.6512	20.1800	5.2484	15.8700
r <= 4	r = 5	4.4028	9.1600	4.4028	9.1600

Panel B: Unrestricted Intercept and No Trend (Model 3)					
Rank		Trace Test	95% Critical value	Maximum Eigenvalue Test	95% Critical Value
r = 0	r >= 1	71.2854	70.4900	34.5818	33.6400
r <=1	r >=2	36.7036	48.8800	18.2985	27.4200
r <=2	r>= 3	18.4051	31.5400	13.1860	21.1200
r <=3	r >=4	5.2191	17.8600	4.5865	14.8800
r <= 4	r = 5	0.63257	8.0700	0.63257	8.0700

Panel C: No Intercept or Trend (Model 1)					
Rank		Trace Test	95% Critical value	Maximum Eigenvalue Test	95% Critical Value
r = 0	r >= 1	57.2408	59.3300	26.4563	29.9500
r <=1	r >=2	30.7845	39.8100	18.5495	23.9200
r <=2	r>= 3	12.2350	24.0500	6.7960	17.6800
r <=3	r >=4	5.4390	12.3600	4.4084	11.0300
r <= 4	r = 5	1.0306	4.1600	1.0306	4.1600

Note: The Johansen-Juselius cointegration test is represented by the following equation:

$\Delta y_t = a_0 + a_1 t - \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + e_t$ where the number of cointegrating vectors is equal to the rank of the coefficient matrix Π The rank of the coefficient matrix is tested using the Trace and Maximum eigenvalue tests. A VAR lag order of 2 as selected by the AIC is used in all the Panels. The variables included in the cointegration test in all Panels are Germany, France, the UK, Italy and Spain. There are 484 observations from 01-Jul-09 to 09-May-11 (sample period). **Panel A** is based on a cointegration equation tested with Restricted Intercept and No Trend (Model 2) which asserts that $a_0 = \Pi\mu$ and $a_1 = 0$ thus the equation used in the above analysis is represented as follows: $\Delta y_t = -\Pi(y_{t-1} - \mu) + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + e_t$. This implies no trend being present in the levels of the times series data but an intercept (μ) being present in the cointegrating relationship/ vector i.e. $\Pi(y_{t-1} - \mu)$. **Panel B** is based on a cointegration equation tested with Unrestricted Intercept and No Trend (Model 3) which asserts that $a_0 \neq 0$ and $a_1 = 0$. As a result, the equation used in the above analysis is represented as follows: $\Delta y_t = a_0 - \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + e_t$ implying a time trend being present in the levels of the times series data but no trend or intercept being present in the cointegrating relationship i.e. Πy_{t-1} . **Panel C** is based on a cointegration equation tested with No Intercept and No Trend (model 1). No Intercept or Trend asserts that $a_0 = 0$ and $a_1 = 0$. As a result, the equation used in Panel C is represented as follows:

$\Delta y_t = -\Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + e_t$ implying no intercept or trend being present in the variables thus asserting that the levels of the time series data are represented by a random walk without drift/ constant. Furthermore, No Intercept or Trend exists in the cointegrating relationship i.e. Πy_{t-1} .

The cointegration results in Table 15 (Post GFC period), show that Model 2 (Panel A) provides evidence of one cointegrating vector at the 5% significance level using both the Trace test and Maximum eigenvalue test. The results appear to be quite weak. Model 3 (Panel B) also provides evidence of one cointegrating vector at 5% using both the Trace test and Maximum eigenvalue test. In contrast, Model 1 (Panel C) which asserts no trend or constant in the variables finds no cointegration present among the stock markets at 5%.

Cointegration among the stock markets is expected because of the close trade and economic ties these countries have, thus the results of Model 2 (Panel A) and Model 3 (Panel B) are chosen in preference over Model 1 (Panel C). Thus, it can be concluded that one cointegrating vector is present among these stock markets, implying that these stock markets are interdependent in the long run and move closely together. Both results are fairly weak and almost borderline in accepting the null hypothesis of no cointegration (rank = 0).

In the case of the European stock markets, in the pre-GFC sample period no evidence of cointegration is found but during the GFC and in the post GFC sample period, the presence of one cointegrating vector is found. This result implies an increase in long run interdependencies and long run integration among the European stock markets in comparison to the Pre-GFC sample period.

The finding of an increase in long run interdependencies due to financial crises such as the October 1987 crash is documented by Malliaris & Urrutia (1992) and Yang, Kolari & Min (2002). The finding of increased interdependencies and co-movements during the GFC as compared to the Pre-GFC sample period can be attributed to contagion which is defined as an increase in common movements in a set of financial stock markets in crisis periods compared to non-crisis periods (Baur & Fry, 2009).

If comparisons are made between the results during the GFC and in the post GFC sample period, the evidence highlights no change in long run interdependencies among the stock markets because one cointegrating vector is present in both sample periods. The finding of no change in long run interdependencies due to financial crises such as the October 1987 Crash and the Asian financial crisis has been documented by Masih & Masih (1997) and Worthington et al (2003).

5.5.3 Cointegration results (Asian Stock markets)

In the case of the Asian stock markets in the pre-GFC sample period, the time series plots (Appendix) show that Japan appears to have a quadratic trend while China appears not to trend until the end of the sample period. Thus Model 5 has been used to take into account Japan's quadratic trend. Models 4 and 3 have also been used to analyse cointegration because these cases take into account Japan's downward trend from the beginning of the sample period to the end of July 2008 and its upward trend from end of July 2008 up until the end of the sample period. Model 2 has also been used to take into account China's appearance of no trend. The results are presented below:

Table 16: The Johansen-Juselius Cointegration Test: Pre GFC (Asian Stock Markets)

Panel A: Unrestricted Intercept and Unrestricted Trend (Model 5)					
Rank		Trace Test	95% Critical Value	Maximum Eigenvalue Test	95% Critical Value
r = 0	r >= 1	23.0293	23.8300	17.3491	18.3300
r <=1	r =2	5.6802	11.5400	5.6802	11.5400

Panel B: Unrestricted Intercept and Restricted Trend (Model 4)					
Rank		Trace Test	95% Critical value	Maximum Eigenvalue Test	95% Critical Value
r = 0	r >= 1	46.5195	25.7700	31.0901	19.2200
r <=1	r =2	15.4294	12.3900	15.4294	12.3900
Panel C: Unrestricted intercept and No Trend (Model 3)					
Rank		Trace Test	95% Critical value	Maximum Eigenvalue Test	95% Critical Value
r = 0	r >= 1	23.7748	17.8600	23.7651	14.8800
r <=1	r =2	0.0097608	8.0700	0.0097608	8.0700
Panel D: Restricted Intercept and No Trend (Model 2)					
Rank		Trace Test	95% Critical value	Maximum Eigenvalue Test	95% Critical Value
r = 0	r >= 1	26.9265	20.1800	26.7012	15.8700
r <=1	r =2	0.22532	9.1600	0.22532	9.1600

Note: The Johansen-Juselius cointegration test is represented by the following equation:

$\Delta y_t = a_0 + a_1 t - \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + e_t$ where the number of cointegrating vectors is equal to the rank of the coefficient matrix Π . The rank of the coefficient matrix is tested using the Trace and Maximum eigenvalue test. The VAR lag order of 7 as selected by the AIC is used in all the Panels. The variables included in the cointegration test in all Panels are Japan and China. There are 1803 observations from 01-Sep-00 to 31-Jul-07.. **Panel A** is based on a cointegration equation tested with Unrestricted Intercept and Unrestricted Trend (Model 5) which asserts that $a_0 \neq 0$ and $a_1 \neq 0$ thus implying a constant and time trend being present in the VECM but not in the cointegrating relationship of Πy_{t-1}. The time trend present in the VECM is due to a quadratic trend that exists in the levels of the time series data.. **Panel B** is based on the cointegration equation tested with Unrestricted Intercept and Restricted Trend (Model 4) which asserts that $a_0 \neq 0$ and $a_1 = \Pi \gamma$. As a result, the equation used in the above analysis is represented as follows: $\Delta y_t = a_0 - \Pi(y_{t-1} - \gamma_t) + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + e_t$ implying a time trend being present in the levels of the times series data and a time trend ((γ_t) being present in the cointegrating relationship i.e. $\Pi(y_{t-1} - \gamma_t)$. **Panel C** is based on a cointegration equation tested with Unrestricted Intercept and No Trend (Model 3) which asserts that $a_0 \neq 0$ and $a_1 = 0$ thus the equation used in the above analysis is represented as follows:

$\Delta y_t = a_0 - \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + e_t$ implying a time trend being present in the levels of the times series data but no trend or intercept being present in the cointegrating relationship i.e. Πy_{t-1}. **Panel D** is based on a cointegration equation tested with Restricted Intercept and No Trend (Model 2) which asserts that $a_0 = \Pi \mu$ and $a_1 = 0$ thus the equation used in the above analysis is represented as follows: $\Delta y_t = -\Pi(y_{t-1} - \mu) + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + e_t$ implying a no trend being present in the levels of the times series data but an intercept (μ) being present in the cointegrating relationship/ vector i.e. $\Pi(y_{t-1} - \mu)$.

In Table 16 (Pre GFC period), no evidence of cointegration is found between Japan and China using Model 5 (Panel A) but using Model 3 (Panel C) and Model 2 (Panel D), the presence of one cointegrating vector is found at 5% for both the Trace test and Maximum eigenvalue test. Model 4 (Panel B) indicates the presence of two cointegrating vectors or full rank but the finding of full rank implies that Japan and China are stationary (Johansen & Juselius, 1990) but in actual fact the unit root tests (Table 3) provides evidence to show that the levels of Japan and China are both non-stationary, thus the result of Model 4 (Panel B) has not been considered.

Thus, using Model 3 (Panel C) and Model 2 (Panel D) results, it is concluded that one cointegrating vector is present between Japan and China before the GFC. This result implies that these stock markets share a common stochastic trend and thus move closely together in the long run and should never drift apart.

The finding of cointegration between Japan and China contradicts the result of Kashefi (2008) and Jeyanthi (2010) who find no cointegration between Japan and China but supports the result of Azad (2009) who finds the presence of cointegration among Japan, China and South Korea using the Engle-Granger test for cointegration. There is a limitation in Azad's (2009) finding in that the Engle Granger test is suitable for at most two variables but if more than two variables are used in this analysis, a serious bias occurs. This is because depending on the choice of the dependent variable different estimates of the cointegrating vector are obtained (Alexander (2001); Masih & Masih (2004)).

In the case of the Asian stock markets during the GFC, the time series plots (Appendix) show a downward trend for Japan but China appears to have more of a quadratic trend. Japan also appears to have a quadratic trend from about June 2008 to the end of the sample period. Thus, cointegration has been tested using Model 5 to capture the quadratic trends. Model 4 and Model 3 are also used to test for cointegration to capture the downward trends in Japan and China (from about end of February 2007 to November 2008).

The results are presented in Table 17 below and each Model (Panels A, B and C) provides evidence of no cointegration being present between Japan and China during the GFC sample period. This finding supports that of Kashefi (2008) and Jeyanthi (2010) who find no cointegration present between Japan and China. This result implies that these stock markets do not move closely together or do not move in step but move independently and thus are not interdependent in the long run.

Table 17: The Johansen-Juselius Cointegration Test: During the GFC (Asian Stock Markets)

Panel A: Unrestricted Intercept and No Trend (Model 3)					
Rank		Trace Test	95% Critical value	Maximum Eigenvalue Test	95% Critical Value
r = 0	r >= 1	6.1088	17.8600	5.3139	14.8800
r <=1	r =2	0.79488	8.0700	0.79488	8.0700
Panel B: Unrestricted Intercept and Restricted Trend (Model 4)					
Rank		Trace Test	95% Critical value	Maximum Eigenvalue Test	95% Critical Value

r = 0	r >= 1	7.4679	25.7700	6.0354	19.2200
r <=1	r =2	1.4325	12.3900	1.4325	12.3900
Panel C: Unrestricted Intercept and Unrestricted Trend (Model 5)					
Rank		Trace Test	95% Critical value	Maximum Eigenvalue Test	95% Critical Value
r = 0	r >= 1	7.0271	23.8300	5.7397	18.3300
r <=1	r =2	1.2874	11.5400	1.2874	11.5400

Note: The Johansen-Juselius cointegration test is represented by the following equation:

$\Delta y_t = a_0 + a_1 t - \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + e_t$ where the number of cointegrating vectors is equal to the rank of Π.

The rank of the coefficient matrix is tested using the Trace and Maximum eigenvalue tests. A VAR order of 2 as selected by the AIC is used in all the Panels. The variables included in the cointegration test are Japan and China. There are 500 observations from 01-Aug-07 to 30-Jun-09. **Panel A** is based on a cointegration equation tested with Unrestricted Intercept and No Trend (Modell 3) which asserts that $a_0 \neq 0$ and $a_1 = 0$ thus the equation used in the above analysis is represented as follows:

$\Delta y_t = a_0 - \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + e_t$ implying a time trend being present in the levels of the times series data but no trend or intercept being present in the cointegrating relationship i.e. Πy_{t-1}. **Panel B** is based on the cointegration equation tested with Unrestricted Intercept and Restricted Trend (Model 4) which asserts that $a_0 \neq 0$ and $a_1 = \Pi \gamma$ thus the equation used in the above analysis is represented as follows: $\Delta y_t = a_0 - \Pi(y_{t-1} - \gamma_t) + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + e_t$ implying a time trend being present in the levels of the times series data and a time trend (γ_t) being present in the cointegrating relationship i.e. $\Pi(y_{t-1} - \gamma_t)$. **Panel C** is based on a cointegration equation tested with Unrestricted Intercept and Unrestricted Trend (Model 5) which asserts that $a_0 \neq 0$ and $a_1 \neq 0$ thus implying a constant and time trend being present in the VECM but not in the cointegrating relationship of Πy_{t-1}. The time trend present in the VECM is due to a quadratic trend that exists in the levels of the time series data.

In the case of Japan and China in the Post GFC sample period, the times series plots (Appendix) show that China and Japan appear to be random walks without drift and no time trend. Thus, the cointegration tests have been carried out based on Model 1 and Model 2 which assert that the variables do not have an intercept and time trend, respectively.

Both the trace test and the maximum eigenvalue test in Table 18 for both Models (A and B) provide strong evidence of the absence of cointegration between Japan and China in the post GFC sample period. This result implies that Japan and China move independently and do not share a common stochastic trend in the long run and as a result they are not interdependent.

Table 18: The Johansen-Juselius Test: Post GFC (Asian Stock Markets)

Panel A: No Intercept or Trend (Model 1)					
Rank		Trace Test	95% Critical value	Maximum Eigenvalue Test	95% Critical Value
r = 0	r >= 1	5.7181	12.3600	5.7037	11.0300
r <=1	r =2	0.014410	4.1600	0.014410	4.1600
Panel B: Restricted Intercept and No Trend (Model 2)					
Rank	Trace Test	95% Critical value	Maximum Eigenvalue Test	95% Critical Value	
r = 0	r >= 1	11.6857	20.1800	5.9829	15.8700
r <=1	r =2	5.7027	9.1600	5.7027	9.1600

Note: The Johansen-Juselius cointegration test is represented by the following equation:

$\Delta y_t = a_0 + a_1 t - \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + e_t$ where the number of cointegrating vectors is equal to the rank of the coefficient matrix Π. The rank of the coefficient matrix is tested using the Trace and Maximum eigenvalue tests. A VAR order of 3 as selected by the AIC is used in all the Panels. The variables included in the cointegration test in all the panels are Japan and China. There are 484 observations from 01-Jul-09 to 09-May-11(sample period). **Panel A** is based on a cointegration equation tested with No Intercept and No Trend (Model 1). No Intercept or Trend asserts that $a_0 = 0$ and $a_1 = 0$ thus the equation used in Panel C is represented as follows: $\Delta y_t = -\Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + e_t$ implying no intercept or trend being present in the variables thus asserting that the levels of the time series data are represented by a random walk without drift/ constant. Furthermore, No Intercept or Trend exists in the cointegrating relationship i.e. Πy_{t-1}. **Panel B** is based on a cointegration equation tested with Restricted Intercept and No Trend (Model 3) which asserts that $a_0 = \Pi \mu$ and $a_1 = 0$ thus the equation used in the above analysis is represented as follows: $\Delta y_t = -\Pi(y_{t-1} - \mu) + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + e_t$ implying a no trend being present in the levels of the times series data but an intercept (μ) being present in the cointegrating relationship/ vector i.e. $\Pi(y_{t-1} - \mu)$..

In the case of the Asian stock markets (Japan and China),the results show that in the pre-GFC sample period evidence of one cointegrating vector is found but during the GFC and post GFC sample periods, no cointegration is found between these two stock markets. This result implies that long run interdependencies and integration decreased between Japan and China due to the GFC.

The implication of the above results is that if cointegration among stock markets is found, this provides evidence for the limits of portfolio diversification among these stock markets because they move closely together in the long run and share common stochastic trends. The finding of cointegration among the American stock markets in all sample periods implies that portfolio diversification benefits among the American stock markets were non-existent in all three sample periods due to the interdependencies present.

On the other hand, the finding of no cointegration among stock markets provides evidence that long run portfolio diversification among these stock markets is beneficial because they move independently of each other because they do not share common stochastic trends. This is the case for the European stock markets in the pre GFC sample period and for the Asian stock markets during the GFC period and in the post GFC sample periods. In context to reality about the benefits of portfolio diversification and the GFC, risk would not have been substantially reduced via diversifying because of the contagious negative effects perturbed by the GFC in stock markets around the world.

5.6 Long Run Cointegrating Vectors:

Having established cointegration being present in all three sample periods among the American stock markets and during the GFC period and in the post-GFC period among the European stock markets, the importance of each stock market in the American and

European cointegrating relationships has been assessed. In all three sample periods, for the American stock markets, the USA has been normalized upon and for the European stock markets Germany has been normalized.

The significance of each stock market has been analysed in the sample periods where cointegration is present. This is in order to assess if there have been changes in the countries that are important (significant) in the cointegrating (equilibrium) relationship. In the case of Japan and China, since cointegration is only present in the Pre-GFC sample period, the significance of China to the long run equilibrium relationship in the pre GFC sample period has been assessed by normalising on Japan. The choice of which country to normalize on is based on the country with highest GDP in that region in 2009 as ranked by the World Bank.

5.6.1 Long Run Cointegration Vector (American Stock markets)

In analysing the long run cointegration vectors, Microfit displays the maximum likelihood estimates of the cointegrating vector under Johansen's exact identifying restrictions but asymptotic standard errors are not provided for these estimates, thus, one cannot evaluate the significance of the variables to the cointegrating relationship, rendering Johansen's exact identifying estimates uninformative.

As a result, normalising restrictions help estimate (or evaluate) the variables significant to the cointegrating relationship because asymptotic standard errors are provided. Table 19 below presents the estimated cointegrating vector coefficients when the USA is normalized in each sample period, with the cointegrating vector being read vertically in the second column. In Table 19, in the Pre GFC sample period (Panel A), Canada is the only stock

Table 19: Normalised Estimates of Cointegrating Vector Coefficients (American Stock Markets)

Panel A: Pre-GFC Sample Period (Unrestricted Intercept and Restricted Trend – Model 4)			
Cointegrating Vector Variables	Coefficients	Standard error	Test statistic
USA	1.000	NONE	-
Brazil	1.1183	0.79590	1.40508
Canada	-1.8561	0.55211	3.36183*
Trend	0.64124	0.19741	3.24827*
Panel B: During the GFC Sample Period (Unrestricted Intercept and Restricted Trend – Model 4)			
Cointegrating Vector Variables	Coefficients	Standard error	Test statistic
USA	1.000	NONE	
Brazil	0.61820	0.17457	3.54127*
Canada	-0.89635	0.11993	7.47394*
Trend	0.39444	0.092270	4.27485*
Panel C: During the GFC Sample Period (Unrestricted Intercept and Unrestricted Trend – Model Five)			
Cointegrating Vector Variables	Coefficients	Standard error	Test statistic
USA	1.000	NONE	-
Brazil	0.61844	0.17457	3.54365*
Canada	-0.89639	0.11994	7.47365*
Panel D: Post GFC Sample Period (Unrestricted Intercept and No trend – Model 3)			
Cointegrating Vector Variables	Coefficients	Standard error	Test statistic
USA	1.000	NONE	
Brazil	-0.15040	0.12028	1.25042
Canada	-0.58971	0.036456	16.17594*
Panel E: Post GFC Sample Period (Unrestricted Intercept and Restricted Trend – Model 4)			

Cointegrating Vector Variables	Coefficients	Standard error	Test statistic
USA	1.000	NONE	
Brazil	-0.13941	0.079794	1.74712
Canada	-0.76988	0.050709	15.18231*
Trend	0.21424	0.051068	4.19519*

Note: In all Panels, the USA has been normalised upon and this is done by dividing all the coefficients that are part of the cointegrating vector by the coefficient of the USA. * denotes Significant at 5%, critical value = 1.960. The Test statistic in the last column of every Panel is calculated by dividing the estimated coefficients by their respective standard errors **Panel A** is based on a VAR lag length of 4 and Rank = one (only one cointegrating vector is present). There are 1806 observations in the sample period from 29-august-2000 to 31-july-2007.

The VECM used to test cointegration is represented as follows: $\Delta y_t = a_0 + a_1 t - \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + e_t$ and when tested with an unrestricted Intercept and restricted trend (Model 4) this asserts that $a_0 \neq 0$ and $a_1 = \Pi\gamma$ thus this restriction implies a time trend ((γ_t) being present in the cointegrating relationship/ vector i.e. $\Pi(y_{t-1} - \gamma_t)$ as can be seen a time trend is present in panel A. Thus the variables in the cointegrating vector are USA, Brazil, Canada and a time trend. **Panel B** is based on a VAR lag length of 5 and Rank = one (one only cointegrating vector is present). There are 500 observations from 1-Aug-2007 to 30-June-2009 (sample period).

The VECM used to test cointegration is represented as follows: $\Delta y_t = a_0 + a_1 t - \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + e_t$ and when tested with an unrestricted Intercept and restricted trend (Model 4) this asserts that $a_0 \neq 0$ and $a_1 = \Pi\gamma$ thus this restriction implies a time trend ((γ_t) being present in the cointegrating relationship/ vector i.e. $\Pi(y_{t-1} - \gamma_t)$ as can be seen a time trend is present in panel B. Thus the variables in the cointegrating vector are USA, Brazil, Canada and a time trend. **Panel C** is based on a VAR lag length of 4 and Rank = one (only one cointegrating vector is present). There are 500 observations from 1-Aug-2007 to 30-June-2009 (sample period).

The VECM used to test cointegration is represented as follows: $\Delta y_t = a_0 + a_1 t - \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + e_t$ and when tested with an Unrestricted Intercept and Unrestricted Trend (Model 5) which asserts that $a_0 \neq 0$ and $a_1 \neq 0$ thus implying a constant and time trend being present in the VECM but not in the cointegrating relationship/ vector of Πy_{t-1} as can be seen no deterministic components exist in Panel C. Thus the variables in the cointegrating vector are USA, Brazil and Canada. **Panel D** is based on a VAR lag length of 4 and Rank = one (only one cointegrating vector is present). There are 484 observations from 1-Jul-2009 to 09-May-2011 (sample period). The VECM used to test cointegration is represented as follows: $\Delta y_t = a_0 + a_1 t - \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + e_t$ and when tested with an Unrestricted Intercept and No Trend (Model 3) which asserts that $a_0 \neq 0$ and $a_1 = 0$ thus implying a time trend being present in the levels of the times series data but no trend or intercept being present in the cointegrating relationship i.e. Πy_{t-1}. As can be seen no deterministic components exist in Panel D. Thus the variables in the cointegrating vector are USA, Brazil, and Canada. **Panel E** is based on a VAR lag length of 4 and Rank = one (one cointegrating vector is present). There are 484 observations from 1-Jul-2009 to 09-May-2011 (sample period). The VECM used to test cointegration is represented as follows:

$\Delta y_t = a_0 + a_1 t - \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + e_t$ and when tested with an unrestricted Intercept and restricted trend (Model 4) this asserts that $a_0 \neq 0$ and $a_1 = \Pi\gamma$ thus this restriction implies a time trend ((γ_t) being present in the cointegrating relationship i.e. $\Pi(y_{t-1} - \gamma_t)$ as can be seen a time trend is present in panel A. Thus the variables in the cointegrating vector are USA, Brazil, Canada and a time trend.

market that has a significant effect on the USA in the long run thus concluding that Canada is important and significant in the long run cointegrating (equilibrium) relationship at 5%. This result can be justified firstly by the close economic and political ties between Canada and the USA in terms of trade, capital inflow and investments, with Canada being the largest importer and exporter for the USA (Gibley, 2011), (Iseman, 2011) and (U.S. Department of State, 2010).

On the other hand, Brazil is not significant implying that Brazil is not important to the long run equilibrium relationship. Brazil not being significant in the Pre GFC sample period can be attributed to the fact that Brazil is not as strongly linked to the USA as Canada is. This is because Brazil is an emerging economy and is just increasing its influence in the region of America in comparison to Canada (Meyer, 2011).

In Table 19, during the GFC sample period (Panels B and C) we see that the number of stock markets important to the long run equilibrium relationship increases, with Brazil being significant and thus being important to the long run cointegrating relationship. This result implies that the USA became influenced by more stock markets in the long run. This result during the GFC could be attributed to the negative effects of crisis that were wide spread across the globe, with bad news in one stock market having negative effects in other stock markets due to uncertainty, more so if the stock market is a major stock market. With uncertainty and high volatility faced by investors, investors are not willing to invest and as a result they either reduce investments in these major stock markets or sell stocks to prevent further losses. These actions in turn create downward pressure on stock prices thus investors from other stock markets exert more influence via the choices they make on investments.

In the post GFC sample period (Panels D and E), Canada is the only significant stock market in the cointegrating relationship implying that in the post GFC sample period, the number of stock markets affecting the USA declined in comparison to during the GFC. If all three samples periods are compared, it can be concluded that there was a temporary increase in the number of stock markets important to the long run equilibrium relationship during the GFC sample period. On the other hand, Canada is significant in all three sample periods as compared to Brazil that's only significant during the GFC thus highlighting Canada's consistent importance to the long run equilibrium relationship. As mentioned earlier this can be attributed to the stronger ties the USA and Canada have in comparison to the USA and Brazil. The finding that Canada is significant to the long run cointegrating relationship has been documented by Masih & Masih (1997)

5.6.2 Long Run Cointegration Vector (European Stock Markets)

Since cointegration is not found in the pre-GFC sample period for the European stock markets, the importance of each stock market to the equilibrium relationship is only analysed during the GFC and in the Post-GFC sample periods and in both sample periods Germany is normalised upon. The results are presented below, with the cointegrating vector being read vertically in the second column.

Table 20: Normalised Estimates of Cointegrating Vector Coefficients (European Stock Markets)

Panel A: During the GFC Sample period (Unrestricted Intercept and No Trend – Model 3)			
Cointegrating Vector Variables	Coefficients	Standard error	Test Statistic
Germany	1.000	NONE	-
France	-0.96625	0.55159	1.75175

UK	-1.1580	0.56283	2.05746*
Italy	3.8853	1.3397	2.90013*
Spain	-1.2876	1.2123	1.06211

Panel B: During the GFC Sample Period (Unrestricted Intercept and Restricted trend – Model 4)

Cointegrating Vector Variables	Coefficients	Standard error	Test Statistic
Germany	1.000	NONE	-
France	-1.1797	0.79467	1.48452
UK	-1.8473	1.3188	1.40074
Italy	6.6881	4.2984	1.55595
Spain	-2.1792	2.1789	1.00014
Trend	0.65227	0.74167	0.87946

Panel C: Post GFC Sample Period (Restricted Intercept and No trend – Model 2)

Cointegrating Vector Variables	Coefficients	Standard error	Test Statistic
Germany	1.000	NONE	-
France	39.3459	142.1656	0.27676
UK	-17.8585	62.1302	0.28744
Italy	-79.7158	285.3556	0.27936
Spain	26.3916	95.2554	0.27706
Intercept	7657.9	26439.6	0.28960

Panel D: Post GFC Sample Period (Unrestricted Intercept and No trend – Model 3)

Cointegrating Vector Variables	Coefficients	Standard error	Test Statistic
Germany	1.000	NONE	-
France	38.9195	138.8484	0.28030
UK	-17.6753	60.6958	0.29121
Italy	-78.7978	278.3945	0.28304
Spain	26.0243	92.6453	0.28090

Note: In all Panels, Germany has been normalised upon and this is done by dividing all the coefficients that are part of the cointegrating vector by the coefficient of the Germany. * denotes Significant at 5%, critical value = 1.960. In each Panel, the Test statistic in the last column is calculated by dividing the estimated coefficients by their respective standard errors. **Panel A**: is based on a VAR lag length of 2 and Rank = one (one cointegrating vector is present). There are 500 observations in the sample period from 1-august-2007 to 30-june-2009. The VECM used to test cointegration is represented as follows: $\Delta y_t = a_0 + a_1 t - \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + e_t$ and when tested with an Unrestricted Intercept and No Trend (Model 3) which asserts that $a_0 \neq 0$ and $a_1 = 0$ thus implying a time trend being present in the levels of the times series data but no trend or intercept being present in the cointegrating relationship i.e. Πy_{t-1}. As can be seen no deterministic components exist in Panel A. Thus the variables in the cointegrating vector are Germany, France, the UK, Italy and Spain.**Panel B**: is based on a VAR lag length of 2 and Rank = one (one cointegrating vector is present). There are 500 observations from 1-Aug-2007 to 30-June-2009 (sample period). The VECM used to test cointegration is represented as follows:
$\Delta y_t = a_0 + a_1 t - \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + e_t$ and when tested with an unrestricted Intercept and restricted trend (Model 4) this asserts that $a_0 \neq 0$ and $a_1 = \Pi \gamma$ thus this restriction implies a time trend ((γ_t) being present in the cointegrating relationship/ vector i.e. $\Pi(y_{t-1} - \gamma_t)$ as can be seen a time trend is present in panel B. Thus the variables in the cointegrating vector are Germany, France, UK, Italy, Spain and a time trend. **Panel C**: is based on a VAR lag length of 2 and Rank = one (one cointegrating vector is present). There are 484 observations from 1-July-2009 to 09-May-2011 (sample period). The VECM used to test cointegration is represented as follows: $\Delta y_t = a_0 + a_1 t - \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + e_t$ and when tested with Restricted Intercept and No Trend (Model 2) which asserts that $a_0 = \Pi \mu$ and $a_1 = 0$ thus this restriction implies an intercept (μ) being present in the cointegrating relationship/ vector i.e. $\Pi(y_{t-1} - \mu)$ as can be seen an intercept is present in Panel C. Thus the variables in the cointegrating vector are Germany, France, UK, Italy, Spain and an intercept. **Panel D**: is based on a VAR lag length of 2 and Rank = one (one cointegrating vector is present). There are 484 observations from 1-Jul-2009 to 09-May-2011 (sample period). There are 500 observations in the sample period from 1-august-2007 to 30-june-2009. The VECM used to test cointegration is represented as follows:
$\Delta y_t = a_0 + a_1 t - \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + e_t$ and when tested with an Unrestricted Intercept and No Trend (Model 3) which asserts that $a_0 \neq 0$ and $a_1 = 0$ thus implying a time trend being present in the levels of the times series data but no trend or intercept being present in the cointegrating relationship i.e. Πy_{t-1}. As can be seen no deterministic components exist in Panel A. Thus the variables in the cointegrating vector are Germany, France, the UK, Italy and Spain.

During the GFC period (Panels A and B), the stock markets that have a significant impact on Germany in the long run are the UK and Italy for Panel A at 5% but none are significant for Panel B. Thus, Panel A's result can be interpreted as the UK and Italy are important to the long run cointegrating (equilibrium) relationship during the GFC sample period. The finding that the UK and Italy are significant in the long run cointegrating relationships supports the finding of Masih & Masih (2004) but contradicts the finding of Corhay et al (1993) who finds that Italy is not significant in the long run cointegrating relationship among European stock markets. In contrast, Cheung et al (1999) find that Italy is important and significant to the long run cointegrating relationship contradicting Corhay et al's (1993) finding that Italy is not significant to the long run relationship.

The contradicting results can be attributed to different sample periods used. Furthermore, Corhay et al (1993) have all the five stock markets used in my analysis except for Spain which is replaced with the Netherlands and Cheung et al (1999) only use France, Germany and Italy thus, the contradicting results could be attributed to the different countries used and the difference in the number of countries used too.

The finding that the UK and Italy are significant during the GFC period (Panel A) can be attributed to the close economic and political ties between Germany and the UK and between Germany and Italy in terms of large volumes of trade between them as well as high foreign direct investment flows among the European Union countries (U.S. Deparment of state, 2010), (Federal Foreign Office, 2011) and (European Commission Eurostat, n.d.).

In contrast, Panel B's result implies that none of the stock markets are significant (important) to the long run equilibrium relationship during the GFC sample period. This result contradicts the finding of cointegration among these stock markets because there must be at least one stock market that is important and has a significant effect in the long run equilibrium relationship. Thus during the GFC period the result offered by Panel A is more desirable, more consistent and is in line with the findings of cointegration.

In the post-GFC sample period (Panel C and D), none of the stock markets have a significant impact on Germany and thus, it can be concluded that none of the stock markets are important to the long run equilibrium relationship. This result contradicts the finding of cointegration among the stock markets in the post GFC sample period. There, must be at least one stock market that has a significant effect on the long run equilibrium relationship if cointegration is present. Thus, it can be concluded that in comparison to during the GFC sample period (Panel A), there is a decrease in the stock markets significance (importance) to the long run equilibrium relationship in the post-GFC sample period.

This finding could be attributed to the sovereign debt crisis that began at the end of 2009 and got more severe in 2010 in Europe, more so for Italy and Spain, and this event led to a loss in confidence in the stability of the euro and European debt markets (Financial Stability Review, 2010) which in turn could have led to reduced investments and interaction among the European stock markets.

5.6.3 Long Run Cointegration Vector (European Stock Markets):

Since cointegration is only found in the pre-GFC sample period for the Asian stock markets, the importance of each stock market to the equilibrium relationship is only analysed in the pre GFC sample period with Japan being normalised upon. The results are presented below, with the cointegrating vector being read vertically in column two.

Table 21: Normalised Estimates of Cointegrating Vector Coefficients (Asian Stock Markets)

Panel A: Pre GFC Sample Period (Restricted Intercept and No trend – Model Two)			
Cointegrating Vector Variables	Coefficients	Standard error	Test Statistic
Japan	1.000	NONE	-
China	2.7529	1.8054	1.52481
Intercept	-1749.5	548.4559	3.18986*
Panel B: Pre GFC Sample Period (Unrestricted intercept and No Trend – Model 3)			
Cointegrating Vector	Coefficients	Standard error	Test Statistic

Variables			
Japan	1.000	NONE	-
China	2.7473	1.8001	1.52619

Note: In all Panels, Japan has been normalised upon and this is done by dividing all the coefficients that are part of the cointegrating vector by the coefficient of Japan. * denotes Significance at 5%, critical value = 1.960. The test statistic in the last column of each Panel is calculated by dividing the estimated coefficients by their respective standard errors. **Panel A:** is based on a VAR lag length of 7 and Rank = one (one cointegrating vector is present). There are 1803 observations from 1-september-2000 to 31-July-2007 (sample period). The VECM used to test cointegration is represented as follows: $\Delta y_t = a_0 + a_1 t - \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + e_t$ and when tested with Restricted Intercept and No Trend (Model 2) which asserts that $a_0 = \Pi\mu$ and $a_1 = 0$ thus this restriction implies an intercept (μ) being present in the cointegrating relationship/ vector i.e. $\Pi(y_{t-1} - \mu)$ as can be seen an intercept is present in Panel C. Thus the variables in the cointegrating vector are Japan, China and an intercept. **Panel B:** is based on a VAR lag length of 7 and Rank = one (one cointegrating vector is present). There are 1803 observations from 1-September-2000 to 31-July-2007 (sample period). The VECM used to test cointegration is represented as follows: $\Delta y_t = a_0 + a_1 t - \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + e_t$ and when tested with an Unrestricted Intercept and No Trend (Model 3) which asserts that $a_0 \neq 0$ and $a_1 = 0$ thus implying a time trend being present in the levels of the times series data but no trend or intercept being present in the cointegrating relationship i.e. Πy_{t-1}. As can be seen no deterministic components exist in Panel A. Thus the variables in the cointegrating vector are Japan and China.

In terms of the Asian stock markets when Japan is normalized upon, China has a significant impact on Japan in the long run and is not important to the long run equilibrium relationship in either Panel A or Panel B. This finding of China not being significant contradicts the finding of cointegration between the two stock markets because China is not important or does not have a significant effect to the long run equilibrium relationship.

5.7 Vector Error Correction Model

Even if stock markets are cointegrated in the long run, it can be the case that in the short run there is disequilibrium or the stock prices drift apart. As asserted by Engle & Granger (1987), a cointegrated relationship can be expressed as a Vector Error Correction Model (VECM) that corrects for any short run disequilibrium present among the variables. In each of the sample periods for the cointegrated stock markets, I have assessed whether there has been a change in the stock market that bears the burden of correcting short run disequilibrium back to the long run cointegrating (equilibrium) relationship. The results of the VECM are presented below and I start by analysing the American stock markets, followed by the European stock markets then lastly the Asian stock markets.

The VECM tables are organised in such a way that each Table represents the vector error correction model for a specified dependent variable (highlighted in the first row of each table). Each table consists of columns of estimated lagged coefficients and an error correction term for the sample periods where cointegration is present. Furthermore, R-Squared, adjusted R-Squared and diagnostic test results for serial correlation, Heteroscedasticity and normality of the distributions are enclosed in each of the tables as Panel B. There is a limitation with R-Squared in that it increases as the number of independent variables increase thus the adjusted R-Squared is preferred because it penalises for an increase in the number of independent variables. Thus, the adjusted R-squared is the preferred result though both the R-Squared and adjusted R-Squared values are disclosed to give an idea of the goodness of fit of the Vector Error Correction Models (VECM).

Only a brief overview of the lagged coefficients in the VECM is given because this area is not the focus of this research. The main focus of this study is assessing the significance of the error correction terms and if significant, analysing the size of the coefficients of the error correction terms in order to assess the speed at which the dependent variable adjusts from short run disequilibrium back to the long run cointegrating (equilibrium) relationship.

5.7.1 Vector Error Correction Model (American Stock Markets)

Table 22 shows that lagged values of Brazil do not have a significant impact on the USA in any of the sample periods but lagged values of Canada significantly affect the USA in the pre GFC period and during the GFC but not in the post GFC period. The finding of Brazil not having a significant impact on the USA can be attributed to the fact that Brazil is a developing country that is just starting to increase its influence in the American region and thus, is not as influential an economy as compared to Canada.

Table 23, provides evidence showing that lagged values of the USA do not significantly affect Brazil in the pre and post GFC period but during the GFC period lagged values of the USA significantly affect Brazil. Furthermore lagged values of Canada significantly affect Brazil in the pre GFC period and during the GFC but not in the post GFC. Table 24 shows that lagged values of the USA significantly affect Canada in all sample periods highlighting the high interdependencies between Canada and the USA relative to interdependencies between Brazil and the USA. The finding of some significant lagged coefficients is in line with the finding of cointegration among these stock markets as there must be at least one significant lagged coefficient of the independent variables to tie the cointegrating relationship together or to keep them in equilibrium (Alexander, 2001).

In assessing the significance of the error correction terms for the American stock markets (Tables 22 to 24), in the pre-GFC period the error correction terms for each stock market are significant implying that all three stock markets of the USA, Brazil and Canada do their fair share in correcting any short run disequilibrium so that they are in equilibrium in the long run. In contrast, during the GFC sample period based on both Model Four (unrestricted intercept and restricted trend) and Model five (Unrestricted Intercept and Unrestricted Trend), Canada's error correction term (Table 24) is the only one that is significant implying that during the GFC, Canada is the only stock market that bears the burden of correcting short run disequilibrium.

Table 22: VECM Models for the USA Stock Market as the Dependent Variable

	Dependent Variable (Δ USA)				
Panel A:	Pre – GFC Sample Period	During the GFC Sample Period		Post GFC Sample Period	
Regressors	Unrestricted Intercept and Restricted Trend (Model 4)	Unrestricted Intercept and Restricted trend (Model 4)	Unrestricted Intercept and Unrestricted Trend (Model 5)	Unrestricted Intercept and No Trend (Model 3)	Unrestricted Intercept and Restricted Trend (Model 4)
Intercept	-2.7811 [0.005]*	-1.0969 [.273]	-1.0803 [0.281]	2.5797 [0.010]*	2.1188 [0.035]*
Trend			0.90320 [0.367]		
Δ USA(-1)	-1.0614 [0.289]	-1.0472 [0.296]	-1.0447 [0.297]	-1.6553 [0.099]	-1.9396 [0.053]
Δ USA (-2)	-1.6722 [0.095]	-1.5870 [0.113]	-1.5831 [0.114]		
Δ USA (-3)	-0.026180 [0.979]	1.6080 [0.108]	1.6071 [0.109]		
Δ USA (-4)		-1.6156 [0.107]	-1.6124 [0.108]		
Δ Brazil (-1)	0.080446 [0.936]	1.0781 [0.282]	1.0755 [0.283]	1.0404 [0.299]	1.2353 [0.217]
Δ Brazil (-2)	1.7872 [0.074]	-0.34136 [0.733]	-0.34249 [0.732]		
Δ Brazil (-3)	-0.36113 [0.718]	-1.9125 [0.056]	-1.9107 [0.057]		
Δ Brazil (-4)		-.37653 [0.707]	-0.37742 [0.706]		
Δ Canada (-1)	0.59767 [0.550]	-2.5298 [0.012]*	-2.5273 [0.012]*	0.86548 [0.387]	0.96261 [0.336]
Δ Canada (-2)	-1.9764 [0.048]**	0.81611 [0.415]	0.81545 [0.415]		

Δ Canada (-3)	0.059926 [0.952]	0.23243 [0.816]	0.23256 [0.816]		
Δ Canada (-4)		2.6581 [0.008]*	2.6556 [0.008]*		
Coefficient ECT (-1)	0.0083047 2.8389 [0.005]*	0.035119 1.0233 [0.307]	0.035073 1.0207 [0.308]	-0.074268 -2.437 4 [0.015]*	-0.036638 -1.1854 [0.236]
Panel B: Diagnostic Tests					
R – Squared (R^2)	0.010868	0.077410	0.077412	0.016601	0.025800
Adjusted R – Squared ($\bar{R}^2$)	0.0053571	0.052732	0.050780	0.0083892	0.017664
Serial Correlation $\chi^2(1)$	0.0073135 [0.932]	2.2717 [0.132]	2.2708 [0.132]	1.3552 [0.244]	0.74657 [0.388]
Heteroscedasticity $\chi^2(1)$	8.7341 [0.003]*	22.8193 [0.000]*	22.8443 [0.000]*	7.4092 [0.006]*	11.5677 [0.001]*
Normality $\chi^2(2)$	673.5265 [0.000]*	104.0494 [0.000]*	103.9674 [0.000]*	60.4791 [0.000]*	57.9766 [0.000]*

Note: **Panel A**: Shows the Vector error correction models estimated by OLS with the USA as the dependent variable based on a VAR lag order of 4 in the Pre-GFC period, a lag order of 5 during the GFC period and a lag order of 2 in the post GFC period with the lag orders selected by the AIC. Δ represents the first difference (stock return) of each of the stock markets and the values in brackets () denotes the lag length for the first difference i.e. $\Delta USA(-1)$ is the estimated coefficient for the first difference of USA at lag 1 . The values inside the table are the t-statistics with the p-values in parentheses. * denotes significance at 5%. A general VECM is represented by the following equation:

$\Delta y_t = a_0 + a_1 t - \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + e_t$. Since cointegration is present $\Pi = \alpha * \beta'$

A VECM estimated with **Unrestricted Intercept and No Trend (Model 3)** asserts that $a_0 \neq 0$ and $a_1 = 0$ thus, the VECM is represented as follows:

$\Delta y_t = a_0 - \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + e_t$ implying an intercept being present in the VECM model but no trend or intercept being present in the cointegrating relationship (Πy_{t-1}). A VECM estimated with **Unrestricted Intercept and Restricted Trend (Model 4)** asserts that $a_0 \neq 0$ and $a_1 = \Pi \gamma$ thus the VECM is represented as follows:

$\Delta y_t = a_0 - \alpha\beta'(y_{t-1} - \gamma_t) + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + e_t$ implying an intercept is included in the VECM but the time trend is present (γ_t) in the cointegrating relationship i.e. $\Pi(y_{t-1} - \gamma_t)$.

A VECM estimated with **Unrestricted Intercept and Unrestricted Trend (Model 5)** asserts that $a_0 \neq 0$ and $a_1 \neq 0$ thus a constant and time trend are present in the VECM model but not in the cointegrating relationship of Πy_{t-1}. **Column two** represents the VECM model in the Pre-GFC period using Model 4 (Unrestricted Intercept and Restricted Trend) with USA as the dependent variable and the rows represent the regressors. **Columns three and four** represent the VECM model during the GFC estimated with Model 4 (Unrestricted Intercept and Restricted Trend) and Model 5 (Unrestricted Intercept and Unrestricted Trend), respectively with the USA as the dependent variable. **Columns Five and Six** represents the VECM model in the Post-GFC period using Model Three (Unrestricted Intercept and No Trend) and Model 4 (Unrestricted Intercept and Restricted Trend), respectively with the USA as the dependent variable. The rows represent the regressors present in the VECM models. Any empty cells or rows represent no deterministic components or no coefficients for those lags due to having a shorter lag length with the lag length selected by the AIC. **The last row** represents the error correction terms (α) for each VECM model with USA as the dependent variable in each sample period. The error correction term coefficients are in the top half of the row and the t-statistics with p-values in parentheses are in the bottom half of the row.

Each of the error correction terms are derived from normalising the cointegrating vector on the USA resulting in r (in this case r= 1) error correction terms for each equation.

The Pre GFC error correction term based on Model 4 (Unrestricted Intercept and Restricted Trend) and from normalising the cointegration vector on the USA is represented as follows: **ect = 1.0000*USA -0.13941*BRAZIL -0.76988*CANADA + 0.21424*Trend.**

During the GFC error correction term based on Model 4 (unrestricted Intercept and Restricted Trend) is represented as follows: **ect = 1.0000*USA + 0.61820*BRAZIL - 0.89635*CANADA + 0.39444*Trend.**

During the GFC period the error correction term based on Model 5 (Unrestricted Intercept and Unrestricted Trend) is: **ect = 1.0000*USA + .61844*BRAZIL -.89639*CANADA.**

In the post GFC sample period the error correction term based on Model 3 (Unrestricted Intercept and No Trend) is estimated as: **ect = 1.0000*USA -0.15040*BRAZIL - 0.58971*CANADA**

In the Post GFC Sample period the error correction term based on Model 4 (Unrestricted Intercept and Unrestricted trend)is: **ect = 1.0000*USA -0.13941*BRAZIL - 0.76988*CANADA + 0.21424*Trend**

Panel B: Serial correlation test is a Lagrange Multiplier test of Serial Correlation, the Normality test is based on a test of skewness and kurtosis of residuals, the Heteroscedasticity test is based on the regression of squared residuals on squared fitted values.

Table 23: VECM Models for Brazil as the Dependent Variable

	Dependent Variable (Δ Brazil)				
Panel A:	Pre – GFC Sample Period	During the GFC Sample Period		Post GFC Sample Period	
Regressors	Unrestricted Intercept and Restricted Trend (Model 4)	Unrestricted Intercept and Restricted trend (Model 4)	Unrestricted Intercept and Unrestricted Trend (Model 5)	Unrestricted Intercept and No Trend (Model 3)	Unrestricted Intercept and Restricted Trend (Model 4)
Intercept	-1.4645 [0.143]	-1.5549 [0.121]	-1.4723 [0.142]	1.6262 [0.105]	0.77588 [0.438]
Trend			1.1781 [0.239]		
Δ USA(-1)	0.88671 [0.375]	3.3345 [0.001]*	3.3432 [0.001]*	-0.95956 [0.338]	-1.2912 [0.197]
Δ USA (-2)	-0.94791 [0.343]	-1.6843 [0.093]	-1.6664 [0.096]		
Δ USA (-3)	1.0930 [0.275]	0.74651 [0.456]	0.76179 [0.447]		
Δ USA (-4)		-1.6780 [0.094]	-1.6637 [0.097]		
Δ Brazil (-1)	2.8121 [0.005]*	-2.1844 [0.029]*	-2.1962 [0.029]*	0.39666 [0.692]	0.63827 [0.524]
Δ Brazil (-2)	-0.016342 [0.987]	-0.96329 [0.336]	-0.98274 [0.326]		
Δ Brazil (-3)	-2.9809 [0.003]*	-1.5266 [0.128]	-1.5456 [0.123]		
Δ Brazil (-4)		-1.5039 [0.133]	-1.5197 [0.129]		
Δ Canada (-1)	2.8519 [0.004]*	0.30895 [0.757]	0.30905 [0.757]	1.1255 [0.261]	1.3181 [0.188]
Δ Canada (-2)	-0.90332 [0.366]	2.3964 [0.017]*	2.3985 [0.017]*		
Δ Canada (-3)	2.0164 [0.044]*	-0.22151 [0.825]	-0.21555 [0.829]		

Δ Canada (-4)		3.7102 [0.000]*	3.7148 [0.000]*		
Coefficient ECT (-1)	0.0021720 2.1041 [0.036]**	0.039642 1.5584 [0.120]	0.039396 1.5474 [0.122]	-0.042908 -1.5575 [0.120]	0.8438E-3 0.030261 [0.976]
Panel B: Diagnostic Tests					
R – Squared (R^2)	0.032680	0.089087	0.089606	0.013368	0.0083734
Adjusted R – Squared ($\bar{R}^2$)	0.027291	0.064721	0.063326	0.0051289	0.9264E-4
Serial Correlation $\chi^2(1)$	0.10351 [0.748]	2.1214 [0.145]	2.1098 [0.146]	0.6120E-4 [0.994]	0.11074 [0.739]
Heteroscedasticity $\chi^2(1)$	33.6481 [0.000]*	16.6640 [0.000]*	16.6593 [0.000]*	5.0804 [0.024]*	6.4526 [0.011]*
Normality $\chi^2(2)$	7835.4 [0.000]*	46.3646 [0.000]*	47.7791 [0.000]*	50.0999 [0.000]*	50.6561 [0.000]*

Note: **Panel A:** Shows the Vector error correction models estimated by OLS with Brazil as the dependent variable based on a VAR lag order 4 in the Pre-GFC period, a lag order of 5 during the GFC period and a lag order of 2 in the post GFC period with the lag orders selected by the AIC. Δ represents the first difference (stock return) of each of the stock markets and the values in brackets () denotes the lag length for the first difference i.e. $\Delta USA(-1)$ is the estimated coefficient for the first difference of USA at lag 1 . The values inside the table are the t-statistics with the p-values in parentheses. * denotes significance at 5%. A general VECM is represented by the following equation: $\Delta y_t = a_0 + a_1 t - \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + e_t$. Since cointegration is present $\Pi = \alpha * \beta'$ .A VECM estimated with **Unrestricted Intercept and No Trend (Model 3)** asserts that $a_0 \neq 0$ and $a_1 = 0$ thus, the VECM is represented as follows: $\Delta y_t = a_0 - \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + e_t$ implying an intercept being present in the VECM model but no trend or intercept being present in the cointegrating relationship (Πy_{t-1}).

A VECM estimated with **Unrestricted Intercept and Restricted Trend (Model 4)** asserts that $a_0 \neq 0$ and $a_1 = \Pi \gamma$ thus the VECM is represented as follows: $\Delta y_t = a_0 - \alpha\beta'(y_{t-1} - \gamma_t) + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + e_t$ implying an intercept is included in the VECM but the time trend is present (γ_t) in the cointegrating relationship i.e. $\Pi(y_{t-1} - \gamma_t)$. A VECM estimated with **Unrestricted Intercept and Unrestricted Trend (Model 5)** asserts that $a_0 \neq 0$ and $a_1 \neq 0$ thus a constant and time trend are present in the VECM model but not in the cointegrating relationship of Πy_{t-1}.

Column two represents the VECM model in the Pre-GFC period using Model 4 (Unrestricted Intercept and Restricted Trend) with Brazil as the dependent variable and the rows represent the regressors. **Columns three and four** represent the VECM model during the GFC estimated with Model 4 (Unrestricted Intercept and Restricted Trend) and Model 5 (Unrestricted Intercept and Unrestricted Trend), respectively with the Brazil as the dependent variable. **Columns Five and Six** represents the VECM model in the Post-GFC period using Model Three (Unrestricted Intercept and No Trend) and Model 4 (Unrestricted Intercept and Restricted Trend), with Brazil as the dependent variable. The rows represent the regressors present in the VECM models. Any empty cells or rows represent no deterministic components or no coefficients for those lags due to having a shorter lag length, with the lag length selected by the AIC. The last row represents the error correction terms (α) for each VECM model with Brazil as the dependent variable in each sample period. The **error correction term coefficients** are in the top half of the row and the t-statistics with p-values in parentheses are in the bottom half of the row.

Each of the error correction terms are derived from normalising the cointegrating vector on the USA resulting in r (in this case r= 1) error correction terms for each equation. The Pre GFC error correction term based on Model 4 (Unrestricted Intercept and Restricted Trend) and from normalising the cointegration vector on the USA is represented as follows: **ect = 1.0000*USA - 0.13941*BRAZIL - 0.76988*CANADA + 0 .21424*Trend.**

During the GFC error correction term based on Model 4 (unrestricted Intercept and Restricted Trend) is represented as follows: **ect = 1.0000*USA + 0.61820*BRAZIL - 0.89635*CANADA + 0.39444*Trend.**

During the GFC period the error correction term based on Model 5 (Unrestricted Intercept and Unrestricted Trend) is: **ect = 1.0000*USA + 0 .61844*BRAZIL - 0.89639*CANADA.**

In the post GFC sample period the error correction term based on Model 3 (Unrestricted Intercept and No Trend) is estimated as: **ect = 1.0000*USA - 0.15040*BRAZIL - 0.58971*CANADA**

In the Post GFC Sample period the error correction term based on Model 4 (Unrestricted Intercept and Unrestricted trend)is: **ect = 1.0000*USA - 0.13941*BRAZIL - 0.76988*CANADA + 0.21424*Trend**

Panel B: Serial correlation test is a Lagrange Multiplier test of Serial Correlation, the Normality test is based on a test of skewness and kurtosis of residuals, the Heteroscedasticity test is based on the regression of squared residuals on squared fitted values.

Table 24: VECM Models for Canada as the Dependent Variable

	Dependent Variable (Δ Canada)				
Panel A	Pre – GFC Sample Period	During the GFC Sample Period		Post GFC Sample Period	
Regressors	Unrestricted Intercept and Restricted Trend (Model 4)	Unrestricted Intercept and Restricted trend (Model 4)	Unrestricted Intercept and Unrestricted Trend (Model 5)	Unrestricted Intercept and No Trend (Model 3)	Unrestricted Intercept and Restricted Trend (Model 4)
Intercept	-4.2805 [0.000]*	-4.0300 [0.000]*	-3.9711 [0.000]*	-0.31646 [0.752]	.041275 [0.967]
Trend			3.5542 [0.000]*		
Δ USA(-1)	4.0160 [0.000]*	2.9826 [0.003]*	2.9828 [0.003]*	2.0337 [0.043]*	1.6355 [0.103]
Δ USA (-2)	0.51895 [0.604]	0.011725 [0.991]	0.016826 [0.987]		
Δ USA (-3)	1.9100 [0.056]	0.43910 [0.661]	0.44366 [.657]		
Δ USA (-4)		-1.1641 [0.245]	-1.1586 [0.247]		
Δ Brazil (-1)	3.1912 [0.001]*	-0.40030 [0.689]	-0.40433 [0.686]	0.48333 [0.629]	0.82149 [0.412]
Δ Brazil (-2)	3.0794 [0.002]*	-0.67923 [0.497]	-0.68465 [0.494]		
Δ Brazil (-3)	-2.2112 [0.027]*	-0.43672 [0.663]	-0.44273 [0.658]		
Δ Brazil (-4)		-1.1749 [0.241]	-1.1787 [0.239]		
Δ Canada (-1)	0.035669 [0.972]	-1.5459 [0.123]	-1.5443 [0.123]	-0.58415 [0.559]	-0.17244 [0.863]
Δ Canada (-2)	-3.4101 [0.001]*	0.51637 [0.606]	0.51693 [0.605]		
Δ Canada (-3)	1.5615 [0.119]	0.59570 [0.552]	0.59675 [0.551]		

Δ Canada (-4)		3.1211 [0.002]*	3.1199 [0.002]*		
Coefficient ECT (-1)	0.010883 4.8349 [0.000]*	0.17462 4.0194 [0.000]*	0.17448 4.0116 [0.000]*	-0.020574 0.43399 [0.664]	0.13071 2.7518 [0.006]*
Panel B: Diagnostic Tests					
R – Squared (R^2)	0.057269	0.098953	0.098996	0 .013368	0.035823
Adjusted R – Squared ($\bar{R}^2$)	0.052017	0.074851	0.072988	0.0051289	0.027772
Serial Correlation $\chi^2(1)$	2.1573 [0.142]	1.6595 [0.198]	1.6595 [0.198]	0.6120E-4 [0.994]	0.033807 [0.854]
Heteroscedasticity $\chi^2(1)$	29.2264 [0.000]*	21.7807 [0.000]*	21.9261 [0.000]*	5.0804 [0.024]*	2.9515 [0.086]
Normality $\chi^2(2)$	799.0999 [0.000]*	32.1806 [0.000]*	31.9794 [0.000]*	50.0999 [0.000]*	7.3727 [0.025]*

Note: **Panel A:** Shows the Vector error correction models estimated by OLS with Canada as the dependent variable based on a VAR lag order 4 in the Pre-GFC period, a lag order of 5 during the GFC period and a lag order of 2 in the post GFC period with the lag orders selected by the AIC. Δ represents the first difference (stock return) of each of the stock markets and the values in brackets () denotes the lag length for the first difference i.e. $\Delta USA(-1)$ is the estimated coefficient for the first difference of USA at lag 1 . The values inside the table are the t-statistics with the p-values in parentheses. * denotes significance at 5%. A general VECM is represented by the following equation: $\Delta y_t = a_0 + a_1 t - \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + e_t$. Since cointegration is present $\Pi = \alpha * \beta'$ .A VECM estimated with **Unrestricted Intercept and No Trend (Model 3)** asserts that $a_0 \neq 0$ and $a_1 = 0$ thus, the VECM is represented as follows: $\Delta y_t = a_0 - \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + e_t$ implying an intercept being present in the VECM model but no trend or intercept being present in the cointegrating relationship (Πy_{t-1}). A VECM estimated with **Unrestricted Intercept and Restricted Trend (Model 4)** asserts that $a_0 \neq 0$ and $a_1 = \Pi \gamma$ thus the VECM is represented as follows: $\Delta y_t = a_0 - \alpha\beta'(y_{t-1} - \gamma_t) + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + e_t$ implying an intercept is included in the VECM but the time trend is present (γ_t) in the cointegrating relationship i.e. $\Pi(y_{t-1} - \gamma_t)$. A VECM estimated with **Unrestricted Intercept and Unrestricted Trend (Model 5)** asserts that $a_0 \neq 0$ and $a_1 \neq 0$ thus a constant and time trend are present in the VECM model but not in the cointegrating relationship of Πy_{t-1}.

Column two represents the VECM model in the Pre-GFC period using Model 4 (Unrestricted Intercept and Restricted Trend) with Canada as the dependent variable and the rows represent the regressors. **Columns three and four** represent the VECM model during the GFC estimated with Model 4 (Unrestricted Intercept and Restricted Trend) and Model 5 (Unrestricted Intercept and Unrestricted Trend), respectively with Canada as the dependent variable. **Columns Five and Six** represents the VECM model in the Post-GFC period using Model Three (Unrestricted Intercept and No Trend) and Model 4 (Unrestricted Intercept and Restricted Trend), respectively with the Canada as the dependent variable. The rows represent the regressors present in the VECM models. Any empty cells or rows represent no deterministic components or no coefficients for those lags due to having a shorter lag length with the lag length selected by the AIC. The last row represents the error correction terms (α) for each VECM model with Canada as the dependent variable in each sample period based on each Model used. The **error correction term coefficients** are in the top half of the row and the t-statistics with p-values in parentheses are in the bottom half of the row. Each of the error correction terms are derived from normalising the cointegrating vector on the USA resulting in r (in this case r= 1) error correction terms for each equation.

The Pre GFC error correction term based on Model 4 (Unrestricted Intercept and Restricted Trend) and from normalising the cointegration vector on the USA is represented as follows: **ect = 1.0000*USA - 0.13941*BRAZIL - 0.76988*CANADA + 0.21424*Trend.**

During the GFC error correction term based on Model 4 (unrestricted Intercept and Restricted Trend) is represented as follows: **ect = 1.0000*USA + 0.61820*BRAZIL - 0.89635*CANADA + 0.39444*Trend.**

During the GFC period the error correction term based on Model 5 (Unrestricted Intercept and Unrestricted Trend) is: **ect = 1.0000*USA + 0 .61844*BRAZIL - 0.89639*CANADA.**

In the post GFC sample period the error correction term based on Model 3 (Unrestricted Intercept and No Trend) is estimated as: **ect = 1.0000*USA -.15040*BRAZIL - .58971*CANADA**

In the Post GFC Sample period the error correction term based on Model 4 (Unrestricted Intercept and Unrestricted trend)is: **ect = 1.0000*USA - 0.13941*BRAZIL - 0.76988*CANADA + 0.21424*Trend**

Panel B: Serial correlation test is a Lagrange Multiplier test of Serial Correlation, the Normality test is based on a test of skewness and kurtosis of residuals, the Heteroscedasticity test is based on the regression of squared residuals on squared fitted values.

Thus, the number of stock markets that correct short run disequilibrium decreased during the GFC in comparison to the Pre GFC sample period. In the post-GFC period, using Model 4 (Unrestricted Intercept and Restricted Trend), Canada (Table 24) is the only stock market that bears the burden of adjusting back to the long run equilibrium from short run disequilibrium. This finding implies that Canada consistently adjusts (corrects) any short run disequilibrium in all sample periods.

However, the result provided by Model 3 (Unrestricted Intercept and No trend) in the post-GFC period suggests otherwise and shows that the USA (Table 22) is the only stock market that bears the burden of correcting short run disequilibrium. Thus comparing this result to the Pre GFC sample period result, the evidence shows that the number of stock markets that correct for any short run disequilibrium has decreased. However, when the post GFC result is compared to the finding during the GFC, the results show that the stock market that bears the burden of adjusting short run disequilibrium has changed from Canada during the GFC to USA in the post GFC sample period.

In terms of the speed of adjustment of the American stock markets back to the long run equilibrium relationship, all the stock markets in the pre-GFC period adjust back to the long run equilibrium very slowly with Canada having the fastest adjustment speed of 0.010883 (Table 24) as compared to the USA (0.0083047 – Table 22) and Brazil (0.0021720 – Table 23). In contrast, during the GFC period Canada's (Table 24) adjustment speed increases to 0.17462 in Model 5 (Unrestricted Intercept and Restricted Trend) and 0.17448 in Model 5 (Unrestricted intercept and Unrestricted Trend) implying that the speed of adjustment during the GFC is quicker than the pre-GFC speed of adjustment.

This is also the case in the post-GFC period regarding Model 4 (Unrestricted Intercept and Restricted trend) in which Canada's speed of adjustment (0.13071) back to the long run equilibrium relationship is faster than in the pre-GFC period but slower than during the GFC sample period. If the speed of adjustment is assessed based on Model 3 (Unrestricted Intercept and No Trend) in the post GFC period, the USA's (Table 22) speed of adjustment (-0.074268) back to the long run equilibrium relationship is faster than its speed of adjustment in the Pre-GFC sample period of 0.0083047.

These results generally show that during the GFC, the speed of adjustment of the stock markets is the quickest as compared to the pre GFC and post GFC sample periods. In context to the post GFC period and Canada bearing the burden of adjustment, the results highlight that Canada's speed of adjustment in the post GFC sample period is faster than the speed of adjustment in the pre GFC period but slower than the speed of adjustment during the GFC. Thus, it can be concluded that there is a temporary increase in the speed of adjustment during the GFC sample period.

Assessing the diagnostic tests in the Pre GFC period for each ECM model in the American stock markets (Tables 22 to 24), all the adjusted R-Squared values are very low with the highest being that of Canada at 5.297% (5.7269 R-Squared). This result implies that none of the ECM models are a good model of fit and only a small amount of variation in the regressors in each ECM model explains variation in the dependent stock markets. The adjusted R-Squared for each error correction model increases during the GFC but are still in the low range with the highest being 7.4851% (9.8953% R-Squared) for Canada using Model 4 and 7.2988% (9.98996% R-Squared) using Model 3.

None of the error correction models have serial correlation present at 5% in all sample periods but the Heteroscedasticity problem exists for all the error correction models at 5% in all sample periods, with the exception of Canada's ECM in the post GFC period (p-value being 0.086) using Model 4. When White's Heteroscedasticity adjusted test is used, I find that the OLS standard errors are much lower than when the standard errors are adjusted for Heteroscedasticity, implying the OLS standard errors are better to be used.

For all error correction models there is evidence of non-normally distributed returns supporting Fama's (1965) finding of stock returns being non-normally distributed. The problem of Heteroscedasticity could be caused by the presence of outliers in my data set as well as skewness of the regressors (in this case the first differences) and as can be seen in the summary statistics (Table 2) the stock returns are skewed either to the right or to the left.

5.7.2 Vector Error Correction Model (European Stock markets)

Assessing the lagged coefficients in the VECM, Table 25 shows that Germany is not significantly affected by lagged values of any of the stock markets in any of the sample periods. Table 26 in turn provides results showing the France is significantly affected by lagged values of Germany and Spain with Germany significantly affecting France in both sample periods while Spain only does so in the post GFC period. Furthermore Table 27 shows that the UK is significantly affected by lagged values of Germany during and post the GFC but no other lagged values significantly affect the UK. Table 28 shows that lagged values of Germany and Spain both have a significant impact on Italy and Table 29 shows that Germany and France significantly affects Spain with Germany having a significant effect during the GFC and post the GFC while Spain only significantly impacts France in the post GFC.

A very noticeable result from this analysis is that lagged values of Germany have a significant impact on all the stock markets during and post the GFC except for Italy in the post GFC period but none of the stock markets significantly impacts Germany. This result provides evidence to show that Germany is the most influential stock market among the European stock markets but is not influenced by any other stock markets.

Furthermore, there appears not to be any significant influence by the other stock markets on each individual stock market with the only countries that influence each other (have feedback) being Spain and France with lagged values of Spain having a significant impact on France in the post GFC and vice-versa. This result implies that France and Spain became more influential on each other in the post GFC period. Since no cointegration exists among the European stock markets in the pre-GFC period, the Vector Error Correction Model is only analysed during and post the GFC because cointegration is present among the European stock markets during those sample periods.

During the GFC sample period the only error correction term that is significant is the UK's (Table 27) using both Model 3 (Unrestricted Intercept and No Trend) and Model 4 (Unrestricted Intercept and Restricted Trend) implying that the UK is the only stock market that bears the burden of adjusting any short run disequilibrium during the GFC. As for the post-GFC period, none of the error correction terms are significant in either Model 2 (Restricted Intercept and No Trend) or 3 (Unrestricted Intercept and No Trend) implying that no countries bear the burden of adjusting short run disequilibrium in the post GFC sample period. This result contradicts the finding of cointegration among the European stock markets in the post GFC sample period because if cointegration exists, at least one of the stock markets has to keep the cointegrated stock markets in equilibrium and in step by adjusting short run disequilibrium.

In terms of the speed of adjustment back to the long run equilibrium relationship during the GFC sample period, the UK (Table 27) adjusts any short run disequilibrium at a slow rate in both Model 3(0.012189) and Model 4 (0.042746).

The adjusted R-Squared values for the error correction models for the European stock markets are very low during and post the GFC. The highest adjusted R-Squared being 6.1177% (7.2466% R-Squared) for UK error correction model during the GFC using Model 3 and 5.8690% (7.0009% R-Squared) using Model 4. This implies that the models are not good models of fit and only a small amount of variation in the independent variables explains the variation of the dependent variables. In regards to serial correlation, Germany does not have serial correlation present during the GFC and in the post GFC .In contrast, France, the UK, Italy and Spain all have serial correlation present using both Model 3 and 4 during the GFC sample period but none present in the post GFC sample period in either Model 2 or 3. Thus, the lag length selected by the AIC in the pre GFC period for the European stock markets was not sufficient to get rid of serial correlation in all the stock markets.

With regards to Heteroscedasticity, all error correction models estimated using Model 4 have the presence of Heteroscedasticity at 5% during the GFC. The error correction models estimated using Model 3 during the GFC shows the presence of Heteroscedasticity in all the

Table 25: VECM Models for Germany Stock Market as the Dependent Variable

	Dependent Variable (Δ Germany)			
Panel A:	During the GFC Sample Period		Post GFC Sample Period	
Regressors	Unrestricted Intercept and No Trend (Model 3)	Unrestricted Intercept and Restricted Trend (Model 4)	Restricted Intercept and No Trend (Model 2)	Unrestricted Intercept and No Trend (Model 3)
Intercept	-0.89866 [0.369]	-1.4898 [0.137]		
Trend				
Δ Germany(-1)	1.8204 [0.069]	1.8188 [0.070]	1.4118 [0.159]	1.3526 [0.177]
Δ France (-1)	-0.77044 [0.441]	-0.79336 [0.428]	-0.65980 [0.510]	-0.68431 [0.494]
Δ UK (-1)	-0.27372 [0.784]	-0.28313 [0.777]	-1.1389 [0.255]	1.1625 [0.246]
Δ Italy (-1)	-0.11423 [0.909]	-0.054179 [0.957]	-0.67046 [0.503]	-0.61952 [0.536]
Δ Spain (-1)	-0.21069 [0.833]	-0.23231 [0.816]	1.5380 [0.125]	1.5777 [0.115]
Coefficient ECT (-1)	-0.012189 -0.61350 [0.540]	-0.010315 -0.78574 [0.432]	0.3638E-3 0.29053 [0.772]	0.3523E-3 0.27843 [0.781]
Panel B: Diagnostic Tests				
R – Squared (R^2)	0.016644	0.017124	0.0090224	0.012030
Adjusted R – Squared ($\bar{R}^2$)	0.0046763	0.0051623	-0.0013435	-0.3973E-3
Serial Correlation $\chi^2(1)$	0.12324 [0.726]	0.092246 [0.761]	0.6891E-4 [0.993]	0.0037749 [0.951]

Heteroscedasticity $\chi^2(1)$	13.1212[.000]*	14.4886[.000]*	0.84431 [0.358]	0.080402 [0.777]
Normality $\chi^2(2)$	461.1673[.000]*	455.5400[.000]*	3.1769 [0.204]	3.5464 [0.170]

Note: **Panel A:** Shows the Vector error correction models estimated by OLS with Germany as the dependent variable based on a VAR lag order 2 during the GFC period and a lag order of 2 in the post GFC period with the lag orders selected by the AIC. Δ represents the first difference (stock return) of each of the stock markets and the values in brackets () denotes the lag length for the first difference i.e. $\Delta Germany(-1)$ is the estimated coefficient for the first difference of Germany at lag 1 . The values inside the table are the t-statistics with the p-values in parentheses. * denotes significance at 5%. A general VECM is represented by the following equation:

$\Delta y_t = a_0 + a_1 t - \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + e_t$. Since cointegration is present $\Pi = \alpha * \beta'$ A VECM estimated with **Restricted Intercept and No Trend (Model 2)** asserts that $a_0 = \Pi\mu$ and $a_1 = 0$ thus the VECM is represented as follows: $\Delta y_t = -\Pi(y_{t-1} - \mu) + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + e_t$ implying a no trend being present in the levels of the times series data but an intercept (μ) being present in the cointegrating relationship/ vector i.e. $\Pi(y_{t-1} - \mu)$.A VECM estimated with **Unrestricted Intercept and No Trend (Model 3)** asserts that $a_0 \neq 0$ and $a_1 = 0$ thus, the VECM is represented as follows: $\Delta y_t = a_0 - \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + e_t$ implying an intercept being present in the VECM model but no trend or intercept being present in the cointegrating relationship (Πy_{t-1}).A VECM estimated with **Unrestricted Intercept and Restricted Trend (Model 4)** asserts that $a_0 \neq 0$ and $a_1 = \Pi\gamma$ thus the VECM is represented as follows: $\Delta y_t = a_0 - \alpha\beta'(y_{t-1} - \gamma_t) + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + e_t$ implying an intercept is included in the VECM but the time trend is present (γ_t) in the cointegrating relationship i.e. $\Pi(y_{t-1} - \gamma_t)$.

Column two to three represent the VECM model during the GFC period estimated using Model 3 (Unrestricted Intercept and No Trend) and Model 4 (Unrestricted Intercept and Restricted Trend) with Germany as the dependent variable and the rows representing the regressors. **Columns three and four** represent the VECM model in the post GFC period estimated with Model 2 (Restricted Intercept and No Trend) and Model 3 (Unrestricted Intercept and No Trend), respectively with the Germany as the dependent variable. The rows represent the regressors present in the VECM models. Any empty cells or rows represent no deterministic components present or no coefficients for those lags exist due to having a shorter lag length with the lag length selected by the AIC. The last row represents the error correction terms (α) for each VECM model with Germany as the dependent variable in each sample period. The **error correction term coefficients** are in the top half of the row and the t-statistics with p-values in parentheses are in the bottom half of the row.

Each of the error correction terms are derived from normalising the cointegrating vector on Germany resulting in r (in this case r= 1) error correction terms for each equation. During the GFC error correction term based on Model 3 (Unrestricted Intercept and No Trend) is represented as follows: **ect =1.0000*GERMANY - 0.96625*FRANCE - 1.1580*UK + 3.8853*ITALY - 1.2876*SPAIN.**

During the GFC period the error correction term based on Model 4 (Unrestricted Intercept and Restricted Trend) is: **ect = 1.0000*GERMANY - 1.1797*FRANCE - 1.8473*UK + 6.6881*ITALY - 2.1792*SPAIN + 0 .65227*Trend**

In the post GFC sample period the error correction term based on Model 2 (Restricted Intercept and No Trend) is estimated as: **ect = 1.0000*GERMANY + 39.3459*FRANCE - 17.8585*UK - 79.7158*ITALY + 26.3916*SPAIN + 7657.9**
In the Post GFC Sample period the error correction term based on Model 3 (Unrestricted Intercept and No trend)is: **ect = 1.0000*GERMANY + 38.9195*FRANCE - 17.6753*UK - 78.7978*ITALY + 26.0243*SPAIN**
Panel B: Serial correlation test is a Lagrange Multiplier test of Serial Correlation, the Normality test is based on a test of skewness and kurtosis of residuals, the Heteroscedasticity test is based on the regression of squared residuals on squared fitted values.

Table 26: VECM Models for France Stock Market as the Dependent Variable

	Dependent Variable (Δ France)			
Panel A:	During the GFC Sample Period		Post GFC Sample Period	
Regressors	Unrestricted Intercept and No Trend (Model 3)	Unrestricted Intercept and Restricted Trend (Model 4)	Restricted Intercept and No Trend (Model 2)	Unrestricted Intercept and No Trend (Model 3)
Intercept	0.23563 [0.814]	-1.0236 [0.307]		
Trend				
Δ Germany(-1)	4.9689 [0.000]*	5.0671 [0.000]*	2.1126 [0.035]*	1.3526 [0.177]
Δ France (-1)	-0.65449 [0.513]	-0.70136 [0.483]	-1.9514 [0.052]	-.68431 [0.494]
Δ UK (-1)	-0.072873 [0.942]	-0.10784 [0.914]	-1.2843 [0.200]	1.1625 [0.246]
Δ Italy (-1)	-0.76252 [0.446]	-0.65545 [0.512]	-.18127 [0.856]	-.61952 [0.536]
Δ Spain (-1)	-1.1611 [0.246]	-1.2462 [0.213]	2.3278 [0.020]*	1.5777 [0.115]
Coefficient ECT (-1)	0.016057 0.58440 [0.559]	0.7772E-3 0.042784 [0.966]	-0.0012284 -0.68847 [0.491]	0.3523E-3 0.27843 [0.781]

Panel B: Diagnostic Tests				
R – Squared (R^2)	0.054524	0.053872	0.023586	0.025553
Adjusted R – Squared ($\bar{R}^2$)	0.043017	0.042358	0.013373	0.013295
Serial Correlation $\chi^2(1)$	6.0245 [0.014]*	6.1325 [0.013]*	0.22762 [0.633]	0.27981 [0.597]
Heteroscedasticity $\chi^2(1)$	3.8396 [0.050]	4.3876 [0.036]*	22.6480 [0.000]*	23.2590 [0.000]*
Normality $\chi^2(2)$	166.5088 [0.000]*	168.3297 [0.000]*	22.1655 [0.000]*	21.4655 [0.000]*

Note: **Panel A:** Shows the Vector error correction models estimated by OLS with the France as the dependent variable based on a VAR lag order 2 during the GFC period and a lag order of 2 in the post GFC period with the lag orders selected by the AIC. Δ represents the first difference (stock return) of each of the stock markets and the values in brackets () denotes the lag length for the first difference i.e. $\Delta Germany(-1)$ is the estimated coefficient for the first difference of Germany at lag 1 . The values inside the table are the t-statistics with the p-values in parentheses. * denotes significance at 5%. A general VECM is represented by the following equation: $\Delta y_t = a_0 + a_1 t - \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + e_t$. Since cointegration is present $\Pi = \alpha * \beta'$ A VECM estimated with **Restricted Intercept and No Trend (Model 2)** asserts that $a_0 = \Pi\mu$ and $a_1 = 0$ thus the VECM is represented as follows: $\Delta y_t = -\Pi(y_{t-1} - \mu) + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + e_t$ implying a no trend being present in the levels of the times series data but an intercept (μ) being present in the cointegrating relationship/ vector i.e. $\Pi(y_{t-1} - \mu)$. A VECM estimated with **Unrestricted Intercept and No Trend (Model 3)** asserts that $a_0 \neq 0$ and $a_1 = 0$ thus, the VECM is represented as follows: $\Delta y_t = a_0 - \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + e_t$ implying an intercept being present in the VECM model but no trend or intercept being present in the cointegrating relationship (Πy_{t-1}).A VECM estimated with **Unrestricted Intercept and Restricted Trend (Model 4)** asserts that $a_0 \neq 0$ and $a_1 = \Pi\gamma$ thus the VECM is represented as follows: $\Delta y_t = a_0 - \alpha\beta'(y_{t-1} - \gamma_t) + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + e_t$ implying an intercept is included in the VECM but the time trend is present (γ_t) in the cointegrating relationship i.e. $\Pi(y_{t-1} - \gamma_t)$.**Column two to three** represent the VECM model during the GFC period estimated using Model 3 (Unrestricted Intercept and No Trend) and Model 4 (Unrestricted Intercept and Restricted Trend) with France as the dependent variable and the rows representing the regressors. **Columns three and four** represent the VECM model in the post GFC period estimated with Model 2 (Restricted Intercept and No Trend) and Model 3 (Unrestricted Intercept and No Trend), respectively with the France as the dependent variable. The rows

represent the regressors present in the VECM models. Any empty cells or rows represent no deterministic components present or no coefficients for those lags exist due to having a shorter lag length with the lag length selected by the AIC. The last row represents the error correction terms (α) for each VECM model with France as the dependent variable in each sample period. The **error correction term coefficients** are in the top half of the row and the t-statistics with p-values in parentheses are in the bottom half of the row.
Each of the error correction terms are derived from normalising the cointegrating vector on Germany resulting in r (in this case r= 1) error correction terms for each equation.
During the GFC error correction term based on Model 3 (Unrestricted Intercept and No Trend) is represented as follows: **ect =1.0000*GERMANY - 0.96625*FRANCE -1.1580*UK + 3.8853*ITALY - 1.2876*SPAIN.**
During the GFC period the error correction term based on Model 4 (Unrestricted Intercept and Restricted Trend) is: **ect = 1.0000*GERMANY - 1.1797*FRANCE - 1.8473*UK + 6.6881*ITALY - 2.1792*SPAIN + 0.65227*Trend**
In the post GFC sample period the error correction term based on Model 2 (Restricted Intercept and No Trend) is estimated as: **ect = 1.0000*GERMANY + 39.3459*FRANCE -17.8585*UK - 79.7158*ITALY + 26.3916*SPAIN + 7657.9**
In the Post GFC Sample period the error correction term based on Model 3 (Unrestricted Intercept and No trend)is: **ect = 1.0000*GERMANY + 38.9195*FRANCE - 17.6753*UK - 78.7978*ITALY + 26.0243*SPAIN**
Panel B: Serial correlation test is a Lagrange Multiplier test of Serial Correlation, the Normality test is based on a test of skewness and kurtosis of residuals, the Heteroscedasticity test is based on the regression of squared residuals on squared fitted values.

Table 27: VECM Models for the UK Stock Market as the Dependent Variable

	Dependent Variable (Δ UK)			
Panel A:	During the GFC Sample Period		Post GFC Sample Period	
Regressors	Unrestricted Intercept and No Trend (Model 3)	Unrestricted Intercept and Restricted Trend (Model 4)	Restricted Intercept and No Trend (Model 2)	Unrestricted Intercept and No Trend (Model 3)
Intercept	1.9080 [0.057]	0.28110 [0.779]		
Δ Germany(-1)	4.9967 [0.000]*	5.1439 [0.000]*	2.2529 [0.025]*	2.1991 [0.028]*
Δ France (-1)	-0.53282 [0.594]	-0.53751 [0.591]	-1.4781 [0.140]	-1.4996 [0.134]
Δ UK (-1)	-0.81309 [0.417]	-0.83611 [9.403]	-0.82414 [0.410]	-0.84456 [0.399]
Δ Italy (-1)	-0.87214 [0.384]	-0.87562 [0.382]	-0.35044 [0.726]	-0.30539 [0.760]
Δ Spain (-1)	-0.72101 [0.471]	-0.78125 [0.435]	0.98959 [0.323]	1.0244 [0.306]

Coefficient ECT (-1)	0.074369 2.3152 [0.021]*	0.042746 2.0108 [0.045]*	0.7648E-3 0.41590 [0.678]	0.7543E-3 0.40582 [0.685]
Panel B: Diagnostic Tests				
R – Squared (R^2)	0.072466	0.070009	0.011413	0.013755
Adjusted R – Squared ($\bar{R}^2$)	0.061177	0.058690	0.0010720	0.0013489
Serial Correlation $\chi^2(1)$	5.3935 [0.020]*	5.9195[0.015]*	1.8476 [0.174]	1.6556 [0.198]
Heteroscedasticity $\chi^2(1)$	8.7853 [0.003]*	12.2146 [0.000]*	4.3575 [0.037]*	9.2175 [0.002]*
Normality $\chi^2(2)$	57.7842 [0.000]*	59.7759 [0.000]*	23.3721 [0.000]*	24.2365 [0.000]*

Note: **Panel A**: Shows the Vector error correction models estimated by OLS with the UK as the dependent variable based on a VAR lag order 2 during the GFC period and a lag order of 2 in the post GFC period with the lag orders selected by the AIC. Δ represents the first difference (stock return) of each of the stock markets and the values in brackets () denotes the lag length for the first difference i.e. $\Delta Germany(-1)$ is the estimated coefficient for the first difference of Germany at lag 1 . The values inside the table are the t-statistics with the p-values in parentheses. * denotes significance at 5%. A general VECM is represented by the following equation: $\Delta y_t = a_0 + a_1 t - \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + e_t$. Since cointegration is present $\Pi = \alpha * \beta'$ A VECM estimated with **Restricted Intercept and No Trend (Model 2)** asserts that $a_0 = \Pi\mu$ and $a_1 = 0$ thus the VECM is represented as follows: $\Delta y_t = -\Pi(y_{t-1} - \mu) + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + e_t$ implying a no trend being present in the levels of the times series data but an intercept (μ) being present in the cointegrating relationship/ vector i.e. $\Pi(y_{t-1} - \mu)$ .A VECM estimated with **Unrestricted Intercept and No Trend (Model 3)** asserts that $a_0 \neq 0$ and $a_1 = 0$ thus, the VECM is represented as follows: $\Delta y_t = a_0 - \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + e_t$ implying an intercept being present in the VECM model but no trend or intercept being present in the cointegrating relationship (Πy_{t-1}). A VECM estimated with **Unrestricted Intercept and Restricted Trend (Model 4)** asserts that $a_0 \neq 0$ and $a_1 = \Pi\gamma$ thus the VECM is represented as follows: $\Delta y_t = a_0 - \alpha\beta'(y_{t-1} - \gamma_t) + \sum_{i=1}^{p-1}\Gamma_i \Delta y_{t-i} + e_t$ implying an intercept is included in the VECM but the time trend is present (γ_t) in the cointegrating relationship i.e. $\Pi(y_{t-1} - \gamma_t)$. **Column two to three** represent the VECM model during the GFC period estimated using Model 3 (Unrestricted Intercept and No Trend) and Model 4 (Unrestricted Intercept and Restricted Trend) with the UK as the dependent variable and the rows representing the regressors. **Columns four and five** represent the VECM model in the post GFC period estimated with Model 2 (Restricted Intercept and No Trend) and Model 3 (Unrestricted Intercept and No Trend), respectively with the UK as the dependent variable. The rows represent the regressors present in the VECM models. Any empty cells or rows represent no deterministic components present or no coefficients for those lags exist due to having a shorter lag length with the lag length selected by the AIC. The last row represents the error correction terms (α) for each VECM model with the UK as the dependent variable in each sample period based on each Model used. The **error correction term coefficients** are in the top half of the row and the t-statistics with p-values in parentheses are in the bottom half of the row.

Each of the error correction terms are derived from normalising the cointegrating vector on Germany resulting in r (in this case r= 1) error correction terms for each equation.

During the GFC error correction term based on Model 3 (Unrestricted Intercept and No Trend) is represented as follows: **ect =1.0000*GERMANY - 0.96625*FRANCE - 1.1580*UK + 3.8853*ITALY - 1.2876*SPAIN.**

During the GFC period the error correction term based on Model 4 (Unrestricted Intercept and Restricted Trend) is: **ect = 1.0000*GERMANY - 1.1797*FRANCE - 1.8473*UK + 6.6881*ITALY - 2.1792*SPAIN + 0.65227*Trend**

In the post GFC sample period the error correction term based on Model 2 (Restricted Intercept and No Trend) is estimated as: **ect = 1.0000*GERMANY + 39.3459*FRANCE - 17.8585*UK - 79.7158*ITALY + 26.3916*SPAIN + 7657.9**

In the Post GFC Sample period the error correction term based on Model 3 (Unrestricted Intercept and No trend)is: **ect = 1.0000*GERMANY + 38.9195*FRANCE - 17.6753*UK - 78.7978*ITALY + 26.0243*SPAIN**

Panel B: Serial correlation test is a Lagrange Multiplier test of Serial Correlation, the Normality test is based on a test of skewness and kurtosis of residuals, the Heteroscedasticity test is based on the regression of squared residuals on squared fitted values.

Table 28: VECM Models for Italy Stock Market as the Dependent Variable

	Dependent Variable (Δ Italy)			
Panel A	During the GFC Sample Period		Post GFC Sample Period	
Regressors	Unrestricted Intercept and No Trend (Model 3)	Unrestricted Intercept and Restricted Trend (Model 4)	Restricted Intercept and No Trend (Model 2)	Unrestricted Intercept and No Trend (Model 3)
Intercept	-0.42337 [0.672]	-1.6130 [0.107]		
Δ Germany(-1)	4.4941 [0.000]*	4.5632 [0.000]*	1.6435 [0.101]	1.6152 [0.107]

Δ France (-1)	-0.073379 [0.942]	-0.12439 [0.901]	-1.5314 [0.126]	-1.5403 [0.124]
Δ UK (-1)	-0.92727 [0.354]	-0.95935 [0.338]	-1.0063 [0.315]	-1.0156 [0.310]
Δ Italy (-1)	-0.59985 [0.549]	-0.48048 [0.631]	-0.53812 [0.591]	-0.51547 [0.606]
Δ Spain (-1)	-1.0475 [0.295]	-1.1245 [0.261]	2.3827 [0.018]*	2.3967 [0.017]*
Coefficient ECT (-1)	-0.3572E-3 -0.030911 [0.975]	-0.041340 -0.54146 [0.588]	0.2031E-3 0.28797 [0.773]	0.2008E-3 0.28150 [0.778]
Panel B: Diagnostic Tests				
R – Squared (R^2)	0.043523	0.044090	0.019136	0.019692
Adjusted R – Squared ($\bar{R}^2$)	0.031882	0.032456	0.0088759	0.0073609
Serial Correlation $\chi^2(1)$	4.6995 [0.030]*	4.6488 [0.031]*	0.90746 [0.341	.94385 [0.331]
Heteroscedasticity $\chi^2(1)$	6.5462 [0.011]*	6.8403 [0.009]*	21.0533 [0.000]	22.1550 [0.000]*
Normality $\chi^2(2)$	93.6739 [0.000]*	94.7393 [0.000]*	37.3276 [0.000]	37.3856 [0.000]*

Note: **Panel A**: Shows the Vector error correction models estimated by OLS with the Italy as the dependent variable based on a VAR lag order 2 during the GFC period and a lag order of 2 in the post GFC period with the lag orders selected by the AIC. Δ represents the first difference (stock return) of each of the stock markets and the values in brackets () denotes the lag length for the first difference i.e. $\Delta Germany(-1)$ is the estimated coefficient for the first difference of Germany at lag 1 . The values inside the table are the t-statistics with the p-values in parentheses. * denotes significance at 5%. A general VECM is represented by the following equation: $\Delta y_t = a_0 + a_1 t - \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + e_t$. Since cointegration is present $\Pi = \alpha * \beta'$ A VECM estimated with **Restricted Intercept and No Trend (Model 2)** asserts that $a_0 = \Pi\mu$ and $a_1 = 0$ thus the VECM is represented as follows: $\Delta y_t = -\Pi(y_{t-1} - \mu) + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + e_t$ implying a no trend being present in the levels of the times series data but an intercept (μ) being present in the cointegrating relationship/ vector i.e. $\Pi(y_{t-1} - \mu)$.A VECM estimated with **Unrestricted Intercept and No Trend**

(Model 3) asserts that $a_0 \neq 0$ and $a_1 = 0$ thus, the VECM is represented as follows: $\Delta y_t = a_0 - \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + e_t$ implying an intercept being present in the VECM model but no trend or intercept being present in the cointegrating relationship (Πy_{t-1}). A VECM estimated with **Unrestricted Intercept and Restricted Trend (Model 4)** asserts that $a_0 \neq 0$ and $a_1 = \Pi \gamma$ thus the VECM is represented as follows: $\Delta y_t = a_0 - \alpha \beta^{'} (y_{t-1} - \gamma_t) + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + e_t$ implying an intercept is included in the VECM but the time trend is present (γ_t) in the cointegrating relationship i.e. $\Pi(y_{t-1} - \gamma_t)$.

Column two to three represent the VECM model during the GFC period estimated using Model 3 (Unrestricted Intercept and No Trend) and Model 4 (Unrestricted Intercept and Restricted Trend) with Italy as the dependent variable and the rows representing the regressors. **Columns four and five** represent the VECM model in the post GFC period estimated with Model 2 (Restricted Intercept and No Trend) and Model 3 (Unrestricted Intercept and No Trend), respectively with the Italy as the dependent variable. The rows represent the regressors present in the VECM models. Any empty cells or rows represent no deterministic components present or no coefficients for those lags exist due to having a shorter lag length with the lag length selected by the AIC. The last row represents the error correction terms (α) for each VECM model with Italy as the dependent variable in each sample period based on each Model used. The **error correction term coefficients** are in the top half of the row and the t-statistics with p-values in parentheses are in the bottom half of the row.

Each of the error correction terms are derived from normalising the cointegrating vector on Germany resulting in r (in this case r= 1) error correction terms for each equation.

During the GFC error correction term based on Model 3 (Unrestricted Intercept and No Trend) is represented as follows: **ect =1.0000*GERMANY - 0.96625*FRANCE - 1.1580*UK + 3.8853*ITALY - 1.2876*SPAIN.**

During the GFC period the error correction term based on Model 4 (Unrestricted Intercept and Restricted Trend) is: **ect = 1.0000*GERMANY - 1.1797*FRANCE - 1.8473*UK + 6.6881*ITALY - 2.1792*SPAIN + 0.65227*Trend**

In the post GFC sample period the error correction term based on Model 2 (Restricted Intercept and No Trend) is estimated as: **ect = 1.0000*GERMANY + 39.3459*FRANCE - 17.8585*UK - 79.7158*ITALY + 26.3916*SPAIN + 7657.9**

In the Post GFC Sample period the error correction term based on Model 3 (Unrestricted Intercept and No trend)is: **ect = 1.0000*GERMANY + 38.9195*FRANCE - 17.6753*UK - 78.7978*ITALY + 26.0243*SPAIN**

Panel B: Serial correlation test is a Lagrange Multiplier test of Serial Correlation, the Normality test is based on a test of skewness and kurtosis of residuals, the Heteroscedasticity test is based on the regression of squared residuals on squared fitted values.

Table 29: VECM Models for Spain Stock Market as the Dependent Variable

	Dependent Variable (Δ Spain)			
Panel A	During the GFC Sample Period		Post GFC Sample Period	
Regressors	Unrestricted Intercept and No	Unrestricted Intercept and	Restricted Intercept and No	Unrestricted Intercept and No

	Trend (Model 3)	Restricted Trend (Model 4)	Trend (Model 2)	Trend (Model 3)
Intercept	-0.33578 [0.737]	-1.2536 [0.211]		
Δ Germany(-1)	4.2682 [0.000]*	4.3227 [0.000]*	2.0430 [0.042]*	2.0198 [0.044]*
Δ France (-1)	-0.68355 [0.495]	-0.71974 [0.472]	-2.3134 [0.021]*	-2.3191 [0.021]*
Δ UK (-1)	-0.54449 [0.586]	-0.56743 [0.571]	-0.89149 [0.373]	-0.89825 [0.370]
Δ Italy (-1)	-1.1689 [0.243]	-1.0778 [0.282]	-0.29429 [0.769]	-0.27688 [0.782]
Δ Spain (-1)	0.077056 [0.939]	0.022829 [0.982]	2.7766 [0.006]*	2.7856 [0.006]*
Coefficient ECT (-1)	-0.1621E-3 -0.024510 [0.980]	-0.0017122 -0.39178 [0.695]	-0.5609E-3 -1.2248 [0.221]	-0.5689E-3 -1.2278 [0.220]
Panel B: Diagnostic Tests				
R – Squared (R^2)	0.041643	0.041940	0.030390	0.030712
Adjusted R – Squared ($\bar{R}^2$)	0.029979	0.030280	0.020247	0.018520
Serial Correlation $\chi^2(1)$	5.3461 [0.021]*	5.2519 [0.022]*	0.86124 [0.353]	0.89657 [0.344]
Heteroscedasticity $\chi^2(1)$	6.3467 [0.012]*	6.4551 [0.011]*	20.8245 [0.000]*	22.1397 [0.000]*
Normality $\chi^2(2)$	175.1495 [0.000]*	174.9164 [0.000]*	129.2083 [0.000]*	127.6062 [0.000]*

Note: **Panel A**: Shows the Vector error correction models estimated by OLS with the Spain as the dependent variable based on a VAR lag order 2 during the GFC period and a lag order of 2 in the post GFC period with the lag orders selected by the AIC. Δ represents the first difference (stock return) of each of the stock markets and the values in brackets () denotes the lag length for the first difference i.e. $\Delta Germany(-1)$ is the estimated coefficient for the first difference of Germany at lag 1 . The values inside the table are the t-statistics with the p-values in parentheses. * denotes significance at 5%. A general VECM is represented by the following equation:

$\Delta y_t = a_0 + a_1 t - \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + e_t$. Since cointegration is present $\Pi = \alpha * \beta'$ A VECM estimated with **Restricted Intercept and No Trend (Model 2)** asserts that $a_0 = \Pi\mu$ and $a_1 = 0$ thus the VECM is represented as follows: $\Delta y_t = -\Pi(y_{t-1} - \mu) + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + e_t$ implying a no trend being present in the levels of the times series data but an intercept (μ) being present in the cointegrating relationship/ vector i.e. $\Pi(y_{t-1} - \mu)$.A VECM estimated with **Unrestricted Intercept and No Trend (Model 3)** asserts that $a_0 \neq 0$ and $a_1 = 0$ thus, the VECM is represented as follows: $\Delta y_t = a_0 - \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + e_t$ implying an intercept being present in the VECM model but no trend or intercept being present in the cointegrating relationship (Πy_{t-1}). A VECM estimated with **Unrestricted Intercept and Restricted Trend (Model 4)** asserts that $a_0 \neq 0$ and $a_1 = \Pi\gamma$ thus the VECM is represented as follows: $\Delta y_t = a_0 - \alpha\beta'(y_{t-1} - \gamma_t) + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + e_t$ implying an intercept is included in the VECM but the time trend is present (γ_t) in the cointegrating relationship i.e. $\Pi(y_{t-1} - \gamma_t)$.

Column two to three represent the VECM model during the GFC period estimated using Model 3 (Unrestricted Intercept and No Trend) and Model 4 (Unrestricted Intercept and Restricted Trend) with Spain as the dependent variable and the rows representing the regressors. **Columns four and five** represent the VECM model in the post GFC period estimated with Model 2 (Restricted Intercept and No Trend) and Model 3 (Unrestricted Intercept and No Trend), respectively with the Spain as the dependent variable. The rows represent the regressors present in the VECM models. Any empty cells or rows represent no deterministic components present or no coefficients for those lags exist due to having a shorter lag length with the lag length selected by the AIC. The last row represents the error correction terms (α) for each VECM model with Spain as the dependent variable in each sample period based on each Model used. The **error correction term coefficients** are in the top half of the row and the t-statistics with p-values in parentheses are in the bottom half of the row.

Each of the error correction terms are derived from normalising the cointegrating vector on Germany resulting in r (in this case r= 1) error correction terms for each equation.
During the GFC error correction term based on Model 3 (Unrestricted Intercept and No Trend) is represented as follows: **ect =1.0000*GERMANY - 0.96625*FRANCE - 1.1580*UK + 3.8853*ITALY - 1.2876*SPAIN.**
During the GFC period the error correction term based on Model 4 (Unrestricted Intercept and Restricted Trend) is: **ect = 1.0000*GERMANY - 1.1797*FRANCE - 1.8473*UK + 6.6881*ITALY - 2.1792*SPAIN + 0.65227*Trend**
In the post GFC sample period the error correction term based on Model 2 (Restricted Intercept and No Trend) is estimated as: **ect = 1.0000*GERMANY + 39.3459*FRANCE - 17.8585*UK - 79.7158*ITALY + 26.3916*SPAIN + 7657.9**
In the Post GFC Sample period the error correction term based on Model 3 (Unrestricted Intercept and No trend)is: **ect = 1.0000*GERMANY + 38.9195*FRANCE - 17.6753*UK - 78.7978*ITALY + 26.0243*SPAIN**
Panel B: Serial correlation test is a Lagrange Multiplier test of Serial Correlation, the Normality test is based on a test of skewness and kurtosis of residuals, the Heteroscedasticity test is based on the regression of squared residuals on squared fitted values.

error correction models with the exception of France's ECM model (Table 26) whose p-value is exactly 5%. In the post GFC period, the error correction models for each stock market have Heteroscedasticity present, except for Germany (Table 25) whose p-value is 0.358. When Heteroscedasticity is adjusted for using White's Heteroscedasticity adjusted test, I find that in most cases the OLS standard errors are lower than the ones adjusted for Heteroscedasticity thus the OLS estimates are used. All error correction models are non-normally distributed in the post GFC sample period with the exception of Germany when the error correction estimated model is using Model 3 (Unrestricted Intercept and No Trend).

5.7.3 Vector Error Correction Model (Asian Stock markets)

Lastly the Vector Error Correction Model (VECM) for the Asian stock markets is assessed only during the Pre GFC sample period because that is the only sample period where cointegration is present. The results are provided below:

Table 30: VECM Models for Japan Stock Market as the Dependent Variable

	Dependent variable(Δ japan)	
Panel A	Pre GFC Sample Period	
Regressors	Restricted Intercept and No trend (Model 2)	Unrestricted Intercept and No Trend (Model 3)
Intercept		1.3135[.189]
Δ Japan (-1)	1.0704 [0.285]	1.0700[.285]
Δ Japan (-2)	-1.4346 [0.152]	-1.4343[.152]
Δ Japan (-3)	0.14406 [0.885]	.14403[.885]
Δ Japan (-4)	-1.7673 [0.077]	-1.7671[.077]
Δ Japan (-5)	1.4243 [0.155]	1.4235[.155]
Δ Japan (-6)	-1.3222 [0.186]	-1.3223[.186]
Δ China (-1)	-0.049782 [0.960]	-.045766[.964]
Δ China (-2)	0.028382 [0.977]	.032002[.974]

Δ China (-3)	0.37906 [0.705]	.38286[.702]
Δ China (-4)	1.2459 [0.213]	1.2500[.211]
Δ China (-5)	-1.1866 [0.236]	-1.1821[.237]
Δ China (-6)	-0.64986[0.516]	-.64575[.519]
Coefficient ECT (-1)	-0.8168E-3 -1.2728 [0.203]	-0.9200E-3 -1.3492[.177]
Panel B: Diagnostic tests		
R – Squared (R^2)	0.0081548	0.0082662
Adjusted R – Squared ($\bar{R}^2$)	0 .0015055	0.0010597
Serial Correlation $\chi^2(1)$	0.0018449 [0.966]	.0018588 [0.966]
Heteroscedasticity $\chi^2(1)$	12.4246 [0.000]*	11.7684 [0.001]*
Normality Correlation $\chi^2(1)$	259.9104 [0.000]*	261.9537 [0.000]*

Note: **Panel A:** Shows the Vector error correction models estimated by OLS with the Japan as the dependent variable based on a VAR lag order 7 in the pre GFC sample period with the lag order selected by the AIC. Δ represents the first difference (stock return) of each of the stock markets and the values in brackets () denotes the lag length for the first difference i.e. $\Delta Japan(-1)$ is the estimated coefficient for the first difference of Japan at lag 1 . The values inside the table are the t-statistics with the p-values in parentheses. * denotes significance at 5%. A general VECM is represented by the following equation: $\Delta y_t = a_0 + a_1 t - \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + e_t$. Since cointegration is present $\Pi = \alpha * \beta'$ A VECM estimated with **Restricted Intercept and No Trend (Model 2)** asserts that $a_0 = \Pi\mu$ and $a_1 = 0$ thus the VECM is represented as follows: $\Delta y_t = -\Pi(y_{t-1} - \mu) + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + e_t$ implying a no trend being present in the levels of the times series data but an intercept (μ) being present in the cointegrating relationship/ vector i.e. $\Pi(y_{t-1} - \mu)$.
A VECM estimated with **Unrestricted Intercept and No Trend (Model 3)** asserts that $a_0 \neq 0$ and $a_1 = 0$ thus, the VECM is represented as follows: $\Delta y_t = a_0 - \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + e_t$ implying an intercept being present in the VECM model but no trend or intercept being present in the cointegrating relationship (Πy_{t-1}). **Columns two and three** represent the VECM model in the pre GFC period estimated with Model 2 (Restricted Intercept and No Trend) and Model 3 (Unrestricted Intercept and No Trend), respectively with Japan as the dependent variable. The rows represent the regressors present in the VECM models. Any empty cells or rows represent no deterministic components present or no coefficients for those lags exist due to having a shorter lag length with the lag length selected by the AIC. The last row represents the error correction terms (α) for each VECM model with Japan as the dependent variable. The **error correction term coefficients** are in the top half of the last row in Panel A and the t-statistics with p-values in parentheses are in the bottom half of the last row in Panel A.
Each of the error correction terms are derived from normalising the cointegrating vector on Japan resulting in r (in this case r= 1) error correction terms for each equation. In the pre GFC period the error correction term based on Model 2 (Restricted Intercept and No trend) is represented as follows: **ect = 1.0000*JAPAN + 2.7529*CHINA -1749.5**
In the pre GFC period the error correction term based on Model 3 (Unrestricted intercept and No Trend) is represented as follows: **ect = 1.0000*JAPAN + 2.7473*CHINA**
Panel B: Serial correlation test is a Lagrange Multiplier test of Serial Correlation, the Normality test is based on a test of skewness and kurtosis of residuals, the Heteroscedasticity test is based on the regression of squared residuals on squared fitted values.

Table 31: VECM Models for China Stock Market as the Dependent Variable

	Dependent variable(Δ China)	
Panel A:	Pre GFC Sample Period	
Regressors	Restricted Intercept and No trend (Model 2)	Unrestricted Intercept and No Trend (Model 3)
Intercept		-4.0582 [0.000]*
Δ Japan (-1)	1.1430 [0.253]	1.1424 [0.253]
Δ Japan (-2)	-0.77008 [0.441]	-0.77007 [0.441]
Δ Japan (-3)	-0.75811 [0.448]	-0.75806 [0.449]
Δ Japan (-4)	0.70675 [0.480]	0.70634 [0.480]
Δ Japan (-5)	2.1438 [0.032]*	2.1429 [0.032]*
Δ Japan (-6)	0.73996 [0.459]	0.73946 [0.460]
Δ China (-1)	-1.1230 [0.262]	-1.1212 [0.262]
Δ China (-2)	-2.0404 [0.041]*	-2.0385 [0.042]*
Δ China (-3)	4.2160 [0.000]*	4.2161 [0.000]*
Δ China (-4)	3.2905 [0.001]*	3.2910 [0.001]*
Δ China (-5)	-2.4703 [0.014]*	-2.4680 [0.014]*
Δ China (-6)	-3.6005 [0.000]*	-3.5980 [0.000]*
Coefficient ECT (-1)	0.0014126 4.9114 [0.000]*	0.0013996 4.5800 [0.000]*
Panel B: Diagnostic tests		
R – Squared (R^2)	0.045981	0.045992
Adjusted R – Squared ($\bar{R}^2$)	0.039585	0.039059
Serial Correlation $\chi^2(1)$	0.21986 [0.639]	0.22042 [0.639]
Heteroscedasticity $\chi^2(1)$	51.0094 [0.000]*	51.0659 [0.000]*
Normality $\chi^2(1)$	32585.8 [0.000]*	32560.0 [0.000]*

Note: **Panel A:** Shows the Vector error correction models estimated by OLS with China as the dependent variable based on a VAR lag order 7 in the pre GFC sample period with the lag order selected by the AIC. Δ represents the first difference (stock return) of each of the stock markets and the values in brackets () denotes the lag length for the first difference i.e. $\Delta Japan(-1)$ is the estimated coefficient for the first difference of Japan at lag 1 . The values inside the table are the t-statistics with the p-values in parentheses. * denotes significance at 5%. A general VECM is represented by the following equation: $\Delta y_t = a_0 + a_1 t - \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + e_t$. Since cointegration is present $\Pi = \alpha * \beta'$ A VECM estimated with Restricted Intercept and No Trend (Model 2) asserts that $a_0 = \Pi\mu$ and $a_1 = 0$ thus the VECM is represented as follows: $\Delta y_t = -\Pi(y_{t-1} - \mu) + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + e_t$ implying a no trend being present in the levels of the times series data but an intercept (μ) being present in the cointegrating relationship/ vector i.e. $\Pi(y_{t-1} - \mu)$.A VECM estimated with Unrestricted Intercept and No Trend (Model 3) asserts that $a_0 \neq 0$ and $a_1 = 0$ thus, the VECM is represented as follows: $\Delta y_t = a_0 - \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + e_t$ implying an intercept being present in the VECM model but no trend or intercept being present in the cointegrating relationship (Πy_{t-1}). **Columns two and three** represent the VECM model in the pre GFC period estimated with Model 2 (Restricted Intercept and No Trend) and Model 3 (Unrestricted Intercept and No Trend), respectively with China as the dependent variable. The rows represent the regressors present in the VECM models. Any empty cells or rows represent no deterministic components present or no coefficients for those lags exist due to having a shorter lag length with the lag length selected by the AIC. The last row represents the error correction terms (α) for each VECM model with Japan as the dependent variable. The **error correction term coefficients** are in the top half of the last row and the t-statistics with p-values in parentheses are in the bottom half of the last row before Panel B.

Each of the error correction terms are derived from normalising the cointegrating vector on Japan resulting in r (in this case r= 1) error correction terms for each equation.

In the pre GFC period the error correction term based on Model 2 (Restricted Intercept and No trend) is represented as follows: **ect = 1.0000*JAPAN + 2.7529*CHINA -1749.5**

In the pre GFC period the error correction term based on Model 3 (Unrestricted intercept and No Trend) is represented as follows: **ect = 1.0000*JAPAN + 2.7473*CHINA**

Panel B: Serial correlation test is a Lagrange Multiplier test of Serial Correlation, the Normality test is based on a test of skewness and kurtosis of residuals, the Heteroscedasticity test is based on the regression of squared residuals on squared fitted values.

Table 31 shows that lagged values of Japan have a significant effect on China but none of China's lagged values significantly affect Japan (Table 30) using both Model 2 and 3.

In the case of the Asian stock markets (Tables 30 and 31), the significance of the error correction term is only analysed in the pre-GFC sample period because that's the only period where cointegration exists. The results show that in both Model 2 and 3, China is the only stock market that bears the burden of adjusting any short run disequilibrium back to the long run equilibrium relationship. China's speed of adjustment back to the long run cointegrating relationship in all Models is very slow with size of the coefficient being 0.0014126 in Model 2 and 0.0013996 in Model 3.

In a similar manner to the American and European stock markets, the R-Squared values for the error correction models for the Asian stock markets are very low with the highest being

4.598% (3.9585 adjusted R-Squared) for China's ECM model in Model 2 and 4.5992% (3.9059adjusted R-Squared) for Model 3. Japan's R-squared values are 0.81548% (0.15055% adjusted R-Squared) using Model 2 and 0.82662% (0.10597% adjusted R-Squared) using Model 3. None of the error correction models have serial correlation present but Heteroscedasticity is present and when adjusted for using White's test, the OLS standard errors are lower than the Heteroscedasticity adjusted standard errors thus OLS estimates are used. All the error correction models are non-normally distributed too. As mentioned earlier, the Heteroscedasticity can be attributed to outliers in my data or skewness in the distribution of my regressors.

5.8 Granger Causality:

Even if cointegration is not present in the long run, it can be so that there are short run interdependencies present among the stock markets that are not cointegrated. Thus Granger Causality tests have been carried out to analyse whether short run interdependencies exist between pairs of the European stock markets (Germany, France, UK, Italy and Spain) in the pre-GFC period and between the Asian (Japan and China) stock markets during and post-GFC periods. Granger Causality tests have been carried out using the first differences of these stock markets.

5.8.1 Lag Length Selection:

As Granger Causality is based on a VAR model, the optimal lag length has to be selected so that serial correlation is not present (Gujarati & Porter, 2009). The Akaike Information Criteria (AIC) and the Schwartz-Bayesian Information Criteria (SBIC) are used to select the optimal lag length as shown on the next page.

Table 32: VAR Lag Length Selection for European Stock Returns

Pre-GFC sample period										
	VAR (1)	VAR (2)	VAR (3)	VAR (4)	VAR (5)	VAR (6)	VAR (7)	VAR (8)	VAR (9)	VAR (10)
AIC	32951.8	32955.7	32979.2	32989.6	32994.2	32996.4	32994.2	32999.4	32998.1	32984.7
SBIC	32883.1	32818.3	32773.1	32714.8	32650.8	32584.3	32513.4	32449.9	32379.9	32297.9

Note: AIC stands for Akaike Information Criteria, SBIC stands for Schwartz-Bayesian Information Criteria. A maximum lag order of ten is chosen. The columns VAR () represent the Information Criteria values for the lag order in the brackets. The selection procedure involves choosing the highest value of the AIC or SBIC.

For the European stock markets in the pre-GFC period, the lag length selected by the AIC is 8 and 1 by the SBIC. In testing for serial correlation, it is found that serial correlation is not present at lag 1 or 8. Lag eight is selected as the optimal lag length because if too few lags are chosen, this may lead to rejecting the null hypothesis when it is true (size distortion), (Maddala, 2001).

Table 33: VAR Lag Length Selection for Asian Stock Returns

During GFC sample period										
Asian	VAR (1)	VAR (2)	VAR (3)	VAR (4)	VAR (5)	VAR (6)	VAR (7)	VAR (8)	VAR (9)	VAR (10)
AIC	2425.0	2425.6	2426.0	2425.3	2421.9	2420.6	2422.2	2419.3	2416.5	2412.9
SBIC	2416.6	2408.8	2400.7	2391.6	2379.8	2370.1	2363.2	2351.8	2340.6	2328.6
Post GFC sample period										
Asian	VAR (1)	VAR (2)	VAR (3)	VAR (4)	VAR (5)	VAR (6)	VAR (7)	VAR (8)	VAR (9)	VAR (10)
AIC	2771.6	2775.7	2772.6	2769.7	2766.6	2762.8	2759.8	2758.1	2755.0	2752.4
SBIC	2763.2	2759.0	2747.5	2736.2	2724.8	2712.6	2701.3	2691.1	2679.7	2668.8

Note: AIC stands for Akaike Information Criteria, SBIC stands for Schwartz-Bayesian Information Criteria. A maximum lag order of ten is chosen. The columns VAR () represent the Information Criteria values for the lag order in the brackets. The selection procedure involves choosing the highest value of the AIC or SBIC.

In Table 33, during the GFC period the optimal lag length chosen for the Asian stock markets by the AIC is 3 and by the SBIC is 1. The lag length of 3 is chosen in order to avoid size distortion. In the post-GFC sample period, the AIC choses an optimal lag length of 2 and the

SBIC choses a lag length of 1. The AIC result is chosen in order to avoid size distortion. The optimal lag length during the GFC period and in the post-GFC sample period is 3 and 2, respectively and at both lags no serial correlation is present.

5.8.1.1 Granger Causality Results (European Stock Markets):

The results of Granger causality for the European stock markets are presented below:

Table 34: Likelihood Ratio Test for Granger Non-Causality between European Stock Markets (Pre GFC Sample Period)

Null Hypothesis	Chis-square statistic	Probability value	Conclusion
Germany does not Granger cause France	59.3481	0.000*	Reject null
France does not Granger cause Germany	13.4423	0.098	Accept null
Germany does not Granger cause UK	70.6859	0.000*	Reject null
UK does not Granger cause Germany	24.3748	0.002*	Reject null
Germany does not Granger cause Italy	34.0862	0.000*	Reject null
Italy does not Granger cause Germany	23.1066	0.003*	Reject null
Germany does not Granger cause Spain	27.8590	0.001*	Reject null
Spain does not Granger cause Germany	12.0940	0.147	Accept null
France does not Granger cause UK	22.9915	0.003*	Reject null
UK does not Granger cause France	16.8958	0.031*	Reject null
France does not Granger cause	15.8392	0.045*	Reject null

Italy			
Italy does not Granger cause France	20.5483	0.008*	Reject null
France does not Granger cause Spain	14.3860	0.072	Accept null
Spain does not Granger cause France	12.0810	0.148	Accept null
UK does not Granger cause Italy	15.4464	0.051	Accept null
Italy does not Granger cause UK	20.0485	0.010*	Reject null
UK does not Granger cause Spain	18.2185	0.020*	Reject null
Spain does not Granger cause UK	6.7813	0.560	Accept null
Italy does not Granger cause Spain	30.3278	0.000*	Reject null
Spain does not Granger cause Italy	31.4537	0.000*	Reject null

Note: The Granger causality test is a Likelihood ratio Granger non-causality test using a lag order of 8 as chosen by the AIC. * denotes significance at 5%. The Granger non-causality test as shown by Microfit is based on :

$$z_{1t} = \sum_{i=1}^{p} \Phi_{i,11} z_{1,t-i} + \sum_{i=1}^{p} \Phi_{i,12} z_{2,t-i} + u_{1t}$$

$$z_{2t} = \sum_{i=1}^{p} \Phi_{i,21} z_{1,t-i} + \sum_{i=1}^{p} \Phi_{i,22} z_{2,t-i} + u_{2t}$$, The hypothesis that z_{2t} does not Granger-Cause z_{1t} is defined by :

$H_G : \Phi_{12} = 0$ where p is number of lags sufficient to get rid of serial correlation in this case p = 8

Below is a summary table of the directions of Granger causality present between pairs of the European Stock Markets in the Pre GFC sample period.

Table 35: Summary Table of the directions of Granger Causality (European Stock Markets)

Bi-variate Granger Causality	Uni-variate Granger causality	No Granger causality
Germany and UK	From Germany to France	France and Spain
Germany and Italy	From Germany to Spain	

France and UK	From Italy to the UK	
France and Italy	From the UK to Spain	
Italy and Spain		

The presence of bivariate Granger causality between Germany and the UK has been documented by Gerrits et al (1999) and Masih & Masih (2004). This finding can be attributed to the strong trade and direct investment relations between the UK and Germany with exports from UK to Germany being over €30billion a year (Foreign and Commonwealth Office , 2011).

The presence of Granger causality (uni-variate or bivariate) between the European Union countries has been documented by King & Serletis (1997), Masih & Masih (2004) and Worthington et al (2003). This result is expected because of the strong trade, economic ties and direct investment they have with each other. Furthermore, all except the UK share a common currency thus sharing common monetary policy (U.S. department of State, 2010).

I expected to find bi-variate Granger causality between Germany and France because France is a major exporter to and importer from Germany (U.S. Department of State , 2010) with France ranking number one in 2010 for Germany's turnover (exports and imports). The finding of no Granger causality between France and Spain is also unexpected because France is one of Spain's largest trading partners. (Encyclopedia Britannica, n.d.) and (World Trade Organization, n.d.).

5.8.1.2. Granger Causality Results (Asian Stock Markets)

The results of the Granger Causality tests for the Asian stock markets are presented in the table below:

Table 36: Likelihood Ratio Test for Granger Non-Causality between Asian Stock Markets (During GFC Sample Period)

Null Hypothesis	F-Statistic	Probability value	Conclusion
Japan does not Granger cause China	6.1288	0.106	Accept null
China does not Granger cause Japan	3.0628	0.382	Accept null

Note: The Granger causality test is a Likelihood ratio Granger non-causality test using a lag order of 3 as chosen by the AIC. The Granger non-causality test as shown by Microfit is based on :

$$z_{1t} = \sum_{i=1}^{p} \Phi_{i,11} z_{1,t-i} + \sum_{i=1}^{p} \Phi_{i,12} z_{2,t-i} + u_{1t}$$

$z_{2t} = \sum_{i=1}^{p} \Phi_{i,21} z_{1,t-i} + \sum_{i=1}^{p} \Phi_{i,22} z_{2,t-i} + u_{2t}$, The hypothesis that z_{2t} does not Granger-Cause z_{1t} is defined by :

$H_G : \Phi_{12} = 0$ where p is number of lags sufficient to get rid of serial correlation in this case p = 3

Table 37: Likelihood Ratio Test for Granger non-Causality between Asian Stock Markets (Post GFC Sample Period)

Null Hypothesis	F-Statistic	Probability value	Conclusion
Japan does not Granger cause China	0.82344	0.663	Accept null
China does not Granger cause Japan	0.044102	0.978	Accept null

Note: The Granger causality test is a Likelihood ratio Granger non-causality test using a lag order of 2 as chosen by the AIC. The Granger non-causality test as shown by Microfit is based on :

$$z_{1t} = \sum_{i=1}^{p} \Phi_{i,11} z_{1,t-i} + \sum_{i=1}^{p} \Phi_{i,12} z_{2,t-i} + u_{1t}$$

$z_{2t} = \sum_{i=1}^{p} \Phi_{i,21} z_{1,t-i} + \sum_{i=1}^{p} \Phi_{i,22} z_{2,t-i} + u_{2t}$, The hypothesis that z_{2t} does not Granger-Cause z_{1t} is defined by :

$H_G : \Phi_{12} = 0$ where p is number of lags sufficient to get rid of serial correlation in this case p = 2.

The Granger Causality results during the GFC (Table 36) and in the post GFC (Table 37) sample periods for the Asian stock markets show no Granger Causality (uni-variate or bivariate) being present between China and Japan, implying that no short run interdependencies exist between these two stock markets. As a result, portfolio diversification between Japan and China can be beneficial in the short run. Furthermore, short run profit strategies to predict movements in China (Japan) using lagged returns of Japan (China) cannot be beneficial because Granger causality is not present.

The finding of no Granger Causality between Japan and China contradicts the results of (Li, n.d.) who finds uni-directional causality running from China to Japan. However my result is similar to that of (Azad, 2009), Worthington et al (2004) and Jeyanthi (2010) who find no Granger causality present between Japan and China.

The implication of finding Granger causality among the European stock markets except for France and Spain implies that short term profit strategies can be formulated in the sense that if Granger causality is present, a movement in one stock market causes a preceding movement in the other stock market. As a result, predicting the movement of the stock market that is being led is possible by assessing the movement of the leading stock market and as a result short term profit strategies can be formed by investors. In contrast, in the case where Granger causality is not found, then interdependencies among the stock markets are non-existent and thus portfolio diversification is beneficial in the short run. The downside of Granger causality not being present is that short term profit strategies cannot be formulated because the movement of one stock market does not cause a movement in another stock market and so both their movements are random and cannot be predicted by assessing the movement of the other stock market.

Thus, the above results suggest that portfolio diversification between Japan and China was beneficial during the GFC and in the post GFC period because their movements were independent. As a result it can be concluded that there has been no change in the short run interdependencies between Japan and China due to the GFC. On the other hand, the European stock markets appear to be highly interdependent with the exception of France and Spain that do not Granger cause each other, implying that portfolio diversification between these two stock markets was beneficial in the Pre GFC period.

5.9 Generalized Impulse Response Function analysis results:

The Generalised Impulse Response Analysis graphs help to map out the response of each of the stock markets in each region to a one standard error shock to another variable in the same region. By graphing the responses, important information is provided about how long the effect of the shocks last and also which stock markets are affected more than others by shocks to a specific stock market. For the sample periods where cointegration is found, Microfit creates generalized impulse response graphs that display the responses to variable specific shocks on the different variables in the cointegrating system. Due to rank deficiency of the coefficient matrix Π, shocks to equations may have persistence effects on the individual variables in the model and thus, the effects may not die out (Pesaran & Pesaran , 2009). For the sample periods where cointegration is not found, the GIRF analysis is based on the first differences of the levels using an unrestricted VAR model. The estimates of the VAR model are not displayed due to space limitations and because the focus of this thesis is the GIRF graphs produced by the VAR models.

5.9.1 Generalized Impulse Response Results (American Stock Markets)

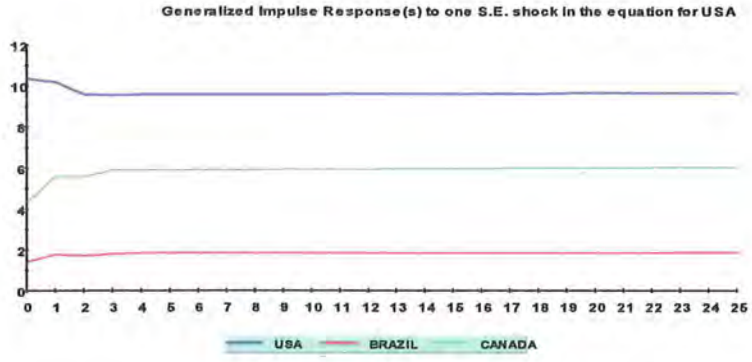
Since cointegration is found in all three sample periods for the American stock markets, the impulse response graph created is based on the cointegrating VECM model in each sample period when the USA is normalised upon. The impulse response graphs displayed for each sample period is based on Model 4 (unrestricted intercept and restricted trend) reasons being that Model 4 has stronger cointegration results than Model 3 (unrestricted intercept and no trend). Furthermore, the generalised impulse response graphs are similar for both Models thus due to space limitations the only focus is on Model four. This information is included as notes beneath each graph.

As can be seen a shock to the USA (Figure 1) in the pre-GFC period (Panel A) does not create strong responses in all the stock markets but the initial responses are positive for all the stock markets except for the USA itself. Canada appears to have the strongest response among these stock markets. The stronger response can be explained as higher interdependencies between Canada and the USA than between the USA and Brazil. As mentioned earlier, this result this can be associated with the stronger political and trade ties between Canada and the USA as compared to the USA and Brazil.

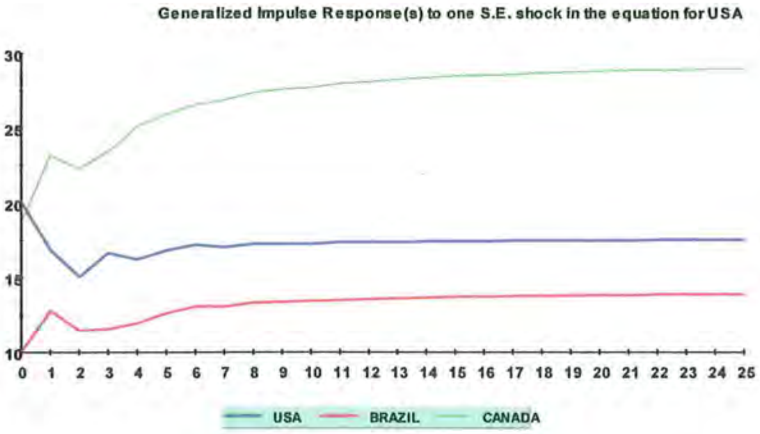
Brazil has the weakest response but has the most instantaneous response, with the response being fully incorporated by day one unlike the response of Canada that lasts up to three days and the USA that lasts up to two days until they taper off. Brazil having the most instantaneous response is unexpected because Brazil is an emerging stock market. Instead, it is expected that Canada and USA will have faster response times because they are both developed stock markets with advanced Information technology making it more likely for shocks/ news to travel faster and therefore being incorporated faster in the developed stock markets than in the developing stock market. In contrast, during the GFC sample period (Figure1, Panel B) there is a visibly significant increase in how strongly the stock markets respond to a shock to the USA. As can be seen the values of the responses on the vertical axis have increased but as mentioned in the methodology section this does not necessarily imply a stronger (larger) response but instead implies a change (increase or decrease) in the estimated coefficients, in the VECM during the GFC in comparison to the pre GFC estimated coefficients. Therefore, looking at the values does not tell us anything about whether the response was stronger or not. The bigger responses can be attributed to the negative effects of crisis that spread and spilled over to other stock markets around the globe affecting economies either directly through financial markets or indirectly via trade. As a result, these negative events and reductions in trade and financial investment among economies means that these economies were influenced and affected significantly by these events causing larger responses. The effect of the shock causes larger initial positive responses in both Brazil and Canada in comparison to the Pre-GFC sample period though Brazil has the smallest response out of all three stock markets showing that Brazil was not as affected by the Global Financial Crisis as much as Canada and the USA. This is supported by Meyer (2011) who points out that economic policies to reduce inflation, create stability and growth that were implemented in Brazil over several decades helped Brazil better absorb the shocks of the financial crisis where Brazil emerged relatively undamaged.

For all stock markets, most of the effect of the shock is incorporated by day one with the size of the responses diminishing thereafter but it appears to take longer for the stock markets to fully incorporate the effects of the shocks during the GFC period as compared to the Pre-GFC period. Furthermore, Canada's response to a shock in the USA stabilises but gradually increases from day two and only levels off after the eleventh day.

Panel A: Pre GFC Sample Period



Panel B: During the GFC Sample Period



Panel C: Post GFC Sample Period

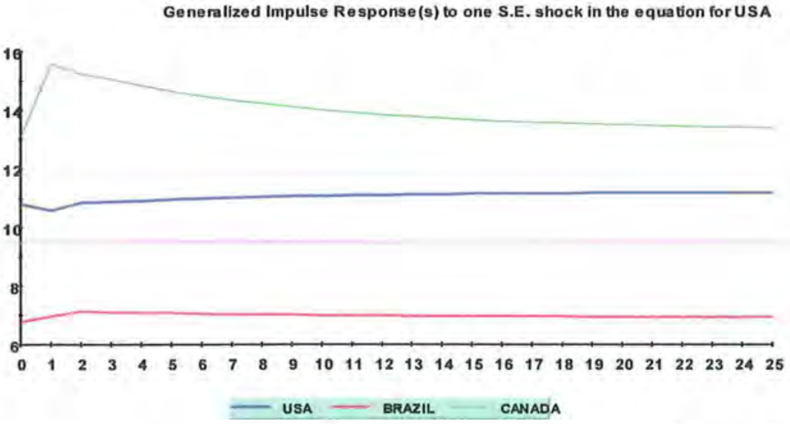


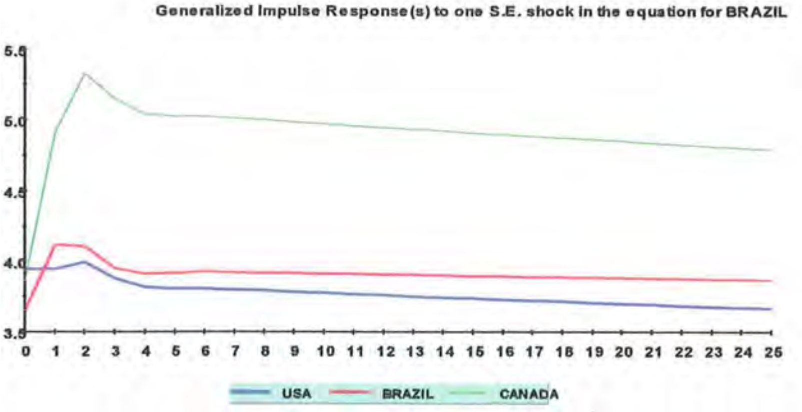
Figure 1: Generalised Impulse Response to one Standard Error Shock in the Equation for USA

Note: Panel A: The GIRF graph is based on the cointegrating VAR model normalized on USA with Unrestricted Intercept and Restricted Trend (Model 4) using VAR lag order of 4.

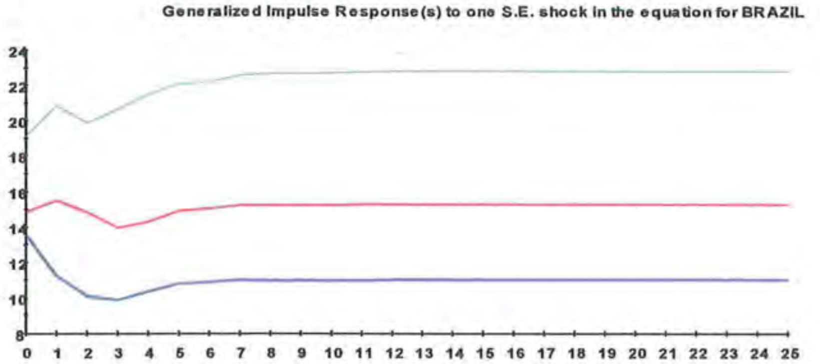
Panel B: The graph in Panel B is based on a cointegrating VAR model normalized on USA with Unrestricted Intercept and Restricted Trend (Model 4) using VAR lag order of 4. Only the IRF graph for Model 4 has been shown due to space limitations and because Model 4 provides stronger cointegration results. (for all of them during)

Panel C: The graph in Panel C is based on a cointegrating VAR model normalized on USA with Unrestricted Intercept and Restricted Trend (Model 4) using VAR lag order of 4. Only the IRF graph for Model 4 has been shown due to space limitations and because the graph based on Model 5 is similar .

Panel A: Pre GFC Sample Period



Panel B: During the GFC Sample Period



Panel C: Post GFC Sample Period

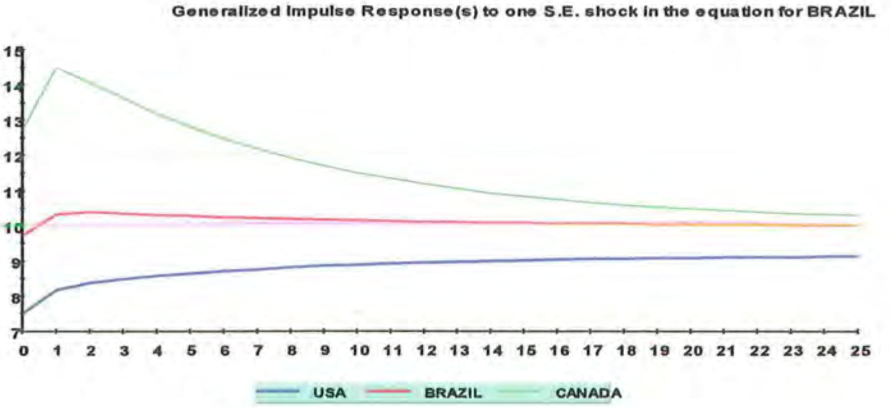


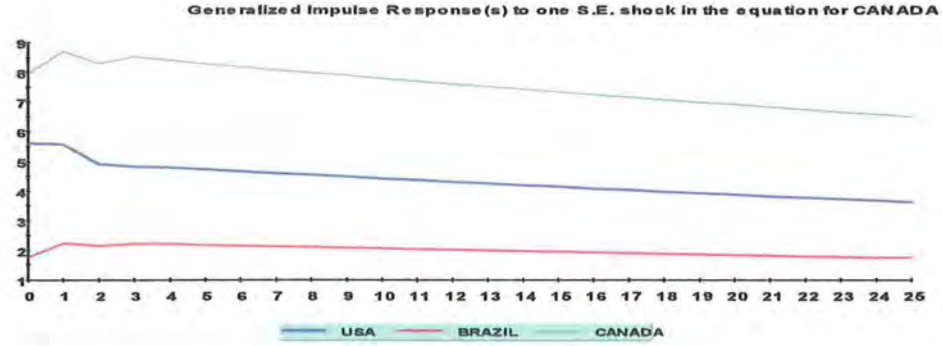
Figure 2: Generalised Impulse Response to one Standard Error in the Equation for Brazil

Note: Panel A: The GIRF graph is based on the cointegrating VAR model normalized on USA with Unrestricted Intercept and Restricted Trend (Model 4) using VAR lag order of 4.

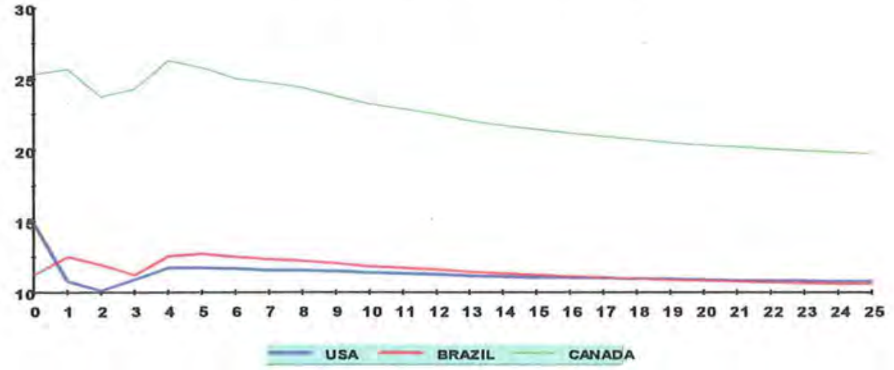
Panel B: The graph in Panel B is based on a cointegrating VAR model normalized on USA with Unrestricted Intercept and Restricted Trend (Model 4) using VAR lag order of 4. Only the IRF graph for Model 4 has been shown due to space limitations and because Model 4 provides stronger cointegration results.

Panel C: The graph in Panel C is based on a cointegrating VAR model normalized on USA with Unrestricted Intercept and Restricted Trend (Model 4) using VAR lag order of 4. Only the IRF graph for Model 4 has been shown due to space limitations and because the graph based on Model 5 is similar .

Panel A: Pre GFC Sample Period



Panel B: During the GFC Sample Period



Panel C: Post GFC Sample Period

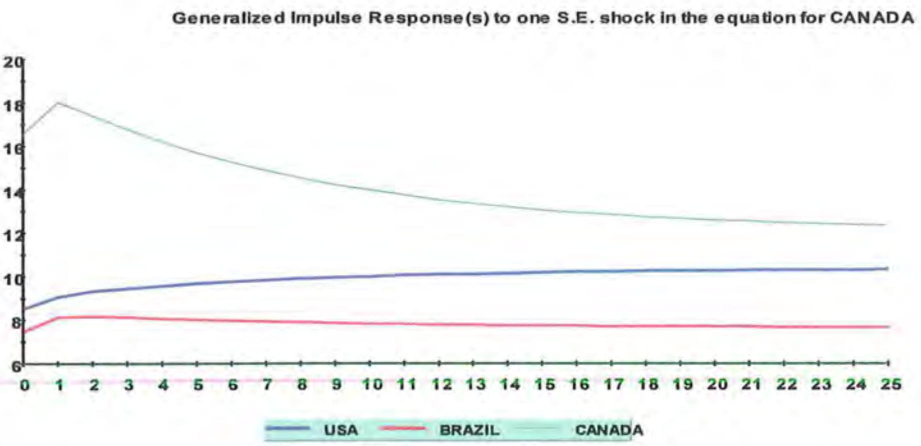


Figure 3: Generalised Impulse Response to one Standard Error Shock in the Equation for Canada

Note: Panel A: The GIRF graph is based on the cointegrating VAR model normalized on USA with Unrestricted Intercept and Restricted Trend (Model 4) using VAR lag order of 4.

Panel B: The graph in Panel B is based on a cointegrating VAR model normalized on USA with Unrestricted Intercept and Restricted Trend (Model 4) using VAR lag order of 4. Only the IRF graph for Model 4 has been shown due to space limitations and because Model 4 provides stronger cointegration results.

Panel C: The graph in Panel C is based on a cointegrating VAR model normalized on USA with Unrestricted Intercept and Restricted Trend (Model 4) using VAR lag order of 4. Only the IRF graph for Model 4 has been shown due to space limitations and because the graph based on Model 5 is similar .

In contrast, in the post-GFC sample period (Figure 1, Panel C) the size of the responses for each stock market to a shock in the USA reduces in comparison to during the GFC but is still stronger than the Pre GFC period responses. The finding of stronger responses in the post GFC period as compared to the pre GFC period but weaker than during the GFC sample period can be attributed to the aftermath effects of the GFC still being in play in the economies though not being as severe as during the crisis period. Thus, the relatively weaker responses in the post GFC period can be attributed to the stabilisation of the financial markets. Another interpretation of smaller responses to shocks in the post GFC period is that there was a temporary increase in the size of the responses during the GFC due to its negative effects. Brazil in all three sample periods has the smallest (weakest) response thus this finding highlights the higher interdependencies between Canada and the USA than between the USA and Brazil and this is observed with Canada being more affected by shocks to the USA than Brazil is. This can be attributed to the stronger economic, political and trade ties Canada has with the USA relative to Brazil.

Furthermore, Brazil is an emerging stock market that is opening its economy and just increasing its influence in the region of America in comparison to Canada. The duration of the USA's response and Brazil's responses before tapering off (being fully incorporated) is shorter than during the GFC period.

A shock to the Brazilian stock market (Figure 2) in the Pre-GFC sample period (Panel A) causes initial positive responses in its own stock market and Canada on the day the shock takes place but the USA appears to respond with a lag to the shock, with the USA's response occurring after day one and not at the time horizon of the initial shock. Furthermore, the USA's response is the weakest and the smallest in size implying that a shock to Brazil does not significantly affect the USA. This further highlights the low interdependency between the USA and Brazil. The Low interdependencies between the USA and Brazil have been documented by Maniam et al (1999).

This result is further highlighted in the VECM with lagged values of Brazil not significantly influencing the USA in any of the sample periods. Canada on the other hand has the strongest and largest positive response to a shock in Brazil with the effects of the shocks lasting four days thereafter tapering off. The larger response by Canada further highlights the higher interdependency between Canada and Brazil than between the USA and Brazil. This is also seen in the VECM with lagged values of Brazil having a significant impact on Canada in the pre GFC sample period. Canada incorporates most of the effect of the shock by day one thereafter the responses diminishing until the graph levels off.

As can be seen in Figure 2, Panel B a shock to Brazil appears to cause the strongest initial negative response in the USA during the GFC period as compared to the Pre GFC sample period. All responses appear stronger during the GFC period than the pre GFC period i.e. for example in the Pre GFC sample period (Figure 3, Panel A) the origin of Canada's response starts at around 3.8 and peaks to a value of about 5.25 giving a response size of about 1.45 in comparison to the during the GFC (Figure 3, panel B) where the origin starts at 19 and peaks to 21 which gives a response size of 2. The duration of Brazil and the USA in fully incorporating the effects of the shock last longer in comparison to the Pre GFC sample period while Canada's response stabilises by day two but with a gradual increase until day seven where the graph completely levels off. In the post GFC period (Panel C) there is a decline in the size (strength) of the responses as compared to during the GFC period but the responses are still larger than the Pre GFC sample periods. As mentioned earlier, the decrease in the size of responses as compared to during the GFC is a sign of stock markets stabilizing from the effects of the GFC.

A shock to Brazil in the post GFC causes an instantaneous positive response in both the USA and Brazil with the effects of the shocks being fully incorporated by day one and this is shown by the levelling off of the graphs on day one. This is in contrast to the longer duration times to fully incorporate shocks in the pre GFC period and during the GFC. Canada has a larger and stronger initial positive response than the USA or Brazil with the effect of the shock peaking on day one then gradually declining thereafter. In the pre and post GFC sample period Canada has the strongest response but this changes to the USA during the GFC.

In the case of a shock to Canada in Figure 3 in the pre-GFC sample period (Panel A), the effects on all stock markets are fairly weak, with the most instantaneous response being that of Brazil with the effect of the shock only lasting until day one in contrast to 3 days for Canada and two days for the USA. For all three stock markets the effect of the shock gradually declines. The USA appears not to respond to a shock in Canada initially with the response only occurring from day one to day two implying the response by the USA is not instantaneous but occurs with a one day delay. This response pattern of the USA is also highlighted when Brazil is shocked. In contrast, during the GFC sample period (Panel B) as was seen in Figures 1 and 2, the responses of each stock market to a shock in Canada are stronger and larger in magnitude than in the Pre-GFC sample period. Furthermore, the effects of the shock last longer than in the pre GFC sample period with all stock markets seeming to stabilise by day 4 thereafter gradually declining.

In the post-GFC sample period (Panel C), the largest and strongest response to a shock in Canada is by Canada itself with an initial positive shock lasting one day thereafter gradually declining. There is barely a visible positive response by the USA up until day two where the graph flattens out. This implies that the USA was barely affected by a shock to Canada in the post GFC sample period. As can be seen the magnitudes of the responses decrease in the post GFC period as compared to during the GFC period, as was seen in the previous cases. This result can be interpreted as a decrease in interdependencies in the post GFC sample period between Canada and the USA because the USA barely responds to a shock in Canada. Furthermore, Brazil's response pattern in the post GFC sample period is similar to its response pattern in the pre GFC sample period with the effects of the shocks being incorporated instantaneously by day one in both sample periods.

In comparing response patterns of Canada in the same sample period to shocks to the USA (Figure 1), Brazil (Figure 2) and itself (Figure 3), it is found that the response pattern of Canada to a shock to itself and shocks to the USA and Brazil in the post GFC sample period are all similar even the size of the responses, the only difference being the response by Canada to a shock in the USA does not decline as much as its response to a shock to Canada and Brazil in the post GFC sample period.

For all stock markets it is generally the finding that during the GFC sample period, response durations and the magnitudes of the responses increased as compared to the pre and post GFC sample periods. Furthermore, the results show a longer duration of each market in fully incorporating/ absorbing the effects of the shocks during the GFC sample period.

5.9.2 Generalized Impulse Response Results (European Stock Markets):

In the case of the impulse response analysis for the European stock markets, since no cointegration is found in the Pre-GFC sample period the impulse response analysis graphs are based on an unrestricted VAR model of the first differences of the European stock indices. These graphs will be interpreted on their own and will not be compared to that of the impulse response analysis graphs during the GFC and post-GFC sample periods. This is because the impulse response graphs during the GFC and post-GFC sample periods are based on the cointegrating relationship found and thus, the responses are based on levels.

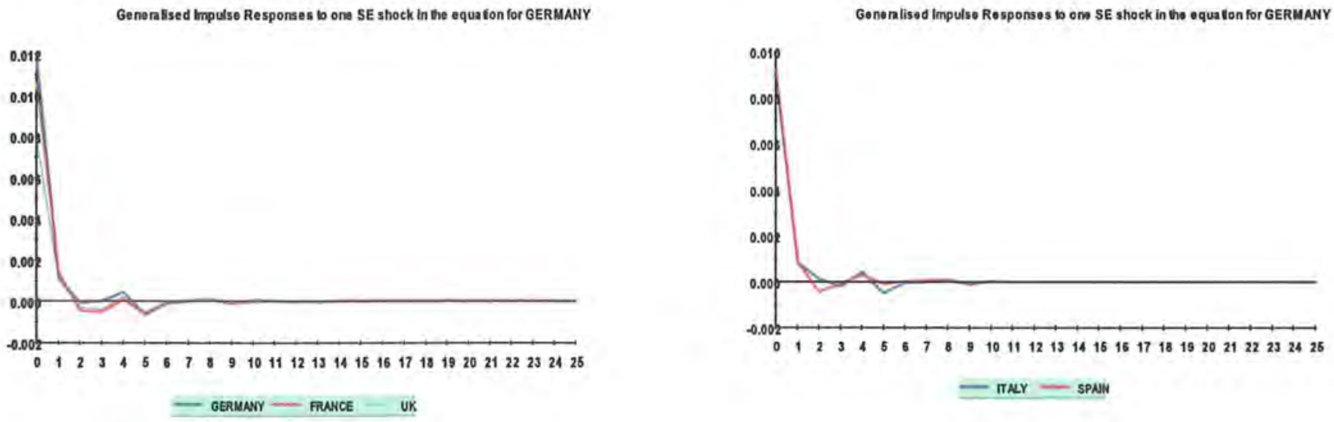
The impulse response graphs in the pre GFC period (Panel A) have been separated into a graph for responses by Germany, France and the UK and another graph to show responses of Italy and Spain. This is because the effects of the shock on the stock markets are not clearly seen if all of them fall on one graph because the responses are clustered together. The graphs for during the GFC sample period and post-GFC sample periods will be compared to assess if any changes have occurred in response patterns for the stock markets in the post-GFC sample period as compared to during the GFC sample period.

A shock to Germany (Figure 4) in the pre- GFC period (Panel A) creates an initial negative response by itself, and all the other stock returns. Germany, France and the UK respond to most of the shock by day one thereafter the responses diminish or appear to be white noise up until day six where the effect of the shock is fully incorporated. This result is similar for Italy and Spain however, Spain fully incorporates the effect of the shock faster than the other stock markets with Spain's response converging to zero by day five in comparison to day six for the other stock markets.

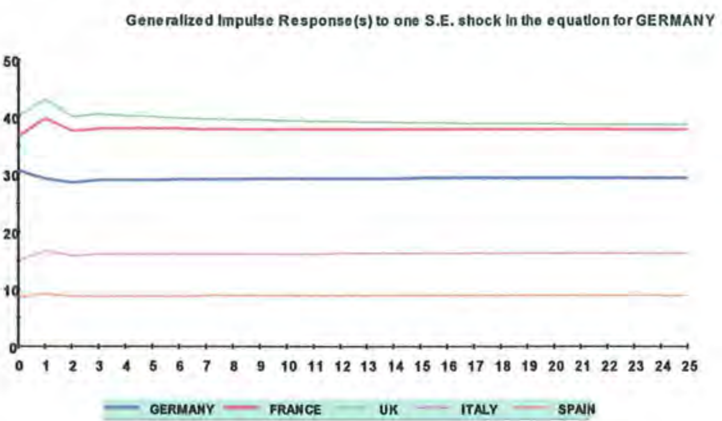
Furthermore, Germany, France and the UK have similar response patterns from day one up until the effect of the shocks wear off (day six), implying that they respond in a similar manner to shocks to Germany. These results show that all the stock markets incorporate most of the effects of the shock to Germany instantly by day one but the duration until the effects of the shocks are fully incorporated last long (six days). In Figure 4 shows that a shock to Germany during the GFC sample period (Panel B) produces an initial weak but positive response in France and the UK. Furthermore, both these stock markets have similar response patterns to a shock in Germany. This is seen with both having a positive response that peaks on day one then declines up until day two thereafter levelling off implying the effects of the shocks being fully incorporated. The effect of a shock to Germany on itself is almost non-existent with the very weak response lasting two days then tapering off. This result is more pronounced for Spain that has a horizontal graph implying that a shock to Germany has no impact on Spain whatsoever during the GFC. This result is unexpected because Spain and Germany are trade partners and thus it is expected that a shock in Germany will affect Spain to some degree. In the case of a response by Italy, the effect of a shock to Germany is weak with a small positive response that levels off at day one. The results found imply that a shock to Germany causes the most impact on the UK and France but no impact on Spain.

A shock to Germany (Figure 4) in the post-GFC sample period causes a weak and smaller response in France in comparison to during the GFC. Germany's response to a shock to itself creates a weak positive response that dies out on day one. The other stock markets are not affected by shocks to Germany with all of them appearing to have horizontal graphs.

Panel A: Pre GFC Sample Period



Panel B: During the GFC Sample Period



Panel C: Post GFC Sample Period

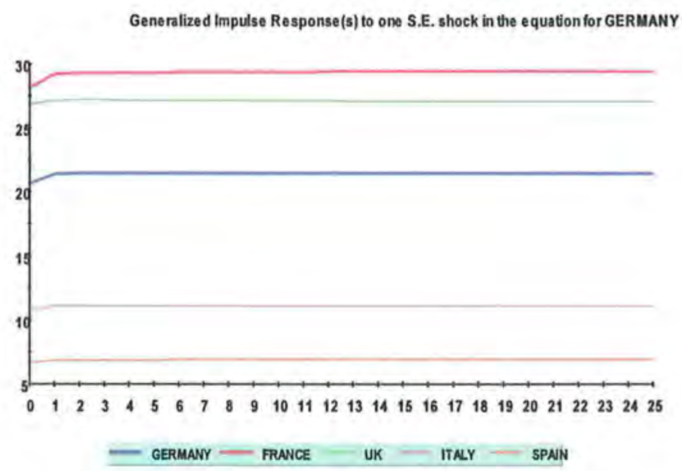


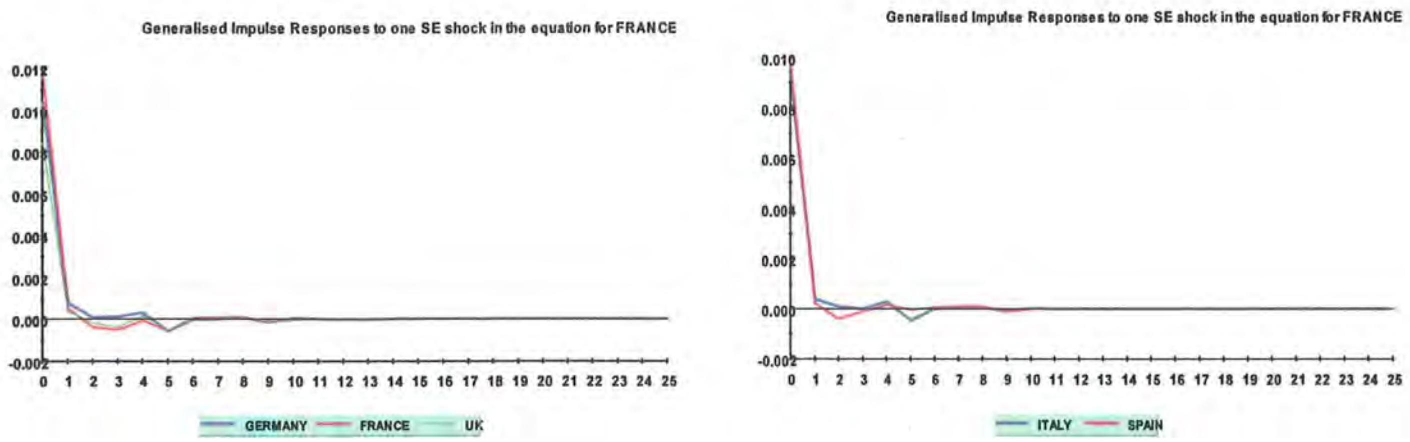
Figure 4: Generalised Impulse Response to one Standard Error Shock in the Equation for Germany

Note :Panel A: The two graphs in panel A are based on an unrestricted VAR model in first differences that includes Germany, France, UK, Italy and Spain using VAR lag order of 8.

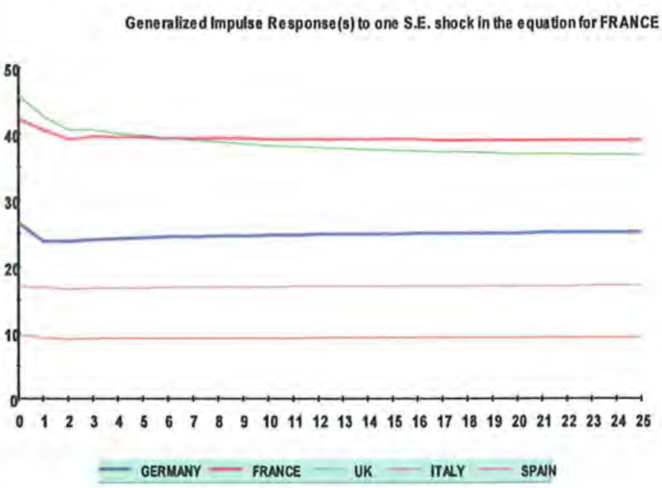
Panel B: The graph is based on a cointegrating VAR model normalized on Germany with Unrestricted Intercept and No Trend (Model 3) using VAR lag order of 2. Only the IRF graph for Model 3 has been shown due to space limitations and because the graph based on Model 4 is similar.

Panel C: The graph is based on a cointegrating VAR model normalized on Germany with Unrestricted Intercept and No Trend (Model 3) using VAR lag order of 2. Only the IRF graph for Model 3 has been shown due to space limitations and because the graph based on Model 4 is similar.

Panel A: pre GFC Sample Period



Panel B: During the GFC Sample Period



Panel C: Post GFC Sample Period

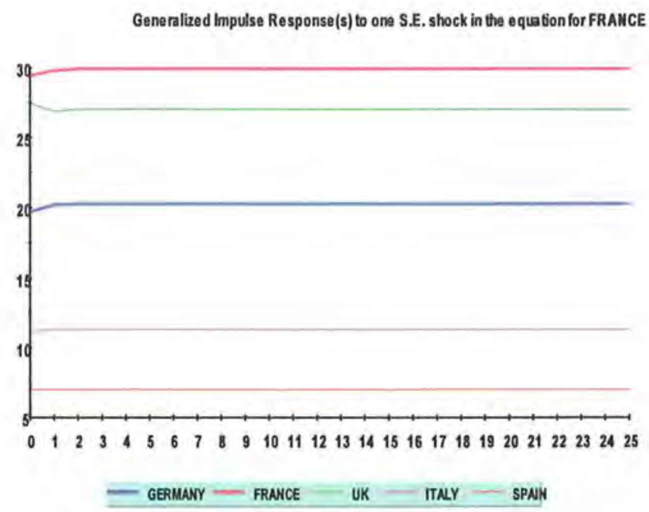
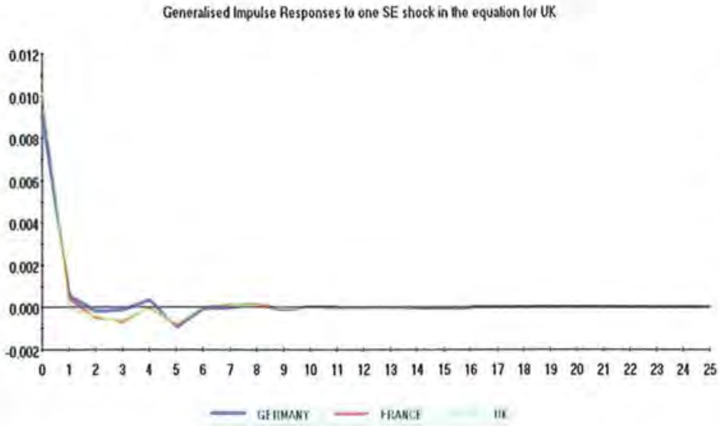
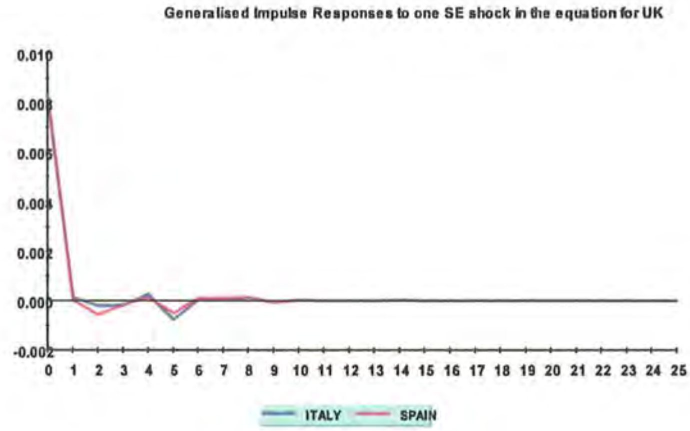


Figure 5: Generalised Impulse Response to one Standard Error Shock in the Equation for France

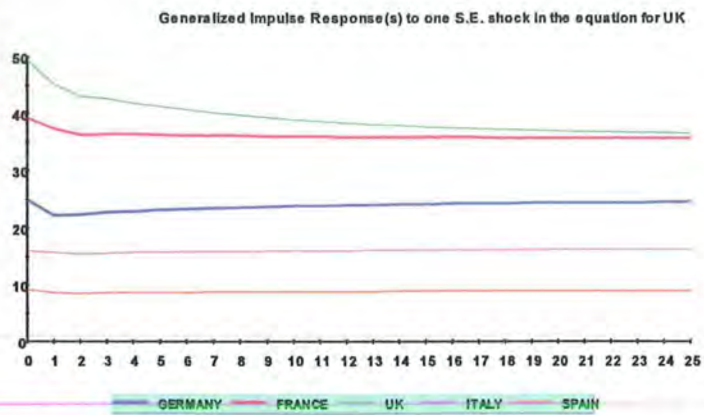
Note: Panel A: The two graphs in panel A are based on an unrestricted VAR model in first differences that includes Germany, France, UK, Italy and Spain using VAR lag order of 8.
Panel B: The graph is based on a cointegrating VAR model normalized on Germany with Unrestricted Intercept and No Trend (Model 3) using VAR lag order of 2. Only the IRF graph for Model 3 has been shown due to space limitations and because the graph based on Model 4 is similar.
Panel C: The graph is based on a cointegrating VAR model normalized on Germany with Unrestricted Intercept and No Trend (Model 3) using VAR lag order of 2. Only the IRF graph for Model 3 has been shown due to space limitations and because the graphs are similar.

Panel A: Pre GFC Sample Period





Panel B: During the GFC Sample Period



Panel C: Post GFC Sample Period

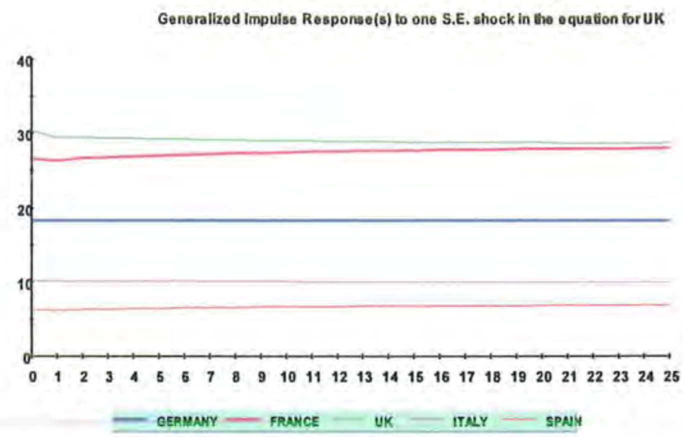
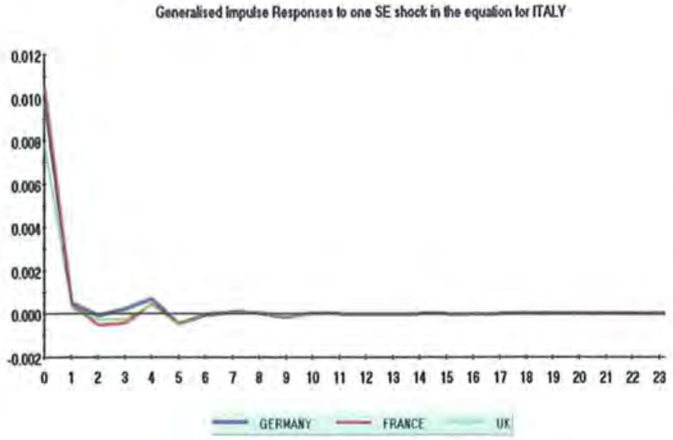
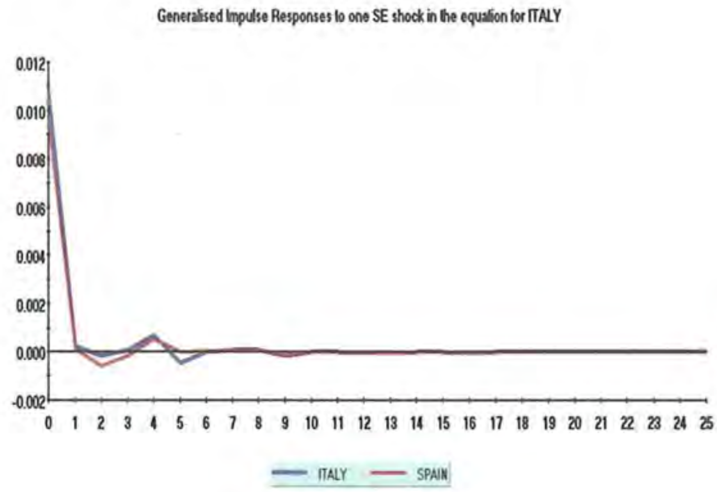


Figure 6: Generalised Impulse Response to one Standard Error Shock in the Equation for the UK

Note: Panel A: The two graphs in panel A are based on an unrestricted VAR model in first differences that includes Germany, France, UK, Italy and Spain using VAR lag order of 8.
Panel B: The graph is based on a cointegrating VAR model normalized on Germany with Unrestricted Intercept and No Trend (Model 3) using VAR lag order of 2. Only the IRF graph for Model 3 has been shown due to space limitations and because the graph based on Model 4 is similar.
Panel C: The graph is based on a cointegrating VAR model normalized on Germany with Unrestricted Intercept and No Trend (Model 3) using VAR lag order of 2. Only the IRF graph for Model 3 has been shown due to space limitations and because the graph based on Model 4 is similar.

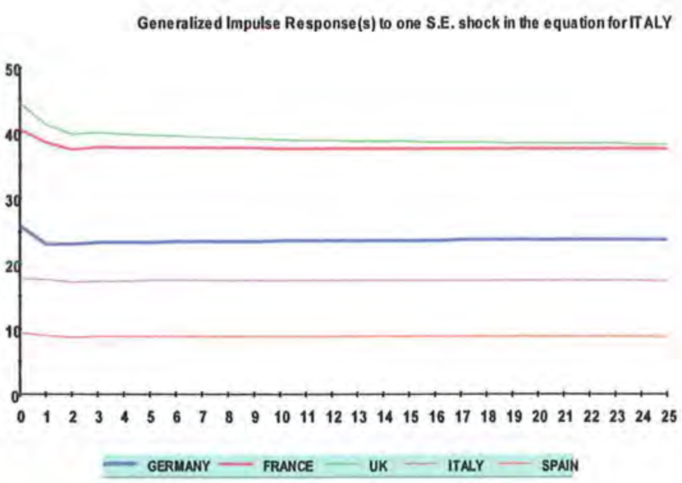
Panel A: Pre GFC Sample Period





Panel B: During the GFC Sample Period

Panel C: Post GFC Sample Period



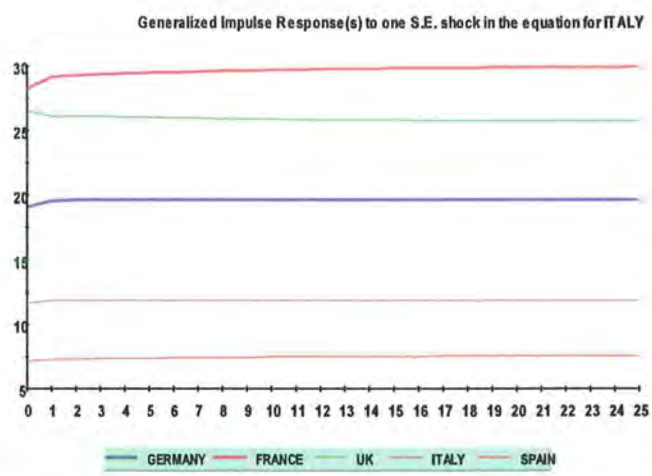
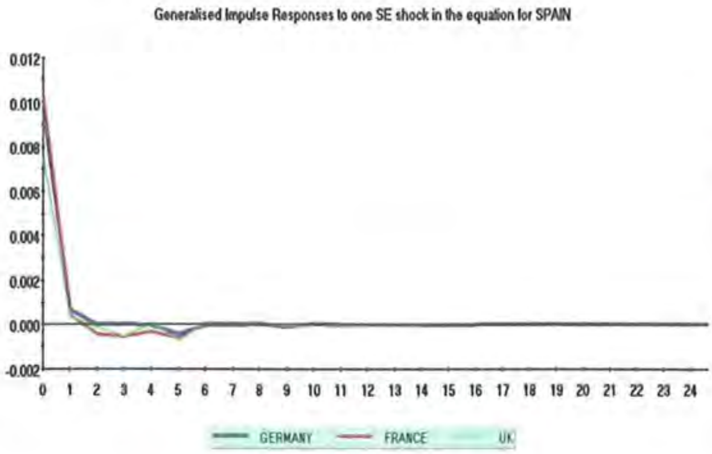
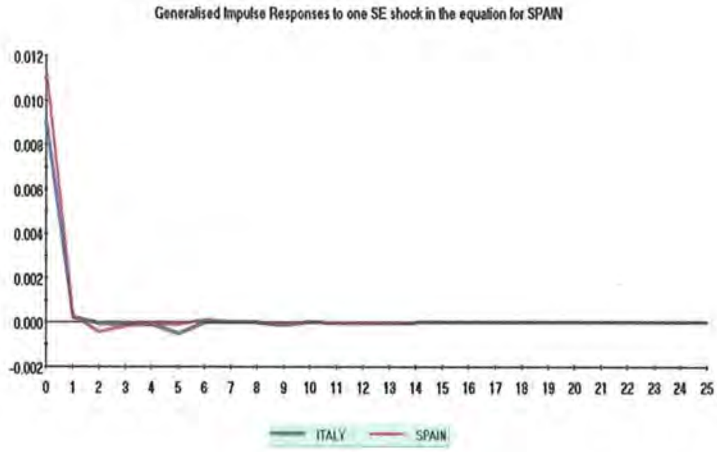


Figure 7: Generalised Impulse Response to one Standard Error Shock in the Equation for Italy

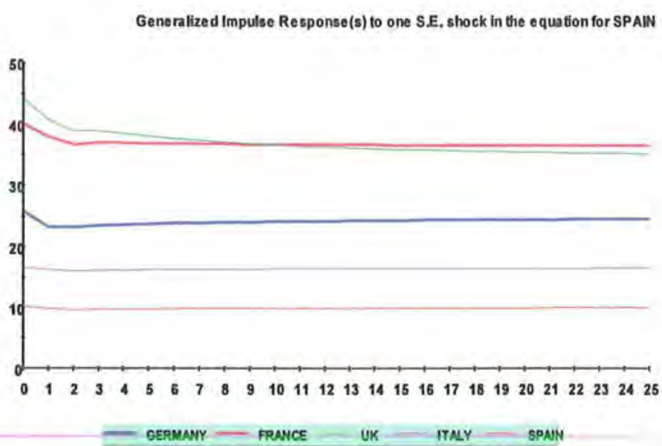
Note: Panel A: The two graphs in panel A are based on an unrestricted VAR model in first differences that includes Germany, France, UK, Italy and Spain using VAR lag order of 8.
Panel B: The graph is based on a cointegrating VAR model normalized on Germany with Unrestricted Intercept and No Trend (Model 3) using VAR lag order of 2. Only the IRF graph for Model 3 has been shown due to space limitations and because the graph based on Model 4 is similar.
Panel C: The graph is based on a cointegrating VAR model normalized on Germany with Unrestricted Intercept and No Trend (Model 3) using VAR lag order of 2. Only the IRF graph for Model 3 has been shown due to space limitations and because the graph based on Model 4 is similar.

Panel A: Pre GFC Sample Period





Panel B: During the GFC Sample Period



Panel C: Post GFC Sample Period

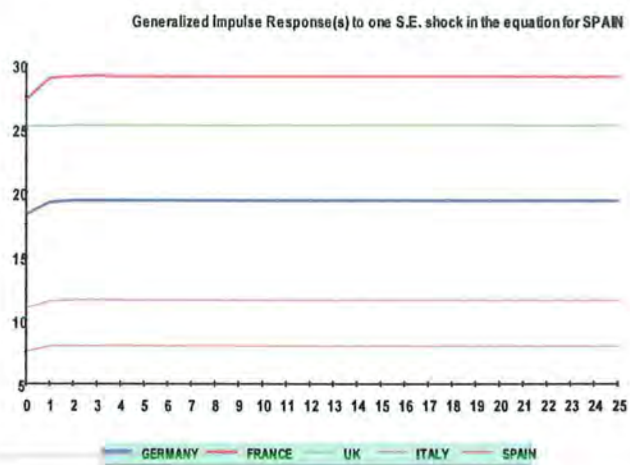


Figure 8: Generalised Impulse Response to one Standard Error Shock in the Equation for Spain

Note: Panel A: The two graphs in panel A are based on an unrestricted VAR model in first differences that includes Germany, France, UK, Italy and Spain using VAR lag order of 8.

Panel B: The graph is based on a cointegrating VAR model normalized on Germany with Unrestricted Intercept and No Trend (Model 3) using VAR lag order of 2. Only the IRF graph for Model 3 has been shown due to space limitations and because the graph based on Model 4 is similar.

Panel C: The graph is based on a cointegrating VAR model normalized on Germany with Unrestricted Intercept and No Trend (Model 3) using VAR lag order of 2. Only the IRF graph for Model 3 has been shown due to space limitations and because the graph based on Model 4 is similar.

This is in contrast to during the GFC period where the UK and Italy also respond to a shock in Germany. This implies that in the post GFC sample period, the UK and Italy are not impacted by shocks in Germany and thus, became independent stock markets as compared to during the GFC period. Furthermore, as can be seen the magnitudes of the responses in the post GFC period are smaller than during the GFC period.

The larger magnitudes of responses during the GFC could be attributed to the uncertainty, volatility and loss of confidence caused by the GFC that led to a decline in trade volume and activity. The visible negative effects on a stock market created the same effect on other stock markets due to uncertainty, thus bad news in one stock market spilled over to other stock markets making them have a higher influence on each other. The post GFC results show evidence of recovery or stabilisation from the GFC as the magnitudes of the responses are smaller implying more confidence in the stock markets.

A shock to France (Figure 5) in the Pre GFC period (Panel A) has an initial negative effect on itself, Germany, the UK, Italy and Spain. The duration at which the shocks get fully incorporated is six days with diminished responses or white noise occurring from day one up until day six. This result provides evidence to show that all the stock markets incorporated most of the effects of the shock by day one in the pre GFC period with the responses fluctuating very close to zero from day one, implying most of the effect of the shock being incorporated instantaneously. Spain has the shortest duration in fully incorporating the effects of the shock with the response by Spain flattening out to zero by day four in contrast to day six for the other stock markets. This result highlights Spain's shorter duration in fully incorporating a shock to France in comparison to the other stock markets and this quick response relative to the other stock markets is also evidenced when Germany is shocked.

A shock to France during the GFC (Panel B) causes negative initial responses in the UK, France and Germany with the UK having the strongest response out of the three stock markets. The effects of the shocks in France and the UK are fully incorporated by day two thereafter levelling off for France but gradually declining for the UK. Germany on the other hand has the most instant response with its response tapering off at day one. The effect of a shock to France on Italy and Spain is non-existent with their graphs being horizontal in nature. In comparison in the post GFC period, the only stock markets that appear to have a response even if the responses are very small and almost non-existent, are the UK and Germany .The other stock markets graphs are horizontal in nature implying a shock to France has no impact on these stock markets. Furthermore, in the post GFC period, the magnitude of the responses decline significantly in comparison to during the GFC period as per the justification when Germany was shocked. Thus, this can be interpreted as a decline in interdependencies or the growing independence of the stock markets explaining the result of not being affected by a shock to France.

A shock to the UK (Figure 6) in the pre GFC sample period (Panel A) appears to create initial negative responses by Germany, France, the UK, Italy and Spain (Panel A) with the effects of the shocks being fully incorporated by day six for all stock markets. Furthermore, for all the stock markets, most of the effects of the shock are incorporated by day one with the responses fluctuating around zero implying a speedy incorporation to most of the effects of a shock to the UK.

During the GFC sample period (Panel B) a shock to the UK creates initial negative responses in Germany, France and in its own stock market. France fully incorporates the effect of the shock by day two while the UK appears to have a gradual decline in its graph. Germany fully incorporates the effect of a shock to the UK by day one thus having the fastest speed in fully incorporating the effects of the shock. Italy and Spain are not affected by a shock to France with their graphs being horizontal in nature. In the post GFC sample period (Panel C), all the graphs appear horizontal with the exception of the UK which has a small response that is almost non-existent. This result implies that in the post GFC sample period there has been a decrease in the number of stock markets impacted by a shock to the UK or the increase in the independence of the stock markets. This result is supported by the VECM results where none of the stock markets are significantly affected by lagged values of the UK in the post GFC sample period. This result is unexpected due to the close economic, trade and investment ties that link these countries.

A shock to Italy (Figure 7) in the pre GFC sample period (Panel A) produces initial negative responses in all the stock markets with the responses being very close to zero by day one and thereafter fluctuating around zero (white noise) up until the sixth day where the effects of the shock wear off implying full incorporation of the effects of the shock to Italy. However Spain's response levels off at day five further highlighting Spain's speedy incorporation of effects of shocks relative to the other stock markets. The responses to the shock are very close to zero by day one implying that most of the effects of the shock are incorporated by day one or are instant.

A shock to Italy (Figure 7) during the GFC (Panel C) period creates an initial negative response in France, the UK and Germany with Germany fully incorporating the effect of the shock by day one in comparison to day three for France and the UK. France and the UK appear to have similar response patterns and this result is also found when the UK (Figure 3, Panel B) and France (Figure 2, Panel B) are shocked. Furthermore, a shock to Italy has no impact on itself or Spain with the graphs being horizontal. In comparison during the post GFC period (Panel C), a shock to Italy appears to have a very minimal, almost non-existent impact on France, the UK and Germany with the other graphs being horizontal in nature implying that a shock to Italy has no impact on them. This result highlights the reduction in interdependencies among these European stock markets in the post GFC sample period. Furthermore as mentioned earlier the magnitudes of the responses are much higher during the GFC than in the post GFC sample period.

The effect of a shock to Spain (Figure 8) on the other stock markets (Panel A) causes an initial negative response that fluctuates below but close to the zero mark, up until day six where the effect of the shocks taper off. In terms of speed of incorporation of effects of the shock, France, Germany and the UK incorporate most of the effect of the shock by day one. Italy and Spain (Panel A) have similar response patterns too. Spain fully incorporates the effect of the shock to itself by day three while Italy's response lasts twice that of Spain tapering off at day six like Germany, France and the UK.

This result further highlights the finding that Spain has the shortest duration in fully incorporating effects of a shock. During the GFC period (Panel B), a shock to Spain causes an initial weak negative response in the UK, France and Germany with Germany fully incorporating the response by day one in comparison to day two for the UK and France. The response patterns of these three stock markets are similar to the responses when Italy (Figure 7) is shocked. As can be seen the UK's response gradually declines as time goes by.

In the post GFC sample period, a shock to Spain creates a minimal positive response in France and Germany with the response being fully incorporated by day one for both stock markets. The UK, Italy and Spain do not get impacted by a shock to Spain. Thus, the impact of a shock to Spain on the UK decreases in the post GFC period as compared to during the GFC period. Furthermore, fewer stock markets are impacted by a shock to Spain in the post GFC period in comparison to during the GFC. The finding of larger responses to shocks during the GFC is further highlighted.

To conclude the GIRF analysis for the European stock markets, a summary of the main findings are put forward. A very important finding is that during the GFC period there is a visible increase in the magnitude of the responses as compared to the Pre GFC period or in comparison to the post GFC period. This result as explained earlier could be attributed to the negative effect the GFC had causing uncertainty and loss in confidence by investors. The loss in confidence combined with high volatility induced a reduction in the willingness to invest and might have caused investors to sell shares to prevent further losses leading to a reduction in trade activity and volume. These events lead to downward pressure on stock prices thus signs of bad news being picked up by other stock markets and as a result, shocks (bad news) in one stock market create larger responses by other stock markets than in stable conditions. This increase in magnitude appears to be temporary because in the post GFC period there is a reduction in the magnitudes of the responses.

Furthermore, most of the effects of a shock during the GFC period take longer to be fully incorporated. In assessing the response patterns in the Pre GFC period by the European stock markets, the results generally show that by day one most of the effects of the shock are fully incorporated thereafter the responses diminish until they taper off. Furthermore, Spain appears to have the quickest duration in fully incorporating effects of shocks to other stock markets.

In the case of Germany's response to a shock in France (Figure 5), the UK (Figure 6), Italy (Figure 7) and Spain (Figure 8) during the GFC (Panel C in all figures), the responses are all similar with the effects of the shock being initially negative and instantaneous tapering off at day one. The finding of Germany being influenced by these stock markets provides evidence that Germany is not completely isolated from these stock markets. A possible reason explaining the negative effect on Germany, France and the UK due to shocks to France, Italy, UK and Spain can be attributed to a decline in direct stock market investment by these European Union stock markets in each of the countries shocked due to uncertainty during the GFC crisis period thus causing negative responses/effects in Germany, France and the UK as a result of these actions.

Italy and Spain appear to be the stock markets that are the least affected by shocks in other stock markets highlighting their independence relative to France, the UK and Germany. Italy is not affected by France and the UK and Spain is not affected by France, the UK and Germany.

In general, in the post GFC sample period, there are fewer stock markets affected by shocks in each individual stock market in comparison to during the GFC sample period. During the GFC the only stock market not affected by any stock market is Spain followed by Italy that is only affected by a shock to Germany. In contrast, in the post GFC sample period the UK does not respond to Germany or Spain unlike during the GFC, Germany also does not respond to the UK in the post GFC sample period unlike during the GFC period and France has a very minimal almost non-existent response to a shock in Italy in comparison to during the GFC period.

Furthermore, all the responses are smaller in comparison to during the GFC. Thus, it can be concluded that there seems to be less interdependencies as well as lower interdependencies among the European stock markets in the post GFC sample period as compared to during the GFC sample period.

5.9.3 Generalised Impulse Response Results (Asian Stock Market):

In the case of the Asian stock markets since cointegration is found in the Pre-GFC sample period, the impulse response analysis is based on Model 3 which has the strongest results compared to Model 2.

Since cointegration has not been found during the GFC and post the GFC, the Impulse response analysis is based on an unrestricted VAR model using first differences of the levels. As a result, the pre GFC results cannot be compared to the results during the GFC and in post the GFC thus, the pre GFC results have been analysed on their own but the results during the GFC and in the post GFC will be compared because they are both based on first differences. This is in order to assess if there have been changes in the response patterns of the stock returns.

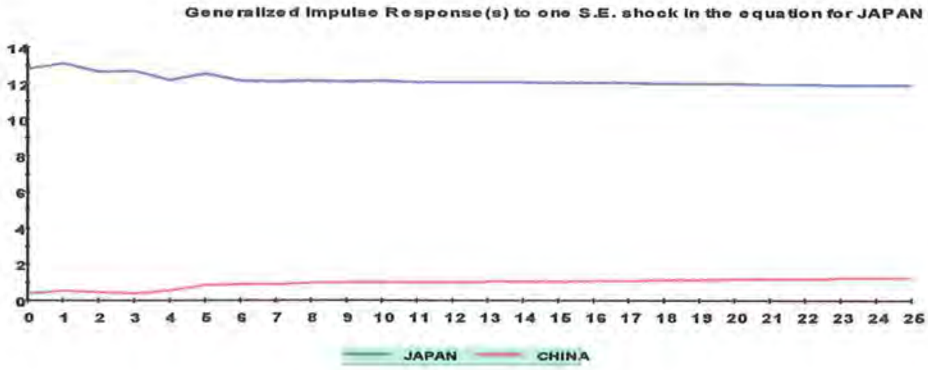
A shock to Japan (Figure 9) in the pre GFC period (Panel A) causes a very minimal and weak response in in its own stock market with the response appearing to be white noise. The effect of the shock lasts until day six where it is fully incorporated. China's response is very small and close to zero but China's response increases from day three to day five thereafter levelling off. Thus, the time taken to fully incorporate the effect of a shock in Japan is not instant and takes up to six days to get fully incorporated.

A shock to Japan (Figure 9) during the GFC sample period (Panel B) causes a negative response by both Japan and China with Japan having the larger response. China fully incorporates the effect of the shock by day two while Japan does so by day three implying that China takes a shorter duration to fully respond to shocks in Japan. In contrast, a shock to China (Figure 10) causes a smaller response on Japan than a shock to Japan causes on China. In the post GFC sample period (Figure 9, Panel C), a shock to Japan still causes a larger response in itself than in China as was seen during the GFC. The effects of the shocks last longer for both stock markets with China fully incorporating the effect of the shock by day three in comparison to day two during the GFC period and Japan fully incorporating the effect of shocks to itself by day four in comparison to day three during the GFC.

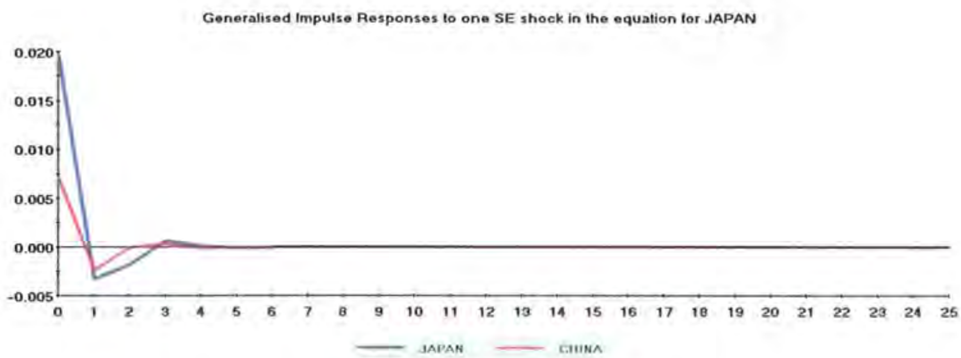
Furthermore, the magnitudes of the responses are larger during the GFC as compared to the post GFC sample period with the reasoning for this being highlighted in the previous GIRF analysis of the American and European stock markets. In concluding the GIRF analyse for all stock markets, the most prominent result for all stock markets is that there is a temporary increase in the size of the responses during the GFC sample period for all stock markets, with all stock markets having larger responses to shocks in other stock markets from the same region. Furthermore, the duration at which these stock markets fully incorporate the effects of the shock during the GFC is longer than in the pre or post GFC sample periods.

An exception is the responses by Japan and China when China is shocked during the GFC period, with both stock markets having an instant response and fully incorporating the effects of the shocks by day one. In general, the results show that the GFC had an effect on both the magnitude of the responses and the duration at which shocks are fully incorporated.

Panel A: Pre GFC Sample Period



Panel B: During the GFC Sample Period



Panel C: Post GFC Sample Period

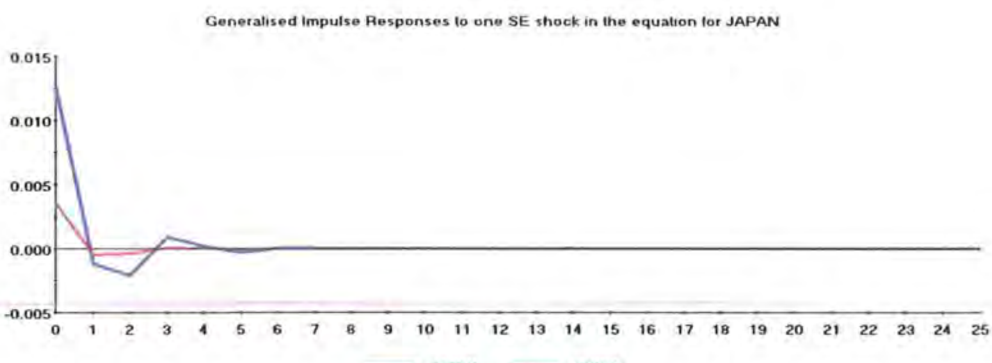


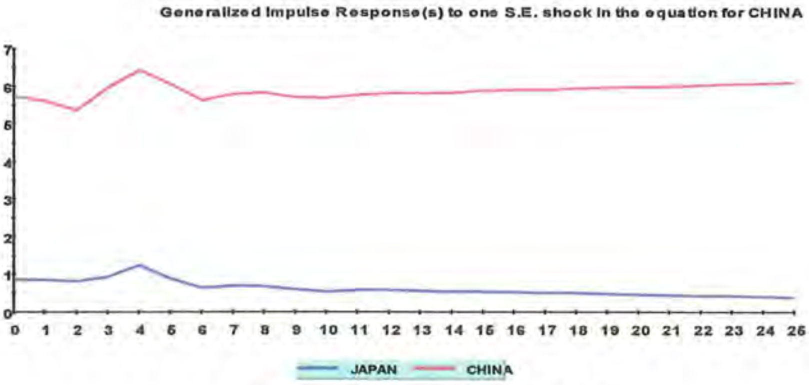
Figure 9: Generalised Impulse Response to one Standard Error Shock in the Equation for Japan

Note: Panel A: The above graph represents the Generalised Impulse Responses of Japan and China based on a cointegrating VAR model normalized on Japan with Unrestricted Intercept and No Trend (Model 3) using VAR lag order of 7. Only the IRF graph for Model 3 has been shown due to space limitations and because the graph based on Model 2 is similar.

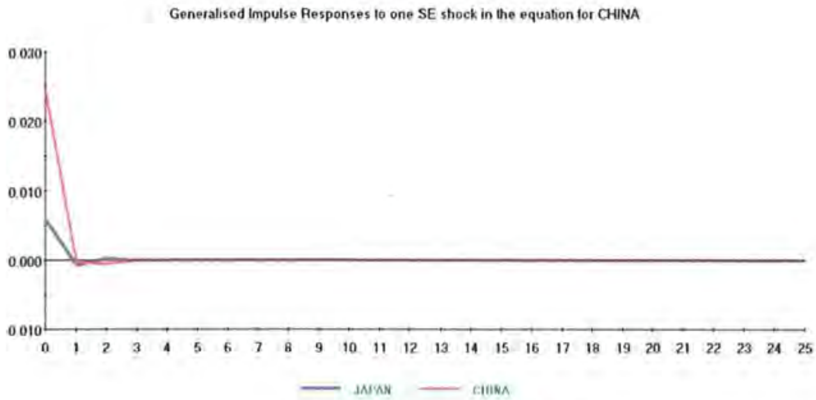
Panel B: The above graph represents the Generalised Impulse Responses for Japan and China to a one standard error shock in Japan. The graph is based on an unrestricted VAR model in first differences that consists of Japan and China using VAR lag order of 3. This is because no cointegration was found in this sample period thus analysis is based on first differences.

Panel C: The above graph represents the Generalised Impulse Responses for Japan and China to a one standard error shock in Japan. The graph is based on an unrestricted VAR model in first differences that consists of Japan and China using VAR lag order of 3. This is because no cointegration was found in this sample period thus analysis is based on first differences.

Panel A: Pre GFC Sample Period



Panel B: During the GFC Sample Period



Panel C: Post GFC Sample Period

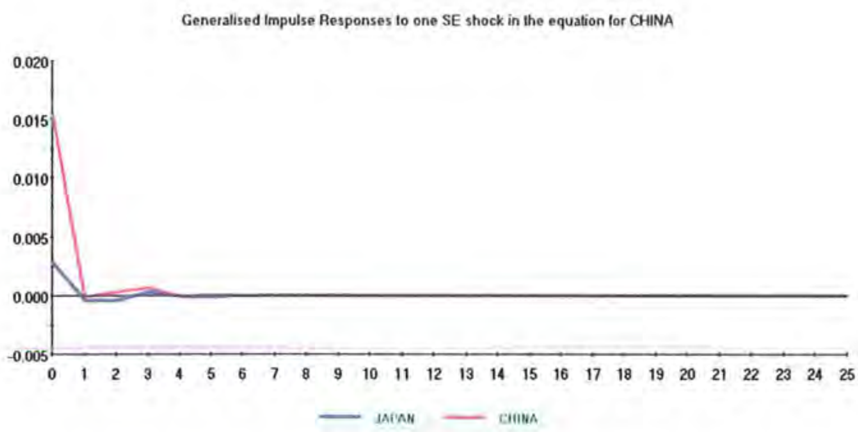


Figure 10: Generalised Impulse to one Standard Error Shock in the Equation for China

Note: Panel A: The above graph represents the Generalised Impulse Responses of Japan and China based on a cointegrating VAR model normalized on Japan with Unrestricted Intercept and No Trend (Model 3) using VAR lag order of 7. Only the IRF graph for Model 3 has been shown due to space limitations and because the graph based on Model 2 is similar.

Panel B: The above graph represents the Generalised Impulse Responses for Japan and China to a one standard error shock in Japan. The graph is based on an unrestricted VAR model in first differences that consists of Japan and China using VAR lag order of 3. This is because no cointegration was found in this sample period thus analysis is based on first differences.

Panel C: The above graph represents the Generalised Impulse Responses for Japan and China to a one standard error shock in Japan. The graph is based on an unrestricted VAR model in first differences that consists of Japan and China using VAR lag order of 3. This is because no cointegration was found in this sample period thus analysis is based on first differences.

5.10 Generalized Forecast Error Variance Decompositions (GFEVD):

The generalised forecast error variance decomposition (GFEVD) analysis provides results on the percentage/ proportion of forecast error variance for each individual stock market explained by innovations/shocks to its own market and the forecast error variance explained by shocks to each individual variable in the system.

As mentioned earlier in the methodology section, the GFEVD do not add up to a 100% due to the non-zero covariance of the error terms and thus, one cannot assess the combined effect of all stock markets on a specific stock market. The GFEVD results provide evidence on which stock markets are the most exogenous. The most exogenous stock market is the one that has the highest percentage of forecast error variance explained by its own market. Furthermore, GFEVD provides evidence on the most endogenous stock market defined as the stock market with the highest forecast error variance explained by each of the other stock markets. Evidence of the least affected (least endogenous) stock market is also provided. The information of which stock markets are least or most affected by other stock markets is beneficial for investors to base portfolio diversification decisions.

The GFEVD analysis has been carried out in each sample period, for each region to analyse whether there has been a change in the most affected, least affected and most exogenous stock markets. In the case of the European stock markets, no cointegration was found in the Pre GFC period thus the GFEVD results in the Pre GFC period are based on first differences.

On the other hand, during the GFC and in the post GFC period cointegration is present among the European stock markets. As a result, the GFEVD results are based on the cointegrating relationship found in the two sample periods. This makes the Pre GFC sample period results incomparable to that of during the GFC results and the post GFC results because the pre GFC GFEVD results are based on first differences while the GFEVD during the GFC and in the post GFC periods are based on levels. As a result, the Pre GFC results will be analysed on their own but the results during the GFC and in the post GFC period will be compared because they are both based on a cointegrating relationship and thus are based on levels.

This is also the case with the Asian stock markets where cointegration is found in the Pre GFC period but not during the GFC and in the post GFC period. Thus, the pre GFC GFEVD are based on the cointegrating relationship found while the GFEVD results during the GFC and in the post the GFC period are based on first differences. As a result, the Pre GFC GFEVD results will be analysed on their own but the results during the GFC and in the post GFC will be compared to evaluate any changes.

5.10.1 Generalized Forecast Error Variance Decompositions Results (American Stock Markets)

In the pre GFC sample period (Figure41, Panel A), the USA explains a higher range of Canada's forecast error variance (16.109% to 29.728%) in comparison to explaining only 14.157% to 15.762% of Brazil's forecast error variance over the whole time horizon. This finding is supported by Liu et al (2005) who find that the USA explains more of Canada's FEVD than a Latin-American stock market. During the GFC sample period (Panel B), the USA explains 39.200% to 48.309% of Canada's forecast error variance in comparison to 38.882% to 44.642% of Brazil's forecast error variance over the whole time horizon. In the post GFC sample period, the USA explains 67.358% to 79.321% of Canada's forecast error variance in comparison to 53.525% to 62.269% of Brazil's forecast error variance over the whole time horizon. These results highlight the high interdependency between Canada and the USA as compared to the USA and Brazil. This result is further supported with the GIRF analysis where it is shown that Canada has a bigger response to a shock in the USA than Brazil, implying Canada is more interdependent because it is affected more by shocks to the USA than Brazil is.

Furthermore, the above values show that during the GFC there was an increase in interdependencies between the stock markets and this is more pronounced in the post GFC sample period. This result can be attributed to the fact that the effects of GFC spread globally due to investors investing in toxic subprime mortgage backed securities that were sold and distributed to foreign investors globally (Poole, 2010). As a result, foreign investors were linked to the USA's financial markets therefore, due to these financial linkages, a shock to anyone of the stock markets caused significant impacts on other stock markets thus, leading to stock markets explaining more of other stock markets forecast error variance. In assessing which stock market is the least endogenous in the pre GFC sample period (Panel A), the results show that Brazil is the least endogenous (least affected) stock market in the pre GFC sample period because the USA and Canada both explain the least amount of Brazil's forecast error variance while the USA explains more of Canada's forecast error variance than Brazil's forecast error variance.

Furthermore, Canada explains more of the USA's forecast error variance than Brazil's. This reasoning is shown below:

- The USA explains 16.109% to 29.728% of Canada's forecast error variance in comparison to explaining a lower range of forecast error variance for Brazil of 14.157% to 14.7999%.

Table 38: Generalised Forecast Error Variance Decomposition Results (American Stock Markets)

Forecast Error Variance explained by:	Day	Panel A – Pre GFC Sample Period			Panel B - During the GFC Sample Period			Panel C - Post GFC Sample Period		
		Percentage of Forecast error Variance for:			Percentage of Forecast error Variance for:			Percentage of Forecast error Variance for:		
		USA	Brazil	Canada	USA	Brazil	Canada	USA	Brazil	Canada
USA	1	0.99996	0.14799	0.29728	0.98874	0.44642	0.48309	0.99237	0.53525	0.67358
	7	0.99616	0.15762	0.25927	0.99022	0.41493	0.46875	0.97935	0.58660	0.73543
	14	0.99160	0.15512	0.23383	0.98719	0.40531	0.44587	0.97075	0.60352	0.76133
	28	0.97852	0.14842	0.19317	0.97827	0.39428	0.41009	0.96186	0.61713	0.78379
	42	0.96210	0.14157	0.16109	0.97294	0.38882	0.39200	0.95786	0.62269	0.79321
Brazil	1	0.16689	0.99691	0.27019	0.56267	0.97905	0.59911	0.46787	0.99811	0.60414
	7	0.19467	0.99298	0.29165	0.63876	0.95893	0.64257	0.47142	0.99869	0.60827
	14	0.20462	0.99222	0.28087	0.67551	0.93556	0.59236	0.47410	0.99922	0.60249
	28	0.21311	0.98834	0.24978	0.69100	0.89801	0.50904	0.47682	0.99958	0.59552
	42	0.21760	0.98043	0.22044	0.69337	0.87753	0.46748	0.47805	0.99970	0.59219
Canada	1	0.35061	0.27764	0.99048	0.66342	0.59729	0.97026	0.68610	0.61589	0.99145

	7	0.44125	0.33963	0.96050	0.81871	0.62642	0.88552	0.77462	0.62821	0.96475
	14	0.48538	0.35728	0.94036	0.89006	0.63195	0.76829	0.82644	0.61753	00.93275
	28	0.55478	0.38420	0.89296	0.92250	0.61331	0.61456	0.87752	0.59775	0.88759
	42	0.61284	0.40358	0.83610	0.92653	0.59877	0.54149	0.90168	0.58610	0 .86265

Note: **Panel A:** Shows the GFEVD results in the pre GFC sample period and there are 1806 observations in this sample period. The above GFEVD results in this sample period are based on cointegrating VECM model normalized on the USA estimated with Unrestricted Intercept and Restricted trend (Model 4) using a lag order of 4 as chosen by the AIC and a rank = one. The list of variables in the cointegrating model is USA, Brazil and Canada. **Columns three to five** represent the forecast error variance decompositions of USA, Brazil and Canada explained by innovations to the stock markets in rows over a forecast horizon shown in column two.

Panel B: Shows the GFEVD results during the GFC sample period and there are 500 observations. The results in this sample period are based on a cointegrating VAR model normalized on the USA estimated with unrestricted Intercept and Restricted Trend using a lag order of 5 as chosen by the AIC and rank=one. Only the Model four results are displayed and not Model Five due to space limitations and because the results for both Model 4 and 5 are similar. The list of variables in the cointegrating model is USA, Brazil and Canada. **Columns six to eight** represent the forecast error variance decompositions of USA, Brazil and Canada explained by innovations to the stock markets in rows over a forecast horizon shown in column two.

Panel C: Shows the GFVED results in the post GFC sample period and there are 484 observations. The above GFEVD results are based on a cointegrating VAR model normalized on the USA estimated with Unrestricted Intercept and Restricted trend using a lag order of 2 as chosen by the AIC and rank = one. Only the Model 4 results are displayed and not Model 3 due to space limitations and because Model 4's results are stronger than Model 3's results in the cointegration tests. The list of variables in the cointegrating model is USA, Brazil and Canada. Columns nine to eleven represent the forecast error variance decompositions of USA, Brazil and Canada explained by innovations to the stock markets in rows over a forecast horizon shown in column two.

- Canada explains 35.061% to 61.284% of USA's forecast error variance in comparison to explaining a lower range of forecast error variance for Brazil of 27.764% to 40.35%.

The above results provide evidence to show that Brazil is the least endogenous stock market in the pre GFC sample period (Panel A).

Similarly, Brazil is still the least endogenous stock market during the GFC sample period (Panel B) but there has been an increase in the forecast error variance of Brazil explained by Canada and the USA during the GFC. There has also been an increase in Canada's forecast error variance explained by the USA and Brazil during the GFC in comparison to the pre GFC sample period. Brazil's minimum forecast error variance in the pre GFC period was 14.157% which increased to 38.882% during the GFC (Panel B). In the case of Canada, its minimum forecast error variance in the pre GFC period was 16.109% which increased to 39.200% during the GFC (Panel B).

Brazil still remains the least endogenous stock market in the post GFC period (Panel C) but there has been an increase in the forecast error variance of Brazil explained by the USA in comparison to the pre GFC period and during the GFC period. In the case of Canada explaining Brazil's forecast error variance, comparing the pre GFC period and during the GFC there is an increase in the forecast error variance explained by Canada but comparing the results during the GFC to that of the post GFC, there is a slight decrease in the percentage of forecast error variance for Brazil explained by Canada.

There has also been an increase in Canada's forecast error variance explained by the USA in the post GFC period (Panel C) in comparison to the pre GFC period and during the GFC sample period. Brazil's minimum forecast error variance in the post GFC period further increases to 53.525% which is larger than its minimum forecast error variance of 14.157% in the pre GFC period (Panel A) and 38.882% during the GFC sample period (Panel B). In the case of Canada, its minimum forecast error variance explained by a shock to the USA was 16.109% in the pre GFC period which increased to 39.200% during the GFC and further increased to a minimum of 59.219% in the post GFC sample period.

The finding of Brazil being the least endogenous (least affected) can be explained because Brazil is still an emerging stock market and thus is not as open an economy unlike Canada and as a result, interdependencies are higher between Canada and the USA than between the USA and Brazil. This result is supported by Liu et al (2005) who find that interdependencies are higher between the USA and Canada than the USA and Latin American stock markets.

The above results also show that there has been an increase in the contribution of other markets in explaining the forecast error variance for each individual market implying an increase in interdependencies. A similar finding is documented by Masih & Masih (1997) and Worthington & Higgs (2004) as a result of the Asian crisis of 1997.

In terms of the most endogenous stock market in the pre GFC sample period (Panel A), the results show that Canada is the most endogenous (most affected) stock market. This is shown by the other individual stock markets explaining the highest forecast error variance for Canada as compared to the lower forecast error variance USA explains for Brazil and vice-versa. This rationalising can be shown in the values below:

- The USA explains 16.109% to 29.728% of Canada's forecast error variance in comparison to explaining only 14.157% to 14.799% of Brazil's forecast error variance (the USA explains more forecast error variance for Canada than Brazil).
- Brazil explains 22.044% to 29.165% of Canada's forecast error variance in comparison to Brazil explaining only 16.1609% to 21.760% of the USA's forecast error variance (Brazil explains more forecast error variance for Canada than for the USA).

Canada remains the most endogenous stock market in the post GFC period (Panel C) but during the GFC period (Panel B) the USA appears to be the most endogenous stock market with Brazil explaining a range of 56.267% to 69.337% of the USA's forecast error variance in comparison to explaining a lower range of Canada's forecast error variance of 46.748% to 64.257%.

Furthermore, Canada explains 66.342% to 92.653% of USA's forecast error variance in comparison to a lower range of Brazil's forecast error variance of 59.729% to 63.195% thus; this provides evidence of the USA being the most endogenous. In comparing the pre GFC period to during the GFC period, the most endogenous stock market changes from Canada in the pre GFC sample period (Panel A) to the USA during the GFC sample period (Panel B) but then changes back to Canada in the post GFC sample period (Panel C). This result implies that there was a temporary change in the most endogenous stock market during the GFC sample period.

Moving on to the most exogenous stock market in the pre GFC sample period (Panel A), the results show that the USA explaining 99.996% of its own forecast error variance is the most exogenous stock market at time horizon one in comparison to Brazil (99.691%) and Canada

(99.048%). In contrast, at time horizon 42 Brazil is the most exogenous stock market explaining 98.043% of its own forecast error variance in comparison to the USA explaining 96.210% of its own forecast error variance and Canada explaining 83.610% of its own forecast error variance.

During the GFC sample period (Panel B), the USA is the most exogenous at all-time horizons with the USA having a higher minimum forecast error variance of 97.294% in comparison to Brazil's (87.753%) and Canada's (54.149%) minimum forecast error variance. In the post GFC sample period (Panel C), Brazil is the most exogenous stock market at all time horizons, having a higher minimum forecast error variance of 99.811% in comparison to the USA which has a minimum forecast error variance of 95.786% and Canada which has minimum forecast error variance of 86.265%. To conclude, a noticeable result is that for Brazil and Canada, during the GFC (Panel B) there is a reduction in the percentage of forecast error variance explained by own markets in all time horizons in comparison to the pre GFC sample period. This result is more pronounced for Canada during the GFC period (Panel B) at horizon 42 where Canada explains only 54.149% of its own forecast error variance in comparison to Brazil explaining 87.753% of its own forecast error variance at the same time horizon.

This is in comparison to the pre GFC period where Canada explains 83.610% of its own variance and Brazil explains 98.043% of its own forecast error variance at time horizon 42. This result is also similar for the USA where at all time horizons except horizon 42, the USA explains more of its own forecast error variance in the pre GFC period as compared to during the GFC period. This result can be attributed to the fact that during the GFC more of the stock markets forecast error variance was being explained by the other stock markets and thus less by their own markets as a result of higher financial linkages among investors globally as a result of the selling and distributing of toxic mortgage backed securities globally. Thus, a shock to anyone of the stock markets caused significant impacts on other stock markets due to these financial ties and therefore leading to stock markets explaining more of other stock markets forecast error variance.

5.10.2 Generalized Forecast Error Variance Decompositions Results (European Stock Markets)

In the case of the European stock markets, since no cointegration is found in the pre GFC sample period, the GFEVD is based on the first differences of the European stock markets. In contrast during the GFC period and in the post GFC period, cointegration is found thus the GFEVD is based on the cointegrating relationship found. More information is given in the notes below Table 42. Furthermore, the pre GFC results (Panel A) cannot be compared to that of during (Panel B) the GFC results and the post GFC results (Panel C) because the pre GFC results are based on first differences while the results during and post the GFC are based on levels. Due to space limitations on each page, the Post GFC sample period results are included in a separate table.

In the pre-GFC sample period (panel A), the results show that the UK is the least explained (least affected) stock market. Since the UK is the least explained stock market this means that it is the most independent (least endogenous) stock market in comparison to the rest of the stock markets. This is because the other stock markets explain a higher forecast error variance for each of the other individual stock markets in comparison to the percentage of forecast error variance they explain for the UK, which is lower.

Table 39: Generalised Forecast error Variance Decomposition Results (European Stock Markets - Pre GFC and During GFC)

Forecast Error Variance explained by:	Day	Panel A – Pre GFC Sample Period					Panel B - During the GFC Sample Period				
		Percentage of Forecast error Variance for:					Percentage of Forecast error Variance for:				
		Germany	France	UK	Italy	Spain	Germany	France	UK	Italy	Spain
Germany	1	0.99395	0.79080	0.58518	0.71088	0.66162	0.99385	0.70813	.61654	.66403	0.66439
	7	0.96268	0.76561	0.57461	0.69383	0.63851	0.99331	0.70071	.62328	.64750	0.66046
	14	0.95544	0.76375	0.57788	0.69113	0.63484	0.99114	0.70661	.63989	.64414	0.66651
	28	0.95534	0.76368	0.57790	0.69110	0.63475	0.98725	0.71351	.65820	.64115	0.67329
	42	0.95534	0.76368	0.57790	0.69110	0.63475	0.98506	0.71669	.66674	.63972	0.67639
France	1	0.78342	0.96968	0.68062	0.75777	0.72496	0.83324	0.97379	.83471	.88535	0.86217
	7	0.76355	0.94191	0.66843	0.73868	0.70721	0.87484	0.96650	.82220	.88146	0.84916
	14	0.75958	0.93676	0.66881	0.73648	0.70127	0.88331	0.96395	.81571	.88198	0.84560
	28	0.75953	0.93666	0.66881	0.73644	0.70119	0.88880	0.96163	.80928	.88305	0.84272
	42	0.75953	0.93666	0.66881	0.73644	0.70119	0.89091	0.96057	.80628	.88361	0.84146
UK	1	0.57990	0.67680	0.96207	0.57748	0.52597	0.74931	0.84830	.96836	.79538	0.78130
	7	0.56704	0.65772	0.94004	0.56363	0.51433	0.82498	0.85060	.93918	.82691	0.78267
	14	0.56788	0.65836	0.93775	0.56466	0.51344	0.85310	0.84614	.90799	.84691	0.77792

	28	0.56788	0.65834	0.93771	0.56467	0.51341	0.87291	0.83385	.86596	.86220	0.76594
	42	0.56788	0.65834	0.93771	0.56467	0.51341	0.88016	0.82593	0.84345	0.86788	0.75833
Italy	1	0.71302	0.77043	0.59034	0.98437	0.70093	0.78466	0.90491	0.78588	0.97925	0.84190
	7	0.69213	0.74529	0.57576	0.95563	0.67762	0.81923	0.90945	0.79076	0.97654	0.83960
	14	0.69000	0.74257	0.57654	0.94931	0.67075	0.82608	0.91616	0.80266	0.97660	0.84479
	28	0.68992	0.74248	0.57657	0.94919	0.67061	0.83010	0.92321	0.81598	0.97656	0.85080
	42	0.68992	0.74248	0.57657	0.94919	0.67061	0.83151	0.92645	0.82228	0.97646	0.85364
Spain	1	0.65928	0.73284	0.53462	0.69738	0.98013	0.77010	0.87321	0.77171	0.83079	0.98074
	7	0.64515	0.71527	0.52631	0.68560	0.95642	0.78500	0.85753	0.76321	0.80549	0.97744
	14	0.64435	0.71590	0.52886	0.68515	0.94956	0.78438	0.85569	0.76766	0.79769	0.97677
	28	0.64432	0.71586	0.52891	0.68512	0.94940	0.78167	0.85483	0.77358	0.79089	0.97601
	42	0.64432	0.71586	0.52891	0.68512	0.94940	0.78009	0.85452	0.77647	0.78787	0.97561

Note: **Panel A**: Shows the GFEVD results in the pre GFC sample period and there are observations in this sample period. The above GFEVD results in this sample period are based on an unrestricted VAR model using a lag order of 8 as chosen by the AIC. The list of variables in unrestricted VAR model is Germany, France, Italy, UK and Spain. **Columns three to seven** represent the forecast error variance decompositions of Germany, France, the UK, Italy and Spain explained by innovations to the stock markets in the rows over a forecast horizon shown in column two.

Panel B: Shows the GFEVD results during the GFC sample period and there are observations. The results in this sample period are based on a cointegrating VAR model normalized on Germany estimated with unrestricted Intercept and No Trend (Model 3) using a lag order of 2 as chosen by the AIC and rank=one. Only the Model 3 results are displayed and not Model 4 (unrestricted Intercept and Restricted Trend) due to space limitations and because the results for both Model 3 provides stronger results than model 4. The list of variables in the cointegrating model Germany, France, the UK, Italy and Spain. **Columns eight to twelve** represent the forecast error variance decompositions of Germany, France, the UK, Italy and Spain explained by innovations to the stock markets in rows over a forecast horizon shown in column two.

Table 40: Generalised Forecast Error Variance Decomposition Results (European Stock Markets - Post GFC Period)

Forecast Error Variance due to shocks in:	Day	Panel C - Post GFC Period (Case Three)				
		Percentage of Forecast error Variance for:				
		Germany	France	UK	Italy	Spain
Germany	1	0.99485	0.89846	0.75033	0.84267	0.79243
	7	0.99012	0.88821	0.72529	0.83399	0.80355
	14	0.98929	0.88659	0.72102	0.83240	0.80524
	28	0.98875	0.88568	0.71832	0.83134	0.80616
	42	0.98854	0.88536	0.71728	0.83091	0.80647
France	1	0.92654	0.98792	0.79142	0.92925	0.89258
	7	0.93567	0.97955	0.79357	0.94302	0.91834
	14	0.93747	0.97634	0.80771	0.95132	0.91988
	28	0.93711	0.97154	0.82420	0.95869	0.91738
	42	0.93630	0.96867	0.83234	0.96183	0.91524
UK	1	0.81140	0.82007	0.99371	0.77002	0.70643
	7	0.83925	0.83490	0.98852	0.77661	0.72709
	14	0.84915	0.84383	0.98553	0.77959	0.73652

	28	0.85823	0.85322	0.98173	0.78219	0.74589
	42	0.86245	0.85782	0.97963	0.78332	0.75039
Italy	1	0.85699	0.90642	0.73368	0.99039	0.90822
	7	0.85624	0.89500	0.71100	0.98245	0.92870
	14	0.85624	0.89347	0.70688	0.98103	0.93213
	28	0.85633	0.89282	0.70414	0.98011	0.93424
	42	0.85639	0.89265	0.70304	0.97974	0.93504
Spain	1	0.75552	0.80623	0.64105	0.84864	0.98796
	7	0.73628	0.76767	0.63619	0.83549	0.97695
	14	0.73146	0.75672	0.65270	0.83955	0.96754
	28	0.72442	0.74401	0.67151	0.84258	0.95294
	42	0.72019	0.73714	0.68047	0.84329	0.94446

Panel C: Shows the GFVED results in the post GFC sample period and there are observations. The above GFEVD results are based on a cointegrating VAR model normalized on Germany estimated with Unrestricted Intercept and No Trend using a lag order of 2 as chosen by the AIC and rank = one. Only the Model 3 results are displayed and not Model 4 due to space limitations and because Model 3's results are stronger than Model 4's results in the cointegration tests. The list of variables in the cointegrating model is Germany, France, the UK, Italy and Spain. **Columns three to seven** in table represents the forecast error variance decompositions of France, Germany, the UK, Italy and Spain explained by innovations to the stock markets in rows over a forecast horizon shown in column two.

As a result, this implies that the other stock markets are more interdependent with each other and least interdependent with the UK thus making the UK the least endogenous stock market.

To show that the UK is the least endogenous stock market, the amount of forecast error variance of each country contributed by the other individual countries is compared to the forecast error variance contributed for the UK by the same individual countries. The figures highlighted in bold in the bullet points below show the forecast error variance of the UK which is the least in comparison to the other stock markets. The format of Bullet points makes it easier to clearly and concisely explain the findings given the large amount of figures available.

Germany explains:

- **57.788% to 58.57% of the UK's forecast error variance**, in comparison to
- 76.368% to 79.080% of France forecast error variance,
- 69.110% to 71.088% of forecast error variance for Italy and
- 63.475% to 66.162% of Spain's forecast error variance.

The UK has the lowest explained forecast error variance by innovations in Germany.

France explains:

- **66.881% to 68.062% of the UK's forecast error variance** in comparison to;
- 75.953% to 78.342% of Germany's forecast error variance
- 73.644% to 75.777% of Italy's forecast error variance and;
- 70.119 to 72.496% of Spain's forecast error variance.

The UK has the lowest explained forecast error variance by innovations to France.

Italy explains:

- **57.654% to 59.034% of the UK's forecast error variance** in comparison to;
- 68.992% to 71.302% of forecast error variance for Germany
- 74.248% to 77.043% of France's forecast error variance and
- 67.061% to 70.093% of Spain's forecast error variance

The UK has the lowest explained forecast error variance by innovations to Italy.

Spain explains:

- **52.631% to 53.462% of the UK's forecast error variance**
- 64.432% to 65.928% of Germany's forecast error variance
- 71.527% to 73.284% of France's forecast error variance and
- 68.512% to 69.738% of Italy's forecast error variance.

The above figures show that the UK has the lowest explained forecast error variance by innovations to Spain. Thus, these results provide evidence of UK being the least endogenous (least affected) stock market in the pre GFC period. As a result, if investors were looking to invest in a stock market that is least affected by the other European stock markets, the UK would be a suitable choice from the evidence provided. The most endogenous (most affected) stock market in the pre GFC sample period is also highlighted in the bullet points below with the italicised figures.

Across the whole time horizon, in the pre GFC sample period (Panel A), France is the most endogenous (most affected) stock market. This is shown by the other individual stock markets explaining the highest forecast error variance of France as compared to the forecast error variances they explain for each of the other individual stock markets. The bullet points below highlight France as the most endogenous stock market and this is illustrated by the figures in italics which show that France has the highest forecast error variance explained by the stock markets of Germany, Italy, Spain and the UK and the forecast error variances explained for the other stock markets are lower.

Germany explains:

- 57.788% to 58.57% of the UK's forecast error variance, in comparison to
- *76.368% to 79.080% of France forecast error variance,*
- 69.110% to 71.088% of forecast error variance for Italy and
- 63.475% to 66.162% of Spain's forecast error variance.

France has the highest explained forecast error variance by innovations in Germany as shown in the above bulleted figures.

The UK explains:

- 56.704% to 57.990% of Germany's forecast error variance,
- *65.722% to 67.680% of France's forecast error variance,*
- 56.363 to 57.748% of Italy's forecast error variance and
- 51.341% to 52.597% of Spain's forecast error variance.

In the above figures, evidence is provided that France has the highest explained forecast error variance by innovations in the UK.

Italy explains:

- 57.654% to 59.034% of the UK's of forecast error variance,
- 68.992% to 71.302% of forecast error variance for Germany,
- *74.248% to 77.043% of France's forecast error variance and*
- 67.061% to 70.093% of Spain's forecast error variance.

The above bulleted figures show that France has the highest explained forecast error variance by innovations to Italy.

Spain explains:

- 52.631% to 53.462% of the UK's forecast error variance
- 64.432% to 65.928% of Germany's forecast error variance
- *71.527% to 73.284% of France's forecast error variance and*
- 68.512% to 69.738% of Italy's forecast error variance.

These figures show that France has the highest explained forecast error variance by Spain.

Furthermore, the above bulleted figures further highlight the UK being the most independent stock market with the UK explaining the least forecast error variance of Germany, France, Italy and Spain.

The most exogenous stock market in the pre GFC period (Panel A) is Germany explaining 99.395% of its own forecast error variance on day one with its exogeneity persisting to the last day of the forecast horizon explaining 95.534% of its own forecast error variance. In contrast, the other stock markets' forecast error variances explained by their own shocks at horizon one is lower than Germany's own forecast error variance of 99.395% and at time horizon 42 the other stock markets' own forecast error variance is lower than 95.534%, thus supporting the result that Germany is the most exogenous stock market. This is shown below with:

- France explains 96.968% of its own forecast error variance at horizon one but reduces to explaining 93.666% of own forecast error variance on day 42,
- The UK explains 96.207% of its own forecast error variance at horizon one but reduces to explaining 93.771% of own forecast error variance at horizon 42,
- Italy explains 98.437% of its own forecast error variance at horizon one but reduced to explaining 94.919% of its own forecast error variance at horizon 42 and
- Spain explains 98.013% of its own forecast error variance at horizon one but reduced to explaining 94.940% of own forecast error variance at horizon 42.

All the above mentioned stock markets own forecast error variance at time horizon one and 42 is lower than that of Germany's at the same time horizon.

The most affected (endogenous) stock market during the GFC period (Panel B) is France. The endogeneity of France during the GFC in comparison to the other stock markets is highlighted below in bold italicised bullet points:

Germany explains:

- 61.654% to 66.674% of the UK's forecast error variance, in comparison to
- ***70.071% to 71.669% of France forecast error variance,***
- 63.972% to 66.403% of forecast error variance for Italy and
- 66.046% to 67.639% of Spain's forecast error variance.

From the above figures, France has the highest explained forecast error variance by shocks to Germany.

Italy explains:

- 78.588% to 82.228% of the UK's forecast error variance in comparison to;
- 78.466% to 83.151% of forecast error variance for Germany
- ***90.491% to 92.645% of France's forecast error variance and***
- 83.960% to 85.364% of Spain's forecast error variance

From the above figures, France has the highest explained forecast error variance by innovations in Italy.

Spain explains:

- 76.321% to 77.647% of the UK's forecast error variance
- 77.010% to 78.500% of Germany's forecast error variance
- ***85.452% to 87.321% of France's forecast error variance and***
- 78.787% to 83.079% of Italy's forecast error variance.

As can be seen, innovations in Spain explain the highest forecast error variance of France.

The UK explains:

- The UK explaining 74.931% to 88.016% of Germany's forecast error variance,
- ***The UK explaining 82.593% to 85.060% of France's forecast error variance,***
- The UK explaining 79.538% to 86.788% of Italy's forecast error variance and
- The UK explaining 75.883% to 78.267% of Spain's forecast error variance.

In terms of innovations in the UK it is less clear cut but since Germany, Italy and Spain explain the highest forecast error variance for France then it is concluded that France is the most endogenous stock market. The least endogenous stock market is not as clear cut during the GFC period (Panel B), with the ranges of forecast error variance for each stock market lying in similar ranges thus, making it hard to identify which is the least affected stock market.

Moving on to the most exogenous stock market during the GFC (Panel B) at time horizon one is Germany explaining 99.385% of its own forecast error variance. Furthermore, Germany's minimum own forecast error variance explained by itself during the GFC is 98.506%. All the other stock markets forecast error variance explained by their own markets at horizon time one is lower than Germany's and the minimum forecast error variance explained by their own shocks are lower than Germany's minimum forecast error variance, thus highlighting Germany's exogeneity. This is shown below:

- France explains 97.379% of its own forecast error variance at horizon one and this reduces to explaining 96.057% of its own forecast error variance at horizon 42.
- The UK explains 96.836% of its own forecast error variance at day one and this reduces to explaining 84.345% of its own forecast error variance at time horizon 42.
- Italy explains 97.925% of its own forecast error variance at horizon one and this reduces to explaining 97.646% of its own forecast error variance at horizon 42.
- Spain explains 98.074% of its own forecast error variance at horizon one and this reduces to explaining 97.561% of its own forecast error variance at horizon 42

The above results show that each of the above mentioned stock markets highest forecast error variance explained by shocks to their own markets is still lower than Germany's highest forecast error variance explained by shocks to itself at the same time horizon. Furthermore, Germany's minimum forecast error variance explained by shocks to its own market is higher than the minimums of the other stock markets forecast error variances explained by shocks to their own markets.

Looking at the post GFC sample period (Panel C), the most exogenous stock market still remains as Germany, explaining 99.485% of its own forecast error variance in the post GFC sample period. Furthermore, Germany's minimum forecast error variance explained by shocks to its own market is 98.854% at horizon 42 in the post GFC sample period. All the other stock markets forecast error variance explained by their own markets at horizon time one is lower than Germany's and the minimum forecast error variance explained by their own shocks at horizon 42 are lower than Germany's minimum forecast error variance. This highlights Germany's exogeneity. This is shown below:

- France explains 98.792% of its own forecast error variance at horizon one and this reduces to explaining 96.867% of its own forecast error variance at horizon 42.
- The UK explains 99.371% of its own forecast error variance at day one and this reduces to explaining 97.963% of its own forecast error variance at horizon 42.
- Italy explains 99.039% of its own forecast error variance at horizon one and this this reduces explaining to 97.974% of its own forecast error variance at horizon 42.
- Spain explains 98.796% of its own forecast error variance at horizon one and this reduces to explaining 94.446% of its own forecast error variance at horizon 42.

Thus these results highlight Germany as the most exogenous stock market in the post GFC sample period.

The most affected (endogenous) stock market in the post GFC sample period is not as clear cut because the number of stock markets with a larger forecast error variance decomposition explained by other stock markets has increased and the ranges of forecast error variance for all the stock markets are almost uniform. In the post GFC sample period (Panel C), the least affected stock market is that of the UK. The results to support this finding are highlighted below:

Germany explains:

- **71.728%% to 75.033% of the UK's forecast error variance**, in comparison to
- Explaining 88.536%% to 89.846% of France forecast error variance,
- Explaining 83.091% to 84.267% of forecast error variance for Italy and
- Explaining 79.243% to 80.647% of Spain's forecast error variance.

The UK has the lowest explained forecast error variance explained by innovations in Germany.

France explains:

- **79.142% to 83.234% of the UK's forecast error variance** in comparison to;
- 92.654% to 93.747% of Germany's forecast error variance
- 92.925%% to 96.183% of Italy's forecast error variance and;
- 89.258 to 91.524% of Spain's forecast error variance.

Thus, the UK has the lowest explained forecast error variance by innovations to France.

Italy explains:

- **70.304% to 73.368% of the UK's forecast error variance** in comparison to;
- 85.699% to 85.624% of forecast error variance for Germany
- 89.265% to 90.642% of France's forecast error variance and
- 90.822% to 93.504% of Spain's forecast error variance

The above show that the UK has the lowest explained forecast error variance by innovations to Italy.

Spain explains:

- **63.619% to 68.047% of the UK's forecast error variance**
- 72.019% to 75.552% of Germany's forecast error variance
- 73.714% to 80.623% of France's forecast error variance and
- 83.549% to 84.864% of Italy's forecast error variance.

From the above results, the UK has the lowest forecast error variance explained by innovations to Spain.

In summary, in all the sample periods none of the European stock markets are fully exogenous because the contribution of other stock markets to each individual stock market forecast error variance is more than zero and in this particular case is more than 50% for each stock market. This result implies that these European stock markets are highly interdependent with each other with more than 50% of each stock markets forecast error variance explained by another stock market.

Furthermore, the results generally show that the UK is the least affected (least endogenous) by innovations to other stock markets in all sample periods. Comparing during the GFC sample period results (Panel B) and the post GFC sample period results (Panel C), evidence is provided to show that each of the European stock markets are highly endogenous but the results show that France is the most endogenous during the GFC. The question of which stock market is the most endogenous in the post GFC period is less clear cut because the range of forecast error variance explained for each stock market by the other stock markets lie in a similar range making it difficult to identify and pin point the most endogenous stock market.

5.10.3 Generalized Forecast Error Variance Decompositions Results (Asian Stock Markets)

The results in the Pre GFC sample period (Panel A) show that Japan is the most exogenous stock market in the pre-GFC sample period explaining 100% (fully exogenous) of its own forecast error variance at horizon one and with its minimum forecast error variance being 99.904% in comparison to China's own forecast error variance at horizon one being 99.954% and its minimum forecast error variance is 98.277% which is below Japan's minimum forecast error variance 99.904%.

In the pre GFC sample period, Japan explains a very minimal amount (almost zero) of China's forecast error variance at all time horizons, showing that China is highly independent, with shocks to Japan having a very minimal impact on China. On the other hand Japan is the most explained (most endogenous) stock market with China explaining 3.8695% by day 42 in comparison to Japan only explaining 0.20952% of China's forecast error variance at the same time horizon. Thus, Japan is more affected by shocks to China than China is by shocks to Japan.

Furthermore, these results show that Japan and China are not highly interdependent and are almost independent to each other. The results found above are supported by the GIRF results that show that a shock to Japan has a very small and almost close to zero impact on China but a shock to China appears to have more impact on Japan. During the GFC period (Panel B) and in the post GFC sample period (Panel C), the GFEVD results show that the stock markets became more interdependent, more so during the GFC sample period.

Table 41: Generalised Forecast Error Variance Decomposition Results (Asian Stock Markets).

Forecast Error Variance due to shocks in:	Day	Panel A - Pre GFC Sample Period (Case Three)		Panel B - During GFC Sample Period		Panel C - Post GFC Sample Period	
		Percentage of Forecast Error Variance for:		Percentage of Forecast Error Variance for:	Percentage of Forecast Error Variance for:	Percentage of Forecast Error Variance for:	Percentage of Forecast Error Variance for:
		Japan	China	Japan	China	Japan	China
Japan	1	1.00000	0.0043917	0.99803	0.081795	0.99993	0.052904
	7	0.99981	0.0049778	0.97007	0.099410	0.99990	0.052521
	14	0.99973	0.0038042	0.97006	0.099415	0.99990	0.052521
	28	0.99942	0.0026845	0.97006	0.099415	0.99990	0.052521
	42	0.99887	0.0019729	0.97006	0.099415	0.99990	0.052521
China	1	0.0070169	0.99954	0.097246	0.98197	0.053310	0.99913
	7	0.012759	0.99708	0.10351	0.97559	0.053790	0.99832
	14	0.020812	0.99314	0.10352	0.97559	0.053790	0.99832
	28	0.029915	0.98797	0.10352	0.97559	0.053790	0.99832
	42	0.038355	0.98250	0.10352	0.97559	0.053790	0.99832

Note: **Panel A:** Shows the GFEVD results in the pre GFC sample period and there are observations in this sample period. The above GFEV results in this sample period are based on cointegrating VECM model normalized on the Japan estimated with Unrestricted Intercept and No trend (Model 3) using a lag order of 7 as chosen by the AIC and rank = one. The list of variables in the cointegrating model is Japan and China. Columns three to four represent the forecast error variance decompositions of Japan and China explained by innovations to the stock markets in rows over a forecast horizon shown in column two. Only the results for Model 3 are chosen to be used because the results provided by Model 2 are similar and due to space limitations the focus is only on Model 3. **Panel B:** Shows the GFEVD results in during the GFC sample period and there are observations in this sample period. The above GFEVD results in this sample period are based on an unrestricted VAR model using a lag order of 3 as chosen by the AIC. The list of variables in unrestricted VAR model is Japan and China. Columns five to six represent the forecast error variance decompositions of Japan and China in this sample period explained by innovations to the stock markets in the rows over a forecast horizon shown in column two. **Panel C:** Shows the GFEVD results in the post GFC sample period and there are observations in this sample period. The above GFEVD results in this sample period are based on an unrestricted VAR model using a lag order of 2 as chosen by the AIC. The list of variables in unrestricted VAR model is Japan and China. Columns seven to eight represent the forecast error variance decompositions of Japan and China in this sample period explained by innovations to the stock markets in the rows over a forecast horizon shown in column two

The percentage of forecast error variance of China explained by innovations in Japan ranges from 8.1795% to 9.9415% in the Post GFC sample period (Panel B) while the percentage of forecast error variance of Japan explained by China ranges from 9.7246% to 10.352%. Thus, during the GFC sample period Japan remains the most endogenous (most affected) stock market and China remains the least endogenous (least affected) stock market. In the post GFC sample period, the percentage of forecast error variance of Japan explained by China and vice-versa, decreases in comparison to during the GFC sample period. Japan remains the most endogenous stock market in the post GFC sample period (Panel C) with China explaining 5.3310% to 5.3790% in comparison to Japan explaining 5.2521% to 5.2904% of China's forecast error variance. Comparing during the GFC period results and the post GFC period results, evidence is provided to show a decrease in the amount of forecast error variance explained by Japan and China in the post GFC sample period in comparison to during the GFC.

In conclusion, the above results provide evidence that all the stock markets from each region are not fully exogenous but are fairly endogenous because the percentage of forecast error variance for each stock market is more than zero. For the American stock markets, we find that Brazil is the least endogenous stock market in all three sample periods and Canada is the most endogenous stock market in the pre and post GFC periods but the USA becomes the most endogenous during the GFC period. With the European stock markets the UK appears to be the least endogenous stock market in all sample periods and France appears to be the most endogenous stock market in the pre and post GFC sample period but during the GFC it is less clear cut. The most exogenous stock market in all sample periods is that of Germany. With regards to the Asian stock markets, China is the least endogenous stock market with the forecast error variance explained by Japan close to zero. A consistent result seen in all regions is that that the GFC led to an increase in the contribution of other stock markets in explaining shocks to each individual stock market.

CHAPTER SIX: CONCLUSION

The main purpose of this research was to examine how the Global financial crisis (GFC) of 2007-2009 affected short and long term interdependencies of ten stock markets grouped into stock markets from the same region (close geographical proximity) and the purpose of this thesis has been achieved to some degree finding a few unexpected results. As standard procedure unit root tests were carried out first and finding the common result of the levels being non-stationary and first differences being stationary implying that the levels are integrated of order one, I(1).

Using the unit root test to satisfy the pre-requisites of cointegration, the Johansen multivariate cointegration method has been used to assess the presence of cointegration and if present, whether the number of cointegrating vectors have changed due to the GFC. For the American stock markets the presence of one cointegrating vector is found in all three sample periods implying no change in long run interdependencies and no change in the level of integration among these stock markets. The presence of cointegration among the American stock markets is expected because of the strong trade ties and political ties present among them, more so for Canada and the USA than Brazil and the USA. Furthermore in analyzing which stock markets are important to the long run equilibrium relationship by normalizing on the USA, it is found that Canada is consistently important to the long run equilibrium relationship in all three sample periods.

Furthermore during the GFC, there is a temporary increase in the number of stock markets that are important to the long run equilibrium relationship with both Canada and Brazil being significant. The finding of cointegration in all sample periods asserts that there must be an error correction mechanism to keep the cointegrated stock markets in step with each other by adjusting (correcting) short run disequilibrium to prevent the cointegrated variables from drifting apart (Engle & Granger, 1987). In assessing whether there has been a change in the stock market/s that bear the burden of correcting short run disequilibrium, it is found that in the pre-crisis period all the American stock markets bear the burden of adjusting for any short run disequilibrium but do so very slowly with Canada having the quickest adjustment speed.

During the GFC period and in the post GFC sample periods, the number of stock markets that bear the burden of adjusting short run disequilibrium decreases in comparison to before the crisis, with Canada bearing the burden during the GFC and in the post GFC if cointegration is tested using Model 4 but using Model 3, the results show that the USA bears the burden of adjusting short run disequilibrium. The speed of adjusting for short run disequilibrium is faster during the GFC for both stock markets as compared to the Pre GFC sample period.

With regards to the European stock markets no cointegration is found in the pre GFC period but during the GFC period and in the post GFC period one cointegrating vector is present. Thus, it is concluded that long run interdependencies increased during the GFC in comparison to before the crisis but stayed the same in the post GFC sample period in comparison to during the GFC. In assessing which stock markets are important to the long run equilibrium relationship, it is found that the UK and Italy are important to the equilibrium relationship during the GFC but none of the stock markets are significant in the post GFC period. This result contradicts the finding of cointegration among the European stock markets in the post GFC period because if cointegration is present, at least one of the stock markets must be significant in the equilibrium relationship

Furthermore, in assessing which stock market bears the burden of adjusting short run disequilibrium and whether this has changed due to the GFC, the results show that the UK bears the burden of adjusting disequilibrium but does so at a slow rate. In the post GFC period none of the error correction terms are significant implying that no stock markets adjust for short run disequilibrium. This result contradicts the theory of cointegration in that if variables are cointegrated there must be some significant error correction mechanism to correct for any short run disequilibrium so as to keep the variables in step so that they move close together otherwise they drift apart.

In regards to the Asian stock markets, the presence of one cointegrating vector is found in the pre-crisis period implying that these stock markets move closely together in the long run and share a common stochastic trend thus portfolio diversification between Japan and China would not be beneficial in the long run. In assessing which stock market is important to the long run relationship, Japan is normalized upon and the finding is that China is not significant implying China is not important to the long run equilibrium relationship. This finding is inconsistent and contradictory to the finding of cointegration between the two stock markets. When the error correction model is evaluated, results show that both Japan and China bear the burden of adjusting short run disequilibrium in order for them to keep in step and to prevent drifting apart. In contrast, during the GFC and in the post GFC sample period no cointegration is found between Japan and China implying that the level of integration and long term interdependencies decreased between the Asian stock markets due to the GFC.

With no cointegration being present in the pre GFC period for the European stock markets and no cointegration between Japan and China during the GFC and in the post GFC periods, Granger Causality tests are carried out to evaluate the short run relationships between Japan and China and pairs of the European stock markets. Evidence of both bi-variate and uni-variate Granger causality exists among the European stock markets except between France and Spain. The presence of Granger causality (uni-variate or bivariate) between the European Union countries is expected because of the strong trade, economic ties and direct investment they have with each other. Furthermore, all of them except the UK share a common currency thus sharing common monetary policy.

This finding of Granger causality implies that better predictions of the movement of the stock market that is being Granger caused can be made by assessing the movements of the stock market that is Granger causing it and thus profit strategies can be formulated from the lead-lag relationship present. In contrast, for the Asian stock markets, the presence of Granger causality is not found during the GFC or in the post GFC period implying that assessing the movements of one stock market cannot help predict the movements of the other stock market. This is because they move independently. However, the absence of Granger causality is a blessing in disguise because if the stock market movements are independent of each other portfolio diversification can be beneficial between the two stock markets.

Generalized impulse response function analysis is carried out for each group of stock markets. The main findings for the American stock markets are that Canada and the USA are more interdependent than the USA and Brazil, with Brazil having the smallest responses to shocks in the USA. This finding is justified with Brazil being a developing economy and just increasing its influence in the region of America in comparison to Canada that has strong trade and political ties with the USA and thus is more interdependent with the USA. This finding is further highlighted by the generalized forecast error variance decompositions that provide evidence to show that Brazil is the least endogenous American stock market in all sample periods with the USA explaining more of Canada's forecast error variance and vice-versa.

For the European stock markets since cointegration is not present in the pre GFC sample period, the generalized impulse response function analysis is based on their first differences. The results show that when all stock markets are shocked they incorporate most of the effects of the shocks by day one, with the responses diminishing and being close to zero after day one. This result implies an instant response by the stock markets. Furthermore, Spain is found to be the stock market that adjusts the quickest to shocks in all the other stock markets.

The generalized impulse response graphs based on the cointegrating relationships provides evidence showing that Italy and Spain are the least affected stock markets by shocks to the other stock markets, implying that these stock markets and the other European stock markets are not highly interdependent. Another finding among the European stock markets is that the number of stock markets affected by shocks to other stock markets declines in the post GFC period with more stock markets not being influenced by shocks to other stock markets. This result implies an increase in independence of the European stock markets.

In the case of Japan and China in the pre GFC period a shock to Japan has a much smaller effect on China than a shock to China has on Japan. During the GFC period and in the post GFC period cointegration is not found between Japan and China thus the generalized impulse response graphs are based on their first differences. The results show that most of the effects of shocks to both China and Japan are incorporated by day one and this is more visible when China is shocked, with the responses declining to zero at day one. This result implies instant responses by both Japan and China. A common result among the groups of stock markets using the generalized impulse response analysis is that for all groups during the GFC period, there is a temporary increase in the magnitudes of the responses to shocks and a temporary increase in the duration to fully incorporate the effects of the shock.

The generalized forecast error variance decompositions further highlight the minimal impact that Japan has on China and vice-versa, though Japan is the most endogenous stock market between the two, both during and post the GFC. The generalized forecast error variance decompositions for the European stock markets show that the UK is the least endogenous (explained) stock market in all sample periods and France is the most endogenous stock market in the pre GFC sample period and during the GFC period with Germany being the most exogenous stock market in all sample periods.

Generally the generalized forecast error variance decomposition analysis shows an increase in the contribution of other stock markets in explaining shocks to each individual stock market due to the GFC. This result implies an increase in interdependencies among stock markets as a result of the GFC because a stock market explains more of another stock markets forecast error variance. Evidence is also provided to show that no market is fully exogenous but is impacted by innovations in another stock market and this result is more pronounced for the European stock markets that have the minimum amount forecast error variance explained being more than 50%. The Asian stock markets on the other hand are the least endogenous relative to the other stock markets with the highest forecast error variance for China explained by Japan being close to 0.497780% in the pre GFC period and increasing to at most 9.9415% during the GFC. China on the other hand explained a higher forecast error variance for Japan of 3.8355% at most in the pre GFC crisis period that increased to 10.352% during the GFC period thus; China had more influence on Japan than Japan had on China. This result is also supported in the generalized impulse response analysis where a shock to Japan causes a smaller response in China but a shock to China causes a larger response by Japan.

CHAPTER SEVEN: FUTURE RESEARCH:

A number of recommendations can be put forward for future research. With the Global Financial Crisis being a fairly recent event, the post crisis sample period used in this analysis is relatively short to fully take into account the long term impacts of the GFC on interdependencies among stock markets, with some economies stabilizing later than others. Thus, in future research a more visible result and more robust results can be provided about the long term impacts of the financial crisis on interdependencies among stock markets because a longer post crisis period can be used.

The start of my post-GFC sample period for all regions is based on the recovery of the USA from the GFC and this is a limitation because the post crisis period is not based on when each region did recover as some regions recovered later than other regions. Thus, in future research the start of the post GFC period for each region can be based on when each region showed signs of recovery from the financial crisis. More robust results would be provided if the post-GFC sample period for each region is based on when each region recovered from the crisis rather than generalising the start of the post GFC period based on one country's period of recovery.

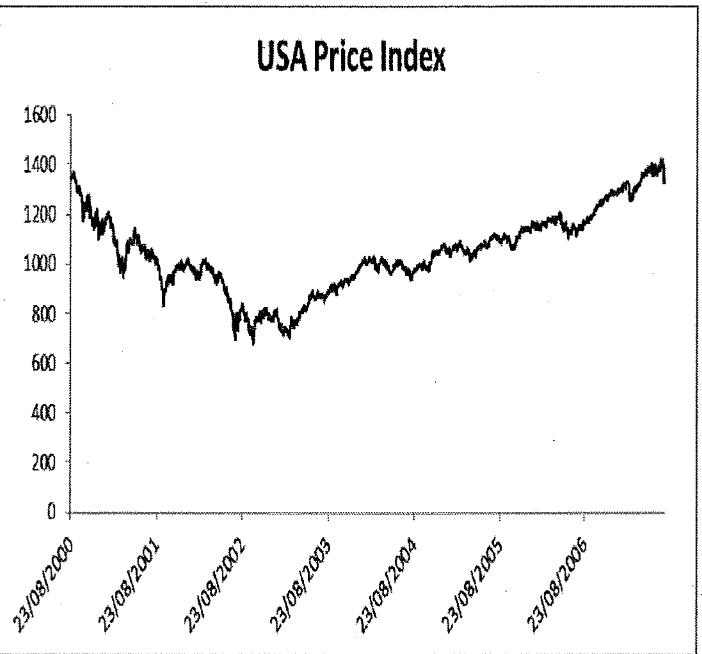
Another point to be considered for future research is adding information variables such as exchange rates or economic variables to the analysis to assess whether the stock markets are impacted by these variables in order to know what underlying factors actually do cause movements in the stock markets.

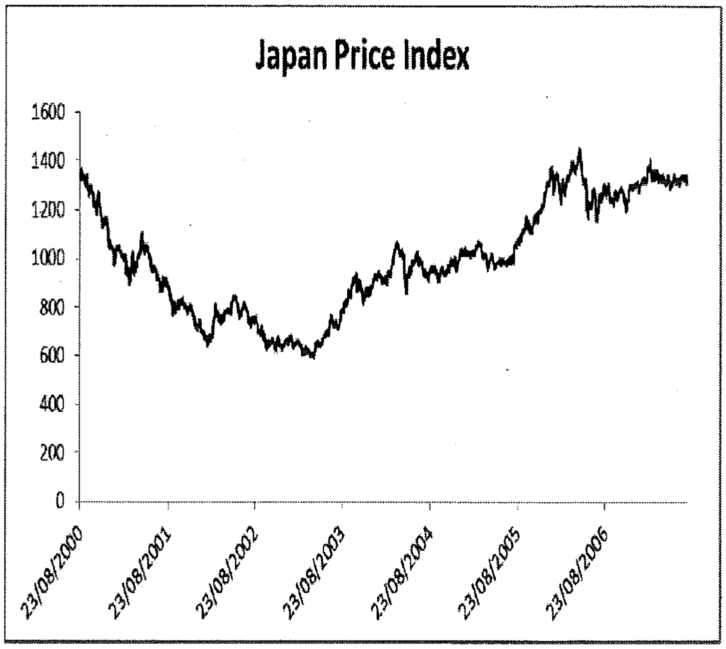
Lastly, assessing how interdependencies have changed among stock markets from different regions can be beneficial in perspective to international portfolio diversification and thus in future adding more emerging stock markets to the analysis to assess the degree to which the financial crisis affected developed stock markets relative to developing stock markets would be valuable information. It would be interesting to empirically assess the disparities in the effects of the financial crisis between developed economies and developing economies.

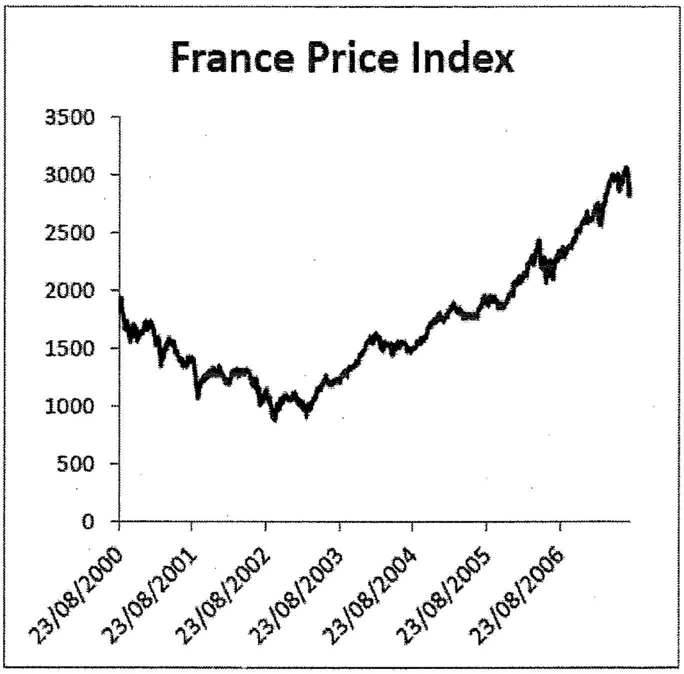
Making these additions would create more robust results based on the impact of the GFC on interdependencies among stock markets.

APPENDIX

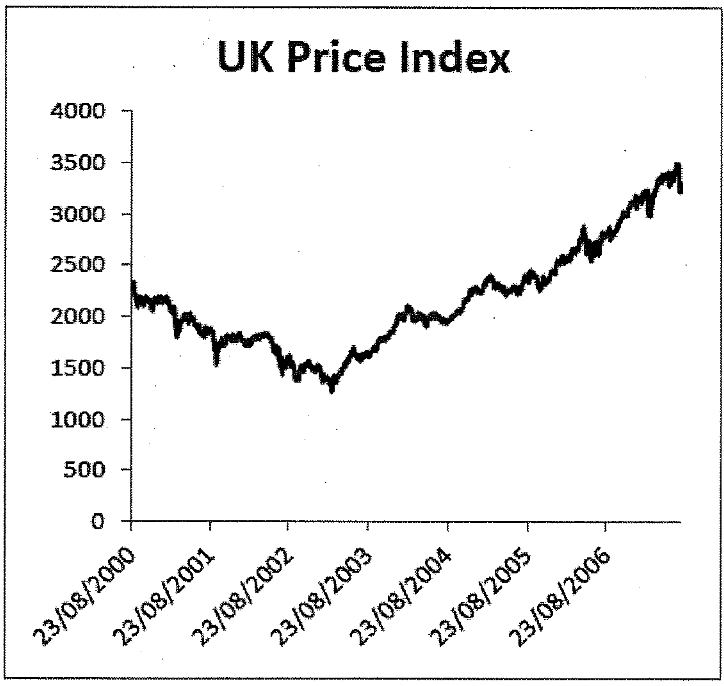
Pre GFC Time Series Plots of Price Indices



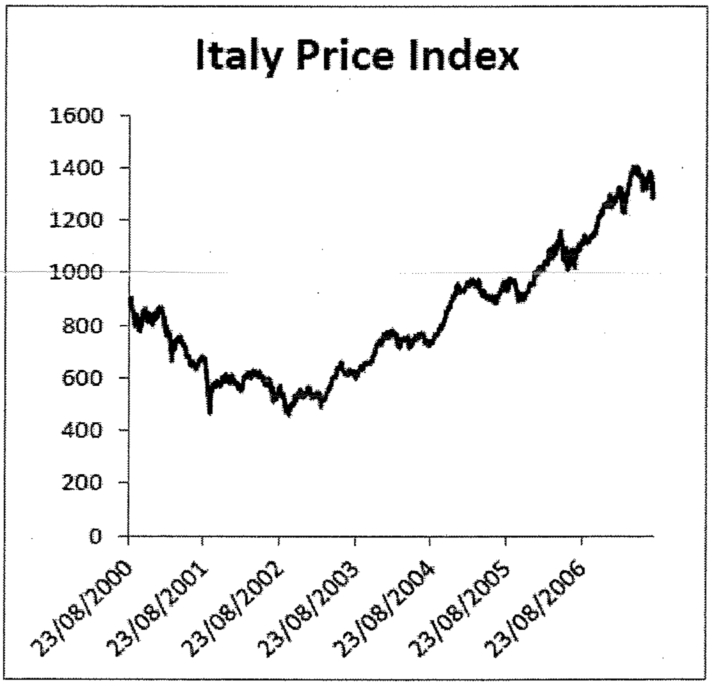




France Price Index
3500
3000
2500
2000
1500
1000
500
0
23/08/2000
23/08/2001
23/08/2002
23/08/2003
23/08/2004
23/08/2005
23/08/2006



UK Price Index
4000
3500
3000
2500
2000
1500
1000
500
0
23/08/2000
23/08/2001
23/08/2002
23/08/2003
23/08/2004
23/08/2005
23/08/2006

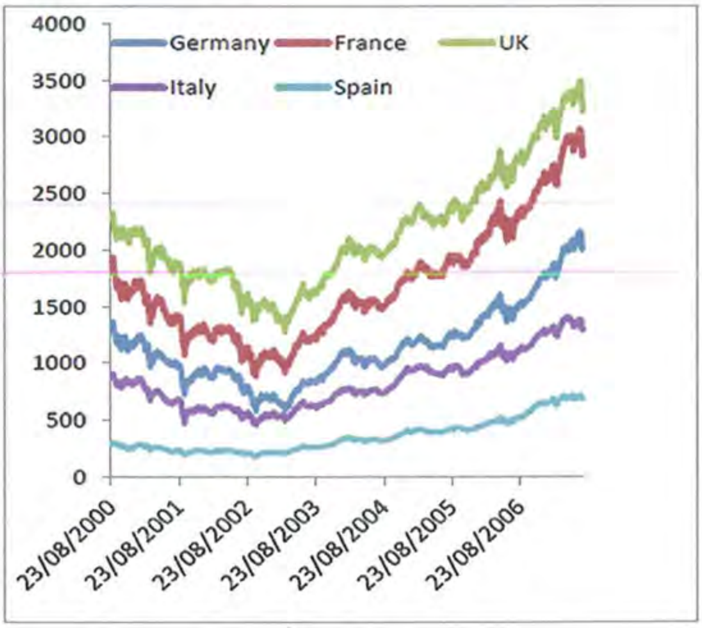


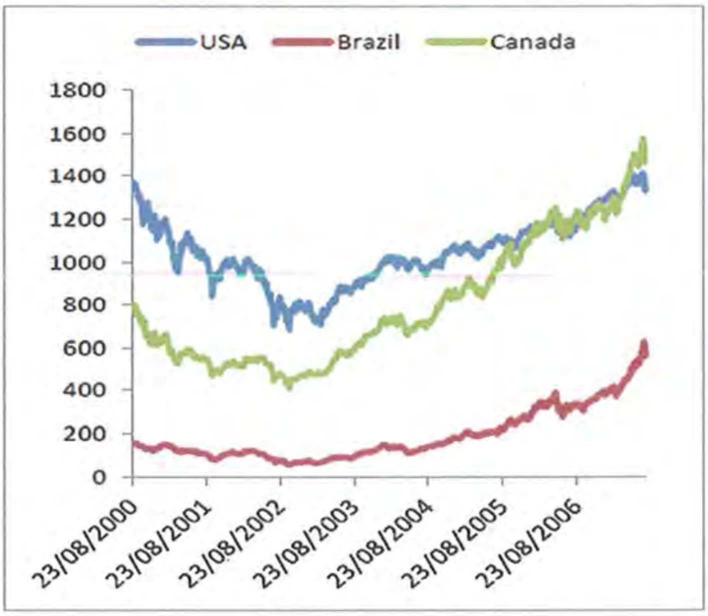
Italy Price Index
1600
1400
1200
1000
800
600
400
200
0
23/08/2000
23/08/2001
23/08/2002
23/08/2003
23/08/2004
23/08/2005
23/08/2006

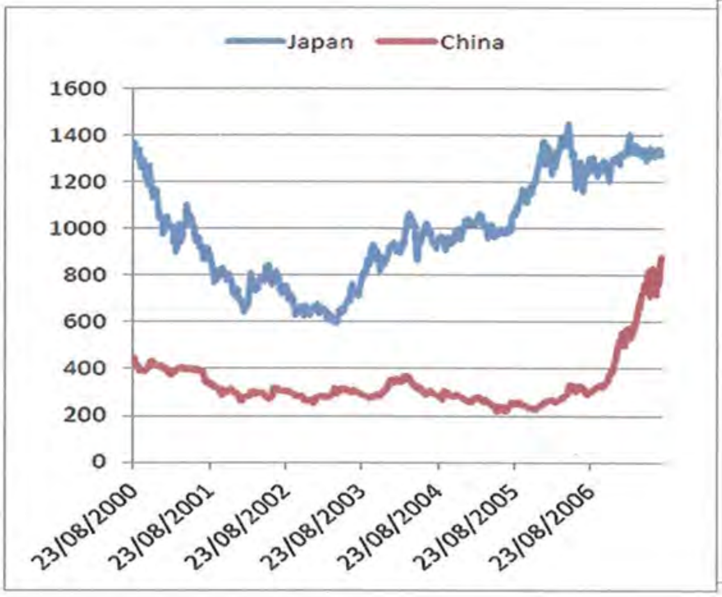
Brazil Price Index
700
600
500
400
300
200
100
0
23/08/2000
23/08/2001
23/08/2002
23/08/2003
23/08/2004
23/08/2005
23/08/2006


Spain Price Index
800
700
600
500
400
300
200
100
0
23/08/2000
23/08/2001
23/08/2002
23/08/2003
23/08/2004
23/08/2005
23/08/2006

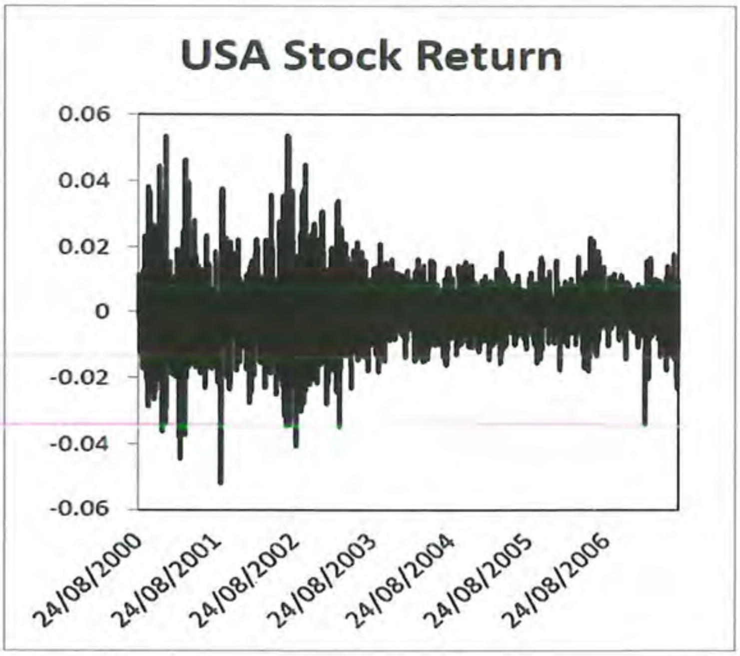

Canada Price Index
1800
1600
1400
1200
1000
800
600
400
200
0
23/08/2000
23/08/2001
23/08/2002
23/08/2003
23/08/2004
23/08/2005
23/08/2006

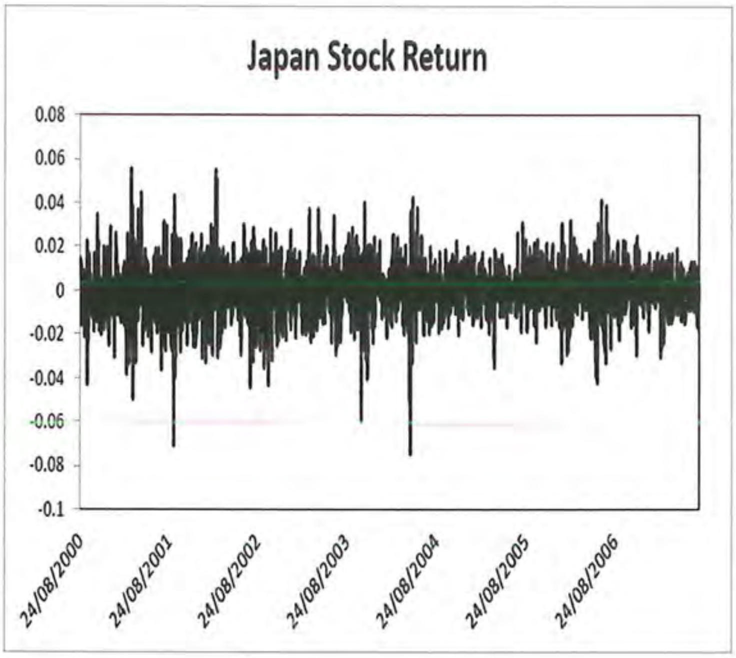

Germany
France
UK
Italy
Spain
4000
3500
3000
2500
2000
1500
1000
500
0
23/08/2000
23/08/2001
23/08/2002
23/08/2003
23/08/2004
23/08/2005
23/08/2006

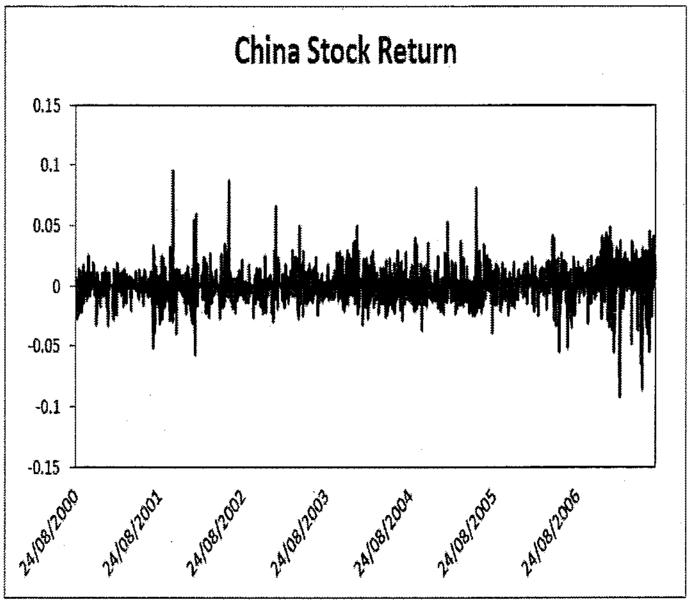

USA
Brazil
Canada
1800
1600
1400
1200
1000
800
600
400
200
0
23/08/2000
23/08/2001
23/08/2002
23/08/2003
23/08/2004
23/08/2005
23/08/2006

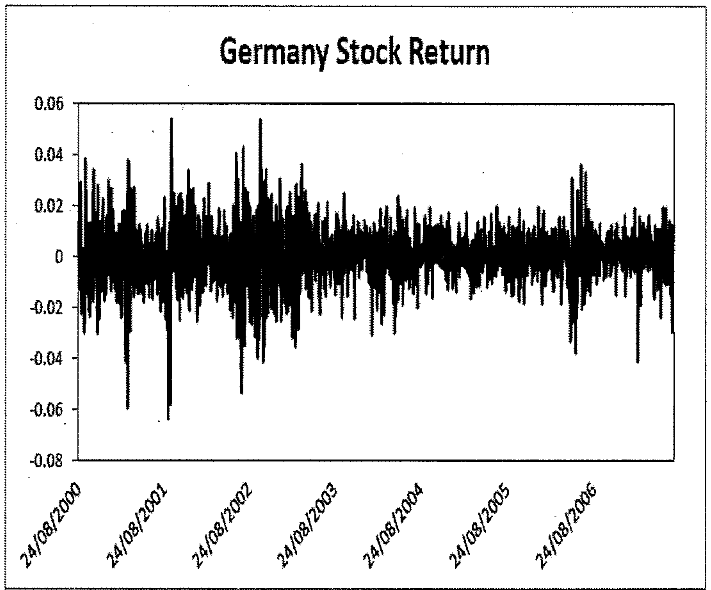


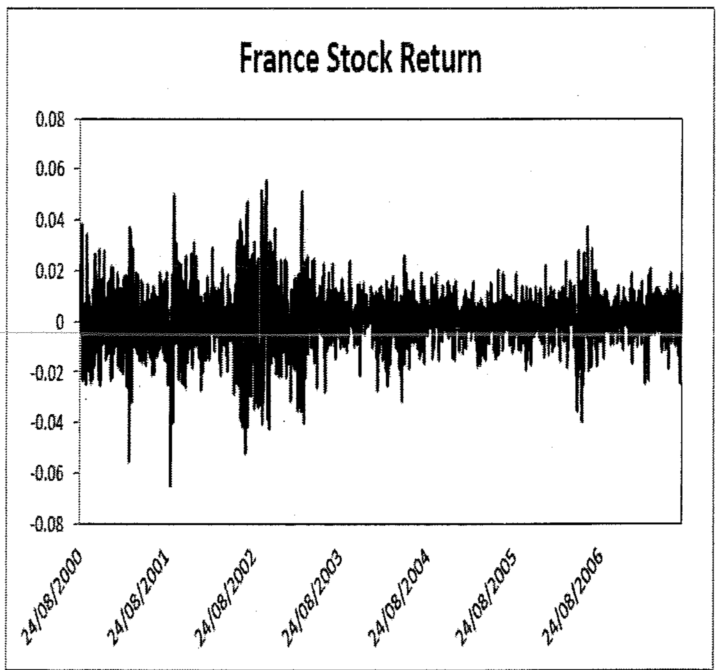
Pre GFC Time Series Plots of Stock Returns

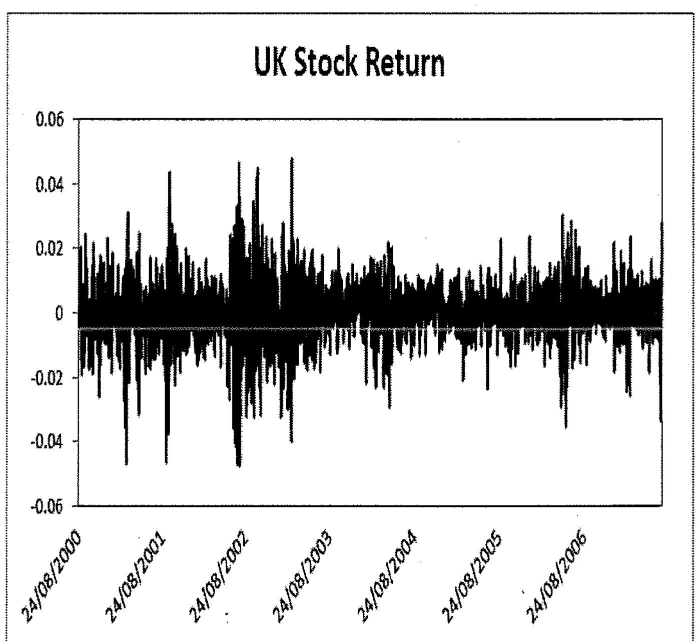


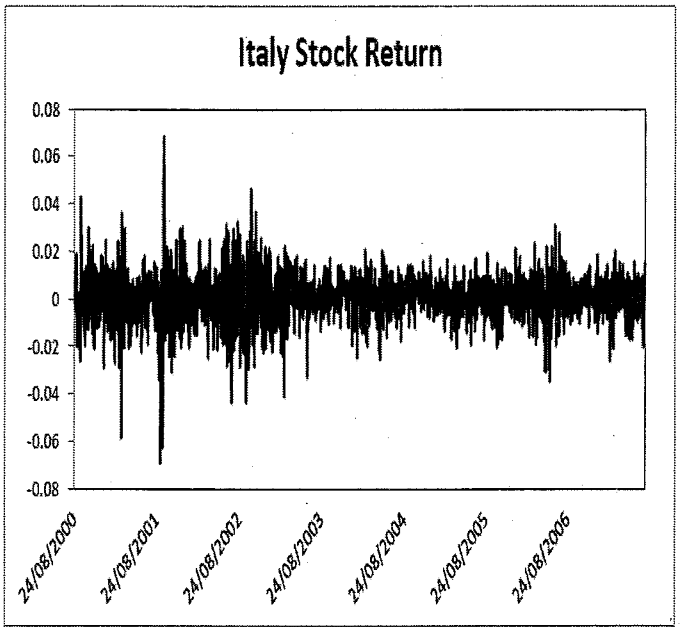


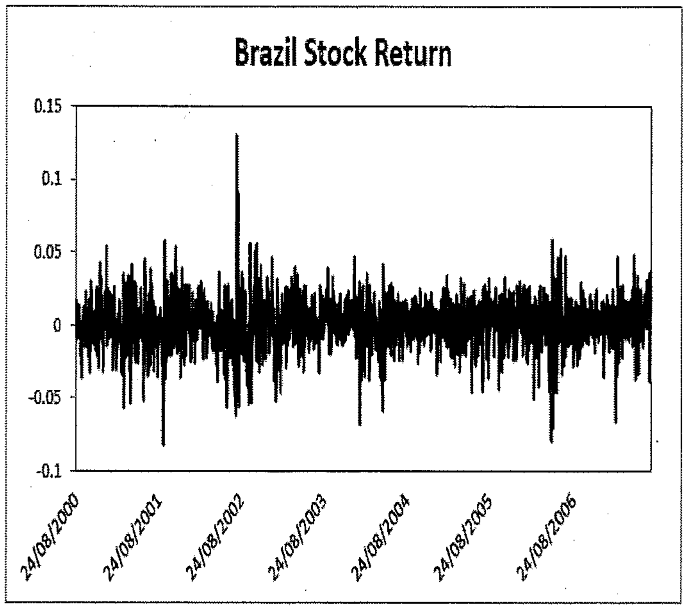

China Stock Return
0.15
0.1
0.05
0
-0.05
-0.1
-0.15
24/08/2000
24/08/2001
24/08/2002
24/08/2003
24/08/2004
24/08/2005
24/08/2006

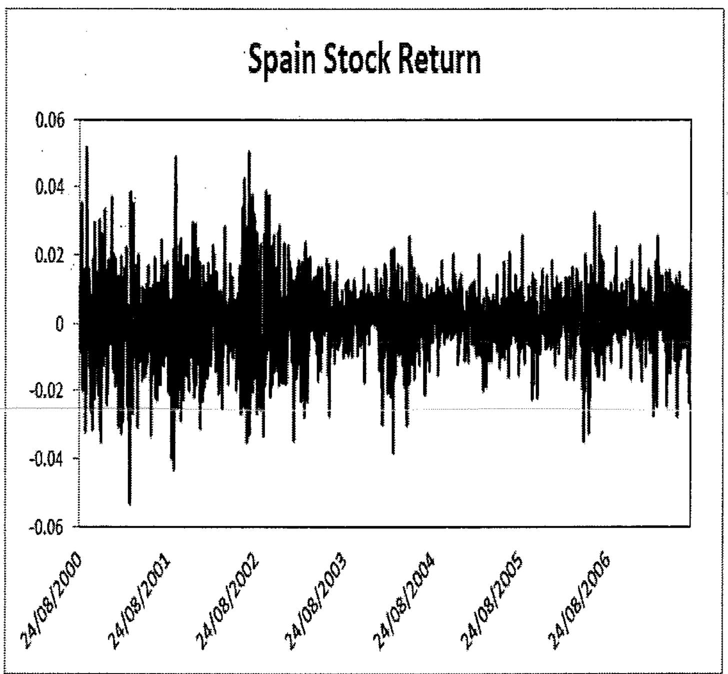

Germany Stock Return
0.06
0.04
0.02
0
-0.02
-0.04
-0.06
-0.08
24/08/2000
24/08/2001
24/08/2002
24/08/2003
24/08/2004
24/08/2005
24/08/2006

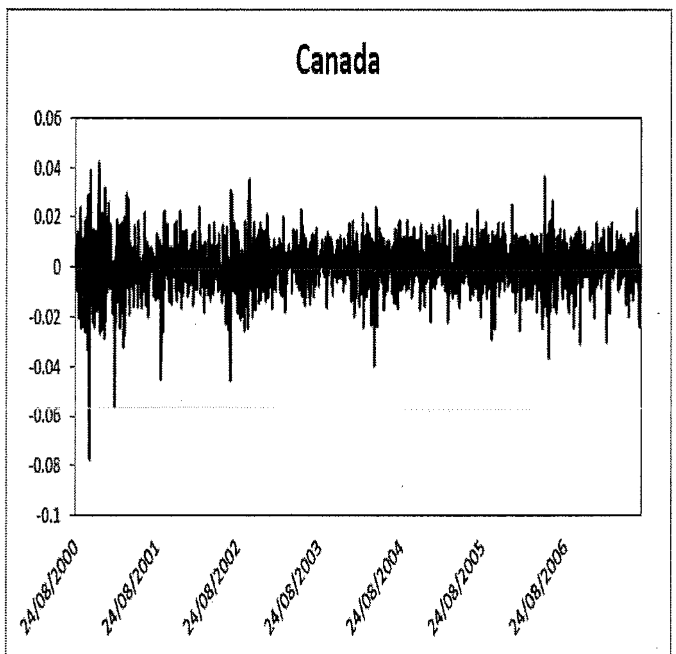

France Stock Return
0.08
0.06
0.04
0.02
0
-0.02
-0.04
-0.06
-0.08
24/08/2000
24/08/2001
24/08/2002
24/08/2003
24/08/2004
24/08/2005
24/08/2006


UK Stock Return
0.06
0.04
0.02
0
-0.02
-0.04
-0.06
24/08/2000
24/08/2001
24/08/2002
24/08/2003
24/08/2004
24/08/2005
24/08/2006

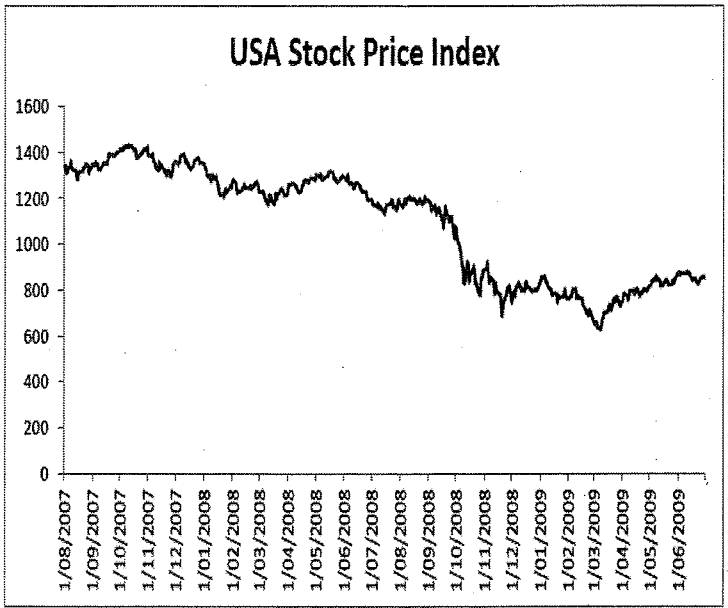

Italy Stock Return
0.08
0.06
0.04
0.02
0
-0.02
-0.04
-0.06
-0.08
24/08/2000
24/08/2001
24/08/2002
24/08/2003
24/08/2004
24/08/2005
24/08/2006

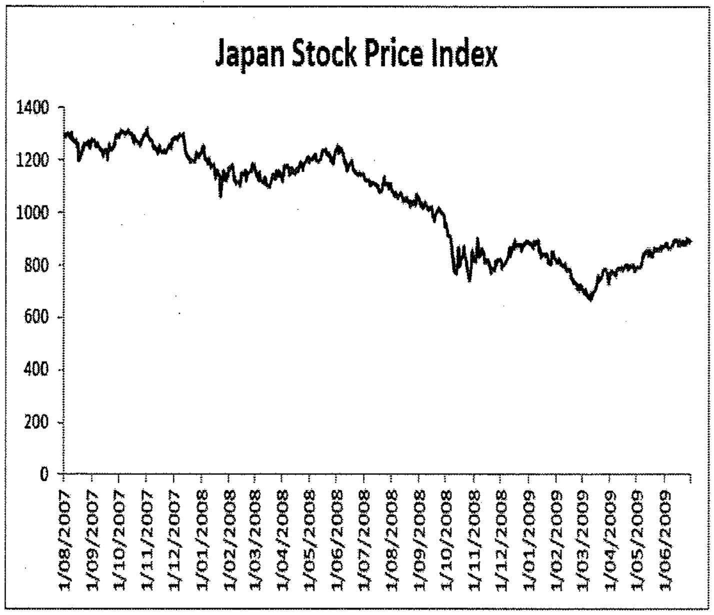

Brazil Stock Return
0.15
0.1
0.05
0
-0.05
-0.1
24/08/2000
24/08/2001
24/08/2002
24/08/2003
24/08/2004
24/08/2005
24/08/2006

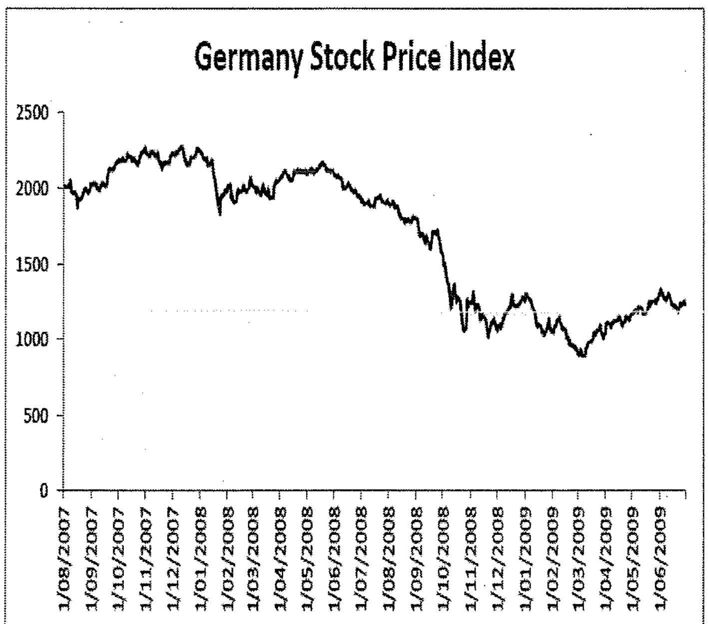

Spain Stock Return
0.06
0.04
0.02
0
-0.02
-0.04
-0.06
24/08/2000
24/08/2001
24/08/2002
24/08/2003
24/08/2004
24/08/2005
24/08/2006

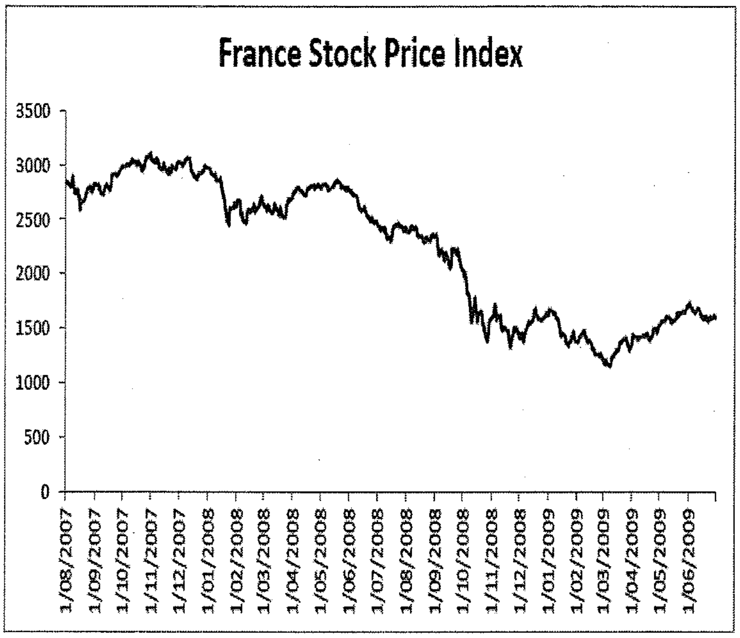

Canada
0.06
0.04
0.02
0
-0.02
-0.04
-0.06
-0.08
-0.1
24/08/2000
24/08/2001
24/08/2002
24/08/2003
24/08/2004
24/08/2005
24/08/2006

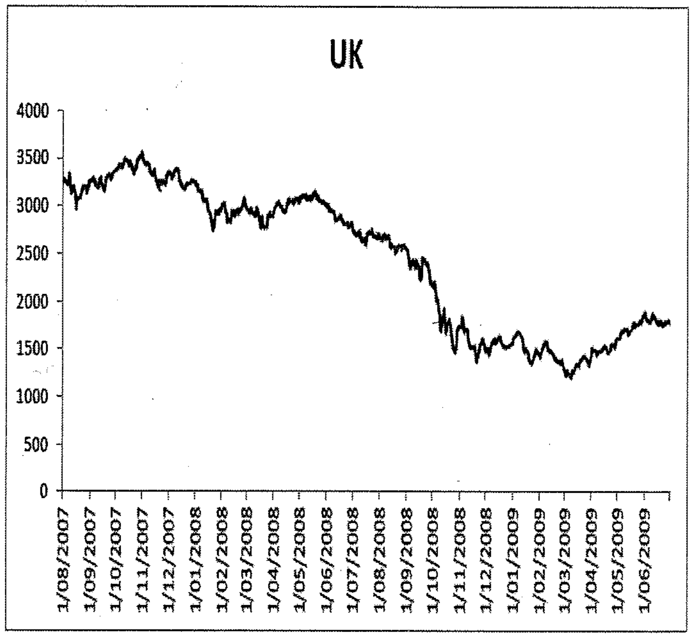
During GFC Time Series Plots of Price Indices

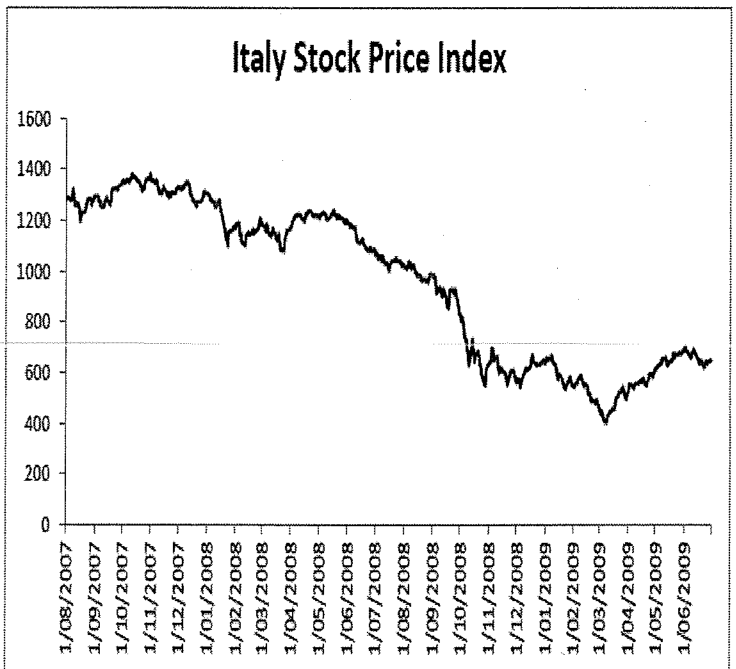


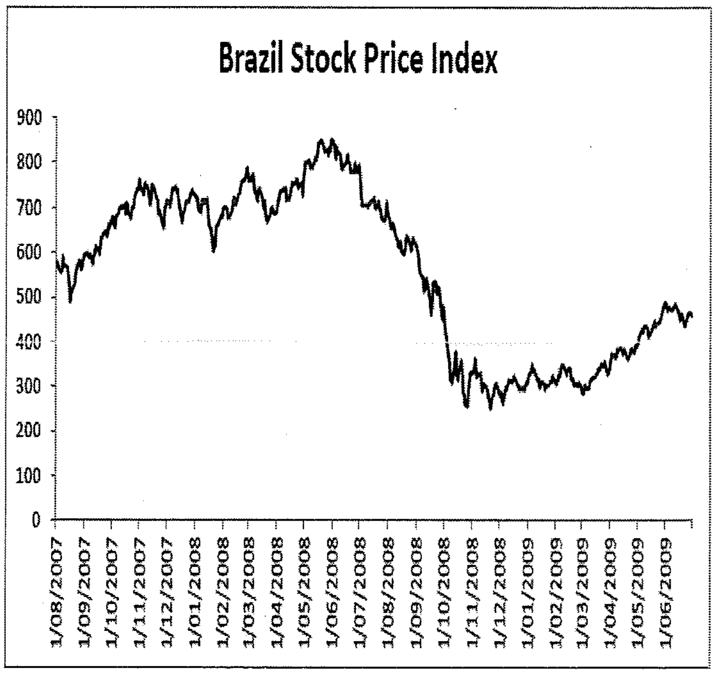




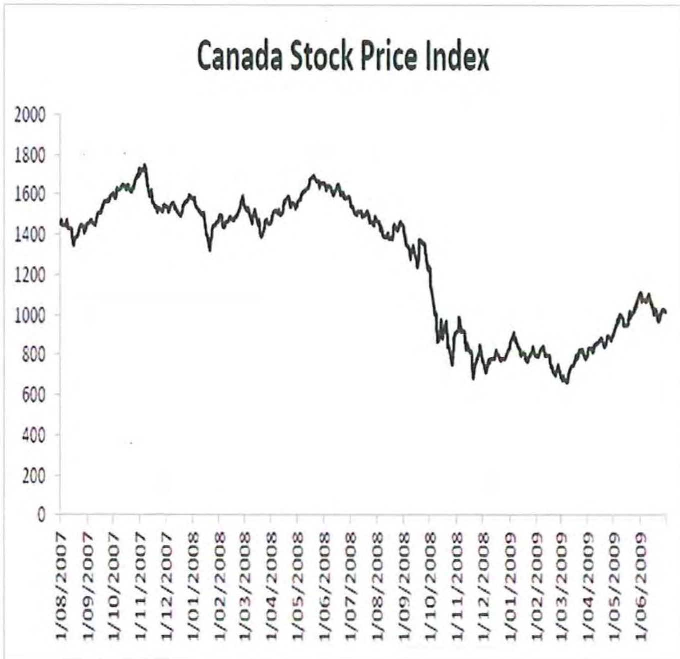

France Stock Price Index
3500
3000
2500
2000
1500
1000
500
0
1/08/2007 1/09/2007 1/10/2007 1/11/2007 1/12/2007 1/01/2008 1/02/2008 1/03/2008 1/04/2008 1/05/2008 1/06/2008 1/07/2008 1/08/2008 1/09/2008 1/10/2008 1/11/2008 1/12/2008 1/01/2009 1/02/2009 1/03/2009 1/04/2009 1/05/2009 1/06/2009

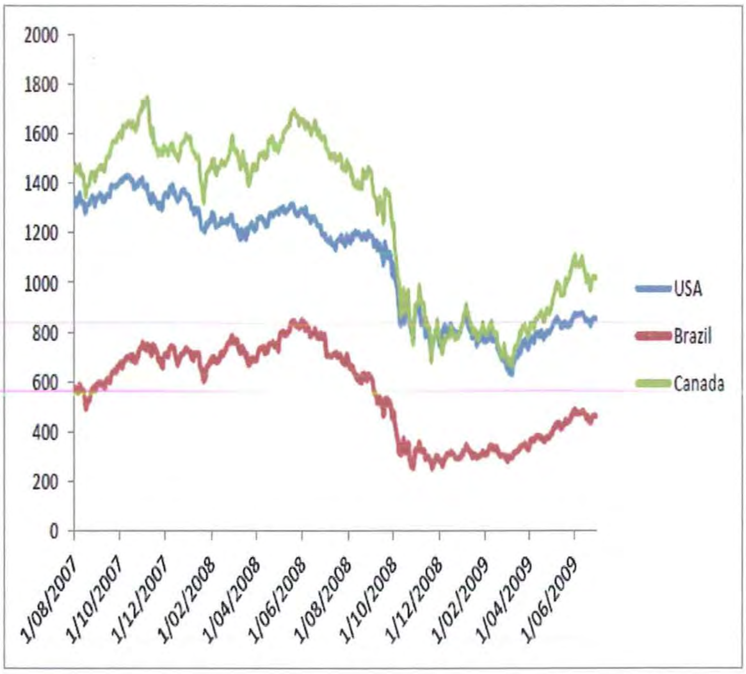

UK
4000
3500
3000
2500
2000
1500
1000
500
0
1/08/2007 1/09/2007 1/10/2007 1/11/2007 1/12/2007 1/01/2008 1/02/2008 1/03/2008 1/04/2008 1/05/2008 1/06/2008 1/07/2008 1/08/2008 1/09/2008 1/10/2008 1/11/2008 1/12/2008 1/01/2009 1/02/2009 1/03/2009 1/04/2009 1/05/2009 1/06/2009

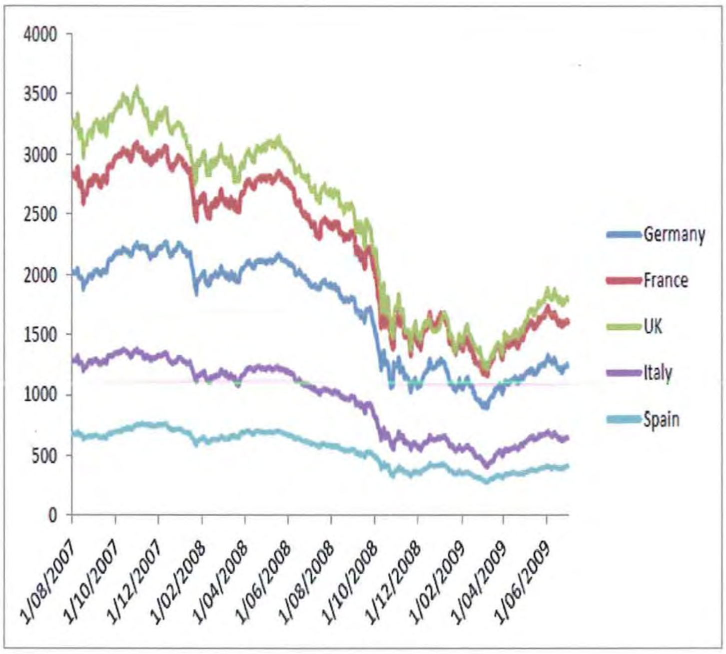

Italy Stock Price Index
1600
1400
1200
1000
800
600
400
200
0
1/08/2007 1/09/2007 1/10/2007 1/11/2007 1/12/2007 1/01/2008 1/02/2008 1/03/2008 1/04/2008 1/05/2008 1/06/2008 1/07/2008 1/08/2008 1/09/2008 1/10/2008 1/11/2008 1/12/2008 1/01/2009 1/02/2009 1/03/2009 1/04/2009 1/05/2009 1/06/2009

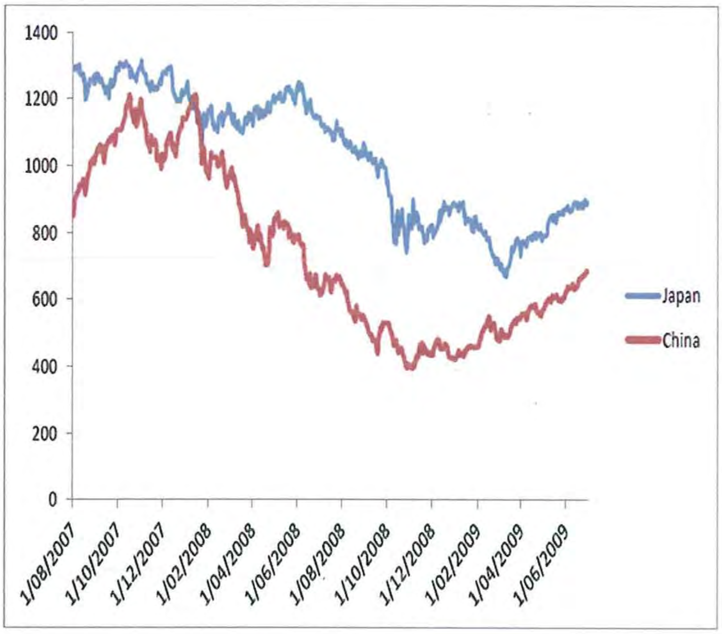

Brazil Stock Price Index
900
800
700
600
500
400
300
200
100
0
1/08/2007 1/09/2007 1/10/2007 1/11/2007 1/12/2007 1/01/2008 1/02/2008 1/03/2008 1/04/2008 1/05/2008 1/06/2008 1/07/2008 1/08/2008 1/09/2008 1/10/2008 1/11/2008 1/12/2008 1/01/2009 1/02/2009 1/03/2009 1/04/2009 1/05/2009 1/06/2009


Spain Stock Price Index

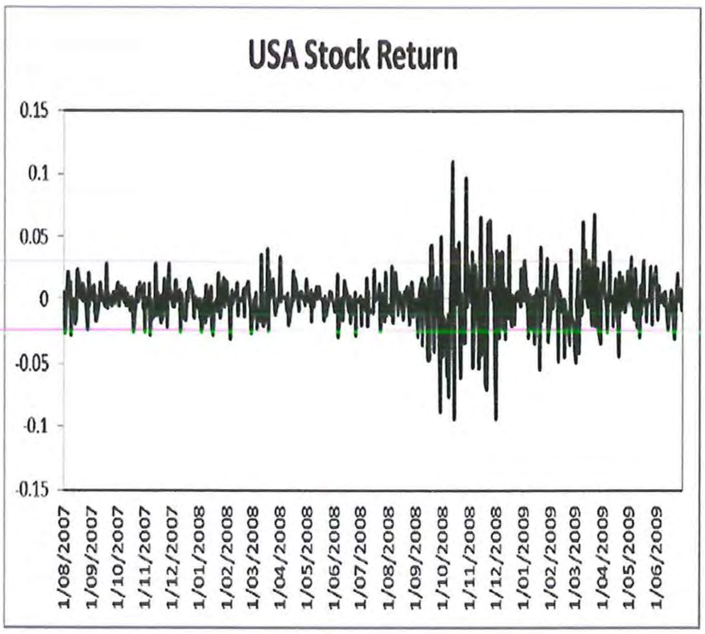

Canada Stock Price Index

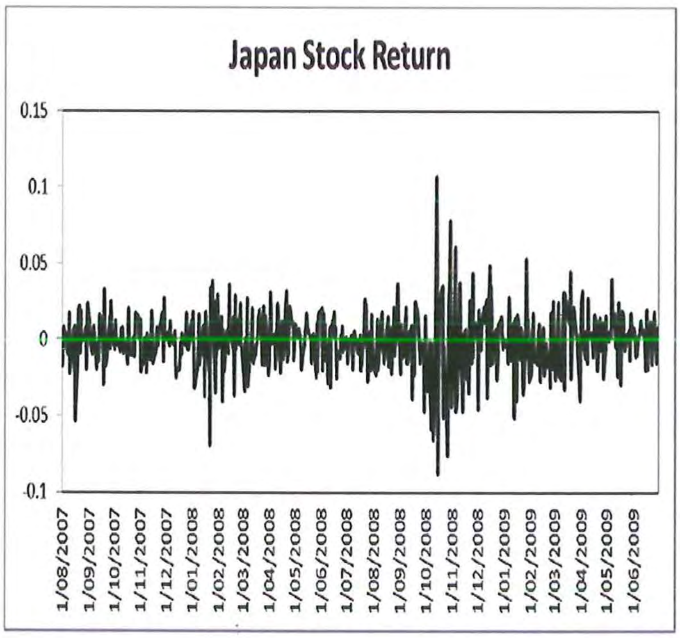

USA
Brazil
Canada

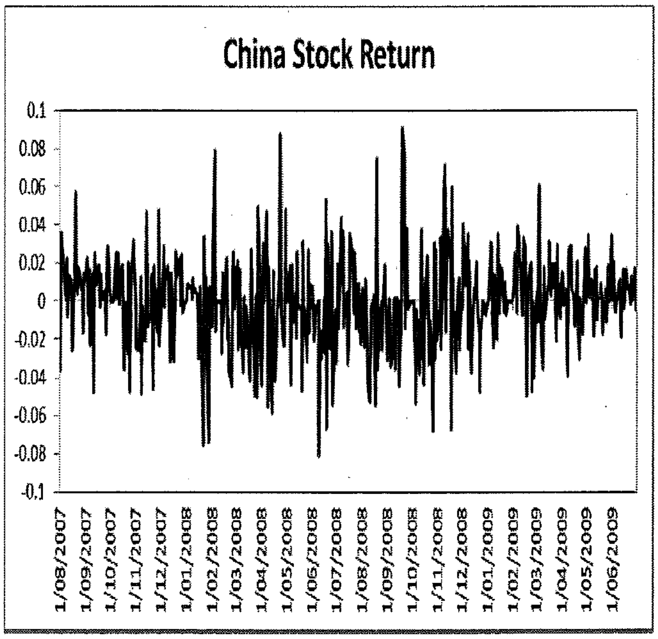

Germany
France
UK
Italy
Spain

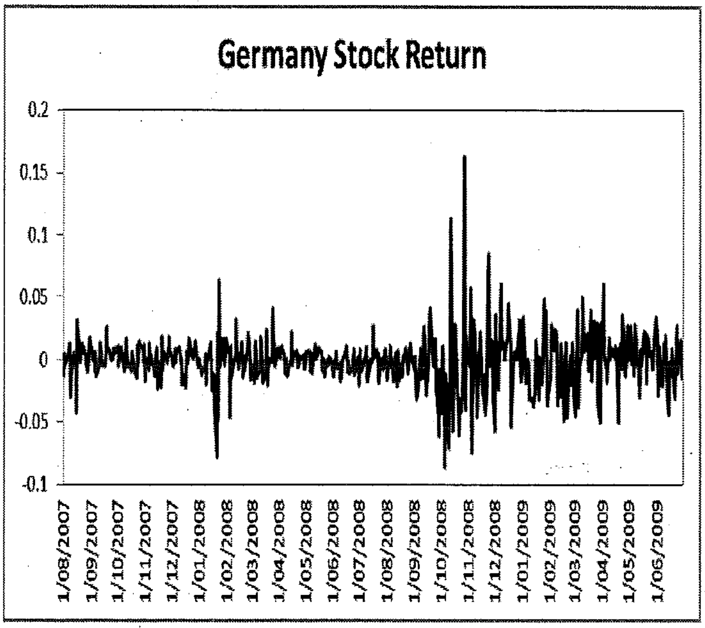


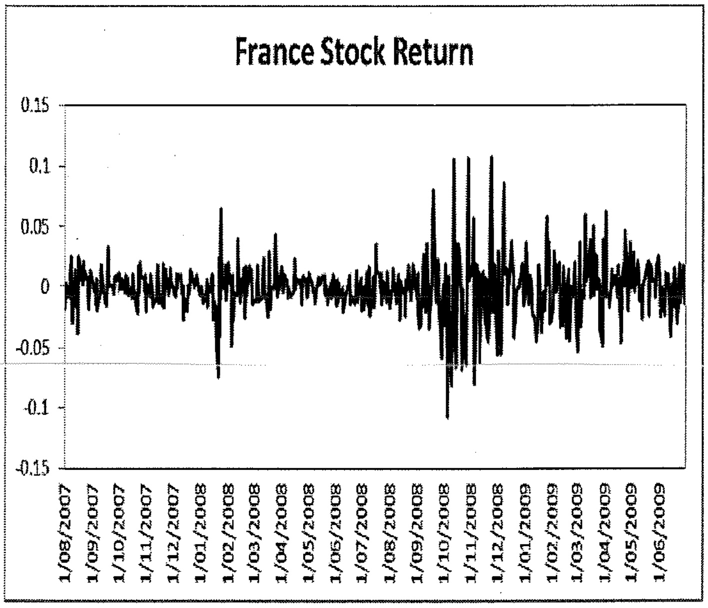
During the GFC Time Series Plots of Stock Returns

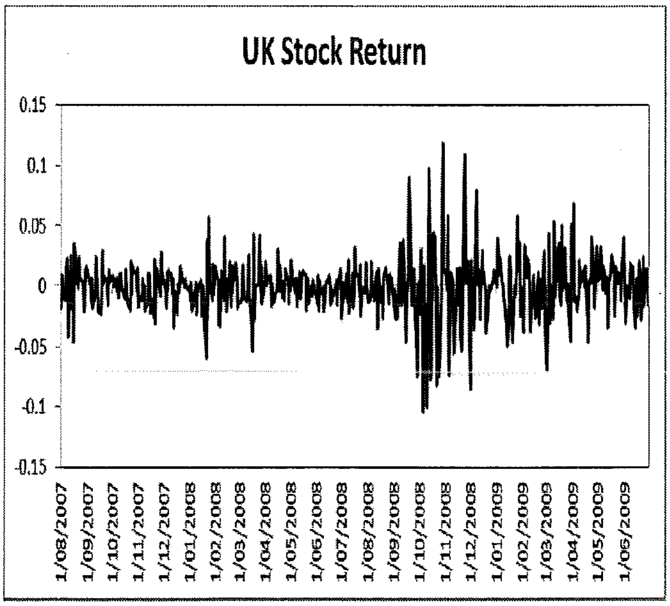


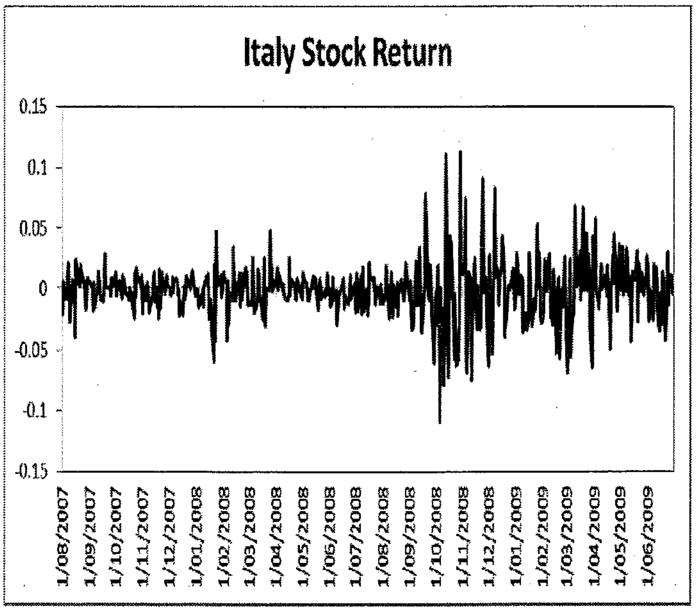


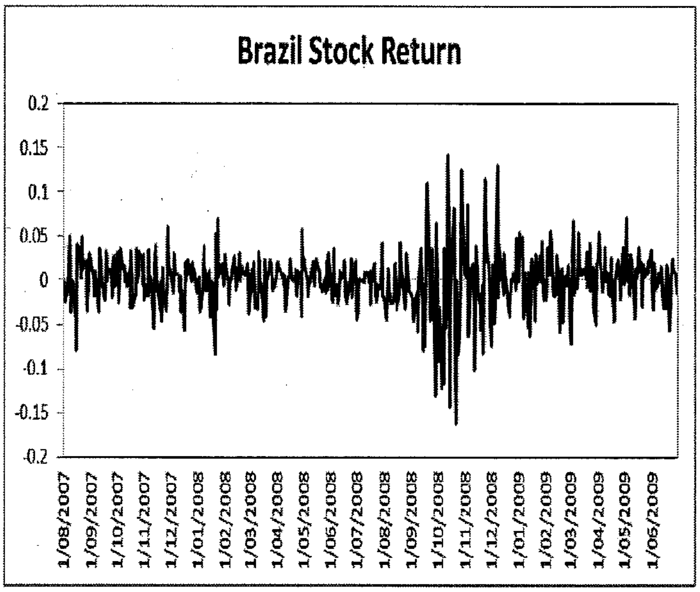

China Stock Return
0.1
0.08
0.06
0.04
0.02
0
-0.02
-0.04
-0.06
-0.08
-0.1
1/08/2007
1/09/2007
1/10/2007
1/11/2007
1/12/2007
1/01/2008
1/02/2008
1/03/2008
1/04/2008
1/05/2008
1/06/2008
1/07/2008
1/08/2008
1/09/2008
1/10/2008
1/11/2008
1/12/2008
1/01/2009
1/02/2009
1/03/2009
1/04/2009
1/05/2009
1/06/2009

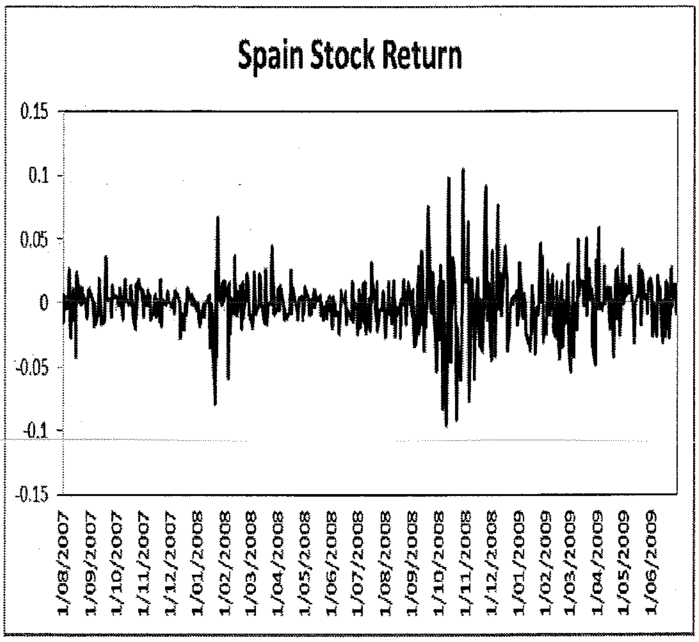

Germany Stock Return
0.2
0.15
0.1
0.05
0
-0.05
-0.1
1/08/2007
1/09/2007
1/10/2007
1/11/2007
1/12/2007
1/01/2008
1/02/2008
1/03/2008
1/04/2008
1/05/2008
1/06/2008
1/07/2008
1/08/2008
1/09/2008
1/10/2008
1/11/2008
1/12/2008
1/01/2009
1/02/2009
1/03/2009
1/04/2009
1/05/2009
1/06/2009

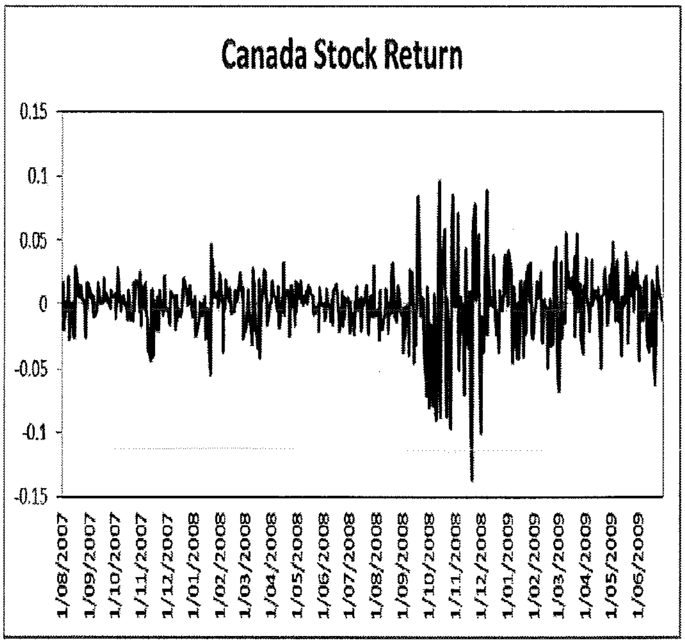

France Stock Return
0.15
0.1
0.05
0
-0.05
-0.1
-0.15
1/08/2007
1/09/2007
1/10/2007
1/11/2007
1/12/2007
1/01/2008
1/02/2008
1/03/2008
1/04/2008
1/05/2008
1/06/2008
1/07/2008
1/08/2008
1/09/2008
1/10/2008
1/11/2008
1/12/2008
1/01/2009
1/02/2009
1/03/2009
1/04/2009
1/05/2009
1/06/2009


UK Stock Return
0.15
0.1
0.05
0
-0.05
-0.1
-0.15
1/08/2007
1/09/2007
1/10/2007
1/11/2007
1/12/2007
1/01/2008
1/02/2008
1/03/2008
1/04/2008
1/05/2008
1/06/2008
1/07/2008
1/08/2008
1/09/2008
1/10/2008
1/11/2008
1/12/2008
1/01/2009
1/02/2009
1/03/2009
1/04/2009
1/05/2009
1/06/2009

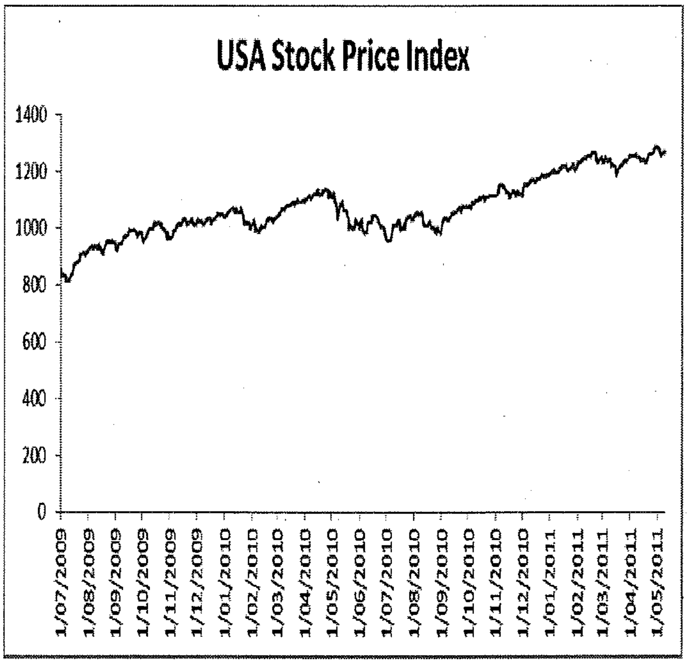

Italy Stock Return
0.15
0.1
0.05
0
-0.05
-0.1
-0.15
1/08/2007
1/09/2007
1/10/2007
1/11/2007
1/12/2007
1/01/2008
1/02/2008
1/03/2008
1/04/2008
1/05/2008
1/06/2008
1/07/2008
1/08/2008
1/09/2008
1/10/2008
1/11/2008
1/12/2008
1/01/2009
1/02/2009
1/03/2009
1/04/2009
1/05/2009
1/06/2009

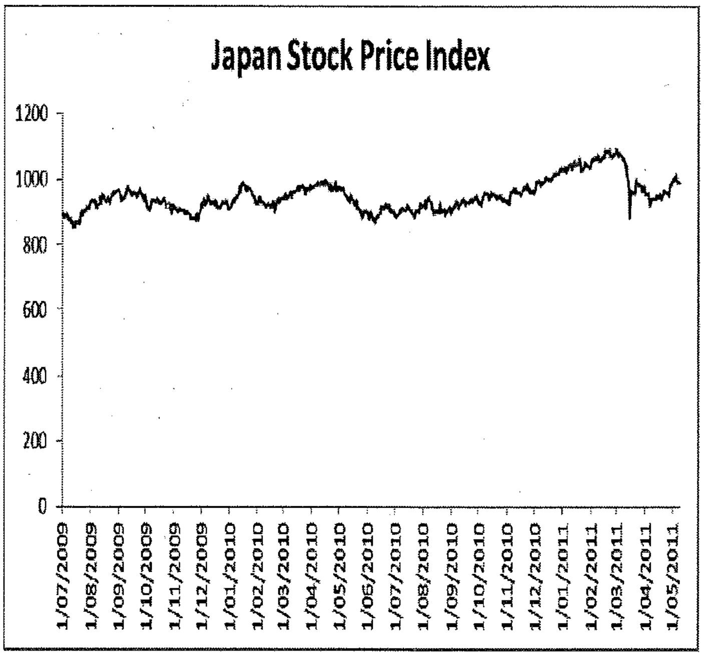

Brazil Stock Return
0.2
0.15
0.1
0.05
0
-0.05
-0.1
-0.15
-0.2
1/08/2007
1/09/2007
1/10/2007
1/11/2007
1/12/2007
1/01/2008
1/02/2008
1/03/2008
1/04/2008
1/05/2008
1/06/2008
1/07/2008
1/08/2008
1/09/2008
1/10/2008
1/11/2008
1/12/2008
1/01/2009
1/02/2009
1/03/2009
1/04/2009
1/05/2009
1/06/2009

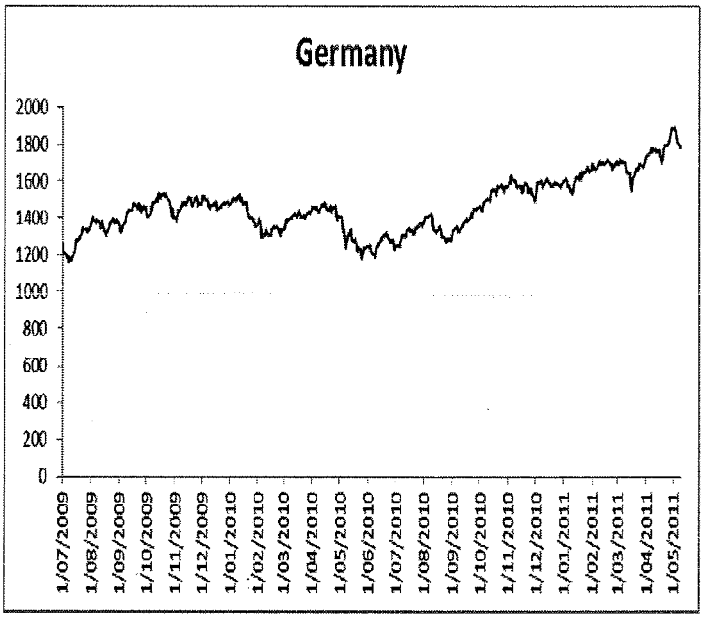

Spain Stock Return
0.15
0.1
0.05
0
-0.05
-0.1
-0.15
1/08/2007
1/09/2007
1/10/2007
1/11/2007
1/12/2007
1/01/2008
1/02/2008
1/03/2008
1/04/2008
1/05/2008
1/06/2008
1/07/2008
1/08/2008
1/09/2008
1/10/2008
1/11/2008
1/12/2008
1/01/2009
1/02/2009
1/03/2009
1/04/2009
1/05/2009
1/06/2009

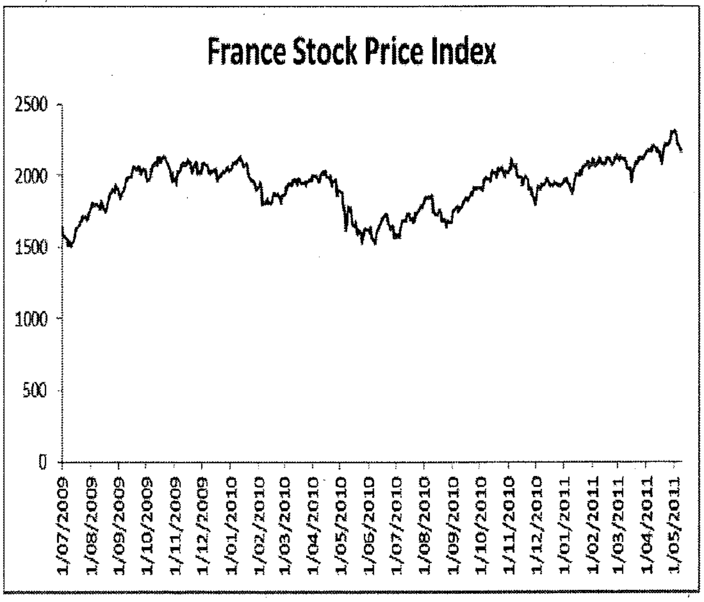

Canada Stock Return
0.15
0.1
0.05
0
-0.05
-0.1
-0.15
1/08/2007
1/09/2007
1/10/2007
1/11/2007
1/12/2007
1/01/2008
1/02/2008
1/03/2008
1/04/2008
1/05/2008
1/06/2008
1/07/2008
1/08/2008
1/09/2008
1/10/2008
1/11/2008
1/12/2008
1/01/2009
1/02/2009
1/03/2009
1/04/2009
1/05/2009
1/06/2009

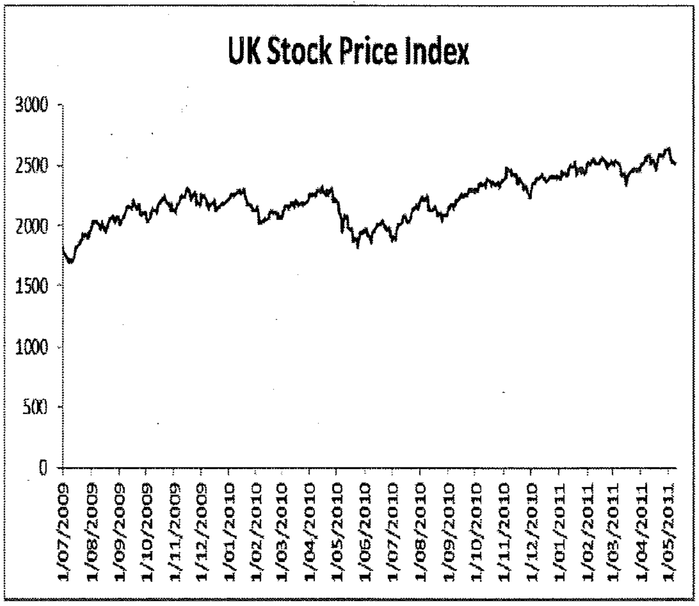
Post GFC Time Series Plots of Price Indices

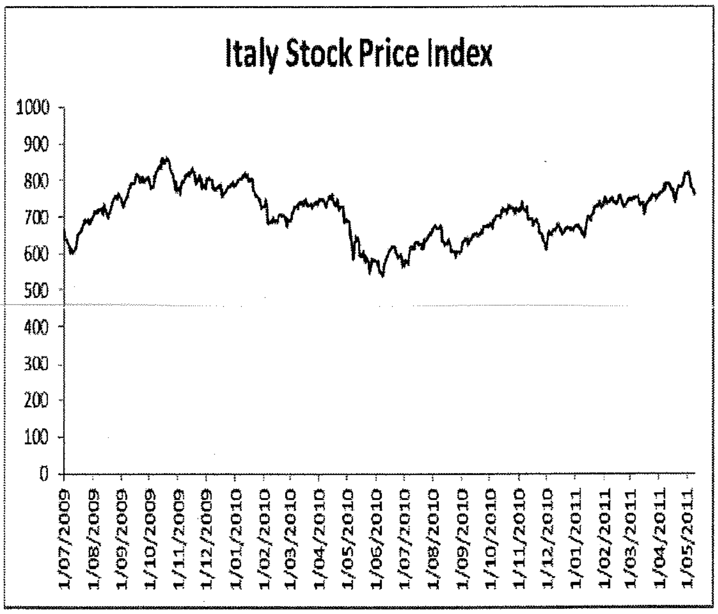


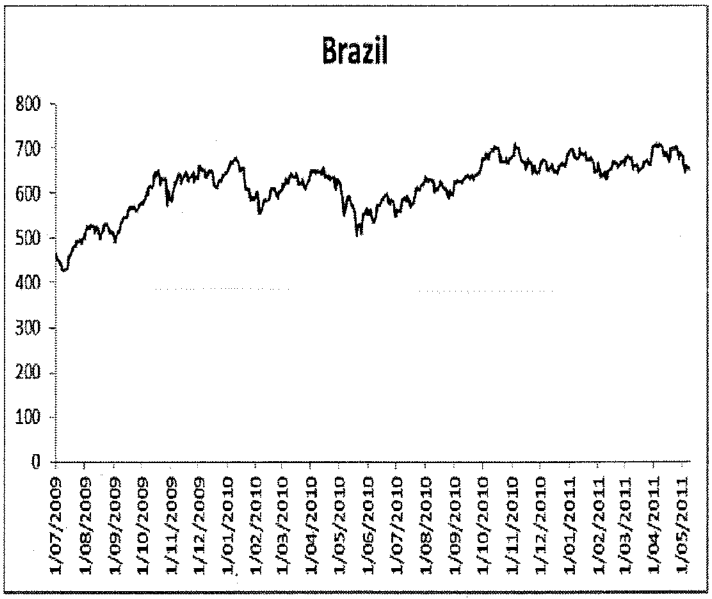


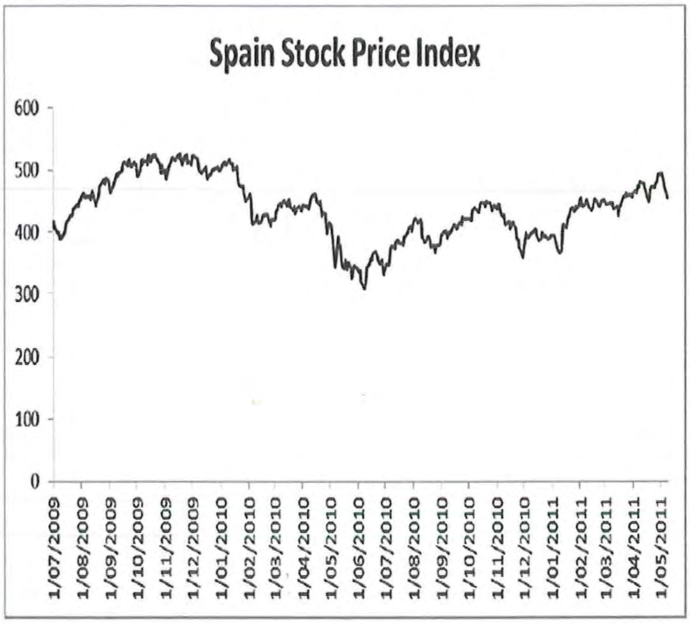


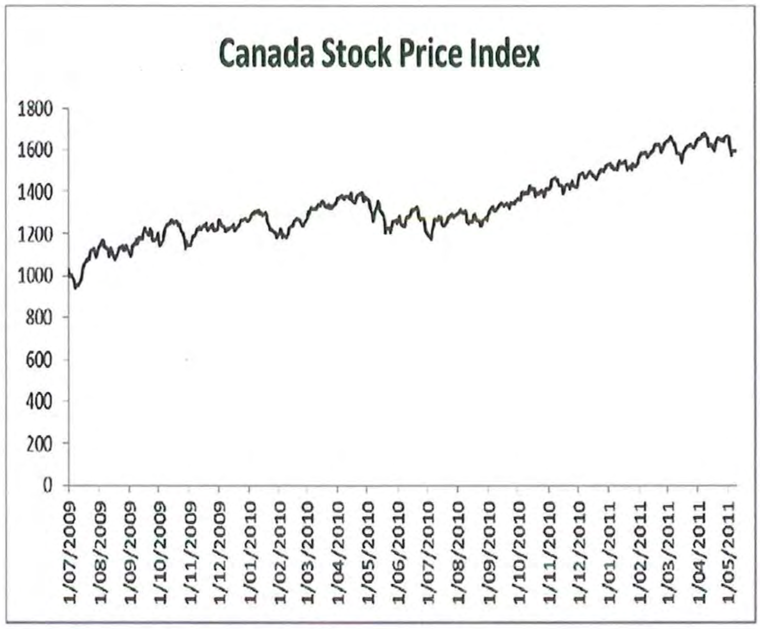

France Stock Price Index
2500
2000
1500
1000
500
0
1/07/2009
1/08/2009
1/09/2009
1/10/2009
1/11/2009
1/12/2009
1/01/2010
1/02/2010
1/03/2010
1/04/2010
1/05/2010
1/06/2010
1/07/2010
1/08/2010
1/09/2010
1/10/2010
1/11/2010
1/12/2010
1/01/2011
1/02/2011
1/03/2011
1/04/2011
1/05/2011

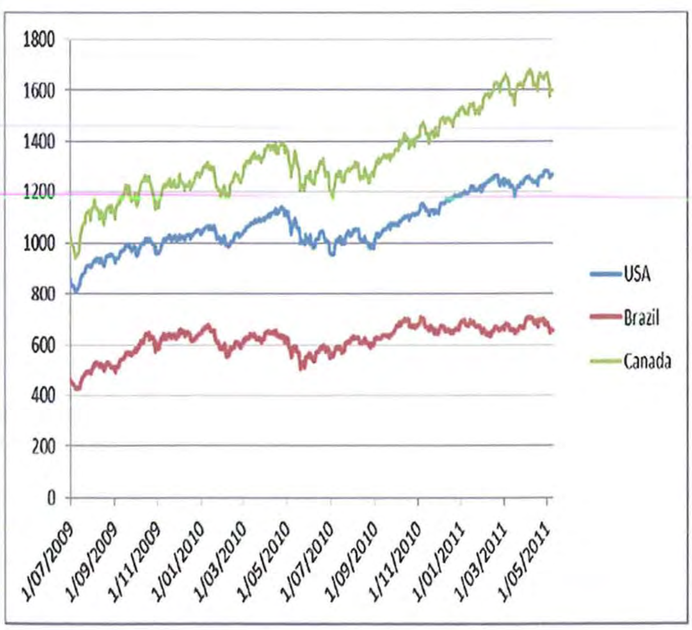

UK Stock Price Index
3000
2500
2000
1500
1000
500
0
1/07/2009
1/08/2009
1/09/2009
1/10/2009
1/11/2009
1/12/2009
1/01/2010
1/02/2010
1/03/2010
1/04/2010
1/05/2010
1/06/2010
1/07/2010
1/08/2010
1/09/2010
1/10/2010
1/11/2010
1/12/2010
1/01/2011
1/02/2011
1/03/2011
1/04/2011
1/05/2011

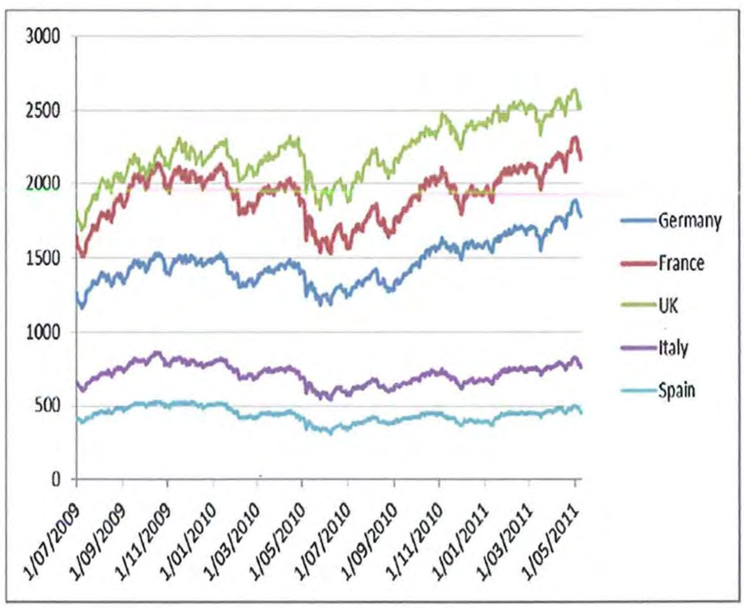

Italy Stock Price Index
1000
900
800
700
600
500
400
300
200
100
0
1/07/2009
1/08/2009
1/09/2009
1/10/2009
1/11/2009
1/12/2009
1/01/2010
1/02/2010
1/03/2010
1/04/2010
1/05/2010
1/06/2010
1/07/2010
1/08/2010
1/09/2010
1/10/2010
1/11/2010
1/12/2010
1/01/2011
1/02/2011
1/03/2011
1/04/2011
1/05/2011

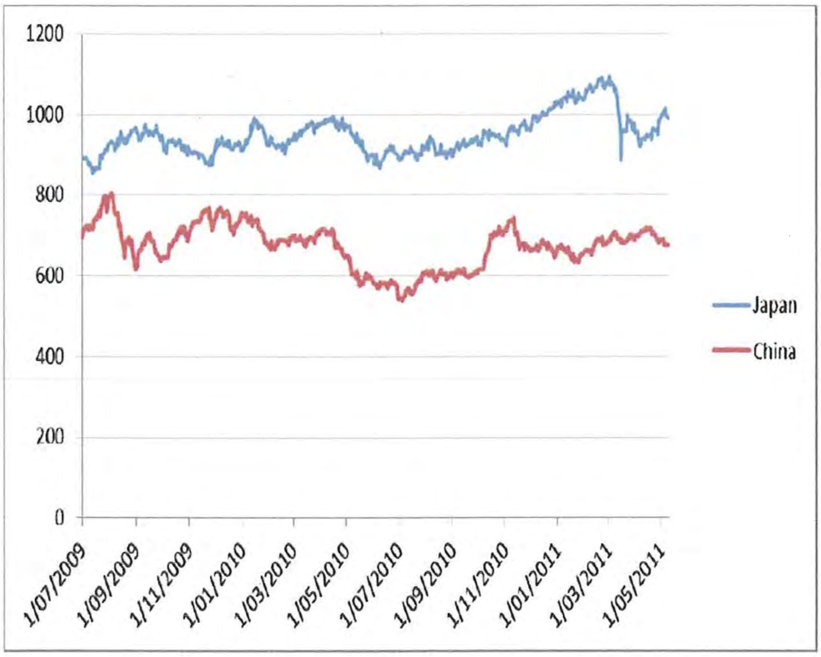

Brazil
800
700
600
500
400
300
200
100
0
1/07/2009
1/08/2009
1/09/2009
1/10/2009
1/11/2009
1/12/2009
1/01/2010
1/02/2010
1/03/2010
1/04/2010
1/05/2010
1/06/2010
1/07/2010
1/08/2010
1/09/2010
1/10/2010
1/11/2010
1/12/2010
1/01/2011
1/02/2011
1/03/2011
1/04/2011
1/05/2011


Spain Stock Price Index
600
500
400
300
200
100
0
1/07/2009
1/08/2009
1/09/2009
1/10/2009
1/11/2009
1/12/2009
1/01/2010
1/02/2010
1/03/2010
1/04/2010
1/05/2010
1/06/2010
1/07/2010
1/08/2010
1/09/2010
1/10/2010
1/11/2010
1/12/2010
1/01/2011
1/02/2011
1/03/2011
1/04/2011
1/05/2011

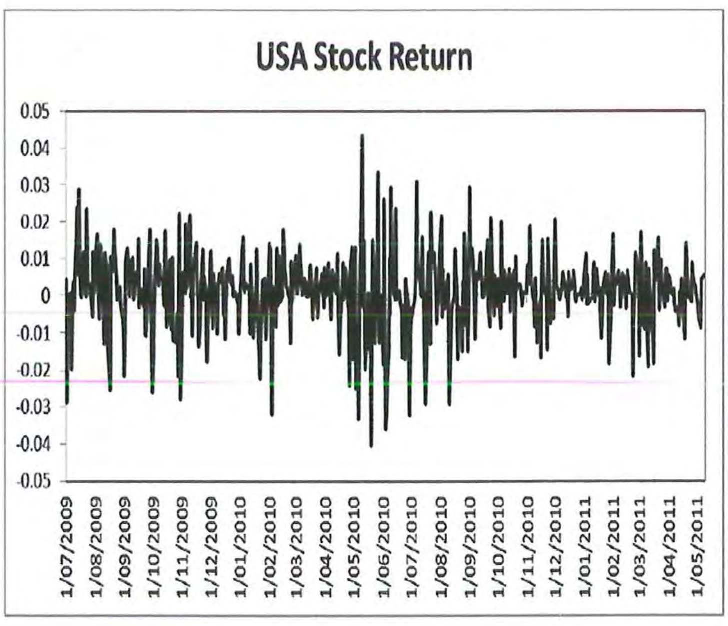

Canada Stock Price Index
1800
1600
1400
1200
1000
800
600
400
200
0
1/07/2009
1/08/2009
1/09/2009
1/10/2009
1/11/2009
1/12/2009
1/01/2010
1/02/2010
1/03/2010
1/04/2010
1/05/2010
1/06/2010
1/07/2010
1/08/2010
1/09/2010
1/10/2010
1/11/2010
1/12/2010
1/01/2011
1/02/2011
1/03/2011
1/04/2011
1/05/2011

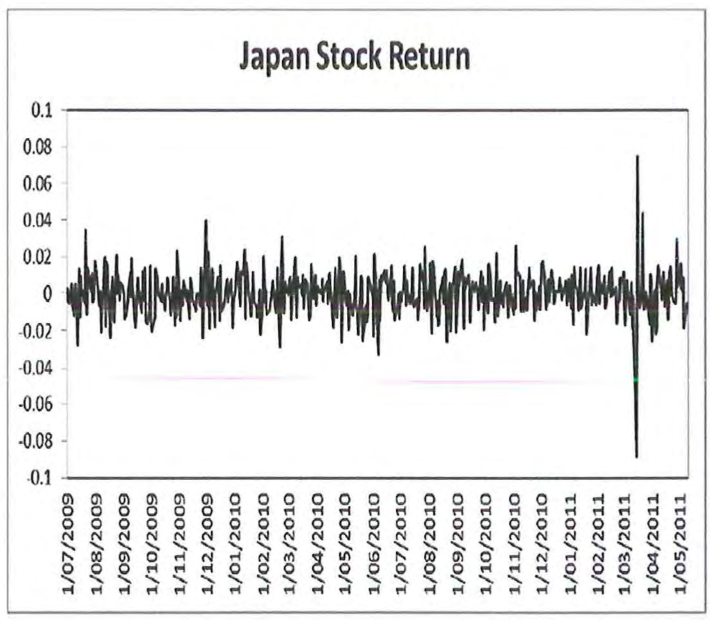

1800
1600
1400
1200
1000
800
600
400
200
0
1/07/2009
1/09/2009
1/11/2009
1/01/2010
1/03/2010
1/05/2010
1/07/2010
1/09/2010
1/11/2010
1/01/2011
1/03/2011
1/05/2011
USA
Brazil
Canada

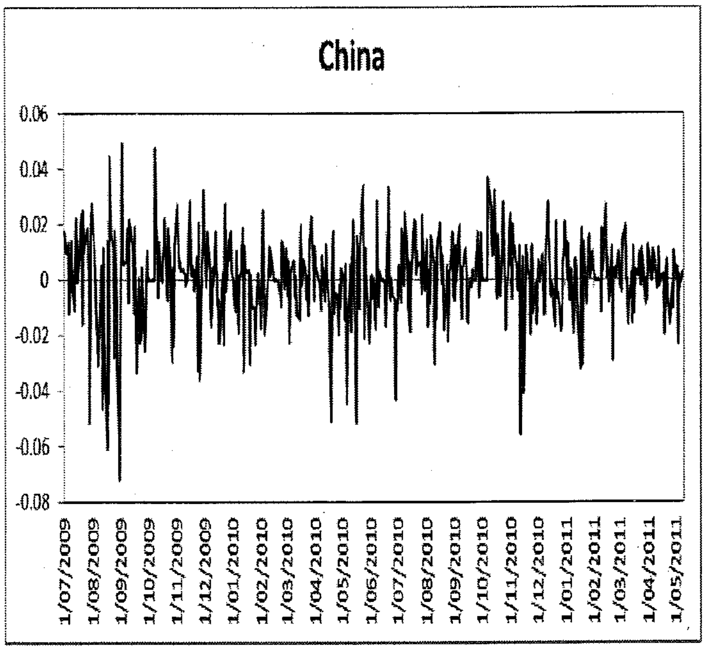

3000
2500
2000
1500
1000
500
0
1/07/2009
1/09/2009
1/11/2009
1/01/2010
1/03/2010
1/05/2010
1/07/2010
1/09/2010
1/11/2010
1/01/2011
1/03/2011
1/05/2011
Germany
France
UK
Italy
Spain

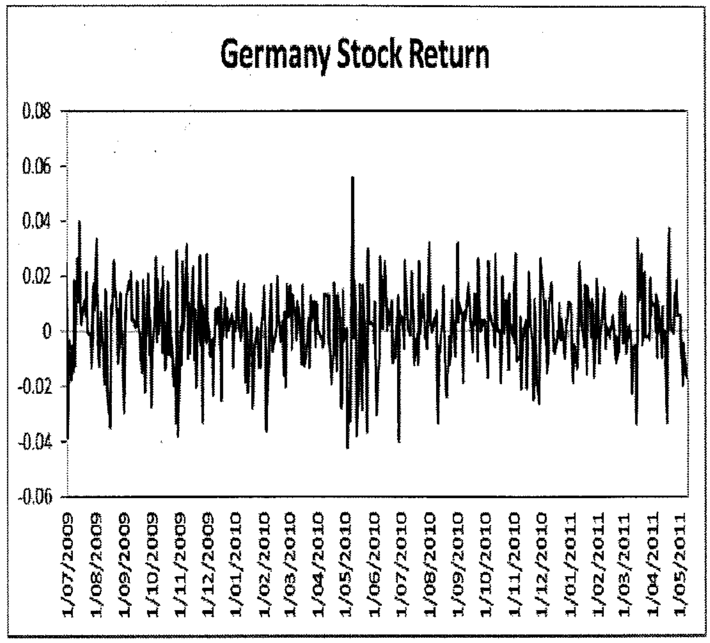


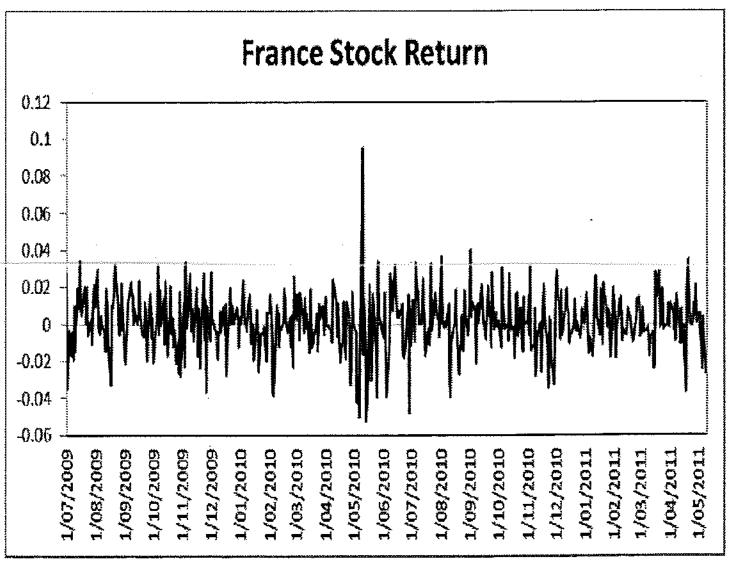
Post GFC Time Series Plots Of Stock Returns

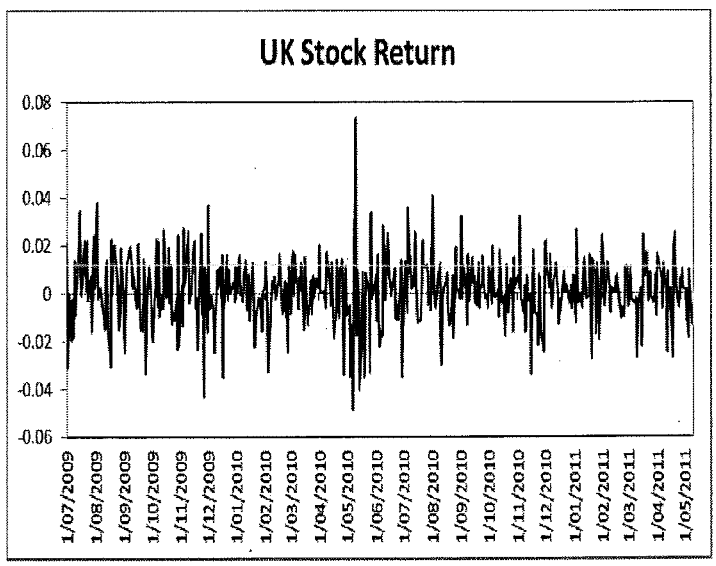


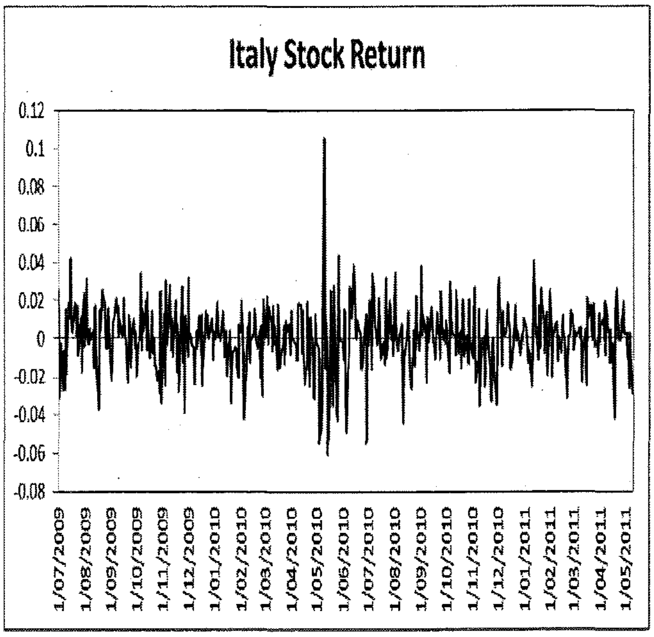


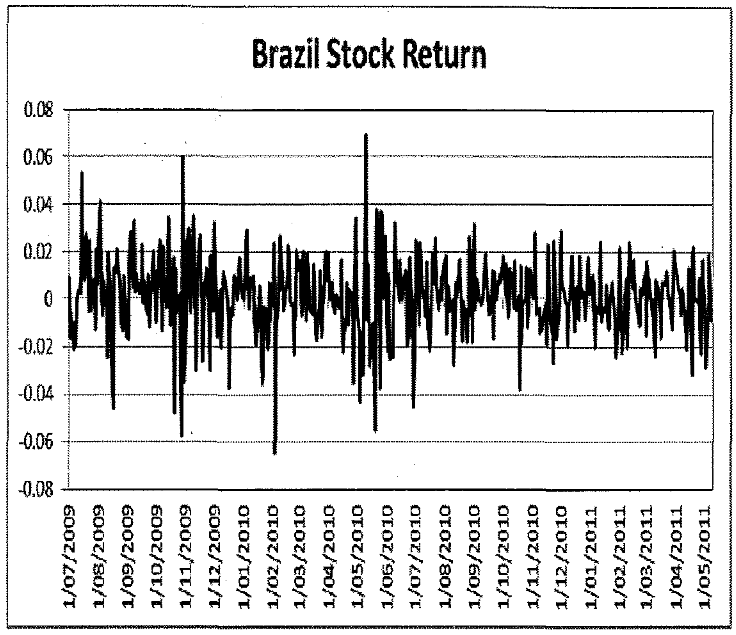

China
0.06
0.04
0.02
0
-0.02
-0.04
-0.06
-0.08
1/07/2009
1/08/2009
1/09/2009
1/10/2009
1/11/2009
1/12/2009
1/01/2010
1/02/2010
1/03/2010
1/04/2010
1/05/2010
1/06/2010
1/07/2010
1/08/2010
1/09/2010
1/10/2010
1/11/2010
1/12/2010
1/01/2011
1/02/2011
1/03/2011
1/04/2011
1/05/2011

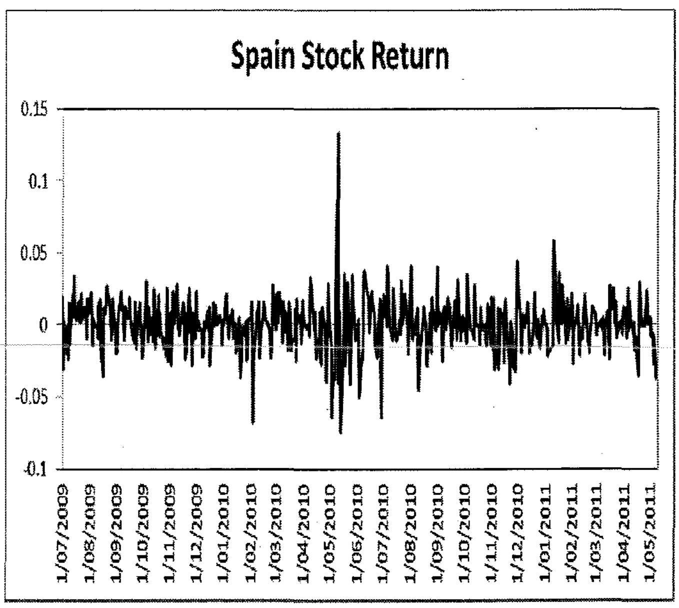

Germany Stock Return
0.08
0.06
0.04
0.02
0
-0.02
-0.04
-0.06
1/07/2009
1/08/2009
1/09/2009
1/10/2009
1/11/2009
1/12/2009
1/01/2010
1/02/2010
1/03/2010
1/04/2010
1/05/2010
1/06/2010
1/07/2010
1/08/2010
1/09/2010
1/10/2010
1/11/2010
1/12/2010
1/01/2011
1/02/2011
1/03/2011
1/04/2011
1/05/2011

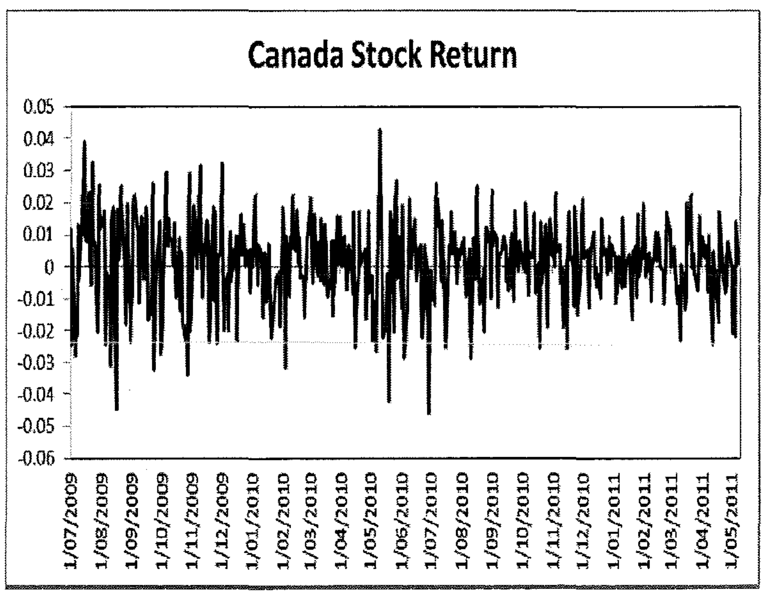

France Stock Return
0.12
0.1
0.08
0.06
0.04
0.02
0
-0.02
-0.04
-0.06
1/07/2009
1/08/2009
1/09/2009
1/10/2009
1/11/2009
1/12/2009
1/01/2010
1/02/2010
1/03/2010
1/04/2010
1/05/2010
1/06/2010
1/07/2010
1/08/2010
1/09/2010
1/10/2010
1/11/2010
1/12/2010
1/01/2011
1/02/2011
1/03/2011
1/04/2011
1/05/2011


UK Stock Return
0.08
0.06
0.04
0.02
0
-0.02
-0.04
-0.06
1/07/2009
1/08/2009
1/09/2009
1/10/2009
1/11/2009
1/12/2009
1/01/2010
1/02/2010
1/03/2010
1/04/2010
1/05/2010
1/06/2010
1/07/2010
1/08/2010
1/09/2010
1/10/2010
1/11/2010
1/12/2010
1/01/2011
1/02/2011
1/03/2011
1/04/2011
1/05/2011


Italy Stock Return
0.12
0.1
0.08
0.06
0.04
0.02
0
-0.02
-0.04
-0.06
-0.08
1/07/2009
1/08/2009
1/09/2009
1/10/2009
1/11/2009
1/12/2009
1/01/2010
1/02/2010
1/03/2010
1/04/2010
1/05/2010
1/06/2010
1/07/2010
1/08/2010
1/09/2010
1/10/2010
1/11/2010
1/12/2010
1/01/2011
1/02/2011
1/03/2011
1/04/2011
1/05/2011


Brazil Stock Return
0.08
0.06
0.04
0.02
0
-0.02
-0.04
-0.06
-0.08
1/07/2009
1/08/2009
1/09/2009
1/10/2009
1/11/2009
1/12/2009
1/01/2010
1/02/2010
1/03/2010
1/04/2010
1/05/2010
1/06/2010
1/07/2010
1/08/2010
1/09/2010
1/10/2010
1/11/2010
1/12/2010
1/01/2011
1/02/2011
1/03/2011
1/04/2011
1/05/2011


Spain Stock Return
0.15
0.1
0.05
0
-0.05
-0.1
1/07/2009
1/08/2009
1/09/2009
1/10/2009
1/11/2009
1/12/2009
1/01/2010
1/02/2010
1/03/2010
1/04/2010
1/05/2010
1/06/2010
1/07/2010
1/08/2010
1/09/2010
1/10/2010
1/11/2010
1/12/2010
1/01/2011
1/02/2011
1/03/2011
1/04/2011
1/05/2011


Canada Stock Return
0.05
0.04
0.03
0.02
0.01
0
-0.01
-0.02
-0.03
-0.04
-0.05
-0.06
1/07/2009
1/08/2009
1/09/2009
1/10/2009
1/11/2009
1/12/2009
1/01/2010
1/02/2010
1/03/2010
1/04/2010
1/05/2010
1/06/2010
1/07/2010
1/08/2010
1/09/2010
1/10/2010
1/11/2010
1/12/2010
1/01/2011
1/02/2011
1/03/2011
1/04/2011
1/05/2011

REFERENCES

U.S. Deparment of state >Home>Electronic Information and Publications> Background notes>Spain. (2010, August 18). Retrieved May 20, 2011, from U.S. Department of state website: http://www.state.gov/r/pa/ei/bgn/3842.htm

U.S. Department of State > Home > Electronic Information and Publications > Background Notes > Germany. (2010, November 10). Retrieved 24 May, 2011, from U.S. Department of State: http://www.state.gov/r/pa/ei/bgn/3997.htm

Federal Foreign Office > Foreign and European policy > Bilateral Relations > Italy. (2011, April). Retrieved May 20, 2011, from Federal Foreign Office: http://www.auswaertiges-amt.de/EN/Aussenpolitik/Laender/Laenderinfos/01-Nodes/Italien_node.html

Foreign and Commonwealth Office > Home > Latest News. (2011, March 25). Retrieved May 24, 2011, from Foreign and Commonwealth Office: http://www.fco.gov.uk/en/news/latest-news/?view=News&id=572557182

U.S. Department of State > Electronic Information and Publications > Background Notes > Italy. (2011, May 12). Retrieved May 17, 2011, from U.S. Department of State: http://www.state.gov/r/pa/ei/bgn/4033.htm

Alexander, C. (2001). *Market Models: a Guide to Financial Data Analysis*. England: John Wiley & Sons Ltd.

Alexander, C. (2009). Market Risk Analysis. In C. Alexander, *Market Risk Analysis* (Vol. II, pp. 1-52). John & Wiley Sons.

Arshanapalli, B., & Doukas, J. (1993). International Stock Market Linkages: Evidence from the pre- and post- October 1982 Period. *Journal of Banking and Finance, 17*(1), 193-208.

Azad, S. A. (2009). Efficiency, Cointegration and Contagion in Equity Markets: Evidence from China, Japan and South Korea. *Asian Economic Journal, 23*(1), 93-118.

Bahng, J. S. (2005). The Response of the Indian Stock Market to movement of Asia's Emerging Markets: From Isolation toward Integration? *Finance India, 19*(3), 937-951.

Baur, D. G., & Fry, R. A. (2009, March). Retrieved June 1, 2011, from http://people.anu.edu.au/renee.fry/Baur%20and%20Fry%202009.pdf

Calomiris, C. W. (2009, April). The Subprime Turmoil: What's Old, What's New and What's Next. *The Journal of Structured Finance, 15*(1), 1-48.

Chatterjee, A., Ayadi, F. O., & Maniam, B. (2003). Asian Financial Crisis: The Pre- and Post- Crisis Analysis of Asian Equity Markets. *Managerial Finance, 29*(4), 62-86.

Chen, G., Firth, M., & Mengrui, O. (2002, June). Stock Market Linkages: Evidence from Latin America. *Journal of Banking & Finance, 26*(6), 1113-1141.

Cheung, W., Fung , S., & Tsai, S.-C. (2010). Global Capital Market Interdependence and Spillover effect of Credit Risk: Evidence From the 2007-2009 Global Financial Crisis. *Applied Financial Economics, 20*(1), 85-103.

Cheung, Y.-W., & Lai, K. S. (1999). Macroeconomic determinants of Long term Stock Market Co-movements among Major EMS Countries. *Applied Fnancial Economics, 9*(1), 73-85.

Chung, P. J., & Liu, D. J. (1994). Common Stochastic Trends in Pacific Rim Stock Markets. *The Quarterly Review of Economics and Finance, 34*(3), 241-259.

Climent, F. J., Meneu, V., & Pardo, A. (2001, December). Information flows among the major Stock market areas. *Journal of Asset Management, 2*(3), 284-292.

Cooray, A., & Wickremasinghe, G. (2007). The Efficiency of Emerging Stock Markets: Empirical Evidence from the South Asian Region. *The Journal of Developing Areas, 41*(1), 171-183.

Corhay, A., Rad, A. T., & Urbain, J. P. (1993). Common Stochastic Trends in European Stock Markets. *Economics Letters, 42*(4), 385-390.

Craig, J. (n.d.). *Center for Policy and Development System.* Retrieved May 10, 2011, from Center for Policy and Development System Web site: http://cpds.apana.org.au/Teams?Articles/globalization.htm

Daly, K. J. (2003, April). Southeast AsianStock Market Linkages: Evidence from pre- and post-October 1997. *ASEAN Economic Bulletin, 20*(1), 73-85.

Dickey, D. A., & Fuller, W. A. (1979). Distribution of the Estimators for Autoregressive Time Series with a Unit Root. *Journal of the American Statistical Association, 74*(366), 427-431.

Dickey, D. A., Jansen, D. W., & Thornton, D. L. (1991, March/April). A Primer on Cointegration with an Application to Money. *Review-Federal Reserve Bank of St. Louis, 73*(2), 58-78.

Dietrich, P. (2011, January 11). *Paul Dietrich's Global Investing Report: A Review of the 2010 Sock Market, Foxhall's Performance and Predictions for 2011.* Retrieved May 26, 2011, from Paul Dietrich's Global Investing Trends Report Website: http://www.paul-dietrich.com/blog/a-review-of-the-2010-stock-market-foxhalls-performance-and-predictions-for-2011

Edey, M. (2009). Financial System Developments in Australia and Abroad. *Financial System to Retail Financial Services Forum* (pp. 26-34). Sydney: The Reserve Bank of Australia.

Ek, C., & Fergusson, I. F. (2010). *Canada-US Relations.* Congressional Research Service.

Engle, R. F., & Granger, C. (1987, March). Co-Integration and Error Correction: Representation, Estimation and Testing. *Econometrica, 55*(2), 251-276.

Erdinc, H., & Milla, J. (2009, October). Analysis of Cointegration in Capital Markets of France, Germany and United Kingdom. *Economics & Business Journal: Inquiries and Perspectives, 2*(1), 109-123.

Eun, C. S., & Shim, S. (1989, June). International Transmission of Stock Market Movements. *The Journal of Financial and Quantitative Analysis, 24*(2), 241-256.

European Commission Eurostat > Foreign Direct Investment Statistics. (n.d.). Retrieved May 20, 2011, from European Commission Eurostat: http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Foreign_direct_investment_statistics

Fadhlaoui, K., Bellalah, M., Dherry, A., & Zouaouii, M. (2009). An Empirical Examination of International Diversification Benefits in Central European Emerging Equity Markets. *International Journal of Business, 14*(2), 164-173.

Fama, E. F. (1965, January). The Behaviour of Stock Returns. *The Journal of Business, 38*(1), 34-105.

Fernandez-Serrano, J. L., & Sosvilla-Rivero, S. (2003). Modelling the Linkages between US and Latin American Stock Markets. *Applied Economics, 35*(12), 1423-1434.

Forbes, k. J., & Rigobon, R. (2002). No Contagion, Only Interdepndence: Measuring Stock Market Comovements. *The Journal of Business, 57*(5), 2223-2261.

Fraser, P., & Oyefeso, O. (2005, January). US, UK and European Stock Market Integration. *Journal of Business Finance Accounting, 32*(1-2), 161-181.

Friedman, J., & Shachmurove, Y. (2005). European Stock Market Dynamics Before and After the Introduction of the Euro. *PIER Working Paper 05-028*, 1-26.

Gerrits, R.-J., & Yuce, A. (1999, February). Short and Long term links among European and US stock markets. *Applied Financial Economics, 9*(1), 1-9.

Ghosh, A., Saidi, R., & Johnson, K. H. (1999). Who Moves the Asia-Pacific Stock Markets-US or Japan? Empirical Evidence Based on the Theory of Cointegration. *The Financial Review, 34*(1), 159-170.

Gibley, M. (2011, January 27). *Market Insight > Investing Strategies > Stocks > "Rising Tide of US Economy may lift Canada and Mexico"*. Retrieved May 17, 2011, from Charles Schwab Limited: http://www.schwab.co.uk/public/schwab-uk-en/markets_research/market_insight/investing_strategies/stocks/rising_tide_may_lift_canada_mexico.html?cmsid=P-3974710&lvl1=markets_research&lvl2=market_insight

Gklezakou, t., & Mylonakis, J. (2009). Interdependence of the Developing Stock Markets, Before and During the Economic Crisis: The Case of South Europe. *Journal of Money, Investing and Banking*(11), 70-78.

Gorton, G. (2008). *The Panic of 2007.* Kansas: Federal Reserve Bank of Kansas City.

Granger, C. W. (1969, August). Investigating Causal Relations by Econometric Models and Cross-Spectral Methods. *Econometrica, 37*(3), 424-438.

Gujarati, D. N., & Porter, D. C. (2009). *Basic Econometrics.* McGraw Hill Publishers.

Harris, R. I. (1992, April). Testing for Unit Root using the Augmented Dickey-Fuller test: Some Issues relating to Size, Power and the Lag Structure of the Test. *Economics Letters, 38*(4), 381-386.

Hendry, D. F., & Juselius, K. (2001). Explaining Cointegration Analysis: Part II. *The Energy Journal, 22*(1).

Iseman, M. (2011, May 11). *Census Bureau > Business & Industry > Foreign Trade > U.S. International Trade Data*. Retrieved May 17, 2011, from U.S. Census Bureau Website: http://www.census.gov/foreign-trade/top/dst/current/balance.html

Jalolov, M., & Miyakoshi, T. (2005, September). Who drives the Russian Financial Markets. *The Developing Economies, 43*(3), 374-395.

Jeyanthi, Q. B. (2010, July). Who Moves BRIC Stock Markets: US or Japan? *IUP Journal of Applied Finance, 16*(5), 61-71.

Johansen, S. (1988, June-September). Statistical Analysis of Cointegrating Vectors. *Journal of Economic Dynamics and Control, 12*(2-3), 231-254.

Johansen, S. (1991, November). Estimation and Hypothesis Testing of Cointegration Vectors in Gaussian Vector Autoregressive Models. *Econometrica, 59*(6), 1551-1580.

Johansen, S., & Juselius, k. (1990). Maximum Likelihood Estimation and Inference on Cointegration - with Applications to the Money to the Demand for Money. *Oxford Bulletin of Economics and Statistics, 52*(2), 169-210.

Jones, C. P., Shamsuddin, A., & Naumann, K. (2007). *Investements: Analysis and Management.* Milton, Queensland, Australia: John Wiley & Sons Australia, Ltd.

Kasa, K. (1992, February). Common Stochastic Trends in International Stock markets. *Journal of Monetary Economics, 29*(1), 95-124.

Kashefi, J. (2008). Are International Stock Markets Linked? Evidence From Pacific Rim Countries and the United States. *Academy of Banking Studies Journal, 7*(1), 43-56.

King, M., & Serletis, A. (1997). Common Stochastic Trends and Convergence of European Union Stock Markets. *The Manchester School of Economic and Social Studies, 65*(1), 44-57.

Kwiatkowski, D., Phillips, P. C., Schmidt, P., & Shin, Y. (1992, November). Testing the Null Hypothesis of Stationary against the Alternative of a Unit Root. *Journal of Econometrics, 54*(1-3), 159-178.

Lamba, A. S. (1999, January-June). How Isolated is the Indian Stock Market Empirical Research Findings? *Journal of Financial Management & Analysis, 12*(1), 35-46.

Lamba, A. S. (2005, October). An Analysis of the Short- and Long-Run Relationships between South Asian and Developed Equity Markets. *International Journal of Business, 10*(4), 383-402.

Li, H. (n.d.). Retrieved May 29, 2011, from http://www.qass.org.uk/2011-May_Brunel-conference/Li.pdf

Lim, K.-P., Lee, H.-A., & Liew, K.-S. (2003, August). *Scientific Commons.* Retrieved October 25, 2010, from Scientific Commons Web site: http://129.3.20.41/eps/fin/papers/0308/0308003.pdf

Listokin, D., Wyly, E. K., Keating, L., Rengert, K. M., & Listokin, B. (2000). *Making New Mortgages: Case Studies of Institutions, Home Buyers and Communities.* Fannie Mae Foundation. Fannie Mae Foundation.

Liu, S. Z., Chang, T., Lin, K.-C., & Lai, M.-Y. (2005). Trade Relations and Stock Market Interdependence: A Correlation Test for the U.S. and Its Trading Partners. *The Business Review, 3*(2), 86-98.

Lutkepohl, H., & Reimers, H.-E. (1992). Impulse Response Analysis of Cointegrated Systems. *Journal of economic Dynamics, 16*(1), 53-78.

Mac, F. (n.d.). *About Freddie Mac: Primary Mortgage Market Archives.* Retrieved October 31, 2010, from Freddie Mac Web site: http://www.freddiemac.com/pmms/pmms30.htm

Maddala, G. S. (2001). *Introduction to Econometrics* (Vol. 3). England: John Wiley and Sons Ltd.

Majid, S. M., Meera, A. K., Omar, M. A., & Aziz, H. A. (2009). Dynamic Linkages among ASEAN-5 Emerging Stock Markets. *International Journal of Emerging Markets, 4*(2), 160-184.

Malliaris, A. G., & Urrutia, J. L. (1992, September). The International Crash of October 1987: Causality Tests. *Journal of Financial and Quantitative Analysis, 27*(3), 353-364.

Maniam, B., Chatterjee, A., & Mehta, S. S. (1999). International Diversification: Case of Selected Latin American Countries. *Journal of Accounting and Finance Research, 7*(3), 90-99.

Marimuthu, M. (2010). The Co-Movements of the Regional Stpck Markets and Some Implications on Risk Diversification. *The IUP Journal of Applied Economics, 9*(2), 61-80.

Markowitz, H. (1952). Portfolio Selection. *The Journal of Finance, 7*(1), 77-91.

Masih, A. M., & Masih, R. (1997). Dynamic Linkages and the Propagation Mechanism Driving Major International Stock Markets: An Analysis of the Pre- and Post- Crash Eras. *The Quarterly Review of Economics and Finance, 37*(4), 859-885.

Masih, R., & Masih, M. A. (2004, February). Common Stochastic Trends and the Dynamic Linkages driving European Stock Markets: Evidence from pre- and post- October 1987 Crash Eras. *The European Journal of Finance, 10*(1), 81-104.

Menezes, R., Dionisio, A., & Mendes, D. (2010, September). Globalization and Granger Causality in the Stock Market for the G7. *The Business Review, Cambridge, 14*(2), 188-194.

Metin, K., & Muradoglu, G. (2001, September/October). Forecasting Integrated Stock markets using International Co-movements. *Russian and east European Finance and Trade, 37*(5), 45-63.

Meyer, P. J. (2011). *Brazil-U.S. Relations.* Congressional Research Services.

Encyclopedia Britannica > Spain > Trade. (n.d.). Retrieved May 2011, 2011, from Encyclopedia Britannica: http://www.britannica.com/EBchecked/topic/557573/Spain/70293/Trade

World Trade Organization > Statistics > International Trade Statistics 2004 > Trade by Region. (n.d.). Retrieved May 24, 2011, from World Trade Organization: http://www.wto.org/english/res_e/statis_e/its2004_e/its04_byregion_e.htm

Narayan, P., Smyth, R., & Nandha, M. (2004, November). Interdependence and Dynamic Linkages between the Emerging stock markets of South Asia. *Accounting and Finance, 44*(3), 419-439.

Naude, W. (2009). *The Financial Crisis of 2008 and the Developing Countries (Discussion paper).* Retrieved October 14, 2010, from http://www.iadb.org/intal/intalcdi/PE/2009/02547.pdf

Pesaran, B., & Pesaran , H. M. (2009). *Time Series Econometrics using Microfit 5.0.* New York: Oxford Press.

Pesaran, H. M., & Shin, Y. (1997, May). *Cambridge Univeristy.* Retrieved January 26, 2011, from Cambridge University: Faculty: Pesaran: Generalized Impulse Response Analysis in Linear Multivariate Models: http://econ.cam.ac.uk/faculty/pesaran/gir.pdf

Poole, W. (2010, June). Causes and Consequences of the Financial Crisis of 2007-2009. *Havard Journal of Law and Public Policy, 33*(2), 421-441.

Raju, G. A., & Khanapuri, H. R. (2009). Regional Integration of Emerging Stock Markets in Asia: Implications for International Investors. *Journal of Investing, 18*(3), 31-40.

Reserve, F. (n.d.). *Federal Reserve: Monetary Policy: Open market Operations Archive*. Retrieved October 14, 2010, from Federal Reserve Web site: http://www.federalreserve.gov/monetarypolicy/openmarket_archive.htm#2000

Roca, E. D., Selvanathan, A. E., & Shepherd, W. F. (1998, August). Are the ASEAN Equity Markets Interdependent? *ASEAN Economic Bulletin, 15*(2), 109-120.

State, U. D. (2010, september 1). *home > Bureau of Public Affairs > Electronic Information and Publications > background Notes > Canada*. Retrieved May 17, 2011, from U.S Department of State: http://www.state.gov/r/pa/ei/bgn/2089.htm

Wang, P. (2008). Shock Persistence and Impulse Response Analysis. In P. Wang, *Financial Econometrics* (pp. 95-98). Abingdon: Taylor & Francis.

Warne, A. (2008, February 27). *Texlips.* Retrieved October 27, 2010, from Texlips: Warme: Research Papers: Generalized Impulse Response: http://www.texlips.net/download/generalized-impulse-response.pdf

Wheelock, D. C. (2010, March). Lessons Learned? Comparing the Federal Reserve's Responses to the Crisis of 1929-1933 and 2007-2009. *Federal Reserve Bank of St. Loius Review, 92*(2), pp. 89-107.

White, L. H. (2009, February). Federal Reserve Policy and the Housing Policy. *Cato Journal, 29*(1), 115-126.

Wolverson, R. (2010, May 5). *Council on Foreign Relations: The Risk of Greek Contagion.* Retrieved November 2, 2010, from Council on Foreign Relations: http://www.cfr.org/publication/22055/risk_of_greek_contagion.html

World Bank. (n.d.). *World Bank: Data: Indicators: GDP ranking table.* Retrieved November 20, 2010, from World Bank Web site: http://siteresources.worldbank.org/DATASTATISTICS/Resources/GDP.pdf

Worthington, A. C., & Higgs, H. (2004). Comovements in Asia-Pacific Equity Markets: Developing Patterns in APEC. *Asia-Pacific Journal of Economics & Business, 8*(1), 78-92.

Worthington, A. C., Katsuura, M., & Higgs, H. (2003). Financial Integration in European equity markets: The Final Stage of Economic and Monetary Union (EMU) and its Impact on Capital markets. *Economica, 54*(1), 79-99.

Worthington, A. C., Katsuura, M., & Higgs, H. (2003). Price Linkages in Asian Equity Markets: Evidence Bordering the Asian Economic, Currency and Financial Crises. *Asia-Pacific Financial Markets, 10*(1), 29-44.

Yandle, B. (2010). Lost Trust: The Real Cause of the Financial Meltdown. *The Independent Review, 14*(3), 341-361.

Yang, J., Kolari, J. W., & Min, I. (2002, May). Stock market Integration and Financial Crises: The Case of Asia. *Applied Financial Economics*, 1-29.