UNIVERSITY OF SOUTHAMPTON
SCHOOL OF SOCIAL SCIENCES
Department of Economics

Essays on GCC Financial Markets and Monetary Policies

by

Wael Mohammad Alshewey

Thesis for the degree of Doctor of Philosophy

April 2014

UNIVERSITY OF SOUTHAMPTON

ABSTRACT

FACULTY OF SOCIAL AND HUMAN SCIENCES

SCHOOL OF SOCIAL SCIENCES

Department of Economics

Doctor of Philosophy

ESSAYS ON GCC FINANCIAL MARKETS AND MONETARY POLICIES

by Wael Mohammad Alshewey

This dissertation explores economic integration in the context of the Gulf Cooperation Council countries (GCC), which planned to form a monetary union, by assessing three different but related empirical research questions regarding GCC financial markets and monetary policies. Chapter 2 presents the first essay, which empirically investigates the pairwise linkages and volatility spillovers between GCC stock markets. In particular, the goal of Chapter 2 is to investigate the extent to which past volatility is transmitted from one GCC stock market to another GCC market at the aggregate level (e.g., the general stock markets' price indices), and to determine whether a past volatility in one GCC market affects the current volatility in another GCC market. Furthermore, Chapter 2 attempts to extend the investigation of the volatility spillover at a more disaggregated level by capturing the intra-sectoral linkages and volatility spillover effects among equivalent sectors across the GCC stock markets, namely the banking, industrial and insurance sectors. Empirically, Chapter 2 exploits the causality-in-variance test pioneered by Cheung and Ng (1996) and developed by Hong (2001), who introduced a class of asymptotic N(0,1) tests for volatility spillover between two time series that exhibit conditional heteroskedasticity and may have infinite unconditional variances.

The second essay, Chapter 3, aims to examine the effect of the recent global economic and financial crisis originating in U.S. stock markets on the stock markets of the GCC countries and to determine whether the sharp falls in these markets were due to the existence of the phenomenon "contagion" or whether they just reflect the continuation of the strong economic and financial linkages between the GCC economies and the U.S. economy, which exist in all states of the world during good and bad times. In particular, Chapter 3 investigates whether contagion exists from the U.S. stock market to the stock markets of the GCC by comparing two sub-periods before (stable) and after (turmoil) the collapse of Lehman Brothers, which is the largest bank to fill for bankruptcy in U.S. history and has been widely used by many economists as a benchmark for the U.S. economic and financial crisis (see Bekaert et al. (2012) and Mishkin (2010)). Empirically, Chapter 3 investigates the existence of contagion using the cross-market correlations tests pioneered by King and Wadhwani (1990) and developed by Forbes and Rigobon (2002), who criticized previous studies for their use of unadjusted correlation coefficients to investigate the presence of contagion across stock markets due to the heteroskedasticity resulting from the bias in stock market returns of the crisis country. Hence, Forbes and Rigobon (2002) introduced the adjusted cross-market correlation

coefficient, which does not depend on the volatility (variance) of the crisis country, especially during the turmoil period.

The last essay is presented in Chapter 4, in which I investigate the implications of fixing exchange rate on monetary policy in the context of the GCC countries whose exchange rate regimes have been fixed to the U.S. dollar for a long time. In particular, Chapter 4 aims to assess the sensitivity of the GCC countries' interest rates to the U.S. rate, since the theory of interest parity suggests that fixing GCC exchange rates to the U.S. dollar should force GCC domestic interest rates to equal the U.S. interest rate. In addition, Chapter 4 interestingly attempts to assess the stability of this sensitivity across time and to investigate whether there exists a pronounced decoupling for some GCC countries over some sub-periods. Furthermore, the fact that some of the countries' exchange rates have pegged to the U.S. dollar over specific sub-periods, then moved away from the peg over some other sub-periods (e.g., Kuwait) also gives us a rich setting through which to investigate the implications of fixing the exchange rate on monetary policy and to determine whether a country's interest rate has a stronger association with a base country's rate under a pegged-period than under a non-pegged period. Empirically, this is done by testing the Uncovered Interest Parity (UIP) of each individual GCC country's interest rate, using the U.S.'s interest rate as the base country. Chapter 4 considers the time series properties of the data and uses unit root and co-integration tests. For each GCC country, it also utilizes a level regression for each interest rate episode throughout the entire sample under investigation; uses the Quandt (1960) Likelihood Ratio statistic (QLR) to determine the timing of any potential structural break during which the country's interest rate sensitivity to the U.S. interest rate changes; and applies the Error Correction Model (ECM) to capture long-run dynamic behaviours between the GCC and U.S. interest rates.

Contents

List of Tables

List of Figures

DECLARATION OF AUTHORSHIP

I, Wael Mohammad Alshewey

Declare that the thesis entitled

ESSAYS ON GCC FINANCIAL MARKETS AND MONETARY POLICIES

and the work presented in the thesis are both my own, and have been generated by me as the result of my own original research. I confirm that:

- this work was done wholly or mainly while in candidature for a research degree at this University;
- where any part of this thesis has previously been submitted for a degree or any other qualification at this University or any other institution, this has been clearly stated;
- where I have consulted the published work of others, this is always clearly attributed;
- where I have quoted from the work of others, the source is always given. With the exception of such quotations, this thesis is entirely my own work;
- I have acknowledged all main sources of help;
- where the thesis is based on work done by myself jointly with others, I have made clear exactly what was done by others and what I have contributed myself;
- none of this work has been published before submission.

Signed: ....

Date: ....

Acknowledgements

I would like to express my sincere thanks to my supervisor, Professor Jean-Yves Pitarakis, for his continuous support, encouragement, and advice. The completion of this dissertation would not have been possible without his guidance and valuable suggestions from the beginning to the very end.

I would like to thank the most important person in my life, my mother *Azza*, who represents everything that is wonderful in this world and has always been a source of inspiration and motivation to me. Mother, I am highly indebted to you for raising me up and bearing so many life burdens to help me reach this level. Thank you for your prayers and support.

I am grateful to my beloved and supportive wife, *Iman*, for being by my side whenever I needed her and for taking over many of my responsibilities so that I could focus on my research and complete this work.

My children-*Mohammad*, *Lujain*, *Faisal*, and the little *Arwa*-thank you for being there for me. You are the most beautiful moments that have happened in my life. I hope you grow up to be great and I love you so much.

Finally, I would like to thank the Public Authority for Applied Education and Training (PAAET) for providing financial support through my period of study.

Chapter 1

Introduction

In 1981, Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the United Arab Emirates (UAE) established the Gulf Cooperation Council (GCC). Since then, one of this council's main goals has been to enhance economic integration among its member states. A year after the GCC's creation, the Unified Economic Agreement (UEA) among the GCC countries was signed, aiming at coordinating GCC economic, monetary, and financial policies with the ultimate objective of adopting a common currency for the six countries. Article 22 of the UEA stated that "Member States shall coordinate their financial, monetary and banking policies and increase cooperation among the Monetary Agencies and Central Banks, including an endeavour to establish a common currency in order to further their desired economic integration." In 2001, the UEA was replaced by a new economic agreement, in which the initiative of forming the GCC monetary union by 2010 was officially declared and a particular timetable was laid down in order to accomplish the necessary requirements for the planned monetary union.

In this regard, some considerable steps have been taken to strengthen GCC efforts towards economic, monetary, and financial integration, started with the GCC free trade area in 1983, the GCC customs union in 2003, the six countries officially pegging their currencies to the U.S. dollar in 2003, the common market in 2007, and the Monetary Union Agreement and the Monetary Council in 2009 (Table 1.1). However, there have been some major setbacks delaying the achievement of the proposed GCC monetary union. Oman officially announced its withdrawal from the proposed monetary union in 2006; Kuwait abandoned the U.S. dollar peg and re-pegged to a currency basket in 2007; the UAE opted out of the proposed monetary union in 2009; and the launching date of the monetary union (originally 2010) has been rescheduled, and the exact date has not yet been set.

With regard to the GCC's economic characteristics, the GCC countries play a key role in the global economy due to the volume of their oil and gas endowments, which leads them to be considered major oil exporters. The six member states collectively produce about 24% and 11% of the world's oil and gas, respectively, and account for 30% and 23% of the global oil and gas reserves, respectively (Figure 1.1). On a national basis, the GCC countries share some common background characteristics, such as history, language, culture, and, most importantly, homogeneous economic structures, that can ease the process of economic and monetary integration. The GCC countries rely heavily on the hydrocarbon sector as their main source of income, since this sector is the largest contributor to GDP. As a bloc, the GCC countries had a combined nominal GDP of 1.49 trillion U.S. dollars and an average per capita GDP of about 47 thousand U.S. dollars in 2012. The largest economy among the GCC countries in terms of population and output is by far that of Saudi Arabia, with a nominal GDP reaching 657 billion U.S. dollars and a population of 28 million people in 2012, representing about 44% and 65% of the GCC's aggregate GDP and population, respectively. Meanwhile Bahrain is GCC's smallest economy, with a nominal GDP reaching 26.50 billion U.S. dollars and population of about 1.15 million people in the same year, accounting for about 2% and 3% of the GCC's aggregate GDP and population, respectively (Table 1.2). Given their heavy dependence on oil and gas as main sources of income, which results in high fluctuations in output due to the oil price volatility, the GCC countries have made some efforts to diversify their economies away from oil and gas. However, the progress towards economic diversification is slow and ineffectual, which may limit the gains of the economic integration desired by the GCC countries.

Moreover, the GCC countries share a common exchange rate mechanism at which all GCC currencies-except Kuwait-are pegged to the U.S. dollar for more than three decades. In fact, from 1980 to 2002, Bahrain, Qatar, Saudi Arabia and the United Arab of Emirates (UAE) currencies were *de jure* (formally) pegged to the International Monetary Fund Special Drawing Rights (SDR) but were *de facto* (effectively) pegged to the U.S. dollar, Oman was *de facto* pegged to the U.S. dollar and Kuwait to an undisclosed basket of major world currencies of its main trading and financial partners. In January 2003, all the GCC countries including Kuwait officially declared that their national currencies were to be *de jure* and *de facto* pegged to the U.S. dollar as a step towards the monetary integration. However, in May 2007 Kuwait announced that it would abandon the dollar peg and return back to its previous exchange rate regime due to the inflationary pressure caused by the continuing depreciation of the U.S. dollar against the other major currencies. Despite the fact that the pegged to the U.S. dollar has limited the autonomy of the GCC monetary policy, the choice of the U.S. dollar as an external anchor for the GCC monetary policy is viewed as credible and has been serving the GCC economies well until recently, except for the last couple years when the inflationary pressure has risen due to the depreciation of the U.S. dollar.

With regard to financial markets, GCC stock markets are relatively new compared to stock markets in developed countries and some stock markets in the Middle East region. The oldest stock market to be established was the Kuwait Stock Exchange in 1977, followed by the Saudi Arabia stock exchange in 1984, the Bahrain stock exchange in 1987, the Oman Securities Market in 1989, the Qatar stock exchange in 1997, while the Dubai Financial Market is the most recently established in 2000. GCC stock markets have witnessed a notable growth in particular over the period 2003-2007, which reflected the oil prices boom, with aggregate market capitalization reached to its highest levels in 2007 accounted for about 1.074 trillion U.S. dollars. However, in the aftermath of the global economic and financial crisis in 2008-2009, the aggregate GCC market capitalization fell sharply and lost about half of its value to reach 565 billion U.S. dollars in 2009 (Table 1.3).

GCC stock markets are considered relatively small when compared to advanced and emerging stock markets in terms of market capitalization, number of listed companies, and liquidity (measured by the value of traded shares). These characteristics make GCC markets classified as frontier markets by Morgan Stanley Capital International (MSCI).[1] In this regard, Table 1.4 reports some GCC stock markets main indicators, such as market capitalization, number of listed companies, and value of traded shares, for the year of 2013. Saudi Arabia's stock market is by far the largest and the most active and liquid market among its other GCC counterparts, with market

[1]Frontier market is commonly used to describe a subset of emerging markets with low market capitalization and illiquid.

capitalization reached about 460 billion U.S. dollars, which accounted for about 48% of the total GCC market capitalization and the value of traded shares reached about 362 billion U.S. dollars, represented about 76% of the aggregate GCC value of traded shares. On the other hand, both Bahrain and Oman stock markets are the smallest and most illiquid markets among the GCC stock markets. In the case of Bahrain, the market capitalization reached about 18 billion U.S. dollars, accounted for 2% of the total GCC market capitalization, and the value of traded shares represented less than 1% of the total GCC value of traded shares. While the Oman market capitalization and value of the traded shares accounted for 3% and 1% of the total GCC market capitalization and value of traded shares, respectively.

The GCC countries have taken some major steps to promote the level of integration among their stock markets. However, these steps are still modest and lag behind the GCC desire to achieve a full economic and financial integration. GCC investors face some varying degrees of restrictions on stock ownership in some GCC stock markets. In addition, GCC and non-GCC foreign investors are not equally treated with regard to the access to GCC stock markets and the level of shares ownership. In this context, Table 1.5 shows the foreign ownership restrictions for listed stocks in the GCC markets.

This dissertation explores economic integration in the context of the Gulf Cooperation Council countries (GCC), which planned to form a monetary union, by assessing three different but related empirical research questions regarding GCC financial markets and monetary policies. Chapter 2 presents the first essay, which empirically investigates the pairwise linkages and volatility spillovers between GCC stock markets. In particular, the goal of Chapter 2 is to investigate the extent to which past volatility is transmitted from one GCC stock market to another GCC market at the aggregate level (e.g., the general stock markets' price indices), and to determine whether a past volatility in one GCC market affects the current volatility in another GCC market. Furthermore, Chapter 2 attempts to extend the investigation of the volatility spillover at a more disaggregated level by capturing the intra-sectoral linkages and volatility spillover effects among equivalent sectors across the GCC stock markets, namely the banking, industrial and insurance sectors. Empirically, Chapter 2 exploits the causality-in-variance test pioneered by Cheung and Ng (1996) and developed by Hong (2001), who introduced a class of asymptotic N(0,1) tests for volatility spillover between two time series that exhibit conditional heteroskedasticity and may have infinite unconditional variances. Investigating the linkages between stock markets in the context of the GCC countries is a central issue by which GCC policy makers gain further insights on how and to what extent the GCC financial markets are integrated. Financial integration among the GCC countries is a vital issue, especially in the critical stage before introducing the GCC common currency, to determine whether these countries fulfil one of the main requirements of the potential monetary union, which enhances the union's macroeconomic stabilization. Moreover, financial integration improves risk sharing among the member states and the financial stability of such a union, which are very important aspects to be considered by GCC policy makers in order to avoid any negative impacts and spillovers to the monetary union as a whole. Furthermore, GCC-integrated stock markets will enhance the efficiency of capital allocation as well as the liquidity of stock markets within the GCC region. For example, when the GCC markets are integrated, the liquidity of the stock markets will be improved due to increases in the trading of individual financial assets caused by increases in cross-boarder flows of funds. This improvement in stock markets liquidity will, in turn, lead to a decrease in the cost of capital for companies willing to raise capital and lower transaction costs for GCC investors.

The second essay, Chapter 3, aims to examine the effect of the recent global economic and financial crisis originating in U.S. stock markets on the stock markets of the GCC countries and to determine whether the sharp falls in these markets were due to the existence of the phenomenon "contagion" or whether they just reflect the continuation of the strong economic and financial linkages between the GCC economies and the U.S. economy, which exist in all states of the world during good and bad times. In particular, Chapter 3 investigates whether contagion exists from the U.S. stock market to the stock markets of the GCC by comparing two sub-periods before (stable) and after (turmoil) the collapse of Lehman Brothers, which is the largest bank to fill for bankruptcy in U.S. history and has been widely used by many economists as a benchmark for the U.S. economic and financial crisis (see Bekaert et al. (2012) and Mishkin (2010)). Empirically, Chapter 3 investigates the existence of contagion using the cross-market correlations tests pioneered by King and Wadhwani (1990) and developed by Forbes and Rigobon (2002), who criticized previous studies for their use of unadjusted correlation coefficients to investigate the presence of contagion across stock markets due to the heteroskedasticity resulting from the bias in stock market returns of the crisis country. Hence, Forbes and Rigobon (2002) introduced the adjusted cross-market correlation coefficient, which does not depend on the volatility (variance) of the crisis country, especially during the turmoil period. Studying contagion is of particular interest to policy makers as well as investors in the GCC to investigate the extent to which GCC stock markets are vulnerable to different international financial crises. If contagion exists, policy makers need to strengthen the ability of the financial system to absorb the adverse impact of any financial crisis. This can be done via improving regulations and supervisory frameworks at domestic levels, increasing the depth of GCC financial markets, pursuing a coordinated set of policies among the GCC countries as a bloc (which would also be beneficial for the formation of the GCC monetary union) in order to make the GCC capable of reducing the exposure to international financial contagions in periods of crisis. Understanding financial contagion is crucial to the fact that gains from international portfolio diversification are reduced when stock markets exhibit correlation, a revelation that will be informative for investors and help them make better decisions regarding portfolio diversification allocations. Finally, knowing that contagion has occurred between two stock markets after a crisis may serve as a “wake-up call” for investors, providing them with useful information for avoiding any future spreads of the crisis.

The last essay is presented in Chapter 4, in which I investigate the implications of fixing exchange rate on monetary policy in the context of the GCC countries whose exchange rate regimes have been fixed to the U.S. dollar for a long time. In particular, Chapter 4 aims to assess the sensitivity of the GCC countries’ interest rates to the U.S. rate, since the theory of interest parity suggests that fixing GCC exchange rates to the U.S. dollar should force GCC domestic interest rates to equal the U.S. interest rate. In addition, Chapter 4 interestingly attempts to assess the stability of this sensitivity across time and to investigate whether there exists a pronounced decoupling for some GCC countries over some sub-periods. Furthermore, the fact that some of the countries’ exchange rates have pegged to the U.S. dollar over specific sub-periods, then moved away from the peg over some other sub-periods (e.g., Kuwait) also gives us a rich setting through which to investigate the implications of fixing the exchange rate on monetary policy and to determine whether a country’s interest rate has a stronger association with a base country’s rate under a pegged-period than under a non-pegged period. Empirically, this is done by testing the Uncovered Interest Parity (UIP) of each individual GCC country's interest rate, using the U.S.'s interest rate as the base country. Chapter 4 considers the time series properties of the data and uses unit root and co-integration tests. For each GCC country, it also utilizes a level regression for each interest rate episode throughout the entire sample under investigation; uses the Quandt (1960) Likelihood Ratio statistic (QLR) to determine the timing of any potential structural break during which the country's interest rate sensitivity to the U.S. interest rate changes; and applies the Error Correction Model (ECM) to capture long-run dynamic behaviours between the GCC and U.S. interest rates. Studying the linkages between domestic and U.S. short-term interest rates in the context of six GCC countries is an important issue, since the harmonization of monetary policy among the GCC countries is a priority if the planned monetary union is to be achieved, especially with the existence of a common central bank, which will be in charge of conducting a single monetary policy among the member states. This is because, if it turns out that all the GCC countries follow the U.S. monetary policy equally, one can conclude that the GCC countries have achieved the harmonization in their monetary policies that is required to make the common currency a success and to allow all members to reap full benefits from it.

The overall findings of this dissertation suggest some policy implications, by which promote financial integration among GCC countries, as well as some recommendations for GCC investors. In this context, despite the fact that the empirical results of the first essay find evidence of strong linkages and volatility spillover among GCC financial markets, GCC countries still have a long path before reaching the required level of financial integration to enhance their efforts towards achieving a well functioning monetary union. In this regard, in order to promote financial integration among GCC countries, GCC policy makers are advised to adopt a comprehensive set of policies and regulations to improve the depth of the GCC financial markets; strengthen convergence across GCC financial systems; increase cross-listed stocks; relaxing the stock ownership restrictions facing both GCC and foreign investors; and, most importantly, put the GCC common market process into practice. In addition, given the evidence found in the second essay regarding the existence of contagion from the U.S. stock market to the GCC stock markets after the global economic and financial crisis originating in the U.S., GCC policy makers need to set some coordinated and precautionary policies to strengthen the ability of their financial systems to absorb the adverse impacts of any future financial crisis and to be capable of reducing the exposure to international financial contagions, which might cause destabilizations in the GCC economies.

With regard to portfolio diversification, empirical results of the second and the third essays suggest that GCC investors are encouraged to diversify their portfolios away from both GCC and U.S. stock markets, given the significant levels of stock market linkages and co-movements among the GCC stock markets from one side, and between GCC and U.S. stock markets from the other side, by which the benefits from diversification within these markets will be evaporated. Hence, GCC investors would be better off when diversifying their portfolios by investing in some other stock markets which are less correlated with both the GCC and U.S. stock markets.

In the last essay, findings show that, pegging GCC exchange rates to the U.S. dollar has resulted in harmonization and convergence among GCC monetary policies in the long-run, which is beneficial if the planned monetary union is to be achieved, especially with the existence of a GCC common central bank, which will be in charge of conducting a single monetary policy among member states. However, there is some evidence of short-run divergence for some countries (e.g. Qatar, Saudi Arabia, and the UAE) over some specific periods, in particular, after the global economic and financial crisis in 2008. This divergence is attributed to the high inflation rates faced by these countries, which were caused by some specific domestic factors, such as increases in the supply of credit, strong domestic demand, and a lack of supply in real estate markets (Morsy and Kandil (2009)); and, in the case of the UAE, to the effect of the Dubai debt crisis on increasing the UAE risk premium, which violates the validation of the theory of interest parity in the case of the UAE. More specifically, while the U.S. monetary authorities continued to lower interest rates in order to curb high levels of inflation, monetary authorities in Qatar, Saudi Arabia, and the UAE did not follow these reductions. Hence, in order to make the GCC monetary union a success, policy makers in these countries may consider adopting some policies that might help in curbing inflation, which caused a distortion in a country's monetary integration with its GCC peers over specific periods. Options of these policies include increasing the supply of real estate by encouraging private investment in this sector and slowing down the growth of private credit.

Date	Achievements
1983	Free Trade Agreement among the GCC countries.
Dec 2001	endorsement of the new Economic Agreement
Jan 2003	GCC Custom Union launched and all the GCC currencies have been officially pegged to the U.S. dollar.
Dec 2005	approved upon the economic convergence criteria similar to those of the European Union.
Jan 2008	GCC Common market launched.
Jan 2009	Heads of States authorised the Monetary Union Agreement and the Statue of the Monetary Council.
March 2010	The board of the Monetary Council first meeting.

Source:GCC Secretariat General

Table 1.1: GCC efforts and achievements towards monetary union.

Country	Nominal GDP* in Billions U.S. $	Per Capita GDP* in Thousands U.S. $	Share of Hydrocarbon in GDP** (%)	Population* in Millions
Bahrain	26.50	23.02	25.5	1.15
Kuwait	174.62	46.14	51.5	3.78
Oman	79.97	25.15	46.1	3.18
Qatar	184.56	100.37	51.2	1.83
Saudi Arabia	657.04	22.82	47.5	28.78
UAE	361.91	65.37	31.6	5.53
GCC	1484.6 (Total)	47.145 (Average)	42.23 (Average)	44.25 (Total)

Source: IMF World Economic Outlook 2013, GCC Secretariat General statistical database, http://sites.gcc-sg.org/DLibrary/index-eng.php?SID=129.

*IMF estimates.

**data for 2010.

TABLE 1.2: Economic indicators for the GCC countries as in 2012.

Country	2006	2007	2008	2009	2010	2011	2012
Bahrain	21.12	28.13	21.17	16.93	20.42	17.15	16.06
Kuwait	128.94	188.04	107.16	95.93	119.62	100.86	97.09
Oman	16.15	23.06	14.19	17.30	20.26	19.71	20.10
Qatar	61.56	95.48	76.30	87.85	120.35	125.41	126.37
Saudi Arabia	326.8	515.1	246.3	318.7	353.4	338.8	373.3
UAE[a]	219.6	224.7	99.14	110.2	125.9	120.6	126.6
Total	774.25	1074.5	565.05	647.06	763.3	722.6	759.63

Source:World Bank, World Development Indicators 2013 and GCC national stock markets.

TABLE 1.3: GCC stock markets market capitalization in billions U.S. $ over the period 2006-2012.

[a]Values are for both Dubai and Abu Dhabi stock markets.

Country	Market Capitalization in Billions U.S. $	Traded shares value in Billions U.S. $	Number of listed companies
Bahrain	18.47	.55	47
Kuwait	103.26	23[a]	210
Oman	27.40	5.77	131
Qatar	152.58	19.88	42
Saudi Arabia	459.5	361.8	161
UAE[b]	187.6	66.59	134
GCC 44.25 (Total)	1484.6 (Total)	47.145 (Average)	42.23 (Average)

Source: World Bank, World Development Indicators 2013 and Arab Monetary Fund (AMF) Report of 3^{rd} *quarter* 2013.

TABLE 1.4: GCC stock markets main indicators as in 2013.

[a] As in 2012
[b] Values are for both Dubai and Abu Dhabi stock markets.

Market	Foreign Investment Ceiling
Bahrain	GCC firms and GCC citizens can own up to 100% of listed Bahrain companies; non-GCC firms or citizens may own up to 49% of listed Bahrain companies.
Kuwait	GCC and non-GCC citizens can own up to 49% of listed Kuwaiti companies.
Oman	GCC and non-GCC citizens can own up to 70% of Omani listed stocks.
Qatar	Non-resident foreign investors and GCC citizens may own up to 25% of a listed company that allows such ownership; there are companies-imposed individual ownership limits. With approval, listed companies can increase foreign ownership level to 100%.
Saudi Arabia	GCC citizens can own up to 25% of Saudi listed company; the Saudi stock market is closed to foreign(non-GCC) investors; currently foreign investors have limited opportunities to invest using equity swaps or via a small number of exchange-traded funds.
UAE	Foreign investors are entitled to 49% ownership; different restrictions may apply to individual companies; up to 100% ownership of listed company for GCC citizens with company's approval.

Source:Standard and Poor's Global Stock Market Factbook, 2013.

Table 1.5: Foreign Ownership Restrictions for Listed Stocks in the GCC Markets.

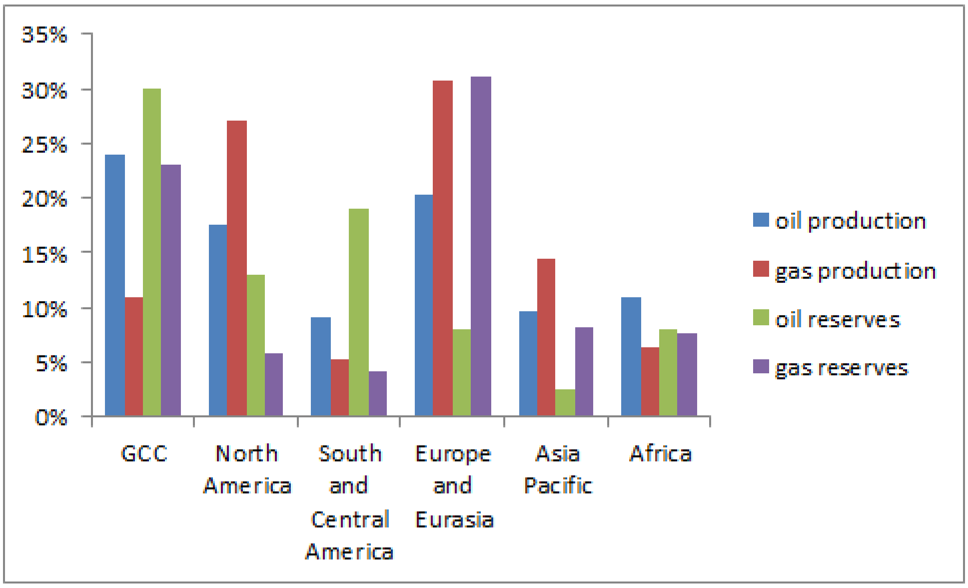

Figure 1.1: Oil and Gas proved reserves and production at the end of 2012.

Source:BP Statistical Review of the world Energy, June 2013.

Chapter 2

Volatility spillover among GCC stock markets

2.1 Introduction

Volatility spillover between stock markets refers to the transmission of past shocks from one stock market to another market. Studying volatility spillover provides useful insights of how information is transmitted from one stock market to another foreign stock market and vice versa. Absence of volatility spillover implies that, the major sources of disturbances are changes in market-specific fundamentals, and a country specific large shock increases the volatility only in its own market. In contrast, existence of volatility spillover implies that, one country-specific large shock increases the volatilities not only in its own market but also in other markets as well (Hong (2001)).

The analysis of volatility spillover is crucial for market participants (e.g., investors and risk managers) and policy makers. It is well known in the financial economics literature that, there exists potential gains from international portfolio diversification only if markets are not significantly correlated. Hence, the presence of volatility spillover between markets severely reduces the benefits of portfolio diversification. So, investors and risk managers need to adjust their portfolios with lower correlated markets Bekaert and Harvey (2003). Policy makers are also interested in understanding the nature of volatility transmission across markets, because of its impact on the stability of the financial system. For instance, when two markets exhibit a volatility spillover, a shock occurred in one market may have a destabilizing effects on the other market. Hence, policy makers need to recognize the volatility spillover between financial markets when implementing their policy coordination and formulate their regulations.

This chapter aims to explore the pairwise linkages and volatility spillover between GCC stock markets, namely, Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the United Arab of Emirates (Dubai). In particular, the goal of this chapter is to investigate the extent to which past volatility or shocks are transmitted from one GCC stock market to another GCC market's current volatility at the aggregate level (e.g., the general stock markets' price indices), and to determine whether a past volatility in one GCC market affects the current volatility in another GCC market. Furthermore, this chapter attempts to extend the investigation of the volatility spillover at a more disaggregated level by capturing the intra-sectoral linkages and volatility spillover effects among equivalent sectors across the GCC stock markets namely, the banking, industrial, and insurance sectors. The purpose of making such a distinction between these two types of volatility spillover effects-the aggregate and the disaggregate-is to enable me to assess the exposure of different sectors-to-sector specific past shocks within the region on one hand; on the other hand, such a distinction gives more insights about which sector derives the volatility spillover at the aggregate level, if exists, across the GCC stock markets. Figures 2.1 : 2.4 plot the daily closing price of the GCC stock markets' general indices as well as the daily closing prices for the GCC's banking, industrial, and insurance sectors indices.

Investigating the linkages between stock markets in the context of the GCC countries is a central issue by which GCC policy makers gain further insights on how and to what extent the GCC financial markets are integrated. Financial integration among GCC countries is a vital issue, especially in the critical stage before introducing the GCC common currency, to determine whether these countries fulfil one of the main requirements of the potential monetary union, which enhances the union's macroeconomic stabilization. Moreover, financial integration improves risk sharing among the member states and the financial stability of such a union, which are very important aspects to be considered by GCC policy makers in order to avoid any negative impacts and spillovers to the monetary union as a whole. Furthermore, GCC-integrated stock markets will enhance the efficiency of capital allocation as well as the liquidity of stock markets within the GCC region. For example, when the GCC markets are integrated, the liquidity of the stock markets will be improved due to increases in the trading of individual financial assets caused by increases in cross-boarder flows of funds. This improvement in stock markets liquidity will, in turn, lead to a decrease in the cost of capital for companies willing to raise capital and lower transaction costs for GCC investors. Accordingly, one would expect some degree of volatility spillover and interdependence between the individual national markets of the GCC, especially due to the presence of strong economic and financial linkages and policy coordination between these countries, which can link their stock markets movement overtime.

Empirically, this chapter exploits the causality-in-variance test pioneered by Cheung and Ng (1996) and developed by Hong (2001), who introduced a class of asymptotic N(0,1) tests for volatility spillover between two time series that exhibit conditional heteroskedasticity and may have infinite unconditional variances. These tests are based on a weighted sum of squared sample cross-correlations between two squared standardised residuals using the conditional variances obtained from univariate Generalised Autoregressive Conditional Heteroscedasticty (GARCH) estimations. This weighting scheme is to assign larger weights to more recent values to capture an interesting feature in financial markets, in which the volatility of a current asset or market is often more affected by the recent past volatility of another asset or market than the distant past volatility.

On the aggregate level, findings show that, except for few cases, each GCC stock market is vulnerable to past shocks that have happened in other GCC stock markets, confirming the existence of a pronounced volatility transmission across the six GCC stock markets. These findings reflect the fact that the GCC countries share strong economic and financial linkages and policy coordination, such that stock markets in the region respond similarly to common shocks. Furthermore, results of the equity sectors analysis indicate that volatility spillover across the six stock markets studied is driven mainly by the linkages and spillover effects between banking sectors and, to lesser extent, industrial sectors, while the insurance sectors played no role in the volatility spillover effects across these markets.

Investigating volatility spillover across either developed or emerging stock markets has been documented in enormous research agenda, however less attention has been made to the GCC stock markets. In this regard, this chapter contributes to the existing literature of the volatility spillover between stock markets by adding empirical evidence in the context of GCC countries using the causality-in-variance test. To the best of my knowledge, unlike the previous studies of GCC markets, this is the first study to investigate the volatility spillover between all the six GCC markets pairs (a total of 30 pairs), as well as employing two relatively new causality-in-variance tests namely, Q_1 and Q_2 developed in Hong (2001) within the context of the GCC countries. Furthermore, it is the first empirical study that I aware of, to investigate the volatility spillover at a more disaggregated level between the GCC stock market sectors. Finally, analysing GCC stock markets co-movement also gives a measure on the level of markets integration between GCC countries, which is of a great interest, especially for the planned GCC monetary union.

The remaining of this chapter is organised as follows. Section 2.2 undertakes a brief survey of the relevant literature. Sections 2.3 and 2.4 describe the methodology and the data adopted for the study. Section 2.5 presents the empirical results. Section 2.6 concludes the chapter.

2.2 Literature review

An extensive research agenda has focused primarily on examining volatility spillover between stock markets in developed countries (Hamao et al. (1990)seminal paper, Susmel and Engle (1994), and Koutmos and Booth (1995)) were among these studies. This line of studies analyses the linkages and volatility spillover between developed stock markets such as New York, Tokyo, and London markets, and found some evidence of the existence of volatility transmission among these markets. Other studies extent the investigation of volatility spillover among stock markets in the context of European countries, especially after the launching of the European monetary union and the introduction of the Euro (Baele (2005), Kim et al. (2005), and Bartram et al. (2007)). The main goal of these studies was to investigate whether European financial markets became more integrated after the formation of the European monetary union. Kim et al. (2005) and Bartram et al. (2007) found some empirical evidence of increased markets dependence within the Euro area after the introduction of the Euro as a common currency, however, Baele (2005) indicated that the European shock spillover intensity increased primarily in the second part of the 1980s and the first part of the 1990s suggesting that, economic integration as well as efforts to further liberalize European capital markets were more important in bringing markets closer together than the process towards monetary integration and the introduction of the single currency. Moreover, enormous studies have focused on testing the volatility spillover across either emerging markets or from developed markets to emerging markets. Among these studies, Edwards and Susmel (2001) who modelled cross-market volatility co-movements between Latin America stock markets and found evidence of existence volatility spillover effects among Argentina, Brazil, Mexico and Chile. Also, Gebka and Serwa (2007) investigated returns and volatility spillovers between 12 emerging stock markets from Central and Eastern Europe, Latin America, and South-East Asia. The authors found evidence of volatility spillover effect in both intra-regional (countries located in the same region) and inter-regional (countries located in different regions), however, the volatility spillover was more pronounced in intra-regional countries. On the other hand, given the growing significance role of financial and trade linkages between emerging and developed countries, Liu and Pan (1997), Ng (2000), and Miyakoshi (2003), examined the volatility spillover effect from the U.S. and Japan to the Asian stock markets. The empirical results of these studies were different, in which the first two studies, suggested that the volatility spillover effect from the U.S. market to the Asian stock markets was greater than the volatility spillover effect from the Japanese market to the Asian stock markets, while Miyakoshi (2003) concluded that the Asian markets are influenced more by the Japanese market's volatility than by that of the U.S stock market.

Despite the substantial numbers of studies investigating the volatility spillover among stock markets, GCC stock markets have received a very little attention by researchers. Most of the literature on GCC stock markets volatility spillover has focused mainly on the spillover of oil prices on the GCC stock markets, reflecting the fact GCC economies are oil-based economies (Malik and Hammoudeh (2007), Hammoudeh and Choi (2006), Arouri and Fouquau (2009), and Hammoudeh and Aleisa (2004)). All these studies, found a significant evidence of volatility transmission from the oil market to the GCC stock markets.

On the other hand, only few researchers have examined the volatility spillover between some selected GCC stock markets, not all of them. These studies have inconsistent evidence with regard to the transmission of volatility across the GCC stock markets. In particular, investigating volatility spillover across five GCC stock markets (Qatar is not included) from May 2004 to September 2006, using GARCH modelling approach, Onour (2010) found that, there was a bi-directional volatility spillover effect between Kuwait and Saudi Arabia stock markets while Bahrain and Oman stock markets are neither influenced each other nor affected the other markets in the region. These findings contradicted with the previous work of Abraham and Seyyed (2006), who investigated volatility spillover between Saudi Arabia and Bahrain stock markets during the period from 19 October, 1998 to 1 October, 2003, using a bivariate EGARCH. The authors observed a volatility spillover effect from Bahrain stock market to its Saudi counterpart but not vice-versa. Furthermore, Al-Deehani and Moosa (2006) used the concept of stochastic volatility and structural time-series modelling to investigate volatility spillovers among the stock markets of Bahrain, Kuwait and Saudi Arabia from January 1, 2000 to April 15, 2003. the empirical results of this study, revealed a strong volatility spillover from Kuwait to the other two markets; while the Saudi market exerted strong spillover effect on Kuwait market but had no effect on the Bahrain market; however, Bahrain market had a positive effect on its Kuwait counterpart but not on Saudi market. Finally, a more recent International Monetary Fund (IMF)'s working paper by Saadi-Sedik and Williams (2011) analysed the impact of global and regional spillovers to GCC equity markets from April, 2000 to September, 2010 using a trivariate GARCH model to identify the magnitude of spillovers and their transmission mechanisms. The empirical results of this paper, suggested that cross effects of past shocks in regional markets had an important spillover effects in local equity markets, which emphasized the need to strengthen cross-border regulatory frameworks.

2.3 Methodology

The objective of this chapter is to investigate the extent to which past volatility or shocks are transmitted from one GCC stock market to another GCC market's current volatility at the aggregate level (e.g., the general stock markets' price indices), as well as at intra-sectoral level of equivalent sectors, namely, banking, industrial, and insurance sectors. In this regard, the two-step causality-in-variance test pioneered by Cheung and Ng (1996) and developed by Hong (2001) is applied. This is a new test for investigating the volatility spillover using the sample cross-correlation function (CCF) between two squared residuals standardized by their conditional variance estimators obtained from the univariate Generalised Autoregressive Conditional Heteroscedasticty (GARCH) proposed by Bollerslev (1986). It is worth-mentioning that a potential drawback of using this approach (pairwise comparisons) is that, it does not allow the entire variance-covariance (e.g, volatility spillovers) interrelationships among GCC stock market returns to be captured. In other words, unlike a multivariate approach, pairwise comparisons might not allow us to discriminate between any direct and indirect spillovers when investigating all GCC stock market returns.

First I estimate the univariate (GARCH) model for each GCC stock market general (sectoral) returns series as follows:

$$R_{it} = b_{i0} + \sum_{j=1}^{p} b_{ij} R_{it-j} + \varepsilon_{it}; \quad i = 1, 2, ..., 6 \tag{2.1}$$

where $R_{it} = ln(r_{it}/r_{it-1})$ is the daily returns, r_{it} is the daily stock market (sectoral) index of the i^{th} GCC country, p is the number of lags, and

$$\varepsilon_{it} = z_{it}\sqrt{h_{it}} \tag{2.2}$$

where $\{z_{it}\}$ is an innovation process. So, the GARCH (1,1) equation would be as in equation 2.3

$$h_{it} = \omega_i + \alpha_i \varepsilon_{it-1}^2 + \beta_i h_{it-1} \tag{2.3}$$

where h_{it} is a conditional variance at time t, α_i captures the effect of the past own shocks of the R_{it} (ARCH effect), and β_i represents the own lagged volatility of the R_{it} (GARCH effect). The sufficient condition to ensure a positive conditional variance ($h_t \geq 0$) is that the estimated GARCH parameters $\hat{\omega_i} > 0$ and $(\hat{\alpha}, \hat{\beta}) \geq 0$ for each GCC stock market.

The second step in the testing procedure is implemented by constructing the test statistic under the null hypothesis as in equation 2.4, that stock market (sector) for country B (R_{2t}) does not Granger-cause stock market(sector) for country A (R_{1t}) in variance with respect to I_{t-1}, where I_{it}, $i = 1, 2$ is the information set of time series

R_{it} available at period t and $I_t = (I_{1t}, I_{2t})$. This can be written as:

$$H_0 : Var(z_{1t}|I_{1t-1}) = Var(z_{1t}|I_{t-1}) \tag{2.4}$$

Versus

$$H_1 : Var(z_{1t}|I_{1t-1}) \neq Var(z_{1t}|I_{t-1}) \tag{2.5}$$

where z_{1t} is an innovation process of equation 2.2 with $E(z_{it}|I_{it-1}) = 0$ and $E(z_{it}^2|I_{it-1}) = 1$. Although the squared innovations $\{z_{it}^2\}$ are unobservable, they can be estimated by using centred squared residuals standardized by their conditional variance estimators, respectively Hong (2001). The centred squared standardized residuals for each pair of the GCC stock markets are obtained from equation 2.3 as $\hat{u}_t = (\hat{\varepsilon}_{1t}^2/\hat{h}_{1t}) - 1$ and $\hat{v}_t = (\hat{\varepsilon}_{2t}^2/\hat{h}_{2t}) - 1$. Thus, we can test H_0 by checking if z_{2t} Granger-causes z_{1t} in variance with respect to I_{t-1}. If H_0 is rejected, one can conclude that there is a volatility spillover from past R_{2t} to R_{1t}.

In order to test for H_0, I follow Hong (2001) by using the sample cross-correlation function between $\hat{u}_t$ and $\hat{v}_t$, which can be written as:

$$\hat{\rho}_{uv}(j) = \{\hat{C}_{uu}(0)\hat{C}_{vv}(0)\}^{-1/2}\hat{C}_{uv}(j) \tag{2.6}$$

where $\hat{C}_{uv}(j)$ is the sample cross-covariance function

$$\hat{C}_{uv}(j) = \begin{cases} T^{-1} \sum_{t=j+1}^{T} \hat{u}_t \hat{v}_{t-j}, \ j \geq 0, \\ T^{-1} \sum_{t=-j+1}^{T} \hat{u}_{t+j} \hat{v}_t, \ j < 0, \end{cases}$$

and $\hat{C}_{uu}(0) = T^{-1} \sum_{t=1}^{T} \hat{u}_t^2$ and $\hat{C}_{vv}(0) = T^{-1} \sum_{t=1}^{T} \hat{v}_t^2$.

Hong (2001) proposed the following test in equation 2.7 and its standardized version in equation 2.8 as follows:

$$T \sum_{j=1}^{T-1} k^2(j/M)\hat{\rho}_{uv}^2(j) \tag{2.7}$$

where $k(.)$ is a weighting function, j is the lag order, and M is a positive integer, which can be considered as the number of the used sample cross correlations included for the spillover effect. Throughout this chapter, I use the Truncated kernel as a weighted function, where

$$k(w) = \begin{cases} 1, & |w| \leq 1, \\ 0, & \text{otherwise}, \end{cases}$$

$$Q_1 = \left\{ T \sum_{j=1}^{T-1} k^2(j/M) \hat{\rho}_{uv}^2(j) - C_{1T}(k) \right\} \Big/ \{2D_{1T}(k)\}^{1/2}, \qquad (2.8)$$

where

$$C_{1T}(k) = \sum_{j=1}^{T-1} (1 - j/T) k^2(j/M),$$

$$D_{1T}(k) = \sum_{j=1}^{T-1} (1 - j/T)\{1 - (j+1)/T\} k^4(j/M).$$

are approximately the mean and variance of equation 2.7 respectively. Moreover, $Q_1 \rightarrow N(0,1)$ in distribution and Q_1 diverges to positive infinity in probability as $T \rightarrow \infty$ under a general class of alternatives. This implies that asymptotically, negative values of Q_1 occur only under H_0. Therefore, Q_1 is a one-sided test; upper-tailed $N(0,1)$ critical values should be used for testing Q_1 (Hong (2001)). The key feature of the Hong (2001) test is the using of the non-uniform weighting functions $k(.)$, on contrary to Cheung and Ng (1996), who used a uniform weighting, because they give equal weighting for each lag. The main idea behind using such a non-uniform weighting functions is that, recent past volatility has a larger influence on current volatility than remote past volatility. So, it gives a greater weight to lower lag order j.

In addition to Q_1, Hong (2001) introduced another test statistic Q_2 (equation 2.9) for other causality hypothesis. More specifically, when there is no prior information about the direction of causality is available, it is more proper to test the bi-directional hypothesis that neither stock market for country B (R_{2t}) Granger-causes stock market for country A (R_{1t}) in variance with respect to (I_{1t}, I_{2t-1}), nor stock market for country A (R_{1t}) Granger-causes stock market for country B (R_{2t}) with respect to (I_{1t-1}, I_{2t}). In other words, we need to test that neither the stock market of country B has a volatility spillover to that of country A, nor the stock market of country A has a volatility spillover to that of country B.

$$Q_2 = \left\{ T \sum_{j=1-T}^{T-1} k^2(j/M) \hat{\rho}_{uv}^2(j) - C_{2T}(k) \right\} \Big/ \{2D_{2T}(k)\}^{1/2} \qquad (2.9)$$

where

$$C_{2T}(k) = \sum_{j=1-T}^{T-1} (1- \mid j \mid /T)k^2(j/M)$$

$$D_{2T}(k) = \sum_{j=1}^{T-1} (1- \mid j \mid /T)\{1-(\mid j \mid +1)/T\}k^4(j/M),$$

In this respect, like Q_1, Q_2 has a null asymptotic $N(0,1)$ distribution and Q_2 is a one-sided test; upper-tailed $N(0,1)$ critical values should be used for testing Q_2 (Hong (2001)).

2.4 Data description

The empirical analysis of this chapter uses continuously compounded daily closing prices (obtained from the data-stream) for the general indices of the six GCC stock markets, namely, the Bahrain Stock Exchange all share index, the Kuwait Stock Exchange, the Oman Muscat Securities Market index, the Qatar Doha Securities Market index, the Saudi Arabia stock market all share index, and the United Arab of Emirates Dubai Financial Market index. The data cover various starting date based on the earliest availability of daily market data for each GCC stock market, as early as 22-10-1996 for Oman and as late as 31-12-2003 for Dubai. Hence, due to these differences in the starting date for each country, the sample size varies among the GCC countries. Table 2.1 shows the starting date, end date, and sample size for each GCC country's stock market. With regard to GCC stock markets' sectors, daily data collected from data-stream cover the period from January 1, 2004 to February 6, 2013 for all GCC sectoral stock market indices-except for Saudi Arabia stock market, data start in April 19, 2007 due to a new sector classifications. The data is divided into three sectoral price indices, namely, banking, industrial, and insurance sectors for all the six GCC stock markets except for Dubai stock market as the industrial sector does not exist in Dubai financial market and no adequate data available for the insurance sector.

2.5 Empirical results

2.5.1 Aggregate levels

After applying the Partial Auto Correlation Function (PACF) and the Akaike Information Criterion (AIC) as diagnostic tests to find which AR (p) models are adequate for the six GCC stock markets series. These tests suggest that, Bahrain is AR (1), while Kuwait and Saudi Arabia are AR (6), both Qatar and Dubai are AR (8), and Oman is AR (2). Table 2.2 (Panel A) summarizes the mean equation results (equation 2.1) for each GCC stock market. Bahrain (AR(1)) results show that, the first lag is statistically significant at the 1% level but the intercept is insignificant. For Kuwait (AR(6)), the intercept, the first, the second, the third, and the fourth lags are statistically significant at the 1% level, however the fifth and the sixth lags are insignificant. In the case of Oman (AR(2)), the results show that the intercept and the first lag are significant at the 5% and 1% levels, respectively, but the second lag is insignificant. Qatar (AR(8)) results imply that the intercept, the first, the fifth, and the sixth lags are significant at the 1% level, however, all the others remaining variables are insignificant. According to the Saudi Arabia data (AR(6)), the intercept and all the lagged coefficients, except the third and the sixth lags, are significant at the 5% level. In the case of Dubai (AR(8)), just the second lag is significant at the 1% level and all the others lags and the intercept are insignificant. In this regard, for all the GCC stock markets, I found that returns are serially correlated (i.e. AR process), which is typically in contrast with more developed/liquid markets like the U.S. or UK and suggesting market inefficiency.

With regard to the Quasi-maximum likelihood (QMLE) results of the univariate GARCH (1,1) model for each GCC stock market (equation 2.3), Table 2.2 (Panel B) shows that, the estimated GARCH parameters $\hat{\omega_i} > 0$ and $(\hat{\alpha}, \hat{\beta}) \geq 0$ for all GCC stock markets, which is considered as a sufficient condition to ensure a positive conditional variance ($h_t \geq 0$). In addition, $\hat{\alpha}$'s estimated parameters are all significant at the 1% level for all the GCC markets, indicating the presence of own past shocks or the ARCH effect, and $\hat{\beta}$'s are highly significant at the 1% level for the six GCC stock markets, namely Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and Dubai ranging from .71 in Qatar to .86 in Kuwait, implying the existence of own past volatility or GARCH effect.

Figures 2.5 : 2.10 plot the conditional variance of GARCH effect for all the GCC stock markets general indices. Moreover, $\hat{\alpha} + \hat{\beta} \simeq 1$, which indicates a strong volatility persistence for these markets. Worth mentioning that, I also tried lower orders AR models for Kuwait, Saudi Arabia, Qatar and Dubai and higher AR orders models for Bahrain and Oman, however, the estimated GARCH parameters remain mostly the same without any significant changes.

Since the goal of this chapter is to investigate whether there exists a volatility spillover effect among the GCC stock markets general and sectors indices, I first consider the one-way volatility spillover test statistic (Q_1) as in equation 2.8 up to 100 M (e.g., $M = 1, 2, 3..., 100$), which is the number of the used sample cross correlations included for the spillover effect, in order to detect the direction for causality in variance for each pair of the GCC stock markets. The reason behind choosing such a high number of the used sample cross correlations included for the spillover effect (M) is to capture any spillover effect across the GCC stock markets, if exists, in three different time periods, in particular, short-run ($M = 1 : 14$) days, medium-run ($M = 15 : 59$) days, and long-run ($M = 60 : 100$) days.

Before tackling the empirical results in this chapter, Table 2.3 summarizes the overall key findings of this chapter. More specifically and with respect to the spillover effect among the GCC stock markets at the aggregate level, findings show that, except for few cases, each GCC stock market is vulnerable to past shocks that have happened in the other GCC stock markets, confirming the existence of a pronounced contemporaneous volatility transmission across the six GCC stock markets. The spillover effect varies across GCC markets with regard to the time during which the volatility transmission occurs (e.g., in the short-run (SR) and/or the medium-run (MR) and/or the long-run (LR)). These findings reflect the fact that the GCC countries share strong economic and financial linkages and policy coordination by which stock markets in the region respond similarly to common shocks. In this regard, Figures 2.11 : 2.16 plot the pairwise correlations among the GCC stock markets at the aggregate level for each M. Furthermore, according to the equity sectors analysis, results indicate that volatility spillover across the six stock markets studied in this chapter is driven mainly by the linkages and spillover effects between banking sectors and, to lesser extent, industrial sectors, while the insurance sectors played no role in the volatility spillover effects across these markets. These results reveal that the banking sector is the most vital sector among the GCC stock markets sectors, which is due to its dominating role in the financial sectors within the GCC region as well as its market capitalization, which is the highest of all sectors in the GCC stock markets. Meanwhile, the industrial sector plays a relatively modest role in causing spillover effects among the GCC stock markets. This is due to the fact that the industrial sector is highly dependent on the oil market's basic variations and price fluctuations, leading this sector to be more vulnerable to these developments than the intra-sector spillover within the GCC region. Finally, the insurance sector plays no role in volatility spillover transmission among the GCC stock markets, which is due to the fact that the insurance sector is characterised by having smallest market capitalization of all GCC sectors, as well as having low trading activities and little investment interest from GCC investors. This leads to the fact that the insurance sectors in some GCC stock markets have had many days with no trading.

Turning back to details of the empirical results, Table 2.4 shows the results for testing whether there exists a volatility spillover effect from past shocks of Bahrain's stock market (R_{2t}) to the other GCC stock markets' current shocks (R_{1t}). With regard to the volatility spillover from Bahrain stock market to Kuwait's market, the values of Q_1 are 2.4, 2.03, 2.02, 1.79, and 1.64 for M = 60, 65, 70, 75, 79, 85, and 90, respectively, suggesting a significant long run volatility spillover effect from past innovations in Bahrain stock market to current innovations in Kuwait stock market at the 1% level of significance for M = 60, at the 5% level for M = 65, 70, 75, 79, and at the 10% level for M = 90. These findings reflect the fact that many cross-listing companies exist between these two markets, which allows shocks in one market to be transmitted to the other market.

Also, the results in Table 2.4 exhibit a highly significant long run volatility spillover from Bahrain market's past shocks to Oman market's current shocks at the 1% level (except for M = 75 and 79), where the values of Q_1 are 3.55, 3.10, 3.32, 3.09, 2.81, 2.52, 2.27, and 1.92 for M = 45, 50, 55, 60, 65, 70, 75, and 79, respectively; this is due to the fact that the Bahrain Securities Market signed on December 25, 1996, a cross listing agreement with the Oman Stock Exchange. It is worth mentioning that, the findings in the case of Kuwait and Oman, which show volatility spillover effect from Bahrain stock market to these two markets in large M (e.g. M = 45 and 60) support what Hong (2001) claimed, in that some financial time series may exhibit strong cross-correlation and such a processes can have a long distributed lag, such that the cross-correlation at each lag is small but their joint effect is substantial. So, tests based on small number of sample cross-correlation(small M) may fail to identify such alternatives.

In the case of testing volatility spillover from Bahrain to Saudi-Arabia, the values of Q_1 are 1.59, 2.82, 2.23, and 1.68 for M = 2, 3, 4, and 5, respectively, implying the existence of a strong short run volatility spillover effect at the 1% level for M = 3 and 4, at the 5% for M = 5, and at the 10% for M = 2. These findings can be considered supportive evidence that recent past volatility has a greater influence more than distant past volatility. Moreover, these findings contradict with the previous work of Al-Deehani and Moosa (2006), who found that Bahrain market did not have any volatility spillover effect on the Saudi market, and are in line with Abraham and Seyyed (2006), who found that there existed a volatility spillover effect from Bahrain stock market to the stock market of Saudi Arabia. Finally, the findings in Table 2.4 suggest that there is no any volatility spillover effects from Bahrain stock market to the stock markets of Qatar and Dubai, where the values of the Q_1 are insignificant at any reasonable level of significance for these two markets.

My interpretation to the overall findings, which investigates volatility spillover effects from Bahrain stock market's past shocks to the other GCC markets' current shocks, is that Bahrain stock market is the most liberalized GCC market, though has the second smallest market capitalization, in terms of openness to foreign investors allowing GCC nationals to own stocks up to 100% and non-GCC citizens up to 49%. Moreover, these findings differs from that of Onour (2010), who found that Bahrain stock market did not affect the other markets in the region as there is no volatility spillover from Bahrain stock market to any GCC stock market.

With regard to testing the existence of volatility spillover effect from past Kuwait stock market's volatility to the other GCC markets current volatility, Table 2.5 reports the Q_1 values for different M as well as their significance for each pair. The results show that there exists a pronounced short run volatility spillover effect from Kuwait stock market's past shocks to Bahrain stock market current ones at the 1% level of significance, where the values of Q_1 are 3.57, 3.71, and 3.13 for M = 2, 3, and 4, respectively, which is considered an additional supportive evidence that recent past volatility has a greater influence than distant past volatility, in that for any shock has occurred in Kuwait stock market will be transmitted to the Bahrain market immediately or in the short run; and as mentioned above the spillover effect is due to the cross-listing between these two markets. Moreover, the Q_1 values, for investigating the spillover from past Kuwait shocks to Oman current ones, are 5.38, 4.11, 3.21, 2.76 and 2.05 for M = 2, 3, 4, 5, and 20 respectively, and are 4.56, 4.13, 3.94, 3.66, 3.56, 2.91, 2.90 for M = 60, 65, 70, 75, 79, 90, and 100, respectively. These results imply a very significant short and long run volatility spillover effects from Kuwait market to Oman market at the 1% significance level (except for $M = 20$).

In addition, the results for testing the volatility spillover from Kuwait to Qatar are not different than the other previous results, in that there exists a significant medium and long run spillover at the 5% significance level for M = 34, 36, and 38, with Q_1 values are 2.06, 1.77, and 1.71 respectively, and at the 1% level for $M = 100$, where Q_1 value is 10.34. Furthermore and in line with the findings of Al-Deehani and Moosa (2006) who found that Kuwait market exerts strong volatility spillover effect on Saudi market, results show that there is a significant short and medium-runs volatility spillover effects from Kuwait market to its Saudi peer at the 5% significance level, where Q_1 values are 2.57, 2.25, 1.78, and 1.69 for M = 1, 20, 24, and 28. Finally, for the volatility spillover from Kuwait market to Dubai financial market, findings show that there is a long-run volatility spillover, though weak, at the 10% level (except for $M = 50$), with the Q_1 values are 1.36, 1.66, 1.53, and 1.35 for M = 45, 50, 55, and 100.

To sum up, Kuwait stock exchange market past shocks affect all the other GCC market volatility. These findings are not surprising for a number of reasons, the Kuwait stock exchange is the second largest stock market in the region in terms of market capitalization; Kuwait stock market is the oldest regulated market in the GCC region; in 2000 the GCC and non-GCC citizens were permitted access to the local market and own shares up to 49% of stocks; finally, the Kuwait stock exchange is one of the most active and liquid markets in the region (Al-Deehani and Moosa (2006)).

When volatility spillover from Oman stock market to the other GCC markets is considered, with the exception of Bahrain and Dubai, findings in Table 2.6 show that, there is no evidence of volatility spillover effect from Oman market to the other GCC market at any level of significance and for any M. These findings are indicative of the fact that the Muscat Securities Market is one of the smallest markets among the GCC stock markets, and it is the most illiquid market. On the other hand, the results show that there exists a short-run volatility spillover from Muscat Securities Market to Bahrain Stock Exchange with Q_1 values equal 1.36, 1.84, 2.08, and 1.67 for M = 2, 3, 4, and 5, respectively. These results are due to-as mentioned before-the cross listing agreement between the two markets in 1996. Moreover, for testing the volatility spillover from Oman market to Dubai market, the Q_1 values are 10.64, 7.03, 5.36, 4.68, 3.88, 2.19, 1.80, 2.46, and 1.91 for M = 1, 2, 3, 4, 5, 20, 24, 45, and 50, respectively, implying a significant short and long-runs volatility spillover effects at the 1% level (except for M = 20, 24, and 50 at the 5% level).

According to the volatility spillover from past innovations in Qatar market to the current innovations in the other GCC stock markets, results in Table 2.7 imply that, there exists a strong volatility spillover from Qatar market to all the other GCC stock markets, despite the fact that Doha Securities Market allows both GCC and non-GCC nationals to own up to just 25% of shares, which is the lowest regrading the limits on foreign ownership (after that of the Saudi Arabia's market) of individual stocks available for GCC investors in all GCC countries. In the case of investigating the volatility spillover effect from Qatar stock market past shocks to Bahrain stock market, the Q_1 values are 1.77, 1.89, 1.82, and 1.83 for M = 65, 75, 79, and 90, indicating a long-run volatility spillover effect at the 5% level. For Kuwait, the results demonstrate a pronounced short-run volatility spillover effect from Qatar stock market to Kuwait stock market at the 1% level for M = 2, 3, 4, and 5, where the Q_1 values are 9.5, 7.88, 6.49, and 5.49, respectively. Again these results are considered supportive evidence that recent past volatility has a greater effect than distant past volatility. When we consider volatility spillover from Qatar market to Oman stock market, the Q_1 values are significant at any reasonable level of significance and for every M except for $M = 1$, implying a strong volatility spillover from Qatar market to Oman market at short, medium, and long runs. In the case of Saudi market, the Q_1 values are significant at the 1% level for the first M (M = 1) up to M = 45 (except for M = 36 and 38) and at the 5% level for M = 50 and 55, suggesting a significant volatility spillover from Qatar stock market to Saudi Arabia stock market over the short, medium, and long-runs. Finally, for testing the volatility spillover from Qatar stock market to Dubai stock market, the Q_1 values are all significant at the 1% level for all the reported Ms, indicating a highly significant volatility spillover effect from Qatar to

Dubai in all the three time periods, namely, short-run, medium-run, and long-run.

With respect to the volatility spillover from Saudi Arabia's stock market to the other GCC markets, the overall findings in Table 2.8, show a strong volatility spillover effects from Saudi market to the other GCC stock markets, which come from the fact that Saudi Arabia's stock market is by far the largest stock market in the gulf region in terms of market capitalization, and due to the leading economic and political role that Saudi Arabia plays not only in the gulf region but also in the Arab world. In particular, findings in Table 2.8 exhibit a highly medium and long-runs volatility spillover effects from Saudi market to Bahrain market at the 1% level of significance for all reported Ms (except for M = 1, 2, 3, 4, 5, 90, and 100). These findings are contradict with the previous work of Al-Deehani and Moosa (2006) and Abraham and Seyyed (2006), who found no volatility spillover from Saudi market to Bahrain market. In the case of testing the volatility spillover effect from Saudi Arabia stock market to that of Kuwait stock market, the values of Q_1 are 3.73, 2.88, 2.24, and 1.72 for M = 2, 3, 4, and 5, respectively as an evidence of the existence of a significant short-run volatility spillover at the 1% level for M= 2 and 3, and at the 5% for the remaining Ms. These results are in line with Al-Deehani and Moosa (2006) who found that the Saudi market has a strong spillover effect on Kuwait market. Moreover, these findings are further evidence that financial markets are usually more influenced by the recent past volatility than by the remote past events. For Oman, the results of the Q_1 values indicate a highly significant volatility spillover from Saudi market to Oman market at any reasonable level of significance and for the all the reported Ms. With regard to testing volatility spillover from Saudi stock market to Qatar market, the Q_1 values are 4.68, 4.37, 3.94, 3.69, 3.2, 6.19, 5.47, 4.66, and 4.34 for M = 45, 50, 55, 60, 65, 70, 75, 79, 90, and 100, suggesting a strong medium-run and long-run volatility spillover effect from Saudi market to Qatar market at the 1% level of significance. These findings emphasize what Hong (2001) claimed regarding tests based on small number of sample cross-correlation (small Ms), in that they may fail to capture the spillover effect when some financial time series may exhibit strong cross-correlation and such a processes can have a long distributed lag, such that the cross-correlation at each lag is small but their joint effect is substantial. Finally, the results for Dubai's financial market are similar to those of Oman market, in which the values of the Q_1 reveal a highly significant spillover from the Saudi market to Dubai market at any conventional level of significance and for all the reported Ms.

Finally, when investigating the volatility spillover effects between past shocks in Dubai Financial Market to current shocks in the other GCC stock markets, table 2.9 reports the results, which indicate a significant volatility spillover from Dubai market to all of its GCC partners. In particular, findings show that, there exists a short-run volatility spillover effect from Dubai market to Bahrain market at the 1% level for M = 3 and at the 5% level for M = 4 and 5, where the Q_1 values are 2.61, 1.98, and 2.06, respectively. In the case of investigating the volatility spillover effect from Dubai stock market to Kuwait stock market, the Q_1 values are 10.66, 9.27, 9.00, 5.33, 4.93, and 4.19 for M = 28, 34 ,36, 79, 90, and 100, suggesting a highly significant medium and long-run volatility spillover effects at the 1% level from Dubai's past volatility to Kuwait's current volatility. In the case of Oman, the results of the Q_1 values indicate a highly significant volatility spillover effect from Dubai's past shocks to Oman's current shocks at any reasonable level of significance and for the all reported Ms. With respect to Qatar, findings emphasize a strong medium and long-run volatility spillover from Dubai market to Qatar market at the 1% level for all reported Ms (except for the first five Ms). In the case of Saudi market, the Q_1 values are 2.33, 2.46, and 2.69 for M = 3, 4, and 5, indicating a pronounced short-run volatility spillover effect from Dubai market to Saudi market at the 1% level of significance. These overall findings regarding investigating volatility spillover from Dubai Financial Market's past shocks to the other GCC stock markets' current shocks reflect the fact that Dubai market is the third largest market in the GCC area with regard to market capitalization; it is one of the most liberalized markets in the region in terms of allowing a 100% of stock ownership to the GCC citizens and a 49% for non-GCC nationals; and it is considered a financial hub of the GCC region. Moreover, it is worth mentioning that, in the case of Kuwait and Qatar, which show volatility spillover effect in large Ms can be considered an additional supportive evidence of the previous work of Hong (2001), in which the author mentioned that some financial time series may exhibit strong cross-correlation and such a processes can have a long distributed lag such that the cross-correlation at each lag is small but there joint effect is substantial. So, tests based on small number of sample cross-correlation(small Ms) may fail to identify such alternatives.

As mentioned earlier in this chapter, when no prior information about the direction of causality is available, it is more appropriate to test the bi-directional hypothesis (Q_2 in equation 2.9) that neither of each GCC stock markets pair are affected by each other past volatilities. In other words, there is no contemporaneous volatility spillover between each GCC stock markets pairs. Table 2.10 reports the results for Q_2 test for each GCC stock markets pair-with the exception of the bi-directional volatility spillover effects between Oman and Qatar, and between Oman and Saudi Arabia-the results are consistent with the previous findings obtained with regard to Q_1. In particular, the results of testing the bi-directional volatility spillover between Bahrain and Kuwait show existence of a significant contemporaneous short and long-run volatility spillover effects between these two markets at the 1% level for M = 2, 3, and 4, and at the 5% level for M = 60 with Q_2 values equal 2.98, 3.32, 2.58, and 2.19, respectively. In the case of examining the bi-directional volatility spillover between Bahrain and Oman stock markets, the Q_2 values are 1.73, 1.78, 1.64, 3.09, 2.74, and 1.98 for M = 2, 3, 4, 50, 60, and 70, confirming a strong bi-directional volatility spillover between these two markets in the short and long-run at the 1% level of significance for M = 50 and 60, and at the 5% level for the remaining Ms.

With respect to Bahrain and Saudi Arabia, the empirical results suggest that, there exists a significant contemporaneous medium and long-run volatility spillover effects between these two markets at the 1% level for M = 20 and 30, and at the 5% level for M = 50 and 60, where the Q_2 values are 5.15, 4.07, 2.44, and 1.71, respectively. On the other hand, the Q_2 values for Bahrain and Dubai (despite the fact that these two markets are the most liberalized among the other GCC stock markets), Bahrain and Qatar, and for Kuwait and Oman are not significant at any reasonable level and at any M, suggesting that there is no contemporaneous volatility spillover between each of these mentioned stock markets pairs. With regard to Kuwait and Qatar stock markets, results exhibit a significant bi-directional short and long-run volatility spillover effects between these two markets at the 1% level for M = 2, 3, 4, 5, and 100, where the values of Q_2 are 6.58, 5.20, 4.04, 3.18, and 7.11, respectively.

In the case of Kuwait and Saudi Arabia stock markets, the Q_2 values are 12.39, 9.62, 9.31, 7.99, and 3.19 for M = 2 ,3, 4 ,5, and 20, respectively, indicating a strong bi-directional short and medium-run volatility spillover effects between Kuwait and Saudi Arabia stock markets at the 1% level of significance. Moreover, the results for Kuwait and Dubai are not different than the previous results, in which these two markets' volatilities are affected by each others' past shocks, where the Q_2 values are

6.22, 6.12, 5.35, 4.60, 4.13, and 3.92, which are significant at the 1% level, for M = 30, 50, 60, 70, 90, and 100, respectively. According to identify the bi-directional volatility spillover between Oman and Dubai, Qatar and Saudi Arabia ,Qatar and Dubai, and Saudi Arabia and Dubai, the results show that there exist a highly contemporaneous volatility spillover between each pair of these mentioned stock markets pairs at any reasonable level of significance and for all the reported Ms (except for M = 30 in the case of Qatar and Saudi Arabia, and for M = 90 and 100 in the case of Saudi Arabia and Dubai).

On the other hand, the only contradictory results I got are these of Oman and Qatar, and Oman and Saudi Arabia, at which the Q_2 findings show that, there exists a bi-directional volatility spillover effect between these two pairs. However, results from Q_1 test statistic show that there is only a one-way volatility spillover effect from Qatar to Oman and from Saudi Arabia to Oman but the opposite does not exist. My interpretation to these contradictory results is that, as Hong (2001) confirmed by Monte Carlo evidence investigating the finite sample performance of the proposed Q_1 and Q_2 tests, the one way-test (Q_1) has a better power than the two-way test (Q_2).

2.5.2 Disaggregate levels

2.5.2.1 Banking sectors

Investigating volatility spillover at a disaggregated level (intra-sectoral) between equivalent sectors across stock markets for different countries is sparse. My goal here is to examine the intra-sectoral volatility spillover within the context of GCC stock markets, namely the banking, industrial, and insurance sectors. Intra-sectoral volatility spillover investigation enables us to assess the exposure of different sector-to-sector specific past shocks within the GCC region, and it gives us more insights about which sector is more influential in causing volatility spillover at the aggregate level between the GCC stock markets.

Starting with the banking sectors across the GCC stock markets, the Quasi-maximum likelihood (QMLE) results of the univariate GARCH (1,1) model for each GCC stock market banking sector (equation 2.3), Table 2.11 (Panel B) show, that the estimated GARCH parameters $\hat{\omega_i} > 0$ and $(\hat{\alpha}, \hat{\beta}) \geq 0$ for all the GCC banking sectors, which is considered a sufficient condition to ensure a positive conditional variance ($h_t \geq 0$). In addition, $\hat{\alpha}$'s estimated parameters are all significant at the 1% level for all the GCC banking sectors, indicating the presence of own past shocks or the ARCH effect, and $\hat{\beta}$'s are highly significant at the 1% level, and ranging from .83 in Qatar to .90 in Bahrain stock markets, implying the existence of own past volatility or GARCH effect. Figures 2.17 : 2.22 plot the conditional variance of GARCH effect for all the GCC stock markets banking sector indices. Moreover, $\hat{\alpha} + \hat{\beta} \simeq 1$, which indicates a nearly integrated GARCH process.

I first employ the one-way volatility spillover test statistic (Q_1) for each GCC banking sector price index pair to identify the direction for causality-in-variance for each pair. The data from Table 2.12 to Table 2.17 show that, there exists a pronounced volatility spillover across all the GCC banking sectors pairs, with the exception of two cases namely, past shocks volatility spillover from Bahrain's banking sector to current volatility of Dubai's banking sector, and from Oman's banking sector to its Kuwaiti peer. These results reveal the fact that the banking sector is one of the most vital sectors in the GCC stock markets; this is due to its dominating role on the financial sectors within the GCC region as well as its highest market capitalization among all other sectors in the GCC stock markets.

Turning back to the results for each GCC banking sector pair, Table 2.12 reports the Q_1 values for different Ms, as well as their significance with regard to testing the volatility spillover from past shocks of Bahrain banking sector to the other GCC banking sectors current volatility. The empirical results show the presence of strong volatility spillover from Bahrain banking sector to that of Kuwait at the 1% level of significance over the short-run and long-run for M = 1, 2, 3, 4, 5, 10, 36, 40, 45, and 50, where the Q_1 values are 7.3, 5.3, 6.4, 5.2, 4.6, 2.56, 3.07, 2.82, 2.74 and 2.37, respectively. In the case of testing volatility transmission from Bahrain banking sector to Oman banking sector, the values of Q_1 are 4.6, 5.6, 7.1, 5.9, 3.3, 2.85, and 2.65 for M = 1, 2 , 3, 4, 20, 24, and 25, respectively, implying the existence of a strong volatility spillover at the 1% level over the short-run and medium-run. For volatility spillover effect from Bahrain banking sector to Qatar banking sector, results show that, there exists only a short-run, though significant at the 1% level, volatility spillover from Bahrain to Qatar banking sector for M = 3 and 4 where the Q_1 values are 2.36 and 2.46. The effect of volatility spillover from Bahrain banking sector to its Saudi counterpart is not different than that of Qatar, in which there exists a short-run volatility spillover at the 5% level for M = 2 and 3 with Q_1 values equal 1.77 and 1.79, respectively. Finally, results show that there is no any volatility spillover effect from Bahrain banking sector to Dubai banking sector at any M because the Q_1 values are not significant at any reasonable level.

With regard to the volatility spillover from past innovations in Kuwait banking sector to the current innovations in the other GCC banking sectors, results in Table 2.13 suggest an existence of a volatility spillover effect from Kuwait to Bahrain banking sector at the 5% level of significance in the medium-run and a significant spillover effect in the long-run at the 1% level, where the Q_1 values are 2.10, 1.84, 2.07, and 2.05 for M = 13, 14, 28, 36, 40, 10, 36, and 40, respectively, and 2.99, 2.34 for M = 80, 90, respectively. Meanwhile, the Q_1 values for volatility spillover from Kuwait's banking sector to Oman's banking sector are 1.76 and 1.79 for M = 14 and 15, suggesting a spillover effect in the medium-run at the 5% level. When Qatar's banking sector is considered, findings show that, there exhibits a pronounced volatility spillover effect from Kuwait's banking sector to that of Qatar at the 1% level over both medium-run and long-run for M = 20 , 24, 25, 90, and 100, where the Q_1 values are 2.87, 2.51, 2.33, 3.03, and 2.56, respectively. Moreover, the Kuwaiti banking sector has a significant volatility spillover effect on the banking sector of Saudi Arabia and Dubai only in the short-run, where the Q_1 values for Saudi Arabia are 2.67 and 1.77 for M = 2 and 3, while for Dubai the Q_1 value is 2.79 for M = 1.

When the volatility spillover from Oman's banking sector past shocks to that of its other GCC partners current volatility is considered, results in Table 2.14 suggest that, there is a strong volatility spillover effect at the 1% level from Oman's banking sector to Bahrain's banking sector in the short-run for M = 2, 3, 4, and 5, with Q_1 values are 3.29, 2.61, 3.11, and 2.47, respectively. In the case of Kuwait's banking sector there is no evidence of volatility spillover from Oman's banking sector to Kuwait's banking sector at any level of significance. While findings for both Saudi Arabia and Dubai indicate a significant volatility spillover effects from Oman banking sector in the medium-run for Qatar and in the short-run for Saudi Arabia, where the Q_1 values for Qatar are 2.41, 2.17, and 1.68 for M = 36, 40, and 45, respectively, and the the Q_1 value for Saudi Arabia is 2.72 for M = 1. Finally, findings emphasize a strong volatility spillover from Oman's banking sector to Dubai's banking sector at the 1% level of significance for all reported Ms.

According to testing volatility spillover from past shocks in Qatar's banking sector to the current volatility in the other GCC banking sectors, the empirical findings in Table 2.15 imply that, there exist short-run and long-run volatility spillover effects from Qatar's banking sector to that of Bahrain for M = 3, 80, 90, and 100, where the Q_1 values are 2.00, 2.24, 1.79, and 2.68, respectively, which are significant at the 5% level (except for M = 100, which is significant at the 1% level). With regard to investigating volatility spillover effect from Qatar's banking sector to Kuwait's banking sector, the Q_1 values are 3.47, 2.85, and 2.24 for M = 3, 4, and 5, suggesting a significant short-run volatility spillover at the 1% level except for M = 5. In the case of Oman, the Q_1 values are 3.09, 2.73, 2.46, 2.96, 3.00, 2.79, and 3.39 for M = 10, 13, 14, 70, 80, 90, and 100, indicating a significant volatility spillover in both medium-run and long-run from Qatar's banking sector to Oman's banking sector at the 1% level. When we consider Saudi Arabia's banking sector, results show that it is strongly affected by Qatar banking sector past shocks in short-run, medium-run, and long-run at the 1% level where the Q_1 values are 2.82, 2.55, 2.52, 2.69, 2.42, 2.80 , 2.57, 2.72, 2.87, 2.53, and 2.37 for M = 1, 10, 25, 28, 36, 40, 45, 70, 80, 90, 100, respectively. Also, Dubai banking sector is vulnerable to past shocks from Qatar banking sector but only in the medium-run, where M = 13, 14, and 15, with Q_1 values equal 2.18, 2.06, and 1.86, respectively.

Furthermore, results in Table 2.16 suggest existence of significant volatility spillover from the Saudi banking sector to all the GCC banking sectors. In particular, there exists pronounced short-run and medium-run volatility spillover effects from Saudi banking sector to Bahrain banking sector at the 1% level for M = 1, 2, 3, and 45, where the Q_1 values are 4.48, 3.67, 2.62, and 2.35, respectively; and a long-run spillover effect at the 5% level for M = 70 and 80, with Q_1 values equal 2.14 and 1.68, respectively. In the case of Kuwait and Qatar, findings show that, there exists strong volatility spillover effects from Saudi banking sector to the banking sectors in these two markets at the 1% level for all the reported Ms (except for M = 3 in the case of Kuwait). Oman results are almost similar to the previous findings of Kuwait and Qatar in which there exhibits a strong volatility spillover effect at the 1% level from Saudi Arabia's banking sector to its Oman counterpart but only in the short-run and medium-run, where Q_1 values are 11.55, 13.11, 10.30, 3.72, and 2.49 for M = 1, 2, 3, 15, and 20, respectively. In the case of Dubai's banking sector, there is evidence of existing volatility spillover effect from Saudi banking sector over the short-run for M = 1, 2, 3, 4, and 5, where the Q_1 values are 2.88, 1.90, 2.23, 1.83, and 2.00, respectively.

With regard to testing the existence of volatility spillover effect from Dubai's banking sector past shocks to the other GCC banking sectors current volatilities, Table 2.17 reports the Q_1 values for different Ms as well as their significance levels. The results show that, there exists a pronounced medium-run and long-run spillover effects from Dubai's banking sector to Bahrain's banking sector at the 1% level for M = 20, where the Q_1 value is 2.51, and at the 5% level for M = 24, 25, 28, and 90, where the Q_1 values are 2.14, 2.12, 1.76, 1.98, respectively. Also, findings suggest a presence of a strong volatility spillover from Dubai's banking sector to Kuwait's banking sector at the 1% level but only in the short-run, where M = 1, 2, and 3, and the Q_1 values are 4.46, 3.41, and 2.39, respectively. In the case of Oman and Saudi Arabia banking sectors, there is a distinct evidence of existing volatility spillover effects from Dubai's banking sector past shocks at the 1% level to these two markets' banking sectors for all the reported Ms (except for M = 1, 2, 3, 4 in Oman case, and M = 70 in Saudi Arabia case). Finally and with respect to Qatar, the Q_1 values are 2.54, 3.10, 2.13, 1.66, 2.74, 2.01, 1.71, which are significant at the 1% level for M = 1, 2, 5, and at the 5% for M = 3, 4, 10, and 13, respectively, which imply the existence of a strong spillover effect in the short-run from Dubai's banking sector to Qatar's banking sector.

According to the Q_2 test, which investigates the bi-directional volatility spillover effects between each GCC banking sector pair, Table 2.18 reports the results, which are consistent with the previous findings of the Q_1 test, in that all the GCC banking sectors have a significant bi-directional volatility spillover effect (except Bahrain-Dubai and Oman-Kuwait). In particular, findings suggest a presence of a significant contemporaneous volatility spillover between Bahrain and Kuwait banking sectors at the 1% level for all the reported Ms, except for M = 100. In the case of examining the bi-directional volatility spillover between Bahrain and Oman banking sectors, the Q_2 values are 6.2, 6.9, 6.4, 5.2, 3.4, 3.1, and 2.9 for M = 2, 3, 4, 5, 13, 14, and 15, respectively, implying that both banking sectors past shocks are highly affected by each other in the short-run and medium-run at the 1% level of significance. With regard to Bahrain and Qatar, findings show that, there exists a strong contemporaneous short-run and long-run volatility spillover effects between these two sectors at the 1% for M = 3 and 4, and at the 5% for M = 5 and 60, where the Q_2 values are 3.08, 2.73, and 2.06, 2.01, respectively.

For Bahrain and Saudi-Arabia, results confirm that, these two banking sectors are highly vulnerable to each other past innovations at the 1% level for M = 2, 3, and 4, with Q_2 values equal 3.85, 3.12, and 2.42, respectively. The results for Kuwait and Qatar also show that, there is a strong spillover effect between these two sectors in the short-run and medium-run at the 1% level for M = 3, 4, and 5, and at the 5% level for M = 14 and 15, where the Q_2 values are 2.58, 2.77, 2.78, and 1.90 and 1.71, respectively. According to identifying the bi-directional volatility spillover between the banking sectors of Kuwait and Saudi Arabia, Oman and Dubai, Qatar and Saudi Arabia, the results show that, there exhibits a highly contemporaneous volatility spillover effects between each pair of these mentioned pairs at any reasonable level of significance and for all the reported Ms (except for M = 80 and 90 in the case of Kuwait-Saudi Arabia).

For Kuwait and Dubai, the Q_2 values are 3.49, 2.28, 1.74, which are significant at the 1% level for M = 2, and at the 5% level for M = 3 and 4, indicating a strong short-run bi-directional volatility spillover effect between these two banking sectors at the mentioned Ms. In the case of Oman and Qatar, findings suggest significant contemporaneous volatility spillover effects in the long-run between these two sectors at the 1% level of significance for M = 60, 80, and 100, where the Q_2 values are 2.33, 2.45, and 2.65, respectively. With regard to Saudi Arabia and Oman, Saudi Arabia and Dubai, results show that, there exists a highly bi-directional volatility spillover effects between each pair at the 1% level for M = 2, 3, 4, 5, and 13 for both cases in addition to M = 80 in the case of Saudi Arabia and Dubai. Finally, in the case of Qatar and Dubai, the Q_2 values are 2.20, 1.98, 1.71 for M = 13, 14, and 15, respectively, implying a significant medium-run bi-directional volatility spillover effect at the 5% significant level.

2.5.2.2 Industrial sectors

The Quasi-maximum likelihood (QMLE) results of the univariate GARCH (1,1) model for each GCC stock market industrial sector (equation 2.3), Table 2.19 (Panel B) shows that, the estimated GARCH parameters $\hat{\omega}_i > 0$ and $(\hat{\alpha}, \hat{\beta}) \geq 0$ for all the five GCC stock market industrial sectors, which is considered a sufficient condition to ensure a positive conditional variance ($h_t \geq 0$). In addition, $\hat{\alpha}$'s estimated parameters are all significant at the 1% level for all the GCC industrial sectors, indicating the presence of own past shocks or the ARCH effect and $\hat{\beta}$'s are highly significant at the 1% and ranging from .62 in Bahrain to .88 in Oman, implying the existence of own past volatility or GARCH effect. Figures 2.23 : 2.27 plot the conditional variance of GARCH effect for all the GCC stock markets' industrial sector indices.

I first apply the Q_1 test statistic for each pair of GCC industrial sector in order to identify the direction of volatility spillover. The results (from Table 2.20 to Table 2.24) show that, there exists a volatility spillover across only some cases of the GCC industrial sectors pairs. My interpretation to these results is that this sector is highly dependent on the oil market's basic variations and price fluctuations, leading this sector to be more vulnerable to these developments than to the intra-sector spillover effects within the GCC region.

In particular, with regard to testing the existence of volatility spillover from past Bahrain's industrial sector volatility to the current volatility in the other GCC industrial sectors, Table 2.20 reports the Q_1 values for different Ms as well as their significance for each pair. The results show that, there exists a volatility spillover from Bahrain's industrial sector to only two GCC industrial sectors namely, Qatar and Saudi Arabia. For Qatar the Q_1 values are 4.04, 2.91, 6.42, 5.54, 4.82, and 3.27 for M = 1, 2, 20, 25, 30, and 40, indicating a strong short-run and medium-run volatility spillover effects from Bahrain industrial to Qatar industrial sector at the 1% level; while for Saudi Arabia the Q_1 values are 2.00, 3.22, 2.00 for M = 25, 60, and 80, respectively, indicating a strong volatility transmission effect in the medium-run and long-run from Bahrain's industrial sector to that of Saudi Arabia.

In the case of investigating volatility spillover from past innovations of Kuwait's industrial sector to its GCC counterparts, results in Table 2.21 suggest existence of volatility transmission effect from Kuwait's industrial sector to only Bahrain and Saudi Arabia industrial sectors, where the Q_1 values for Bahrain are 4.44 and 3.61 for M = 3 and 4, and the Q_1 values for Saudi Arabia are 3.17 and 2.53, for M = 60 and 80. On the other hand, findings in Table 2.22 show that, Oman industrial sector has a significant volatility spillover effect on Kuwait, Qatar and Saudi Arabia industrial sectors at the 1% level. For Kuwait, the Q_1 values are 20.31 and 18.74 for M = 90 and

100. In the case of Qatar the Q_1 values are 2.54, 3.76, 3.41 for M = 2, 10, 11, respectively, while for Saudi Arabia the only significant Q_1 value is at $M = 1$ and equal 2.32.

With respect to investigating the volatility spillover from Qatar industrial sector to the other GCC industrial sectors, findings in Table 2.23 show that, Qatar industrial sector is the only sector in the GCC industrial sectors, which has a volatility spillover to all the GCC industrial sectors. In the case of volatility spillover from Qatar to Bahrain industrial sector, the value of Q_1 is 2.29 for M = 60, while for Kuwait the Q_1 values are 5.17, 4.27, 3.70 for M = 80, 90, and 100, respectively. In the case of Oman, there exists a volatility spillover from Qatar industrial sector to that of Oman for M = 40, 60, 80, 90, and 100, where the Q_1 values are 3.18, 2.17, 1.65, 2.2, and 2.2, respectively. Finally, the results show a significant volatility spillover from Qatar industrial sector to Saudi Arabia industrial sector at the 1% level for M = 10 and 11, with Q_1 values 2.81 and 2.52. The main reason of these over all results regarding the significant volatility spillover effect from Qatar industrial sector to the industrial sectors in the GCC is attributed to the comparative advantage that Qatar has in gas-intensive industries. More specifically, according to the U.S. Energy Information Administration (EIA), Qatar holds the world's third largest natural gas reserves, and be the single largest supplier of liquefied natural gas, as well as the world's largest liquefied natural gas exporter.

Finally, testing the volatility spillover from Saudi Arabia's industrial sector to the other GCC industrial sectors, the data in Table 2.24 show that, there exists a significant spillover to Kuwait industrial sector at the 1% level for M = 1, 2, 3, 4, 20, 25, 30, 60, 80, 90, and 100, where the Q_1 values are 5.30, 4.17, 3.16, 2.48, 2.43, 2.86, 2.59, 3.80, 4.15, 3.51, and 3.05. For Oman and Qatar industrial sectors, the results indicate a highly significant volatility spillover from Saudi Arabia industrial sector at any reasonable level of significance and for all the reported Ms (except for M = 80, 90, 100 in the case of Qatar).

According to the Q_2 test, which investigates the bi-directional volatility spillover effect between each GCC industrial sector pair, Table 2.25 reports the values of Q_2, which are consistent with the Q_1 previous findings (except in the case of Oman-Kuwait) in that there exists a bi-directional volatility spillover at the 1% level between Bahrain and Qatar industrial sectors for M = 20, 60, and 70, where the Q_2 values are 2.96, 3.19, 2.58, respectively. Oman and Qatar also have a contemporaneous volatility spillover effect for M = 10, 20, 30, and 60, with Q_2 values equal 2.77, 2.09, 1.91, and 1.84, respectively. In the case of Oman and Saudi Arabia, there exists a volatility spillover at any reasonable level of significance and for all reported Ms. Finally, the results suggest a presence of bi-directional volatility spillover between Qatar and Saudi Arabia industrial sectors at M = 5, 10, 20, 30, where the values of Q_2 are 6.97, 6.63, 3.13, and 3.13, respectively.

2.5.2.3 Insurance sectors

The Quasi-maximum likelihood (QMLE) results of the univariate GARCH (1,1) model for each GCC stock market insurance sector (equation 2.3), Table 2.26(Panel B) shows that, the estimated GARCH parameters $\hat{\omega}_i > 0$ and $(\hat{\alpha}, \hat{\beta}) \geq 0$ for all the five GCC insurance sectors, which is considered a sufficient condition to ensure a positive conditional variance ($h_t \geq 0$). In addition, $\hat{\alpha}$'s estimated parameters are all significant at the 1% level for all the GCC insurance sectors, indicating the presence of own past shocks or the ARCH effect and $\hat{\beta}$'s are highly significant at the 1% level and ranging from .75 in Bahrain to .92 in Saudi Arabia, implying the existence of own past volatility or GARCH effect. Figures 2.28 : 2.32 plot the conditional variance of the GARCH effect for all the GCC stock markets insurance sector indices.

Unlike the previous results for the other two sectors, volatility spillover across the GCC insurance sectors is very weak and found to be in just seven cases or seven pairs among all the investigated cases (about 20 cases). In particular, in the case of investigating the volatility spillover effect from Bahrain insurance sector to the other GCC insurance sectors, the Q_1 results in Table 2.27 indicate that, there exists a volatility spillover effect from Bahrain's insurance sector to Kuwait's insurance sector for M = 20 and 60, where the Q_1 values are 2.28 and 2.54. On the other hand, findings in Tables 2.28 and 2.29 show that neither Kuwait's insurance sector nor Oman insurance's sector has any volatility spillover effect on the other GCC insurance sectors.

With regard to volatility spillover from Qatar's insurance sector to the other GCC insurance sectors, results in Table 2.30 show that, there exists a volatility spillover from Qatar to Bahrain for M = 75, with Q_1 value is 1.81; for the case of Kuwait, the

Q_1 values are 5.65, 3.88, 3.39, and 2.43 for M = 10, 15, 20, and 25, suggesting a strong volatility spillover at the 1% level from Qatar's insurance sector to that of Kuwait; while data for the volatility spillover from Qatar to Saudi Arabia's insurance sectors imply a volatility spillover existence from Qatar to Saudi Arabia for M = 75 and 90, where the Q_1 values are 12.04 and 10.50, respectively. Finally, Table 2.31 reports the results of investigating the volatility transmission from Saudi Arabia's insurance sector to the other GCC insurance sectors. In particular, only three cases have been found to exhibit a volatility spillover effects from Saudi insurance sector, namely, Bahrain, Oman, and Qatar insurance sectors. In the case of Bahrain, findings show that, there exists a volatility spillover effect from Saudi insurance sector to Bahrain insurance sector at the 1% level for M = 10, 90, and 100, with Q_1 values are 3.26, 2.97, 2.64, and 2.9. For testing the volatility spillover effect from Saudi Arabia insurance sector to that of Oman, results confirm that, there exists a volatility spillover effect from Saudi Arabia's insurance sector to Oman insurance sector at the 1% level of significance for M = 4, 5, 10, and 15, where the Q_1 values are 7.42, 5.78, 4.00, and 2.82. The last case, which has been found to exhibit a volatility spillover effect from Saudi insurance sector is Qatar's insurance sector. The empirical results show that, the Q_1 values are 3.36 and 2.74 for M = 4 and 5, implying a strong volatility spillover effect from Saudi Arabia's insurance to Qatar's insurance sector at the 1% level of significance.
According to the Q_2 test, which investigates the bi-directional volatility spillover between each GCC insurance sector pair, Table 2.32 reports the results, which are consistent with the Q_1 previous findings in that none of the GCC insurance sector pairs-except Oman-Saudi Arabia and Kuwait-Qatar-has any bi-directional volatility spillover effect. In particular, the only case exhibits a bi-directional volatility spillover effect is found to be between Qatar and Saudi Arabia insurance sectors, in that the values of Q_2 are 5.99 and 4.47, which indicate a strong long-run bi-directional volatility spillover effect at the 1% level for M = 80 and 100. The reason behind these over all results comes from the fact that the insurance sector is characterized by having the smallest market capitalization of all GCC sectors, as well as having low trading activities and little investment interest from investors. This leads to the fact that the insurance sectors in some GCC stock markets have had many days with no trading activities.

2.6 Conclusion

In order to investigate the volatility spillover effect among the GCC stock markets at the aggregate levels, as well as at the intra-sector levels, this chapter exploited the causality-in-variance test pioneered by Cheung and Ng (1996) and developed by Hong (2001), who introduced a class of asymptotic N (0,1) tests for volatility spillover between two time series that exhibit conditional heteroskedasticity and may have infinite unconditional variances. The main findings of this chapter showed that, except for few cases, each GCC stock market is vulnerable to past shocks that have happened in other GCC stock markets, confirming the existence of a pronounced contemporaneous volatility transmission across the six GCC stock markets. The spillover effect varies across the GCC markets with regard to the time period at which the volatility transmission might occur (e.g., in the short-run and/or the medium-run and/or the long-run). These findings reflect the fact that, the GCC countries share strong economic and financial linkages and policy coordination, such that stock markets in the region respond similarly to common shocks. Furthermore, results of the equity sectors analysis indicated that volatility spillover across the six stock markets studied in this chapter is driven mainly by the linkages and spillover effects between the GCC banking sectors and, to lesser extent, the industrial sectors, while the insurance sectors played no role in the volatility spillover effects across these markets. These results reveal the fact that the banking sectors are the most vital sectors among the GCC stock markets sectors, which is due to their dominating role in the financial sectors within the GCC region, as well as their market capitalization, which is the highest of all sectors in the GCC stock markets. Meanwhile the industrial sectors played a relatively modest role in causing spillover effects among the GCC stock markets. This is due to the fact that the industrial sector is highly dependent on the oil and gas markets' basic variations and price fluctuations, leading this sector to be more vulnerable to these developments than to the intra-sector spillover within the GCC region. Finally, the insurance sector played no role in volatility spillover transmissions among the GCC stock markets, which is due to the fact that the insurance sectors are characterized by having the smallest market capitalization of all GCC sectors, as well as having low trading activities and little investment interest from GCC investors, which leads to the fact that the insurance sectors in some GCC stock markets have had many days with no trading.

Despite the fact that the empirical results of this chapter found evidence of strong linkages and spillover among GCC financial markets, the GCC countries still have a long path before reaching the required level of financial integration to enhance the GCC efforts towards achieving a well functioning monetary union. In this regard, in order to promote financial integration among GCC countries, GCC policy makers are advised to adopt a comprehensive set of policies and regulations to improve the depth of the GCC financial markets; strengthen convergence across GCC financial systems; increase cross-listed stocks; relaxing the stock ownership restrictions facing both GCC and foreign investors; and most importantly, put the GCC common market process into practice.

country	start-date	end-date	sample size
Bahrain general index	2-1-2003	14-9-2012	2532
Bahrain banking sector	1-1-2004	6-2-2013	2375
Bahrain industrial sector	1-1-2004	6-2-2013	2375
Bahrain insurance sector	1-1-2004	6-2-2013	2375
Kuwait general index	31-12-1999	14-9-2012	3316
Kuwait banking sector	1-1-2004	6-2-2013	2375
Kuwait industrial sector	1-1-2004	6-2-2013	2375
Kuwait insurance sector	1-1-2004	6-2-2013	2375
Oman general index	22-10-1996	14-9-2012	4149
Oman banking sector	1-1-2004	6-2-2013	2375
Oman industrial sector	1-1-2004	6-2-2013	2375
Oman insurance sector	1-1-2004	6-2-2013	2375
Qatar general index	10-8-1998	14-9-2012	3678
Qatar banking sector	1-1-2004	6-2-2013	2375
Qatar industrial sector	1-1-2004	6-2-2013	2375
Qatar insurance sector	1-1-2004	6-2-2013	2375
Saudi-Arabia general index	19-10-1998	14-9-2012	3630
Saudi-Arabia banking sector	19-4-2007	6-2-2013	1515
Saudi-Arabia industrial sector	19-4-2007	6-2-2013	1515
Saudi-Arabia insurance sector	19-4-2007	6-2-2013	1515
Dubai general index	31-12-2003	14-9-2012	2273
Dubai banking sector	1-1-2004	6-2-2013	2375

Table 2.1: GCC stock markets data description.

Parameter	BA	KU	OM	QA	SA	Dubai
Panel (A)						
b_0	.00007	.0004	.0003	.0006	.0009	.0003
	(.41)	(.0001)	(.031)	(.000)	(.000)	(.176)
b_1	.158	.105	.211	.312	.071	.032
	(.00)	(.00)	(.00)	(.00)	(.00)	(.23)
b_2		.052	.042	-.03	.042	.077
		(.012)	(.103)	(.22)	(.077)	(.003)
b_3		.06		.007	.007	.008
		(.004)		(.77)	(.76)	(.70)
b_4		.026		-.034	.043	.033
		(.24)		(.139)	(.028)	(.19)
b_5		.062		.074	.029	.054
		(.001)		(.00)	(.169)	(.03)
b_6		.018		-.049	-.03	-.013
		(.39)		(.03)	(.063)	(.58)
b_7				.013		.012
				(.53)		(.577)
b_8				-.007		.037
				(.71)		(.106)
Panel (B)						
ω	.0000018	.0000012	.0000061	.000001	.0000026	.00000058
	(.000)	(.001)	(.006)	(.135)	(.000)	(.003)
α	.169	.128	.127	.269	.143	.118
	(.00)	(.00)	(.00)	(.00)	(.00)	(.00)
β	.799	.865	.827	.712	.856	.872
	(.00)	(.00)	(.00)	(.00)	(.00)	(.00)
Sample size	2530	3314	4147	3676	3628	2271
Number of lags(p)	1	6	2	8	6	8

The numbers in parentheses are the p-values for the estimated coefficients.

Table 2.2: Quasi-maximum likelihood estimation of univariate GARCH (1,1) models for GCC stock markets.

Country	General index	Banking sector	Industrial sector	Insurance sector
BA↔ *KU*	SR,MR	SR,MR,LR	NO	NO
BA↔ *OM*	SR,MR	SR	NO	NO
BA↔ *QA*	NO	SR,LR	SR,MR	NO
BA↔ *SA*	SR,MR	SR,MR	NO	NO
BA↔ *DU*	NO	NO	NA	NA
KU↔ *OM*	NO	NO	NO	NO
KU↔ *QA*	SR,LR	SR,LR	NO	NO
KU↔ *SA*	SR,MR	SR,MR,LR	MR,LR	NO
KU↔ *DU*	MR,LR	SR	NA	NA
OM↔ *QA*	NO	LR	SR,MR,LR	NO
OM↔ *SA*	NO	SR	SR,MR	NO
OM↔ *DU*	SR,MR,LR	SR,MR,LR	NA	NA
QA↔ *SA*	SR,MR,LR	SR,MR,LR	SR,MR	LR
QA↔ *DU*	SR,MR,LR	SR	NA	NA
SA↔ *DU*	SR,MR,LR	SR,MR,LR	NA	NA

SR = spillover effect in the short-run, MR = spillover effect in the medium- run, and LR = spillover effect in the long-run.
NA = not available due to data unavailability, NO = spillover does not exist.

TABLE 2.3: summary of the overall results.

M	Kuwait	Oman	Qatar	Saudi Arabia	Dubai
1	.74	.12	-.64	.96	-.62
2	.65	1.08	-.004	**1.59***	-.89
3	.99	.67	-.07	**2.82**$^\otimes$	-.54
4	.52	.23	-.40	**2.23****	-.34
5	.79	.05	-.16	**1.68****	-.49
20	-.24	-1.38	-1.94	-.64	-2.04
24	-.50	-1.44	-2.12	-.56	-2.31
28	-.83	-1.58	-2.42	-.37	-2.01
34	-.30	-1.73	-2.68	-.84	-2.16
36	-.40	-1.84	-2.83	-.87	-2.22
38	-.42	-1.96	-2.93	-1.01	-2.21
45	-.75	**3.55**$^\otimes$	-2.75	-1.43	-2.28
50	-.77	**3.10**$^\otimes$	-1.71	-1.33	-2.38
55	-.93	**3.32**$^\otimes$	-1.61	-1.58	.-2.29
60	**2.40**$^\otimes$	**3.09**$^\otimes$	-1.79	-1.81	-2.37
65	**2.03****	**2.81**$^\otimes$	-2.02	-2.15	-2.33
70	**2.02****	**2.52**$^\otimes$	-2.27	-2.33	-2.42
75	**1.79****	**2.27****	-2.52	-2.16	-2.41
79	**1.64****	**1.92****	-2.58	-2.31	-2.45
90	**1.43***	1.22	-2.86	-2.58	-2.61
100	1.04	.61	-2.97	-2.51	-2.31

$*$,$**$ and $\otimes$ indicates significant at 10, 5, and 1% levels, respectively.

TABLE 2.4: Q_1 One-way test statistic for causality-in-variance between Bahrain and the other GCC stock markets' general price indices.

M	Bahrain	Oman	Qatar	Saudi Arabia	Dubai
1	-.70	-.69	-.20	**2.57**$^{\otimes}$	-.23
2	**3.57**$^{\otimes}$	**5.38**$^{\otimes}$	-.20	**1.36***	-.61
3	**3.71**$^{\otimes}$	**4.11**$^{\otimes}$	-.52	.85	-.77
4	**3.13**$^{\otimes}$	**3.21**$^{\otimes}$	-.77	.58	-1.01
5	**2.49**$^{\otimes}$	**2.76**$^{\otimes}$	-.99	**1.39***	-1.19
20	.50	**2.05****	-1.38	**2.25**$^{\otimes}$	-1.22
24	.05	**1.39***	-1.62	**1.78****	-1.52
28	-.09	.83	-1.56	**1.67****	-1.19
34	.17	.33	**2.06****	**1.31***	-1.11
36	.15	.16	**1.77****	1.08	-1.15
38	.05	.10	**1.71****	.84	-.74
45	.93	-.22	1.03	**1.53***	**1.36***
50	.45	-.41	1.20	1.27	**1.66****
55	.97	-.20	.79	1.03	**1.53***
60	.70	**4.56**$^{\otimes}$	.82	.98	1.13
65	.50	**4.13**$^{\otimes}$	.53	.75	.75
70	.22	**3.94**$^{\otimes}$	.26	.60	.54
75	-.02	**3.66**$^{\otimes}$	.13	.37	.26
79	-.15	**3.56**$^{\otimes}$	-.15	.67	1.02
90	-.50	**2.91**$^{\otimes}$	-.05	.57	.91
100	-.74	**2.90**$^{\otimes}$	**10.34**$^{\otimes}$	.50	**1.35***

*,** and $\otimes$ indicates significant at 10, 5, and 1% levels, respectively.

TABLE 2.5: Q_1 One-way test statistic for causality-in-variance between Kuwait and the other GCC stock markets' general price indices.

M	Bahrain	Kuwait	Qatar	Saudi Arabia	Dubai
1	1.01	1.05	-.41	-.30	**10.64**$^{\otimes}$
2	**1.36***	.26	-.78	-.62	**7.03**$^{\otimes}$
3	**1.84****	-.17	-1.03	-.57	**5.36**$^{\otimes}$
4	**2.08****	-.43	-1.24	-.49	**4.68**$^{\otimes}$
5	**1.67****	-.70	-1.40	.39	**3.88**$^{\otimes}$
20	.23	-1.30	-2.10	-1.22	**2.19****
24	-.07	-1.60	-2.31	-1.47	**1.80****
28	-.02	-1.81	-.31	-1.62	1.26
34	.10	-2.17	-.74	-1.85	1.15
36	-.10	-2.20	-.89	-1.98	1.03
38	-.33	-2.19	-1.06	-2.01	.83
45	**1.54***	-1.60	-.31	-1.45	**2.46**$^{\otimes}$
50	1.27	-1.75	-.42	-1.68	**1.91****
55	1.13	-1.96	-.70	-1.94	**1.61***
60	.79	-2.04	-.79	-2.03	1.26
65	.48	-2.15	-.90	-2.21	.93
70	.27	-2.08	-1.08	-2.26	.63
75	.10	-2.17	-.34	-2.37	.40
79	-.04	-2.15	-.45	-2.60	.65
90	.59	-2.25	-.88	-2.04	.57
100	.23	-2.61	-1.04	-2.02	.42

$*$,$**$ and $\otimes$ indicates significant at 10, 5, and 1% levels, respectively.

TABLE 2.6: Q_1 One-way test statistic for causality-in-variance between Oman and the other GCC stock markets' general price indices.

M	Bahrain	Kuwait	Oman	Saudi Arabia	Dubai
1	-.63	-.28	-.58	**22.4**$^{\otimes}$	**21.6**$^{\otimes}$
2	-.82	**9.52**$^{\otimes}$	**5.42**$^{\otimes}$	**16.34**$^{\otimes}$	**31.6**$^{\otimes}$
3	-.99	**7.88**$^{\otimes}$	**11.12**$^{\otimes}$	**12.93**$^{\otimes}$	**25.6**$^{\otimes}$
4	.22	**6.49**$^{\otimes}$	**9.28**$^{\otimes}$	**11.31**$^{\otimes}$	**21.9**$^{\otimes}$
5	.90	**5.49**$^{\otimes}$	**12.9**$^{\otimes}$	**9.97**$^{\otimes}$	**19.3**$^{\otimes}$
20	-.40	**1.58***	**8.07**$^{\otimes}$	**4.50**$^{\otimes}$	**8.45**$^{\otimes}$
24	-.57	.89	**7.54**$^{\otimes}$	**3.67**$^{\otimes}$	**7.33**$^{\otimes}$
28	.72	.33	**6.61**$^{\otimes}$	**3.24**$^{\otimes}$	**6.38**$^{\otimes}$
34	.24	.06	**5.37**$^{\otimes}$	**2.45**$^{\otimes}$	**5.26**$^{\otimes}$
36	.09	-.05	**5.03**$^{\otimes}$	**2.18****	**4.95**$^{\otimes}$
38	-.13	-.24	**4.78**$^{\otimes}$	**2.00****	**4.60**$^{\otimes}$
45	1.17	.81	**5.70**$^{\otimes}$	**2.34**$^{\otimes}$	**5.06**$^{\otimes}$
50	1.04	.57	**5.12**$^{\otimes}$	**1.91****	**4.78**$^{\otimes}$
55	.60	.91	**4.48**$^{\otimes}$	**1.71****	**4.29**$^{\otimes}$
60	.31	.63	**4.33**$^{\otimes}$	**1.32***	**3.80**$^{\otimes}$
65	**1.77****	.54	**4.81**$^{\otimes}$	.90	**3.36**$^{\otimes}$
70	**1.51***	.42	**4.29**$^{\otimes}$	**1.31***	**3.40**$^{\otimes}$
75	**1.89****	.26	**3.99**$^{\otimes}$	.92	**3.21**$^{\otimes}$
79	**1.82****	.20	**3.62**$^{\otimes}$	.81	**2.88**$^{\otimes}$
90	**1.83****	-.22	**2.96**$^{\otimes}$	.39	**2.43**$^{\otimes}$
100	**1.51***	-.29	**2.33**$^{\otimes}$	.18	**2.48**$^{\otimes}$

$*$,$**$, and $\otimes$ indicates significant at 10, 5, and 1% levels, respectively.

TABLE 2.7: Q_1 One-way test statistic for causality-in-variance between Qatar and the other GCC stock markets' general price indices.

M	Bahrain	Kuwait	Oman	Qatar	Dubai
1	.25	.035	**39.5**$^{\otimes}$	.46	**58.3**$^{\otimes}$
2	.15	**3.73**$^{\otimes}$	**36.91**$^{\otimes}$	.05	**40.7**$^{\otimes}$
3	-.22	**2.88**$^{\otimes}$	**29.7**$^{\otimes}$	-.01	**32.8**$^{\otimes}$
4	-.50	**2.24****	**25.68**$^{\otimes}$	-.32	**28.4**$^{\otimes}$
5	-.51	**1.72****	**22.9**$^{\otimes}$	-.59	**25.2**$^{\otimes}$
20	**7.93**$^{\otimes}$	1.27	**12.04**$^{\otimes}$	-1.50	**12.6**$^{\otimes}$
24	**7.07**$^{\otimes}$	**1.34***	**13.03**$^{\otimes}$	-1.64	**12.4**$^{\otimes}$
28	**6.70**$^{\otimes}$	.72	**12.3**$^{\otimes}$	-1.86	**11.08**$^{\otimes}$
34	**5.75**$^{\otimes}$	.47	**10.7**$^{\otimes}$	-1.59	**9.71**$^{\otimes}$
36	**5.82**$^{\otimes}$	.28	**10.5**$^{\otimes}$	-1.75	**9.22**$^{\otimes}$
38	**5.67**$^{\otimes}$	.23	**10.3**$^{\otimes}$	-1.87	**9.37**$^{\otimes}$
45	**5.17**$^{\otimes}$	1.13	**9.1**$^{\otimes}$	**4.68**$^{\otimes}$	**8.19**$^{\otimes}$
50	**4.79**$^{\otimes}$	.94	**8.9**$^{\otimes}$	**4.37**$^{\otimes}$	**7.59**$^{\otimes}$
55	**4.66**$^{\otimes}$	.62	**8.4**$^{\otimes}$	**3.94**$^{\otimes}$	**6.90**$^{\otimes}$
60	**4.23**$^{\otimes}$	.72	**8.5**$^{\otimes}$	**3.69**$^{\otimes}$	**6.51**$^{\otimes}$
65	**3.95**$^{\otimes}$	.80	**8.09**$^{\otimes}$	**3.20**$^{\otimes}$	**6.05**$^{\otimes}$
70	**3.53**$^{\otimes}$	.69	**8.04**$^{\otimes}$	**6.19**$^{\otimes}$	**5.81**$^{\otimes}$
75	**3.15**$^{\otimes}$	.52	**7.9**$^{\otimes}$	**5.83**$^{\otimes}$	**5.39**$^{\otimes}$
79	**2.78**$^{\otimes}$	.72	**7.4**$^{\otimes}$	**5.47**$^{\otimes}$	**4.96**$^{\otimes}$
90	**1.98****	.68	**6.7**$^{\otimes}$	**4.66**$^{\otimes}$	**4.14**$^{\otimes}$
100	**1.71****	.86	**6.2**$^{\otimes}$	**4.34**$^{\otimes}$	**3.86**$^{\otimes}$

$*$,$**$, and $\otimes$ indicates significant at 10, 5, and 1% levels respectively.

TABLE 2.8: Q_1 One-way test statistic for causality-in-variance between Saudi-Arabia and the other GCC stock markets' general price indices.

M	Bahrain	Kuwait	Oman	Qatar	Saudi-Arabia
1	-.60	-.39	**35.7**$^{\otimes}$	-.68	-.70
2	-.88	.20	**27.2**$^{\otimes}$	-.73	-.96
3	**2.61**$^{\otimes}$	-.16	**21.8**$^{\otimes}$	-1.00	**2.33**$^{\otimes}$
4	**1.98****	-.25	**20.3**$^{\otimes}$	-.89	**2.46**$^{\otimes}$
5	**2.06****	-.25	**18.4**$^{\otimes}$	-1.11	**2.69**$^{\otimes}$
20	**1.38***	-.32	**9.35**$^{\otimes}$	**9.65**$^{\otimes}$	.55
24	.80	-.73	**8.42**$^{\otimes}$	**9.08**$^{\otimes}$	.46
28	.25	**10.66**$^{\otimes}$	**8.31**$^{\otimes}$	**8.15**$^{\otimes}$	-.06
34	-.05	**9.27**$^{\otimes}$	**7.84**$^{\otimes}$	**7.25**$^{\otimes}$	-.28
36	-.10	**9.00**$^{\otimes}$	**7.62**$^{\otimes}$	**6.38**$^{\otimes}$	.39
38	-.25	**8.59**$^{\otimes}$	**7.37**$^{\otimes}$	**6.55**$^{\otimes}$	-.43
45	.68	**7.67**$^{\otimes}$	**6.38**$^{\otimes}$	**6.02**$^{\otimes}$	-.56
50	.51	**6.99**$^{\otimes}$	**5.83**$^{\otimes}$	**6.21**$^{\otimes}$	-.78
55	.09	**6.38**$^{\otimes}$	**6.31**$^{\otimes}$	**5.67**$^{\otimes}$	-1.09
60	.32	**6.43**$^{\otimes}$	**5.88**$^{\otimes}$	**5.25**$^{\otimes}$	-1.46
65	-.06	**6.05**$^{\otimes}$	**5.46**$^{\otimes}$	**4.84**$^{\otimes}$	-1.38
70	-.43	**5.96**$^{\otimes}$	**5.04**$^{\otimes}$	**4.96**$^{\otimes}$	-1.64
75	-.72	**5.71**$^{\otimes}$	**5.23**$^{\otimes}$	**5.48**$^{\otimes}$	-1.80
79	.60	**5.33**$^{\otimes}$	**5.55**$^{\otimes}$	**5.13**$^{\otimes}$	-2.02
90	.34	**4.93**$^{\otimes}$	**4.80**$^{\otimes}$	**4.55**$^{\otimes}$	-2.54
100	-.17	**4.19**$^{\otimes}$	**4.66**$^{\otimes}$	**4.23**$^{\otimes}$	-2.69

$*$,$**$ and $\otimes$ indicates significant at 10, 5, and 1% levels, respectively.

TABLE 2.9: Q_1 One-way test statistic for causality-in-variance between Dubai and the other GCC stock markets' general price indices.

$M\rightarrow$ COUNTRY $\downarrow$	2	3	4	5	20	30	50	60	70	90	100
BA$\leftrightarrow$ KU	**2.98**$^{\otimes}$	**3.32**$^{\otimes}$	**2.58**$^{\otimes}$	**2.32**$^{\otimes}$	.18	-.71	-.22	**2.19****	1.59	.66	.21
BA$\leftrightarrow$ OM	**1.73****	**1.78****	**1.64****	1.22	-.81	-1.2	**3.09**$^{\otimes}$	**2.74**$^{\otimes}$	**1.98****	1.28	.60
BA$\leftrightarrow$ QA	-.58	-.76	-.13	.52	-1.65	-1.28	-.47	-1.04	-.53	-.72	-1.02
BA$\leftrightarrow$ SA	1.23	**1.84****	1.22	.82	**5.15**$^{\otimes}$	**4.07**$^{\otimes}$	**2.44**$^{\otimes}$	**1.71****	.85	-.42	-.56
BA$\leftrightarrow$ DU	-1.25	1.46	1.15	1.11	-.46	-1.31	-1.31	-1.44	-2.02	-1.60	-1.76
KU$\leftrightarrow$ OM	-.40	-.88	-1.10	-1.41	-2.88	-2.71	-4.02	-2.82	-3.34	-4.15	-4.64
KU$\leftrightarrow$ QA	**6.58**$^{\otimes}$	**5.20**$^{\otimes}$	**4.04**$^{\otimes}$	**3.18**$^{\otimes}$	.13	-1.04	1.25	1.03	.48	-.28	**7.11**$^{\otimes}$
KU$\leftrightarrow$ SA	**12.39**$^{\otimes}$	**9.62**$^{\otimes}$	**9.31**$^{\otimes}$	**7.99**$^{\otimes}$	**3.19**$^{\otimes}$	**1.65****	.11	1.07	.65	-.11	-.65
KU$\leftrightarrow$ DU	-.28	-.66	-.90	-1.02	-1.09	**6.22**$^{\otimes}$	**6.12**$^{\otimes}$	**5.35**$^{\otimes}$	**4.60**$^{\otimes}$	**4.13**$^{\otimes}$	**3.92**$^{\otimes}$
OM$\leftrightarrow$ QA	**3.28**$^{\otimes}$	**7.13**$^{\otimes}$	**5.68**$^{\otimes}$	**8.17**$^{\otimes}$	**4.22**$^{\otimes}$	**4.10**$^{\otimes}$	**3.32**$^{\otimes}$	**2.50**$^{\otimes}$	**2.26****	1.46	.91
OM$\leftrightarrow$ SA	**25.66**$^{\otimes}$	**20.62**$^{\otimes}$	**17.81**$^{\otimes}$	**15.95**$^{\otimes}$	**7.65**$^{\otimes}$	**7.14**$^{\otimes}$	**5.17**$^{\otimes}$	**4.58**$^{\otimes}$	**4.08**$^{\otimes}$	**3.29**$^{\otimes}$	**2.97**$^{\otimes}$
OM$\leftrightarrow$ DU	**24.23**$^{\otimes}$	**19.26**$^{\otimes}$	**17.71**$^{\otimes}$	**15.76**$^{\otimes}$	**8.16**$^{\otimes}$	**6.81**$^{\otimes}$	**5.48**$^{\otimes}$	**5.06**$^{\otimes}$	**4.01**$^{\otimes}$	**3.80**$^{\otimes}$	**3.59**$^{\otimes}$
QA$\leftrightarrow$ SA	**11.59**$^{\otimes}$	**9.13**$^{\otimes}$	**7.77**$^{\otimes}$	**6.63**$^{\otimes}$	**2.12****	1.18	**4.44**$^{\otimes}$	**3.55**$^{\otimes}$	**5.31**$^{\otimes}$	**3.57**$^{\otimes}$	**3.20**$^{\otimes}$
QA$\leftrightarrow$ DU	**21.8**$^{\otimes}$	**17.42**$^{\otimes}$	**14.90**$^{\otimes}$	**12.91**$^{\otimes}$	**12.80**$^{\otimes}$	**9.75**$^{\otimes}$	**7.77**$^{\otimes}$	**6.40**$^{\otimes}$	**5.92**$^{\otimes}$	**4.94**$^{\otimes}$	**4.75**$^{\otimes}$
SA$\leftrightarrow$ DU	**28.14**$^{\otimes}$	**24.90**$^{\otimes}$	**21.88**$^{\otimes}$	**19.73**$^{\otimes}$	**9.34**$^{\otimes}$	**7.31**$^{\otimes}$	**4.81**$^{\otimes}$	**3.57**$^{\otimes}$	**2.94**$^{\otimes}$	1.13	.82

$**$ and $\otimes$ indicates significant at 5 and 1% levels, respectively

TABLE 2.10: Q_2 Two-way causality-in-variance between each pair of the GCC stock markets' general price indices.

Parameter	BA	KU	OM	QA	SA	Dubai
Panel (A)						
b_0	.00001	.0003	.0003	.0002	.00008	.00001
	(.25)	(.05)	(.04)	(.08)	(.73)	(.51)
b_1	.07	.008	.21	.13	.12	.02
	(.01)	(.71)	(.00)	(.00)	(.00)	(.44)
b_2		.008		.026	.059	.06
		(.74)		(.22)	(.07)	(.01)
b_3		.05			-.026	.008
		(.02)			(.39)	(.72)
b_4		-.02			.003	.044
		(.30)			(.90)	(.04)
b_5		.019			.07	.04
		(.44)			(.05)	(.08)
b_6		.01			-.06	.02
		(.51)			(.04)	(.35)
b_7					-.07	.03
					(.01)	(.15)
b_8					.05	.02
					(.13)	(.41)
Panel (B)						
ω	.0000029	.000003	.0000028	.000002	.000004	.0000004
	(.01)	(.00)	(.00)	(.00)	(.00)	(.00)
α	.06	.09	.14	.18	.11	.10
	(.00)	(.00)	(.00)	(.00)	(.00)	(.00)
β	.90	.883	.85	.83	.877	.88
	(.00)	(.00)	(.00)	(.00)	(.00)	(.00)
Sample size	2530	3314	4147	3676	3628	2271
Number of lags(p)	1	6	1	2	8	8

The numbers in parentheses are the p-values for the estimated coefficients.

TABLE 2.11: Quasi-maximum likelihood estimation of univariate GARCH (1,1) models for each GCC banking sector.

M	Kuwait	Oman	Qatar	Saudi Arabia	Dubai
1	**7.3**$^{\otimes}$	**4.6**$^{\otimes}$	-.62	-.68	-.67
2	**5.3**$^{\otimes}$	**5.6**$^{\otimes}$	-.55	**1.77****	-.43
3	**6.4**$^{\otimes}$	**7.1**$^{\otimes}$	**2.36**$^{\otimes}$	**1.79****	-.74
4	**5.2**$^{\otimes}$	**5.9**$^{\otimes}$	**2.46**$^{\otimes}$	**1.32***	-.88
5	**4.6**$^{\otimes}$	**5.01**$^{\otimes}$	**1.97****	1.15	-1.07
10	**2.56**$^{\otimes}$	**3.59**$^{\otimes}$	.73	-.09	-1.15
13	**1.88****	**3.5**$^{\otimes}$	.18	-.14	-1.51
14	**1.65****	**3.2**$^{\otimes}$	-.01	-.18	-1.64
15	**1.65****	**3.13**$^{\otimes}$	-.18	-.31	-1.74
20	**1.35***	**3.3**$^{\otimes}$	.14	-.62	-1.81
24	1.09	**2.85**$^{\otimes}$	.003	-1.12	-1.86
25	.89	**2.65**$^{\otimes}$	-.06	-1.08	-1.958
28	.70	**2.43**$^{\otimes}$	-.04	-.24	-1.79
36	**3.07**$^{\otimes}$	**1.82****	.40	-.17	-1.76
40	**2.82**$^{\otimes}$	**1.47***	.34	-.51	1.12
45	**2.74**$^{\otimes}$	.95	.37	-.14	.79
50	**2.37**$^{\otimes}$	1.1	.27	-.46	.33
70	**1.99****	.48	.67	.03	.34
80	**1.73****	.63	.60	.13	-.06
90	**1.80****	.32	.04	-.01	-.31
100	**1.54***	-.06	-.52	.0004	-.03
61	.38	-.54	**1.94****	**1.89****	-.13
65	.03	-.70	**1.95****	**1.60***	-.52
70	-.33	-1.10	**1.48***	1.06	-.97
74	-.59	-1.44	**2.00****	.71	-1.21
80	-.85	-1.81	**1.99****	.03	.55
90	-1.1	-1.79	**1.47***	-.71	.21
100	-1.3	-1.2	1.04	-.84	-.49

$*$,$**$ and $\otimes$ indicates significant at 10, 5, and 1% levels, respectively.

TABLE 2.12: Q_1 One-way test statistic for causality-in-variance between Bahrain banking sector and the other GCC banking sectors.

M	Bahrain	Oman	Qatar	Saudi Arabia	Dubai
1	.96	-.36	**1.60***	1.11	**2.79**$^{\otimes}$
2	.33	.27	.63	**2.67**$^{\otimes}$	**1.52***
3	1.04	.87	.18	**1.77****	.83
4	.54	.48	1.07	1.20	.47
5	.19	.71	**1.69****	.77	.12
10	.58	-.47	.66	.34	-.65
13	**2.10****	.45	1.10	.70	-.92
14	**1.84****	**1.76****	**1.68****	.60	-1.05
15	**1.60***	**1.79****	**1.47***	.44	-1.15
20	**1.79****	1.03	**2.87**$^{\otimes}$	.37	-.89
24	**1.55***	.72	**2.51**$^{\otimes}$	.60	-.95
25	**1.57***	.76	**2.33**$^{\otimes}$	.51	-1.07
28	**2.07****	.38	**2.24****	.68	-1.13
36	**2.05****	-.08	**1.80****	.68	-1.17
40	**1.72****	.15	**1.45***	.24	-1.04
45	**1.34***	-.27	1.11	-.24	-.86
50	**1.46***	-.66	**1.99****	-.007	-1.06
70	**2.99**$^{\otimes}$	.21	**1.54***	.63	.34
80	**2.34**$^{\otimes}$	-.14	**1.30***	.46	.001
90	**1.88****	.18	**3.03**$^{\otimes}$	.39	-.34
100	**1.56***	.09	**2.56**$^{\otimes}$	.49	-.13
61	.38	-.54	**1.94****	**1.89****	-.13
65	.03	-.70	**1.95****	**1.60***	-.52
70	-.33	-1.10	**1.48***	1.06	-.97
74	-.59	-1.44	**2.00****	.71	-1.21
80	-.85	-1.81	**1.99****	.03	.55
90	-1.1	-1.79	**1.47***	-.71	.21
100	-1.3	-1.2	1.04	-.84	-.49

$*$,$**$ and $\otimes$ indicates significant at 10, 5, and 1% levels, respectively.

TABLE 2.13: Q_1 One-way test statistic for causality-in-variance between Kuwait banking sector and the other GCC banking sectors.

M	Bahrain	Kuwait	Qatar	Saudi Arabia	Dubai
1	-.69	-.67	1.12	**2.72**$^{\otimes}$	**12.41**$^{\otimes}$
2	**3.29**$^{\otimes}$	-.95	.31	**1.58***	**8.34**$^{\otimes}$
3	**2.61**$^{\otimes}$	-1.15	-.05	.95	**6.82**$^{\otimes}$
4	**3.11**$^{\otimes}$	-1.26	-.27	.48	**5.57**$^{\otimes}$
5	**2.47**$^{\otimes}$	-1.05	-.45	.13	**6.30**$^{\otimes}$
10	**2.14****	-1.10	-.72	-.67	**4.08**$^{\otimes}$
13	**1.32***	-1.37	-.86	-1.01	**3.70**$^{\otimes}$
14	1.17	-1.44	-.64	-1.10	**3.60**$^{\otimes}$
15	1.07	-1.56	-.79	-1.23	**3.32**$^{\otimes}$
20	.55	-.88	-.96	-1.13	**2.51**$^{\otimes}$
24	.23	-1.25	-.74	-1.32	**2.10****
25	.13	-1.27	-.81	-1.41	**2.05****
28	-.02	-.99	.25	-1.66	**3.04**$^{\otimes}$
36	-.54	-1.18	**2.41**$^{\otimes}$	-2.26	**2.86**$^{\otimes}$
40	-.86	-1.50	**2.17****	-2.37	**4.09**$^{\otimes}$
45	-.96	-1.79	**1.68****	-2.63	**4.33**$^{\otimes}$
50	-.11	-2.11	1.14	-2.81	**3.90**$^{\otimes}$
70	-.09	-2.68	.60	-3.28	**5.08**$^{\otimes}$
80	-.03	-2.78	.46	-3.45	**5.33**$^{\otimes}$
90	.46	-2.52	.19	-3.85	**4.71**$^{\otimes}$
100	-.04	-2.31	.36	-3.92	**4.70**$^{\otimes}$
61	.38	-.54	**1.94****	**1.89****	-.13
65	.03	-.70	**1.95****	**1.60***	-.52
70	-.33	-1.10	**1.48***	1.06	-.97
74	-.59	-1.44	**2.00****	.71	-1.21
80	-.85	-1.81	**1.99****	.03	.55
90	-1.1	-1.79	**1.47***	-.71	.21
100	-1.3	-1.2	1.04	-.84	-.49

$*$,$**$ and $\otimes$ indicates significant at 10, 5, and 1% levels, respectively.

TABLE 2.14: Q_1 One-way test statistic for causality-in-variance between Oman banking sector and the other GCC banking sectors.

M	Bahrain	Kuwait	Oman	Saudi Arabia	Dubai
1	.07	**1.36***	.15	**2.82**⊗	-.65
2	1.04	.46	.75	**1.51***	-.93
3	**2.00****	**3.47**⊗	.32	.87	-1.15
4	**1.40***	**2.85**⊗	-.03	.59	-1.05
5	.94	**2.24****	-.19	.22	-.23
10	.23	**1.56***	**3.09**⊗	**2.55**⊗	-.61
13	-.11	1.05	**2.73**⊗	**1.78****	**2.18****
14	-.27	1.00	**2.46**⊗	**1.53***	**2.06****
15	-.25	.95	**2.20****	**1.33***	**1.86****
20	-.55	.23	**1.37***	.80	**1.38***
24	-.23	-.14	.76	**1.70****	**1.30***
25	-.009	-.23	.65	**2.52**⊗	1.18
28	.12	**1.38***	.33	**2.69**⊗	**1.34***
36	.62	.75	-.06	**2.42**⊗	.70
40	.61	.57	.55	**2.80**⊗	.57
45	.52	.05	.24	**2.57**⊗	.14
50	1.05	-.25	1.14	**2.16****	-.06
70	**1.45***	-.93	**2.96**⊗	**2.72**⊗	-.28
80	**2.24****	-.79	**3.00**⊗	**2.87**⊗	.42
90	**1.79****	-.73	**2.79**⊗	**2.53**⊗	.06
100	**2.68**⊗	-1.15	**3.39**⊗	**2.37**⊗	-.05
61	.38	-.54	**1.94****	**1.89****	-.13
65	.03	-.70	**1.95****	**1.60***	-.52
70	-.33	-1.10	**1.48***	1.06	-.97
74	-.59	-1.44	**2.00****	.71	-1.21
80	-.85	-1.81	**1.99****	.03	.55
90	-1.1	-1.79	**1.47***	-.71	.21
100	-1.3	-1.2	1.04	-.84	-.49

*,** and ⊗ indicates significant at 10, 5, and 1% levels, respectively.

TABLE 2.15: Q_1 One-way test statistic for causality-in-variance between Qatar banking sector and the other GCC banking sectors.

M	Bahrain	Kuwait	Oman	Qatar	Dubai
1	**4.48**$^{\otimes}$	**3.79**$^{\otimes}$	**11.55**$^{\otimes}$	**17.6**$^{\otimes}$	**2.88**$^{\otimes}$
2	**3.67**$^{\otimes}$	**2.53**$^{\otimes}$	**13.11**$^{\otimes}$	**12.5**$^{\otimes}$	**1.90****
3	**2.62**$^{\otimes}$	**1.92****	**10.30**$^{\otimes}$	**11.07**$^{\otimes}$	**2.23****
4	**2.10***	**3.10**$^{\otimes}$	**8.67**$^{\otimes}$	**10.78**$^{\otimes}$	**1.83****
5	**1.60***	**3.54**$^{\otimes}$	**7.58**$^{\otimes}$	**9.51**$^{\otimes}$	**2.00****
10	.88	**2.46**$^{\otimes}$	**4.56**$^{\otimes}$	**7.89**$^{\otimes}$	.52
13	.42	**4.06**$^{\otimes}$	**4.38**$^{\otimes}$	**6.80**$^{\otimes}$	.19
14	.31	**3.74**$^{\otimes}$	**4.03**$^{\otimes}$	**6.46**$^{\otimes}$	.07
15	.13	**3.44**$^{\otimes}$	**3.72**$^{\otimes}$	**6.62**$^{\otimes}$	-.10
20	.93	**3.29**$^{\otimes}$	**2.49**$^{\otimes}$	**6.65**$^{\otimes}$	.40
24	**1.51***	**4.75**$^{\otimes}$	**2.23****	**8.29**$^{\otimes}$	-.12
25	**1.39***	**4.52**$^{\otimes}$	**2.07****	**8.14**$^{\otimes}$	-.25
28	1.14	**5.90**$^{\otimes}$	**1.59***	**7.75**$^{\otimes}$	-.36
36	**2.22****	**5.11**$^{\otimes}$	1.10	**7.03**$^{\otimes}$	-.04
40	**2.17****	**4.51**$^{\otimes}$	.72	**6.79**$^{\otimes}$	.10
45	**2.35**$^{\otimes}$	**4.10**$^{\otimes}$	.28	**6.85**$^{\otimes}$	.59
50	**1.77****	**3.83**$^{\otimes}$	**1.65****	**7.22**$^{\otimes}$	.55
70	**2.14****	**3.08**$^{\otimes}$	1.10	**7.63**$^{\otimes}$	.96
80	**1.68****	**2.69**$^{\otimes}$	.50	**6.69**$^{\otimes}$	.65
90	1.24	**2.33**$^{\otimes}$	-.10	**6.02**$^{\otimes}$	.24
100	.76	**3.29**$^{\otimes}$	-.66	**2.37**$^{\otimes}$	.29
61	.38	-.54	**1.94****	**1.89****	-.13
65	.03	-.70	**1.95****	**1.60***	-.52
70	-.33	-1.10	**1.48***	1.06	-.97
74	-.59	-1.44	**2.00****	.71	-1.21
80	-.85	-1.81	**1.99****	.03	.55
90	-1.1	-1.79	**1.47***	-.71	.21
100	-1.3	-1.2	1.04	-.84	-.49

$*$,$**$ and $\otimes$ indicates significant at 10, 5, and 1% levels, respectively.

TABLE 2.16: Q_1 One-way test statistic for causality-in-variance between Saudi Arabia banking sector and the other GCC banking sectors.

M	Bahrain	Kuwait	Oman	Qatar	Saudi Arabia
1	-.34	**4.46**$^{\otimes}$	-.24	**2.54**$^{\otimes}$	**5.04**$^{\otimes}$
2	-.001	**3.41**$^{\otimes}$	.50	**3.10**$^{\otimes}$	**3.44**$^{\otimes}$
3	-.05	**2.39**$^{\otimes}$	.53	**2.13****	**6.73**$^{\otimes}$
4	-.38	**1.98****	**2.25****	**1.66****	**5.50**$^{\otimes}$
5	-.61	**1.61***	**3.78**$^{\otimes}$	**2.74**$^{\otimes}$	**6.26**$^{\otimes}$
10	**1.41***	.76	**8.35**$^{\otimes}$	**2.01****	**4.06**$^{\otimes}$
13	1.04	.14	**7.36**$^{\otimes}$	**1.71****	**3.41**$^{\otimes}$
14	.84	.39	**6.94**$^{\otimes}$	**1.49***	**3.10**$^{\otimes}$
15	.78	.27	**6.64**$^{\otimes}$	**1.40***	**2.85**$^{\otimes}$
20	**2.51**$^{\otimes}$	.16	**5.84**$^{\otimes}$	1.00	**2.15****
24	**2.14****	.33	**5.08**$^{\otimes}$	.48	**2.53**$^{\otimes}$
25	**2.12****	.63	**4.84**$^{\otimes}$	.34	**2.45**$^{\otimes}$
28	**1.76****	.76	**4.35**$^{\otimes}$	-.01	**2.72**$^{\otimes}$
36	1.00	.33	**4.61**$^{\otimes}$	-.08	**3.07**$^{\otimes}$
40	.91	.33	**4.58**$^{\otimes}$	-.11	**2.61**$^{\otimes}$
45	.48	.20	**4.16**$^{\otimes}$	-.31	**2.64**$^{\otimes}$
50	.04	.50	**3.70**$^{\otimes}$	-.28	**2.42**$^{\otimes}$
70	-.16	.49	**5.52**$^{\otimes}$	.20	**1.41***
80	.32	.20	**5.42**$^{\otimes}$	.53	**3.04**$^{\otimes}$
90	**1.98****	1.09	**4.70**$^{\otimes}$	.23	**2.45**$^{\otimes}$
100	**1.51***	.58	**4.17**$^{\otimes}$	.11	**2.50**$^{\otimes}$
61	.38	-.54	**1.94****	**1.89****	-.13
65	.03	-.70	**1.95****	**1.60***	-.52
70	-.33	-1.10	**1.48***	1.06	-.97
74	-.59	-1.44	**2.00****	.71	-1.21
80	-.85	-1.81	**1.99****	.03	.55
90	-1.1	-1.79	**1.47***	-.71	.21
100	-1.3	-1.2	1.04	-.84	-.49

$*$,$**$ and $\otimes$ indicates significant at 10, 5, and 1% levels, respectively.

TABLE 2.17: Q_1 One-way test statistic for causality-in-variance between Dubai banking sector and the other GCC banking sectors.

$M\rightarrow$ COUNTRY $\downarrow$	2	3	4	5	13	14	15	60	80	90	100
BA$\leftrightarrow$ *KU*	**3.98**$^{\otimes}$	**5.26**$^{\otimes}$	**4.06**$^{\otimes}$	**3.44**$^{\otimes}$	**2.82**$^{\otimes}$	**2.46**$^{\otimes}$	**2.30****	**3.77**$^{\otimes}$	**2.88**$^{\otimes}$	**2.60**$^{\otimes}$	**2.19****
BA$\leftrightarrow$ *OM*	**6.2**$^{\otimes}$	**6.9**$^{\otimes}$	**6.4**$^{\otimes}$	**5.2**$^{\otimes}$	**3.4**$^{\otimes}$	**3.1**$^{\otimes}$	**2.9**$^{\otimes}$	.92	.42	.55	-.08
BA$\leftrightarrow$ *QA*	.34	**3.08**$^{\otimes}$	**2.73**$^{\otimes}$	**2.06****	.04	-.20	-.31	1.14	**2.01****	**1.30***	**1.52***
BA$\leftrightarrow$ *SA*	**3.85**$^{\otimes}$	**3.12**$^{\otimes}$	**2.42**$^{\otimes}$	**1.95****	.19	.09	-.13	**1.52***	**1.28***	.86	.54
BA$\leftrightarrow$ *DU*	-.30	-.56	-.89	-1.19	-.33	-.56	-.67	.44	.18	1.17	1.04
KU$\leftrightarrow$ *OM*	-.47	-.20	-.55	-.24	-.65	.23	.15	-1.30	-2.07	-1.66	-1.56
KU$\leftrightarrow$ *QA*	.77	**2.58**$^{\otimes}$	**2.77**$^{\otimes}$	**2.78**$^{\otimes}$	**1.52***	**1.90****	**1.71****	.69	.36	**1.62***	.99
KU$\leftrightarrow$ *SA*	**3.67**$^{\otimes}$	**2.61**$^{\otimes}$	**3.04**$^{\otimes}$	**3.06**$^{\otimes}$	**3.37**$^{\otimes}$	**3.08**$^{\otimes}$	**2.75**$^{\otimes}$	**3.41**$^{\otimes}$	**2.23****	**1.92****	**2.68**$^{\otimes}$
KU$\leftrightarrow$ *DU*	**3.49**$^{\otimes}$	**2.28****	**1.74****	1.22	-.55	-.46	-.62	.64	.14	.52	.31
OM$\leftrightarrow$ *QA*	.75	.19	-.21	-.46	**1.31***	**1.28***	.99	**2.33**$^{\otimes}$	**2.45**$^{\otimes}$	**2.11****	**2.65**$^{\otimes}$
OM$\leftrightarrow$ *SA*	**10.39**$^{\otimes}$	**7.96**$^{\otimes}$	**6.47**$^{\otimes}$	**5.45**$^{\otimes}$	**2.37**$^{\otimes}$	**2.07****	**1.75****	-.92	-2.08	-2.80	-3.24
OM$\leftrightarrow$ *DU*	**6.25**$^{\otimes}$	**5.2**$^{\otimes}$	**5.5**$^{\otimes}$	**7.13**$^{\otimes}$	**7.82**$^{\otimes}$	**7.45**$^{\otimes}$	**7.05**$^{\otimes}$	**4.99**$^{\otimes}$	**7.60**$^{\otimes}$	**6.66**$^{\otimes}$	**6.28**$^{\otimes}$
QA$\leftrightarrow$ *SA*	**9.94**$^{\otimes}$	**8.45**$^{\otimes}$	**8.05**$^{\otimes}$	**6.88**$^{\otimes}$	**6.06**$^{\otimes}$	**5.56**$^{\otimes}$	**5.62**$^{\otimes}$	**6.89**$^{\otimes}$	**6.76**$^{\otimes}$	**6.05**$^{\otimes}$	**5.73**$^{\otimes}$
QA$\leftrightarrow$ *DU*	**1.44***	.62	.37	**1.33***	**2.20****	**1.98****	**1.71****	.27	.75	.44	.36
SA$\leftrightarrow$ *DU*	**3.78**$^{\otimes}$	**6.34**$^{\otimes}$	**5.19**$^{\otimes}$	**5.84**$^{\otimes}$	**2.55**$^{\otimes}$	**2.24****	**1.94****	**1.73****	**2.61**$^{\otimes}$	**1.90****	**1.97****

$**$ and $\otimes$ indicates significant at 5 and 1% levels, respectively.

TABLE 2.18: Q_2 Two-way causality-in-variance between each pair of the GCC banking sectors.

Parameter	BA	KU	OM	QA	SA
Panel (A)					
b_0	-.0002	-.00009	.0003	.0003	.0005
	(.02)	(.83)	(.02)	(.18)	(.11)
b_1	-.02	.05	.21	.10	.06
	(.71)	(.07)	(.00)	(.00)	(.03)
b_2	.06	.02	.02	.02	.09
	(.36)	(.29)	(.36)	(.38)	(.01)
b_3	-.11		-.00		-.018
	(.04)		(.99)		(.63)
b_4	.07		.02		
	(.09)		(.28)		
b_5	-.01		.04		
	(.69)		(.09)		
b_6	-.01				
	(.66)				
b_7	-.00				
	(.96)				
b_8	.01				
	(.55)				
Panel (B)					
ω	.000008	.000001	.000001	.000046	.000005
	(.00)	(.06)	(.00)	(.00)	(.03)
α	.33	.12	.12	.13	.12
	(.00)	(.00)	(.00)	(.00)	(.00)
β	.62	.828	.876	.86	.87
	(.00)	(.00)	(.00)	(.00)	(.00)
Sample size	2530	3314	4147	3676	3628
2271					
Number of lags(p)	8	2	5	2	3

The numbers in parentheses are the p-values for the estimated coefficients.

TABLE 2.19: Quasi-maximum likelihood estimation of univariate GARCH (1,1) models for each GCC industrial sector.

M	Kuwait	Oman	Qatar	Saudi Arabia
1	-.65	-.57	**4.04**$^{\otimes}$	-.44
2	-.71	-.90	**2.91**$^{\otimes}$	-.29
3	-.98	-1.10	**2.10****	-.63
4	-1.19	-1.28	**1.53***	-.70
10	-1.89	-1.79	.52	-1.38
11	-2.01	-1.82	.48	-1.42
20	-2.64	-.66	**6.42**$^{\otimes}$	-2.16
25	-2.99	-1.12	**5.54**$^{\otimes}$	**2.00****
30	-3.23	-1.42	**4.82**$^{\otimes}$	**1.30***
40	-3.70	-2.00	**3.27**$^{\otimes}$	.22
60	-4.54	-2.66	**2.22****	**3.22**$^{\otimes}$
80	-5.20	-1.16	1.15	**2.00****
90	-5.54	-.79	.71	**1.37***
100	-5.80	-1.17	.63	.82

$*$,$**$ and $\otimes$ indicates significant at 10, 5, and 1% levels, respectively.

TABLE 2.20: Q_1 One-way test statistic for causality-in-variance between Bahrain industrial sector and the other GCC industrial sectors.

M	Bahrain	Oman	Qatar	Saudi Arabia
1	-.63	-.63	-.60	-.69
2	-.74	-.88	-.90	-.96
3	**4.44**$^{\otimes}$	-1.02	-.97	-1.15
4	**3.61**$^{\otimes}$	-1.16	-1.05	-1.24
10	1.10	-1.73	-1.54	-1.43
11	.85	-1.83	-1.69	-1.28
20	-.55	-2.22	-2.29	-1.77
25	-1.13	-2.62	-2.13	-2.06
30	-1.59	-2.46	-2.34	-1.95
40	-2.36	-2.96	-2.07	-2.18
60	-2.91	-3.12	-2.87	**3.17**$^{\otimes}$
80	-3.74	-3.60	-2.49	**2.53**$^{\otimes}$
90	-4.12	-3.55	-2.91	**2.24****
100	-4.46	-3.90	-2.36	**2.24****

$*$,$**$ and $\otimes$ indicates significant at 10, 5, and 1% levels, respectively.

Table 2.21: Q_1 One-way test statistic for causality-in-variance between Kuwait industrial sector and the other GCC industrial sectors.

M	Bahrain	Kuwait	Qatar	Saudi Arabia
1	-.70	-.61	-.21	**2.32**$^{\otimes}$
2	-.30	-.91	**2.54**$^{\otimes}$	1.20
3	.24	-1.11	**1.66****	.59
4	-.03	-.59	1.16	**1.28***
10	-.90	.24	**3.76**$^{\otimes}$	.27
11	-1.06	.11	**3.41**$^{\otimes}$	.73
20	-.97	.42	**2.24****	-.21
25	-1.29	.43	**2.14****	-.34
30	-1.56	-.16	**2.06****	-.58
40	.44	-1.04	1.27	-.63
60	-.73	-1.65	.43	-1.78
80	**1.37***	-1.15	-.09	-2.44
90	.95	**20.31**$^{\otimes}$	-.14	-2.09
100	**1.58***	**18.74**$^{\otimes}$	-.31	-1.57

$*$,$**$ and $\otimes$ indicates significant at 10, 5, and 1% levels, respectively.

Table 2.22: Q_1 One-way test statistic for causality-in-variance between Oman industrial sector and the other GCC industrial sectors.

M	Bahrain	Kuwait	Oman	Saudi Arabia
1	-.69	-.60	-.59	-.05
2	-.93	-.86	1.07	-.35
3	-.56	-.81	.57	-.64
4	-.83	-.57	**1.37***	-.84
10	-1.55	-1.35	.16	**2.81**$^{\otimes}$
11	-1.63	-1.42	**1.80****	**2.52**$^{\otimes}$
20	-2.22	.28	.72	.73
25	-2.59	.83	.45	.87
30	-2.60	.29	.64	.29
40	-2.51	-.51	**3.18**$^{\otimes}$	.94
60	**2.29****	-.63	**2.17****	.27
80	**1.31***	**5.17**$^{\otimes}$	**1.65****	-.48
90	**1.28***	**4.27**$^{\otimes}$	**2.20****	-.11
100	.86	**3.70**$^{\otimes}$	**2.20****	-.24

$*$,$**$ and $\otimes$ indicates significant at 10, 5, and 1% levels, respectively.

Table 2.23: Q_1 One-way test statistic for causality-in-variance between Qatar industrial sector and the other GCC industrial sectors.

M	Bahrain	Kuwait	Oman	Qatar
1	-.34	**5.30**$^{\otimes}$	**73.9**$^{\otimes}$	**22.4**$^{\otimes}$
2	-.49	**4.17**$^{\otimes}$	**64.2**$^{\otimes}$	**16.9**$^{\otimes}$
3	-.78	**3.16**$^{\otimes}$	**52.8**$^{\otimes}$	**13.9**$^{\otimes}$
4	-.89	**2.48**$^{\otimes}$	**45.4**$^{\otimes}$	**11.8**$^{\otimes}$
10	-1.55	.48	**28.7**$^{\otimes}$	**6.57**$^{\otimes}$
11	-1.64	.37	**27.4**$^{\otimes}$	**6.11**$^{\otimes}$
20	-2.22	**2.43**$^{\otimes}$	**21.6**$^{\otimes}$	**3.69**$^{\otimes}$
25	-2.49	**2.86**$^{\otimes}$	**22.4**$^{\otimes}$	**5.12**$^{\otimes}$
30	-2.86	**2.59**$^{\otimes}$	**19.9**$^{\otimes}$	**4.13**$^{\otimes}$
40	-2.42	**1.67****	**16.6**$^{\otimes}$	**2.87**$^{\otimes}$
60	-2.22	**3.80**$^{\otimes}$	**12.7**$^{\otimes}$	**1.60***
80	-2.80	**4.15**$^{\otimes}$	**10.5**$^{\otimes}$	.89
90	-3.1	**3.51**$^{\otimes}$	**9.8**$^{\otimes}$	.71
100	-2.28	**3.05**$^{\otimes}$	**8.88**$^{\otimes}$	.43

$*$,$**$ and $\otimes$ indicates significant at 10, 5, and 1% levels, respectively.

TABLE 2.24: Q_1 One-way test statistic for causality-in-variance between Saudi-Arabia industrial sector and the other GCC industrial sectors.

$M \rightarrow$ COUNTRY $\downarrow$	5	10	20	30	60	70	90	100
BA$\leftrightarrow$ *KU*	1.11	-.56	-2.26	-3.41	-5.27	-5.88	-6.38	-7.25
BA$\leftrightarrow$ *OM*	-1.10	-1.90	-1.16	-2.10	-2.40	-1.46	.11	.28
BA$\leftrightarrow$ *QA*	.23	-.72	**2.96**$^{\otimes}$	**1.57***	**3.19**$^{\otimes}$	**2.58**$^{\otimes}$	**1.41***	1.06
BA$\leftrightarrow$ *SA*	-1.32	-2.07	-3.10	-1.09	.70	.01	-1.22	-1.03
KU$\leftrightarrow$ *OM*	-1.48	-1.05	-1.27	-1.86	-3.38	-4.07	**11.8**$^{\otimes}$	**10.49**$^{\otimes}$
KU$\leftrightarrow$ *QA*	-1.21	-2.05	-1.42	-1.44	-2.48	-3.24	.96	.95
KU$\leftrightarrow$ *SA*	.49	-.67	.46	.45	**4.93**$^{\otimes}$	**4.19**$^{\otimes}$	**4.07**$^{\otimes}$	**3.77**$^{\otimes}$
OM$\leftrightarrow$ *QA*	1.21	**2.77**$^{\otimes}$	**2.09****	**1.91****	**1.84****	**1.52***	**1.45***	**1.33***
OM$\leftrightarrow$ *SA*	**29.7**$^{\otimes}$	**20.5**$^{\otimes}$	**15.1**$^{\otimes}$	**13.7**$^{\otimes}$	**7.73**$^{\otimes}$	**6.67**$^{\otimes}$	**5.45**$^{\otimes}$	**5.17**$^{\otimes}$
QA$\leftrightarrow$ *SA*	**6.97**$^{\otimes}$	**6.63**$^{\otimes}$	**3.13**$^{\otimes}$	**3.13**$^{\otimes}$	**1.33***	.70	.42	.13

** and $\otimes$ indicates significant at 5 and 1% levels, respectively.

TABLE 2.25: Q_2 Two-way causality-in-variance between each pair of the GCC industrial sectors.

Parameter	BA	KU	OM	QA	SA
Panel (A)					
b_0	-.00006	-.0009	.0002	.0007	-.0003
	(.67)	(.28)	(.03)	(.01)	(.50)
b_1	-.01	-.24	.21	.004	.1
	(.70)	(.01)	(.00)	(.85)	(.00)
b_2		-.07	.03		
		(.04)	(.18)		
b_3		-.14	.008		
		(.07)	(.74)		
b_4		-.09	.03		
		(.48)	(.13)		
b_5		.05	.01		
		(.72)	(.54)		
b_6		.009	.01		
		(.86)	(.67)		
b_7			-.002		
			(.92)		
b_8			.02		
			(.30)		
Panel (B)					
ω	.000007	.00001	.000001	.000006	.000009
	(.00)	(.00)	(.00)	(.00)	(.22)
α	.13	.17	.13	.11	.06
	(.00)	(.05)	(.00)	(.00)	(.00)
β	.75	.77	.86	.87	.92
	(.00)	(.00)	(.00)	(.00)	(.00)
Sample size	2530	3314	4147	3676	3628
2271					
Number of lags(p)	1	6	8	1	1

The numbers in parentheses are the p-values for the estimated coefficients.

TABLE 2.26: Quasi-maximum likelihood estimation of univariate GARCH (1,1) models for each GCC insurance sector.

M	Kuwait	Oman	Qatar	Saudi Arabia
4	-1.04	-.96	-.77	-1.15
5	-1.19	-1.12	-1.00	-.81
10	-.57	-1.22	-1.64	-1.52
15	.11	-1.85	-1.59	-2.10
20	**2.28****	-2.10	-2.06	-2.49
25	**1.51***	-1.96	-2.42	-2.39
60	**2.54**⊗	.87	-2.78	-2.69
75	1.23	.06	-2.35	-3.10
90	.17	-.33	-2.58	-3.11
100	-.41	-.33	-1.05	-3.34

∗,∗∗ and ⊗ indicates significant at 10, 5, and 1% levels, respectively.

Table 2.27: Q_1 One-way test statistic for causality-in-variance between Bahrain insurance sector and the other GCC insurance sectors.

M	Bahrain	Oman	Qatar	Saudi Arabia
4	-1.18	-1.15	-1.27	-1.33
5	-1.28	-1.34	-1.39	-1.49
10	-1.82	-1.99	-1.87	-2.03
15	-2.07	-2.44	-1.72	-2.37
20	-2.40	-2.79	.41	-2.70
25	-2.67	-3.15	-.10	-2.75
60	-3.52	-4.73	-1.17	-2.81
75	-3.66	-5.28	-1.50	-3.58
90	-3.92	-5.83	-2.27	-3.90
100	-4.35	-6.12	-2.78	-4.34

∗,∗∗ and ⊗ indicates significant at 10, 5, and 1% levels, respectively.

Table 2.28: Q_1 One-way test statistic for causality-in-variance between Kuwait insurance sector and the other GCC insurance sectors.

M	Bahrain	Kuwait	Qatar	Saudi Arabia
4	-.96	-1.15	-1.08	-.97
5	-1.14	-1.34	-.99	-1.15
10	-.85	-1.99	-1.57	-1.66
15	-.61	-2.44	-2.05	-2.00
20	-.82	-2.79	-2.10	-2.17
25	1.05	-3.15	-1.49	-2.54
60	-.37	-4.73	-2.45	-3.85
75	-.82	-5.28	-2.97	-4.29
90	-1.44	-5.83	-3.40	-4.39
100	-1.77	-6.12	-1.71	-4.61

$*$,$**$ and $\otimes$ indicates significant at 10, 5, and 1% levels, respectively.

TABLE 2.29: Q_1 One-way test statistic for causality-in-variance between Oman insurance sector and the other GCC insurance sectors.

M	Bahrain	Kuwait	Oman	Saudi Arabia
4	.60	-1.19	-.20	-.68
5	.22	-1.37	-.46	-.92
10	.13	**5.65**$^{\otimes}$	-1.22	-1.11
15	-.69	**3.88**$^{\otimes}$	-1.12	-1.70
20	-1.14	**3.39**$^{\otimes}$	-1.60	-2.05
25	-1.52	**2.43**$^{\otimes}$	-1.94	-2.64
60	-2.84	-.98	-2.25	-3.64
75	**1.81****	-1.97	-2.18	**12.04**$^{\otimes}$
90	1.02	-2.64	-2.35	**10.50**$^{\otimes}$
100	.76	-3.71	-2.79	**9.62**$^{\otimes}$

$*$,$**$ and $\otimes$ indicates significant at 10, 5, and 1% levels, respectively.

TABLE 2.30: Q_1 One-way test statistic for causality-in-variance between Qatar insurance sector and the other GCC insurance sectors.

M	Bahrain	Kuwait	Oman	Qatar
4	.06	-.94	**7.42**$^{\otimes}$	**3.36**$^{\otimes}$
5	-.25	-1.13	**5.78**$^{\otimes}$	**2.74**$^{\otimes}$
10	**3.26**$^{\otimes}$	-1.78	**4.00**$^{\otimes}$	1.01
15	**2.12****	-2.32	**2.82**$^{\otimes}$	.17
20	**1.41***	-2.41	**1.94****	-.17
25	.80	-2.78	**2.05****	-.65
60	.17	-4.24	-.91	-2.44
75	**2.97**$^{\otimes}$	-4.54	-1.97	-2.79
90	**2.64**$^{\otimes}$	-2.77	-2.21	-3.39
100	**2.90**$^{\otimes}$	-3.22	-2.48	-3.30

$*$,$**$ and $\otimes$ indicates significant at 10, 5, and 1% levels, respectively.

TABLE 2.31: Q_1 One-way test statistic for causality-in-variance between Saudi Arabia insurance sector and the other GCC insurance sectors.

$M\rightarrow$ COUNTRY $\downarrow$	1	20	30	60	80	100
BA$\leftrightarrow KU$	-.71	-1.69	-1.44	-.69	-2.14	-3.36
BA$\leftrightarrow OM$	-.97	-1.47	-.79	.35	-.75	-1.49
BA$\leftrightarrow QA$	-.75	-1.06	-3.23	-3.98	-.65	-.20
BA$\leftrightarrow SA$	-.80	1.23	-1.37	-1.78	-.37	-.31
KU$\leftrightarrow OM$	-.89	-2.80	-3.92	-5.75	-6.76	-7.62
KU$\leftrightarrow QA$	-.64	2.66^{**}	.72	-1.52	-2.86	-4.21
KU$\leftrightarrow SA$	-.83	-2.70	-4.24	-4.49	-6.05	-5.35
OM$\leftrightarrow QA$	.85	-1.98	-2.39	-3.33	-3.95	-3.19
OM$\leftrightarrow SA$	$10.1^{\otimes}$	-.159	-.83	-3.37	-4.18	-5.01
QA$\leftrightarrow SA$	.61	-1.57	-2.03	-4.30	$5.99^{\otimes}$	$4.47^{\otimes}$

$**$ and $\otimes$ indicates significant at 5 and 1% levels, respectively.

TABLE 2.32: Q_2 Two-way causality-in-variance between each pair of the GCC insurance sectors.

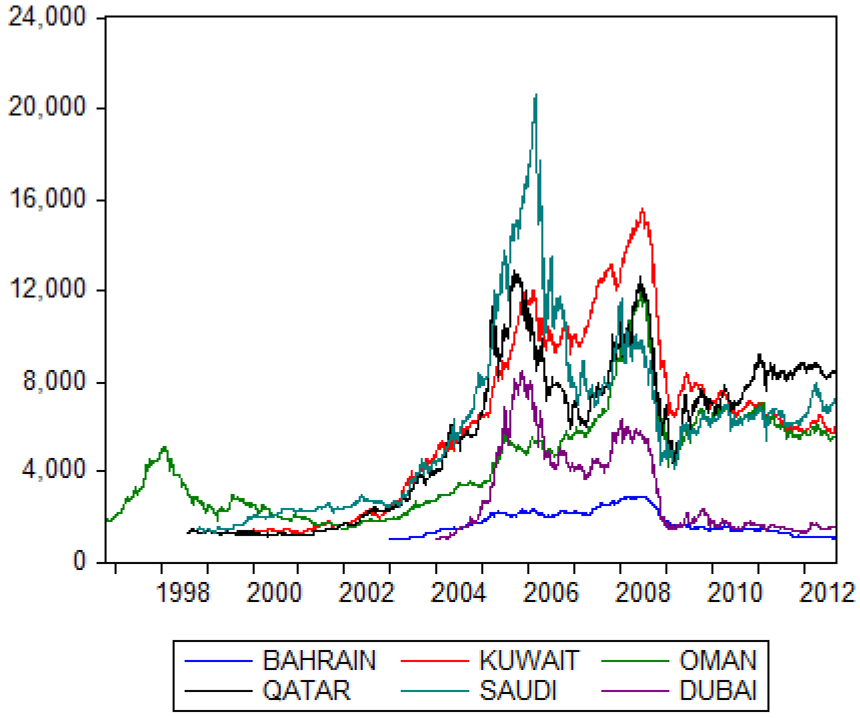

FIGURE 2.1: Daily observations of closing price of the GCC stock markets indices.

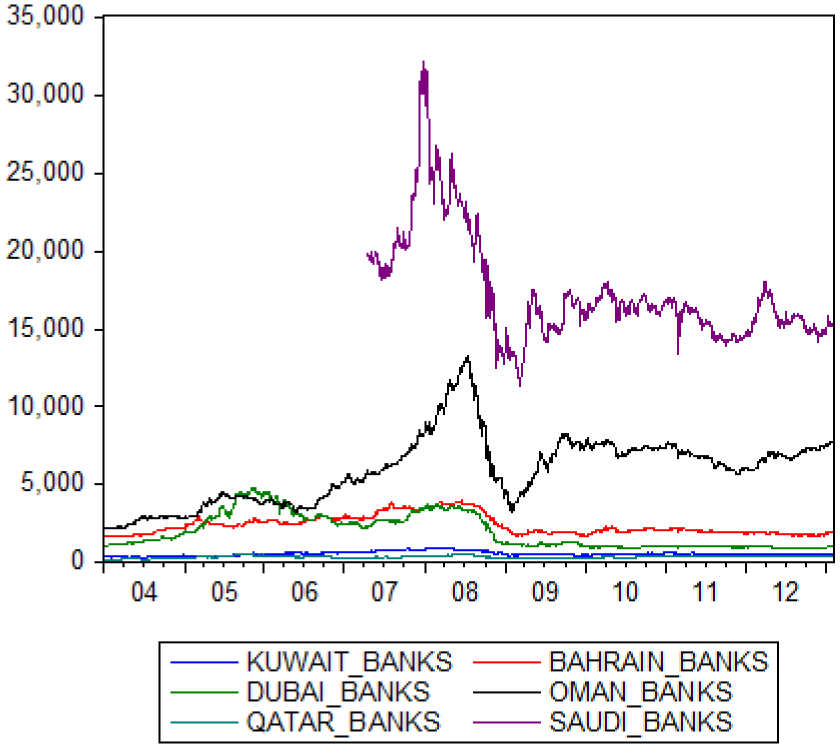

FIGURE 2.2: Daily observations of closing price of the GCC stock markets banking sectors indices.

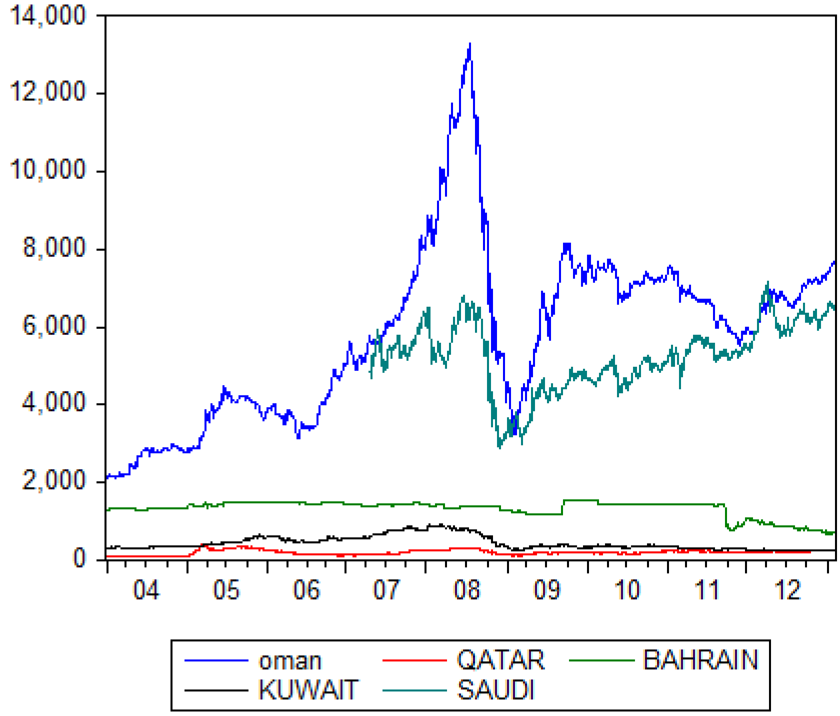

Figure 2.3: Daily observations of closing price of the GCC stock markets industrial sectors indices.

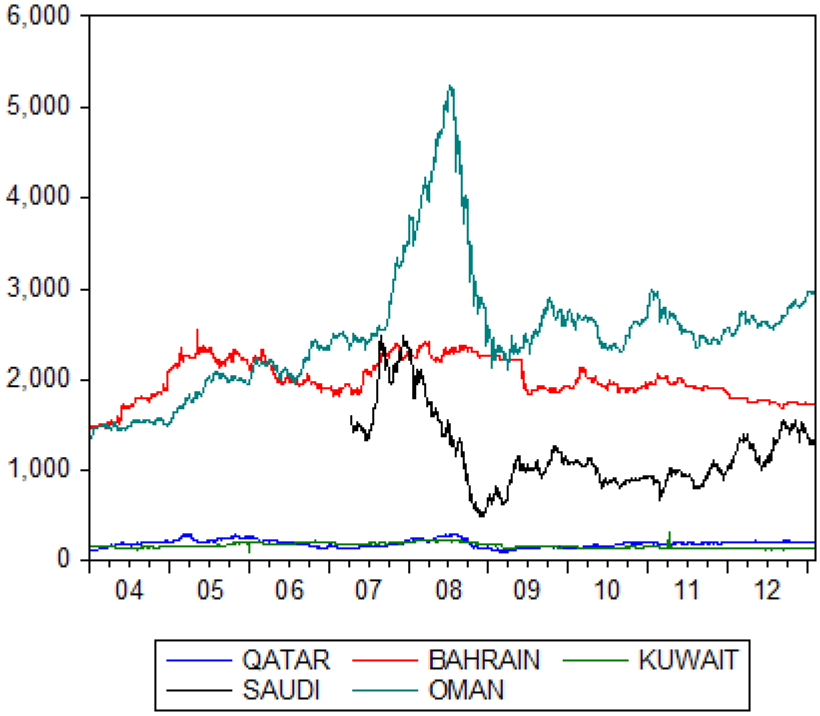

FIGURE 2.4: Daily observations of closing price of the GCC stock markets insurance sectors indices.

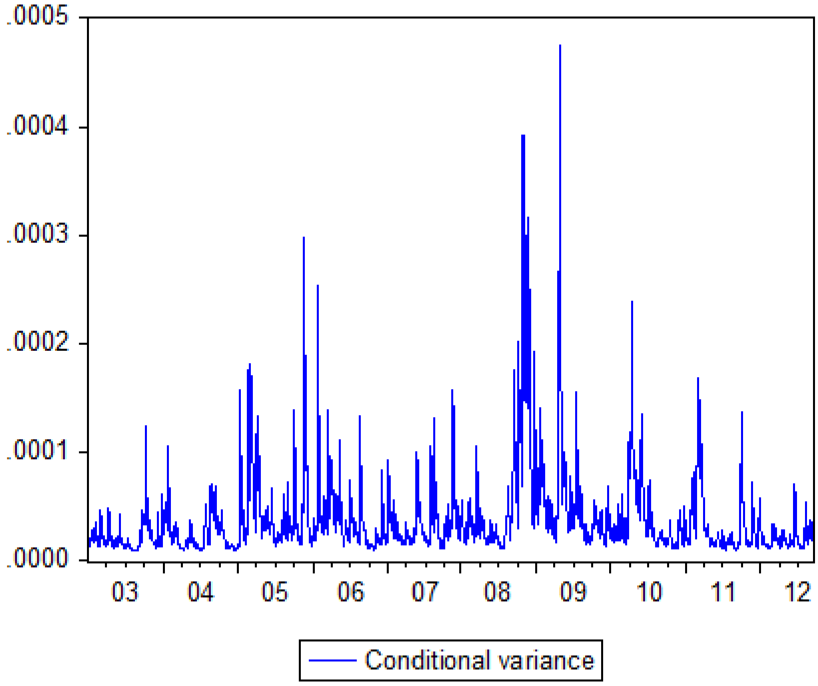

FIGURE 2.5: Bahrain stock market GARCH (1,1).

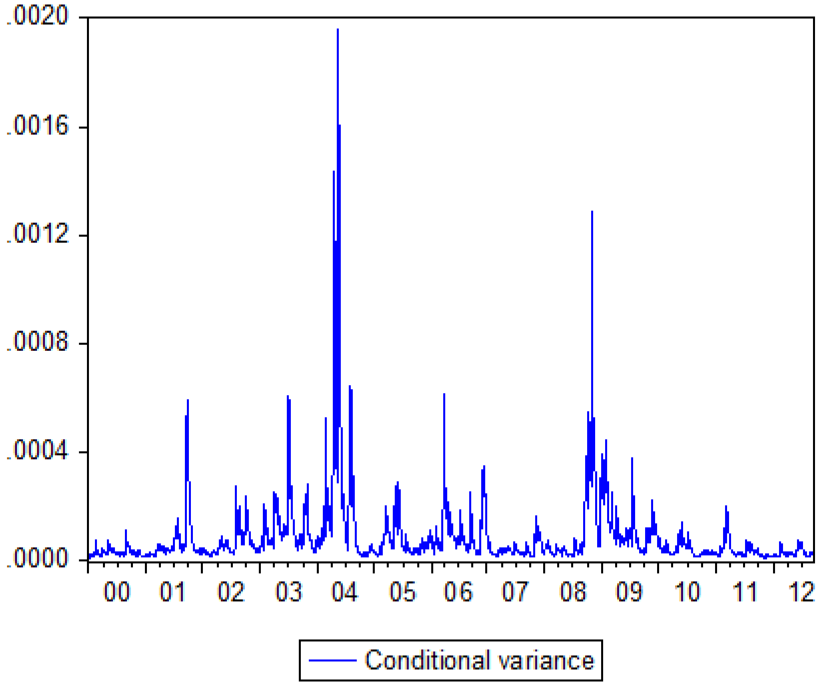

FIGURE 2.6: Kuwait stock market GARCH (1,1).

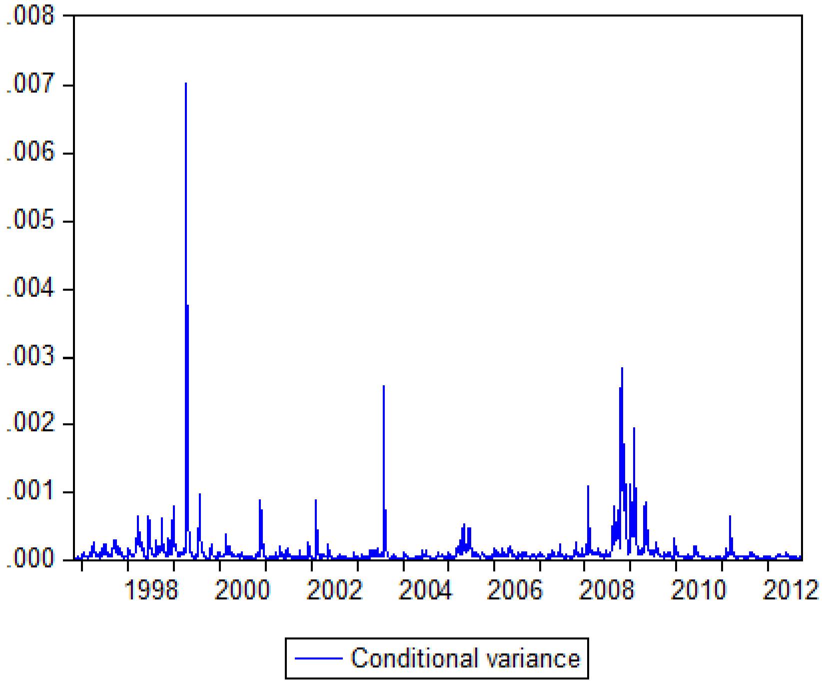

FIGURE 2.7: Oman stock market GARCH (1,1).

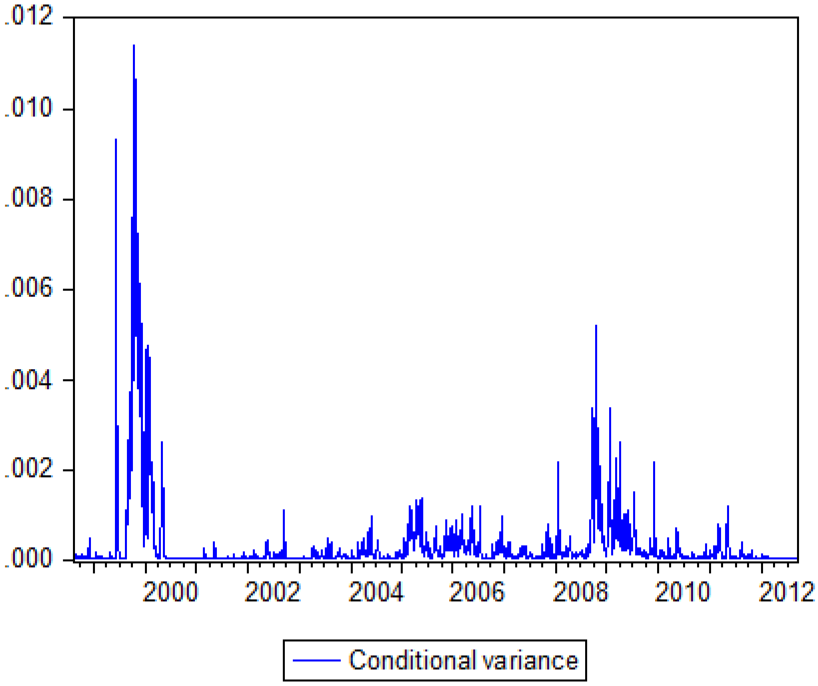

FIGURE 2.8: Qatar stock market GARCH (1,1).

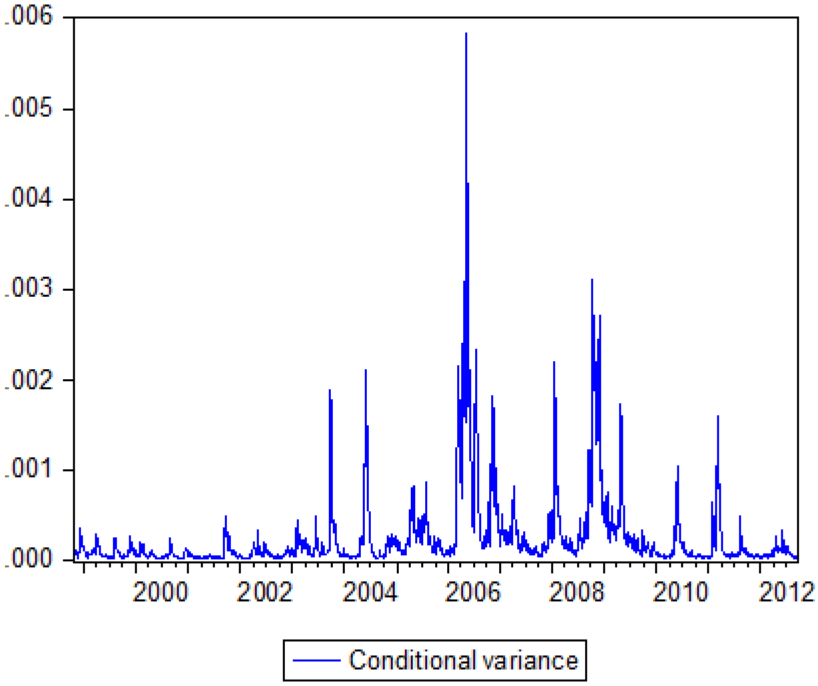

FIGURE 2.9: Saudi-Arabia stock market GARCH (1,1).

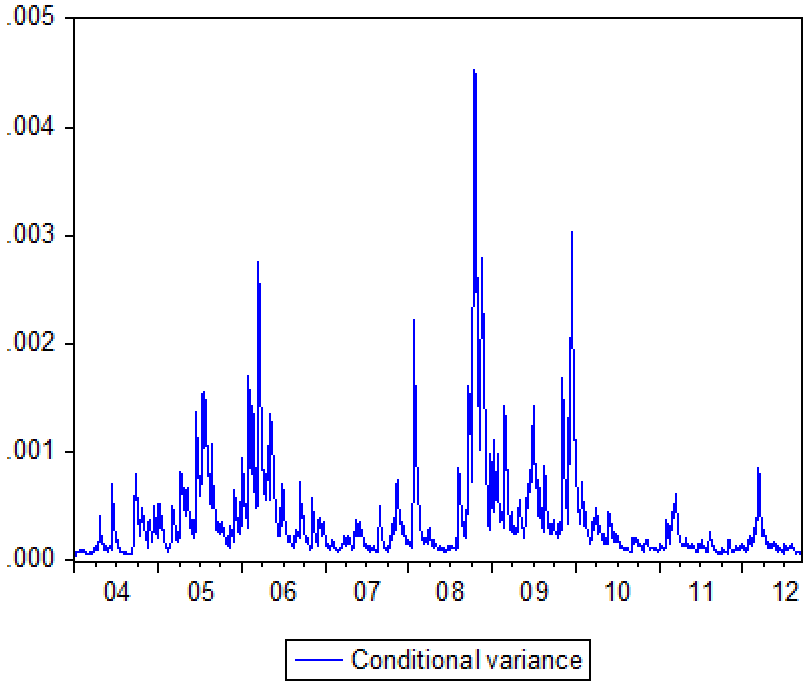

Figure 2.10: Dubai stock market GARCH (1,1).

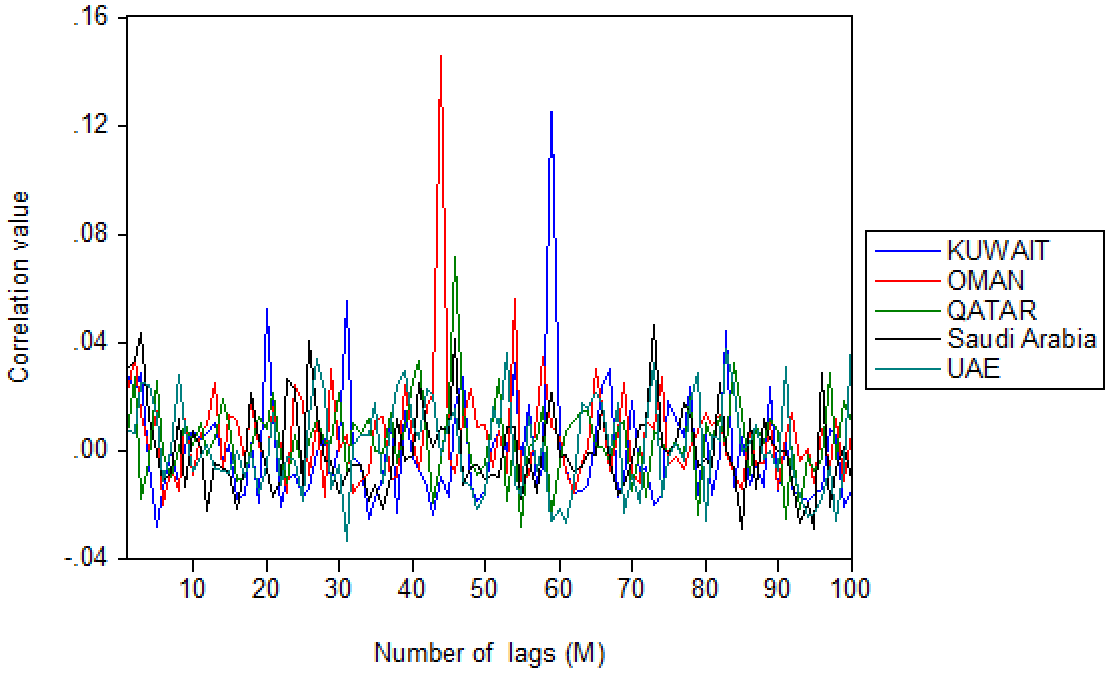

Figure 2.11: Correlation between Bahrain's stock market past shocks and the other GCC stock markets' current shocks.

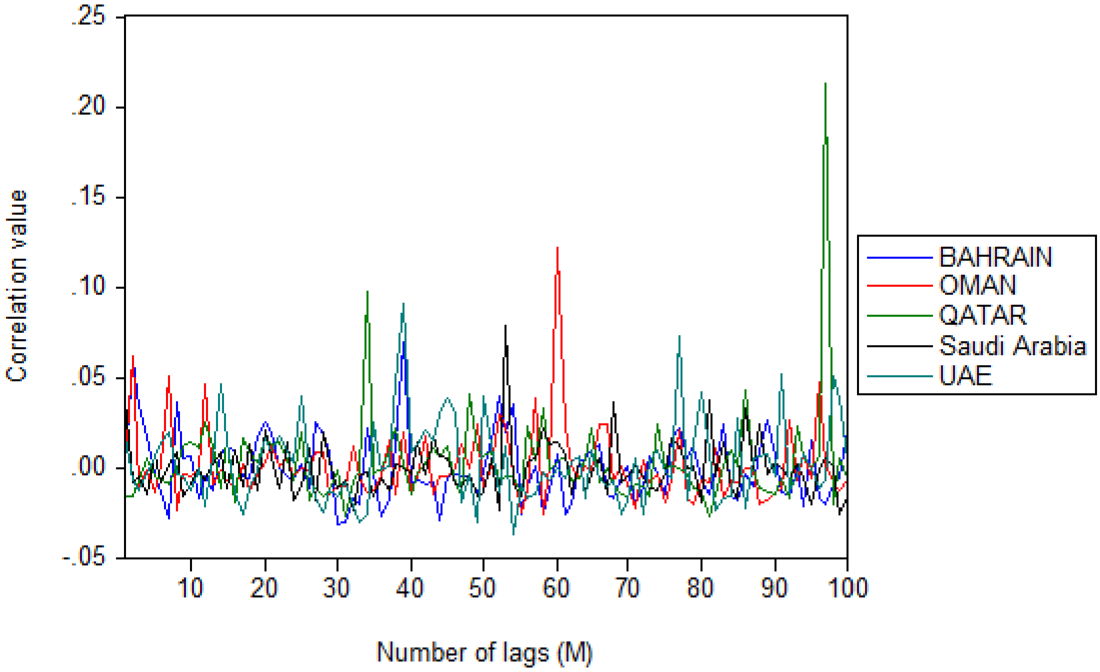

FIGURE 2.12: Correlation between Kuwait's stock market past shocks and the other GCC stock markets' current shocks.

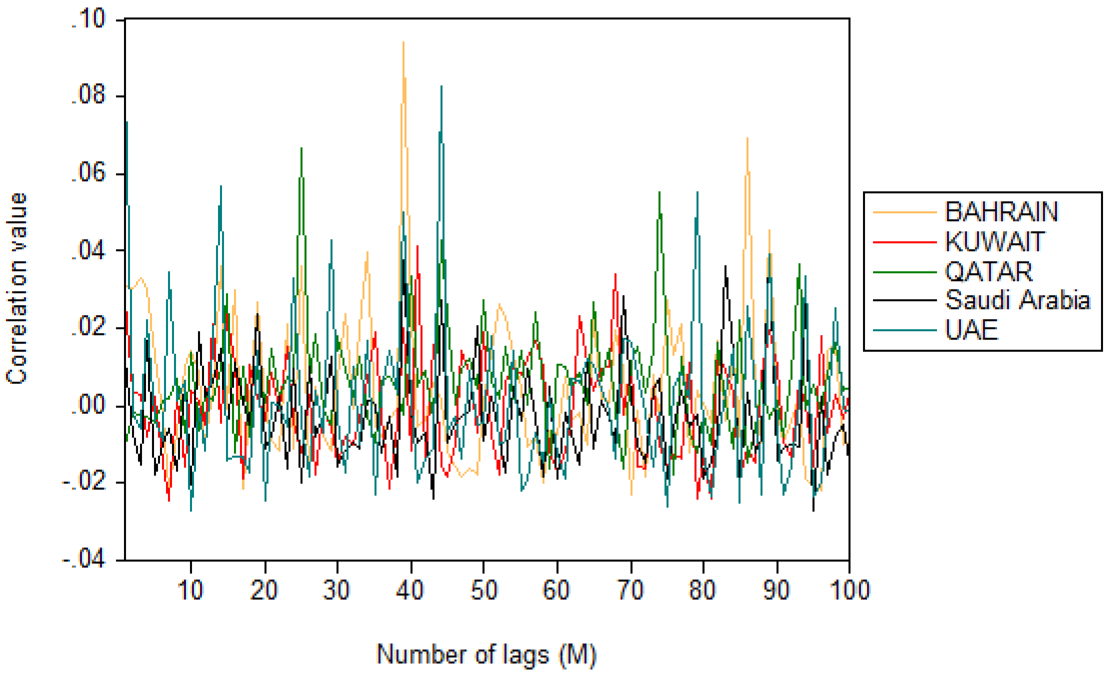

FIGURE 2.13: Correlation between Oman's stock market past shocks and the other GCC stock markets' current shocks.

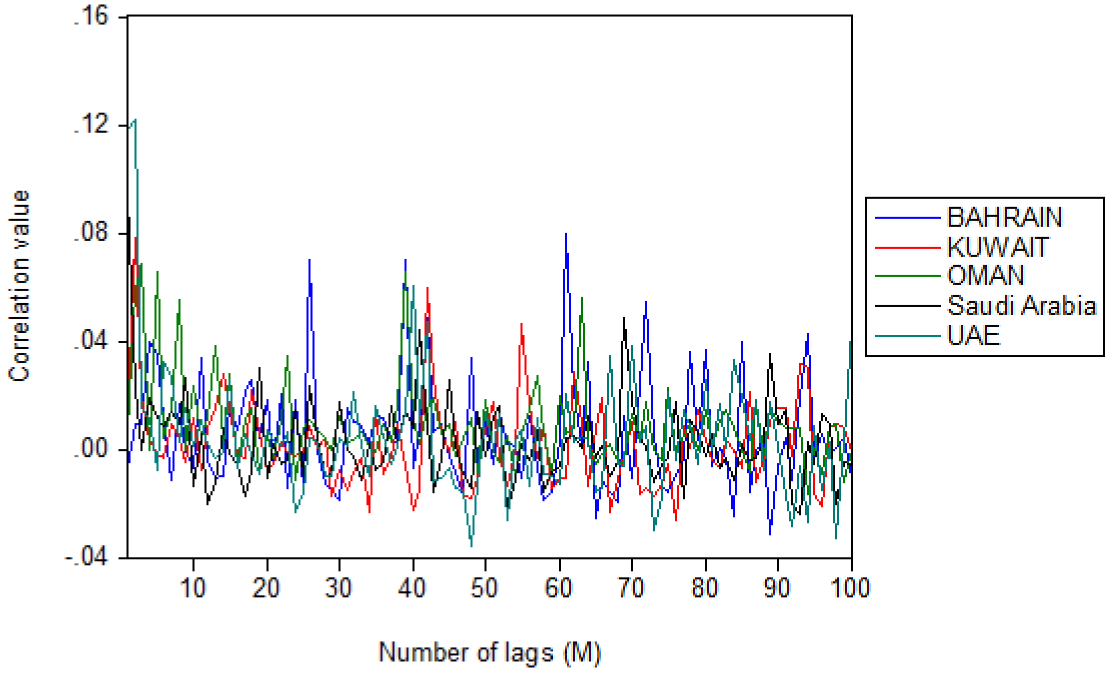

Figure 2.14: Correlation between Qatar's stock market past shocks and the other GCC stock markets' current shocks.

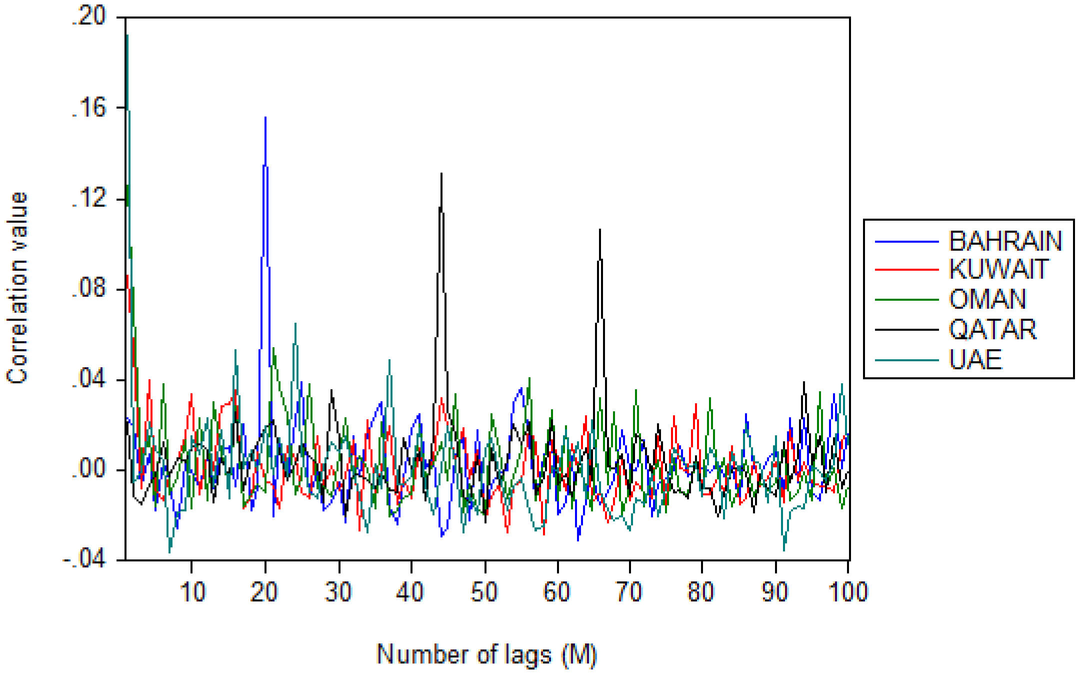

Figure 2.15: Correlation between Saudi-Arabia's stock market past shocks and the other GCC stock markets' current shocks.

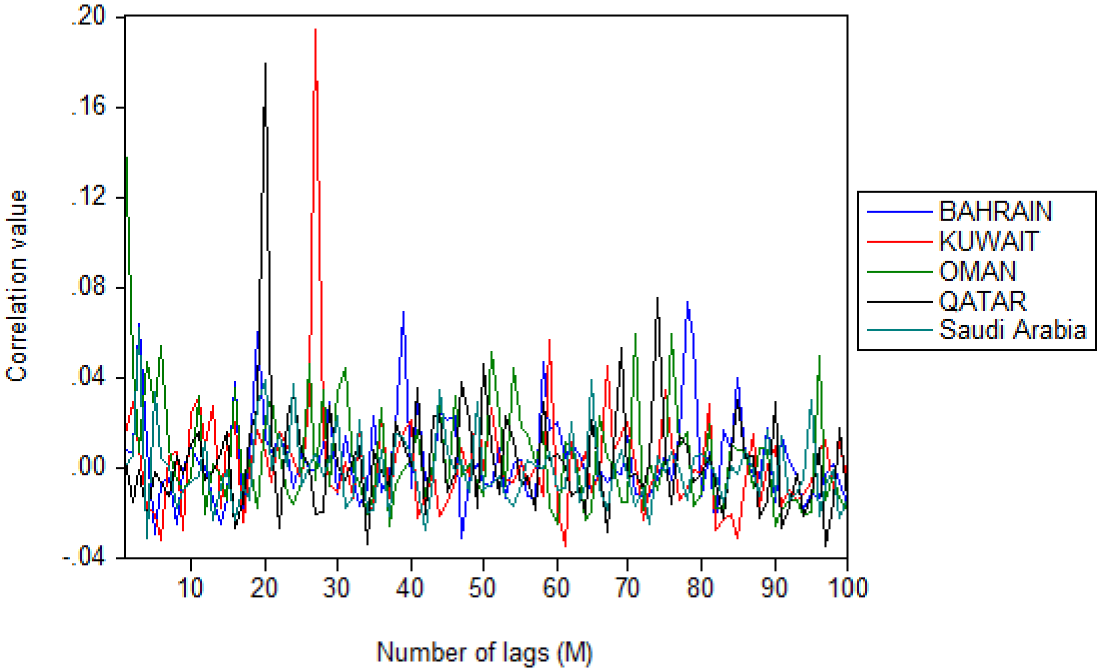

FIGURE 2.16: Correlation between Dubai's stock market past shocks and the other GCC stock markets' current shocks.

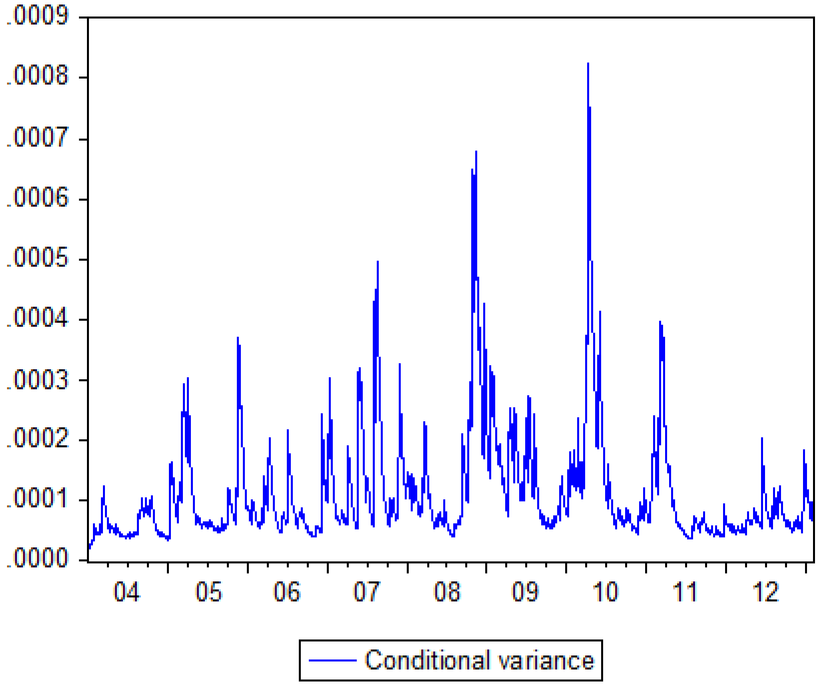

FIGURE 2.17: Bahrain banking sector GARCH (1,1).

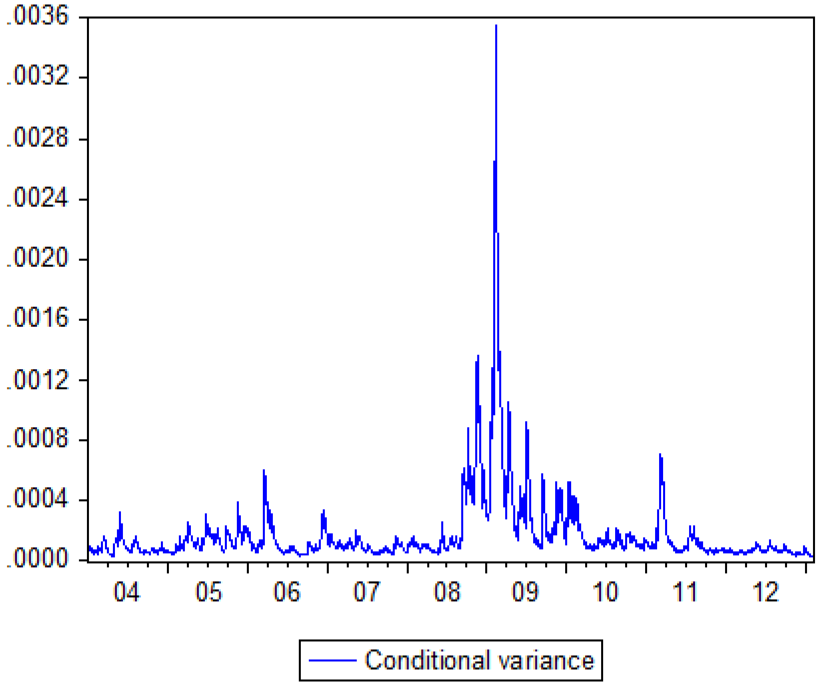

Figure 2.18: Kuwait banking sector GARCH (1,1).

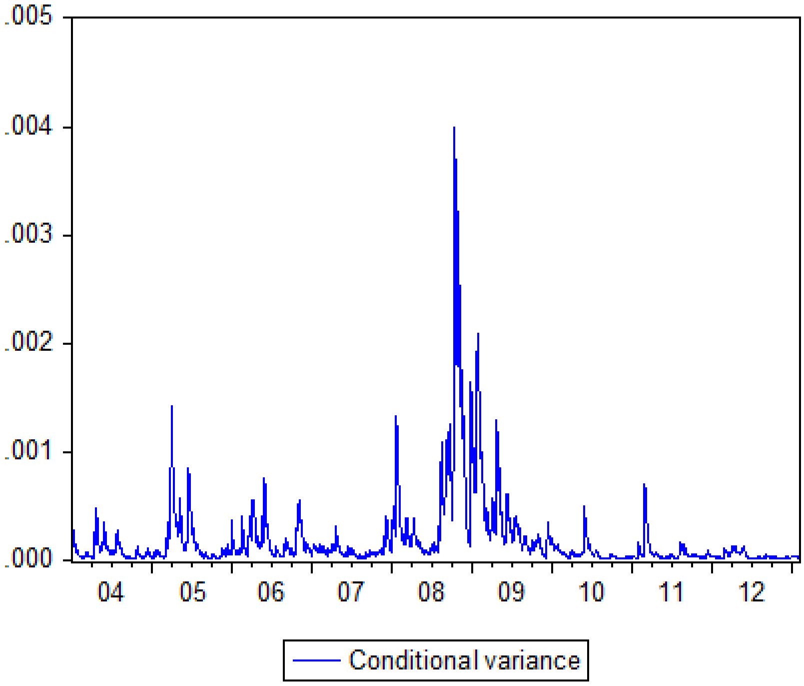

Figure 2.19: Oman banking sector GARCH (1,1).

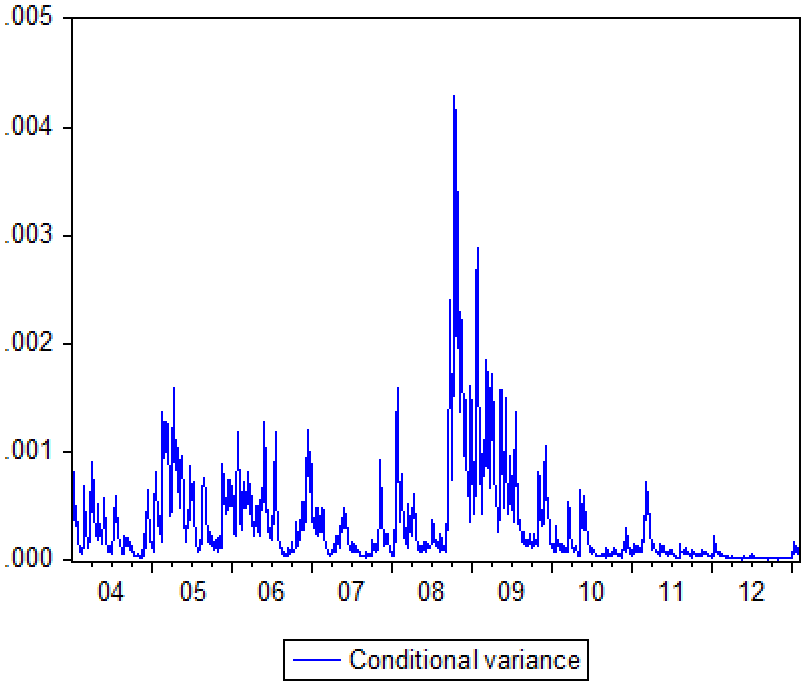

Figure 2.20: Qatar banking sector GARCH (1,1).

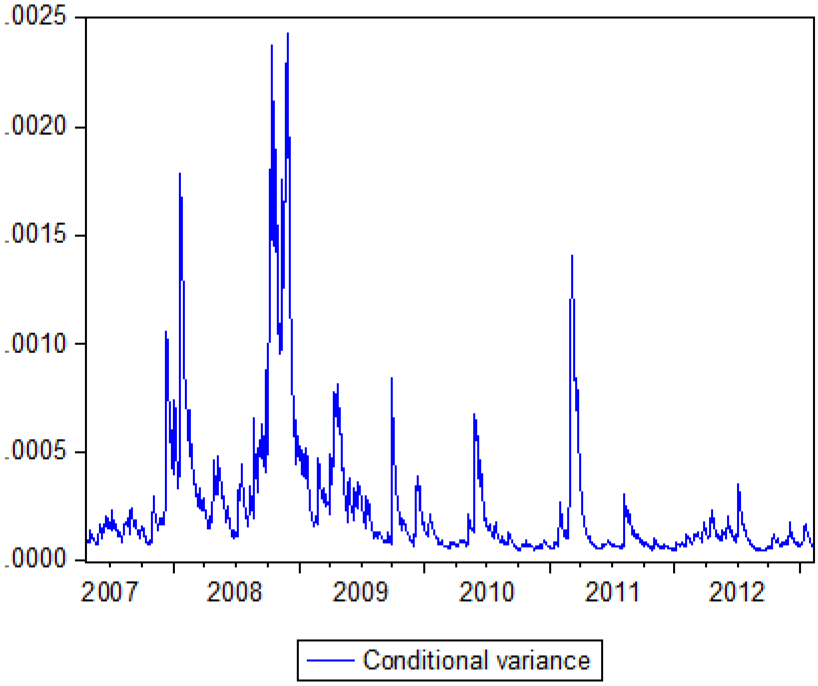

FIGURE 2.21: Saudi-Arabia banking sector GARCH (1,1).

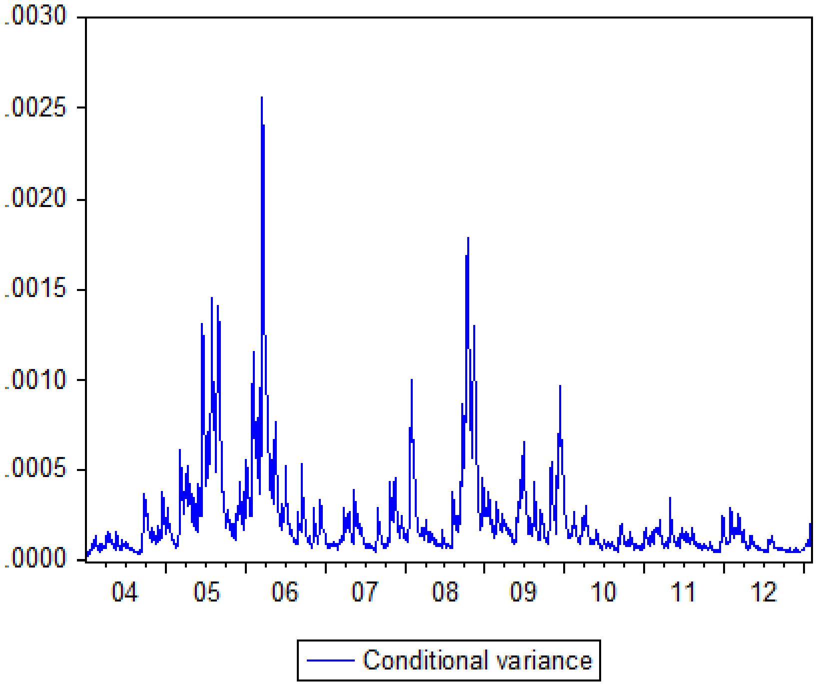

FIGURE 2.22: Dubai banking sector GARCH (1,1).

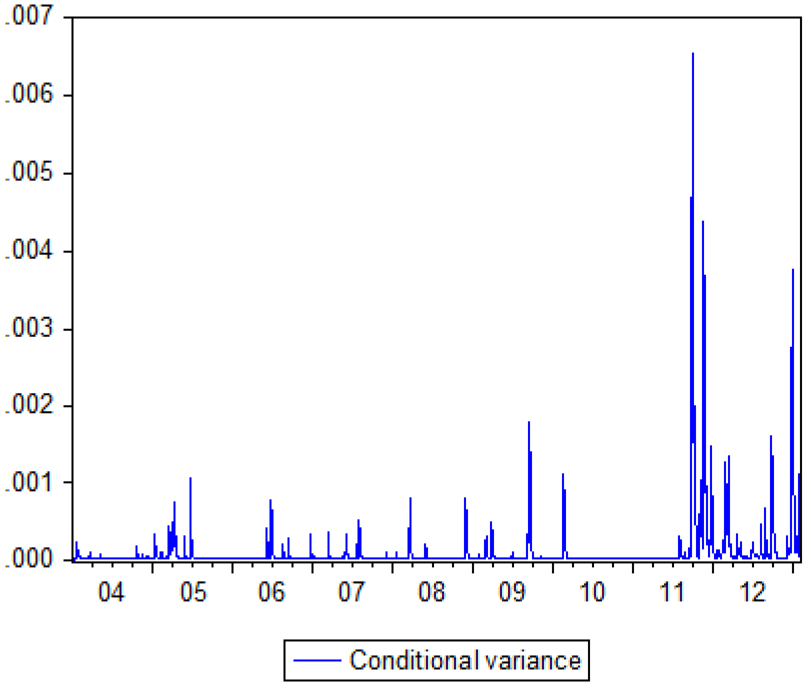

FIGURE 2.23: Bahrain industrial sector GARCH (1,1).

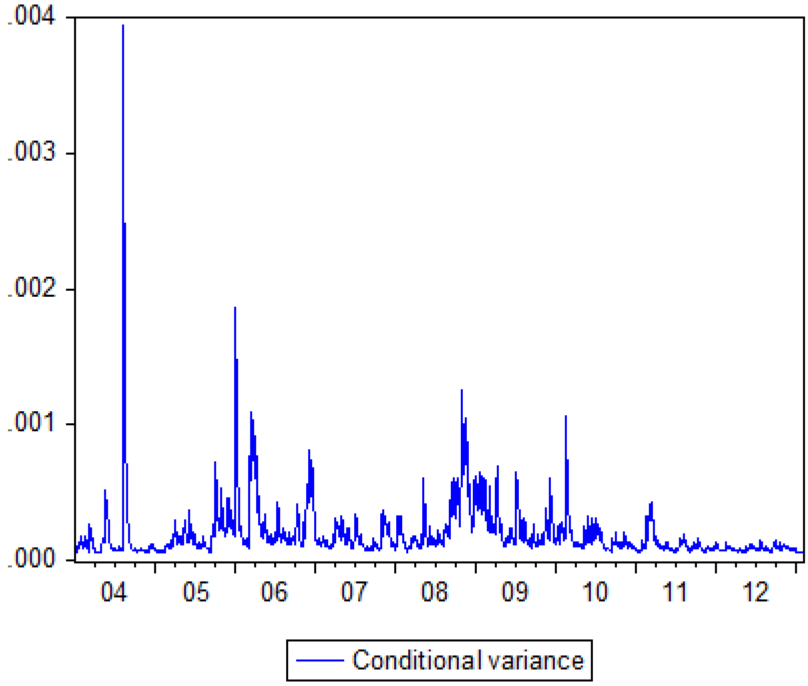

Figure 2.24: Kuwait industrial sector GARCH (1,1).

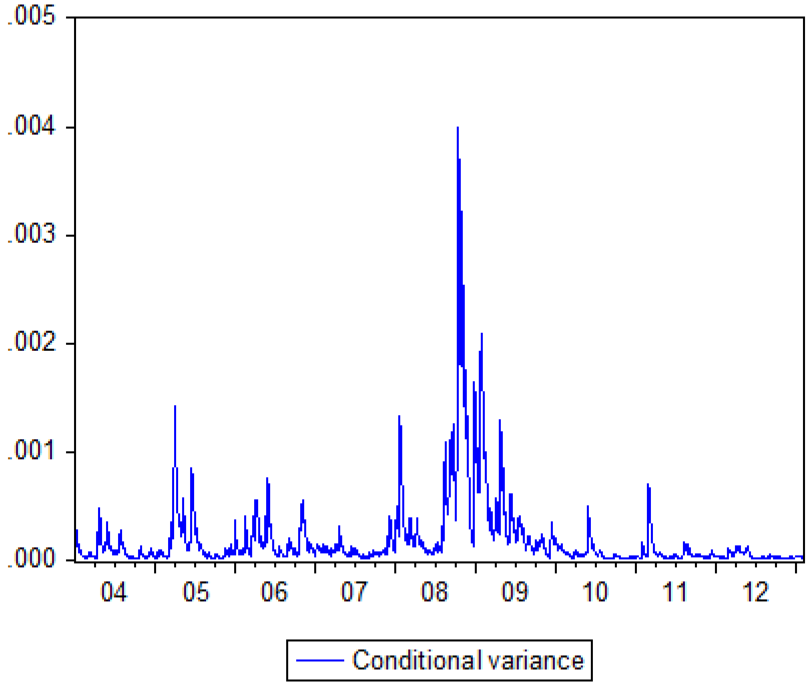

Figure 2.25: Oman industrial sector GARCH (1,1).

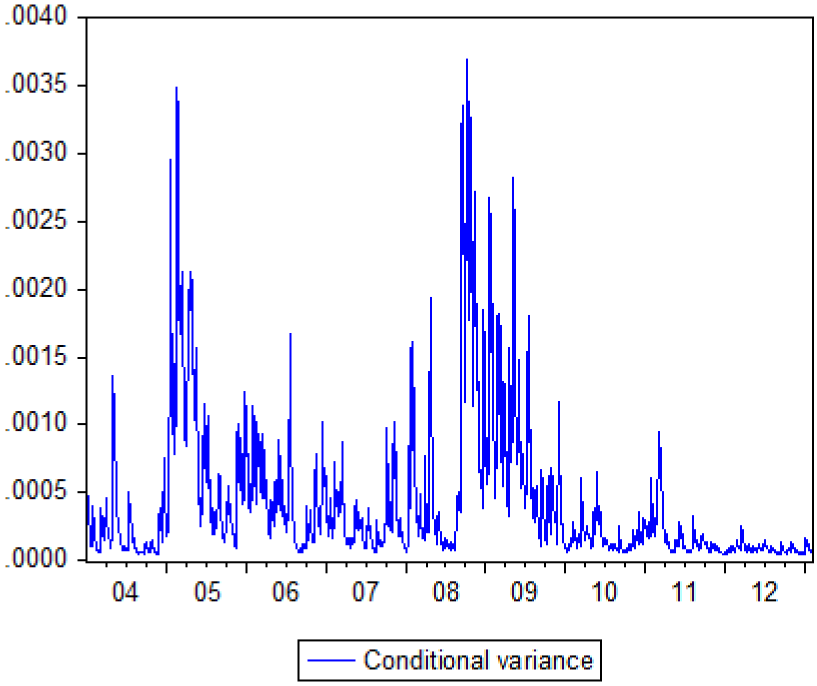

FIGURE 2.26: Qatar industrial sector GARCH (1,1).

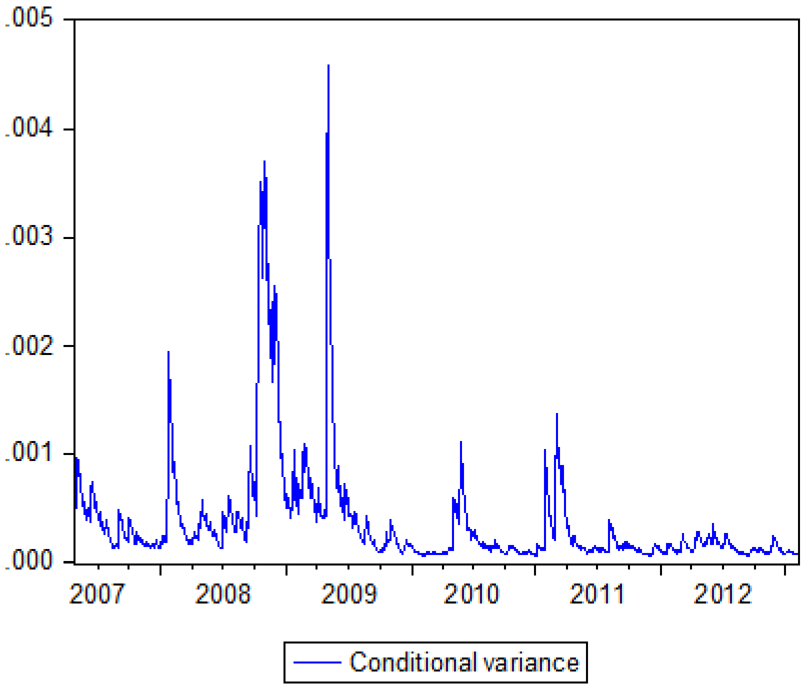

FIGURE 2.27: Saudi-Arabia industrial sector GARCH (1,1).

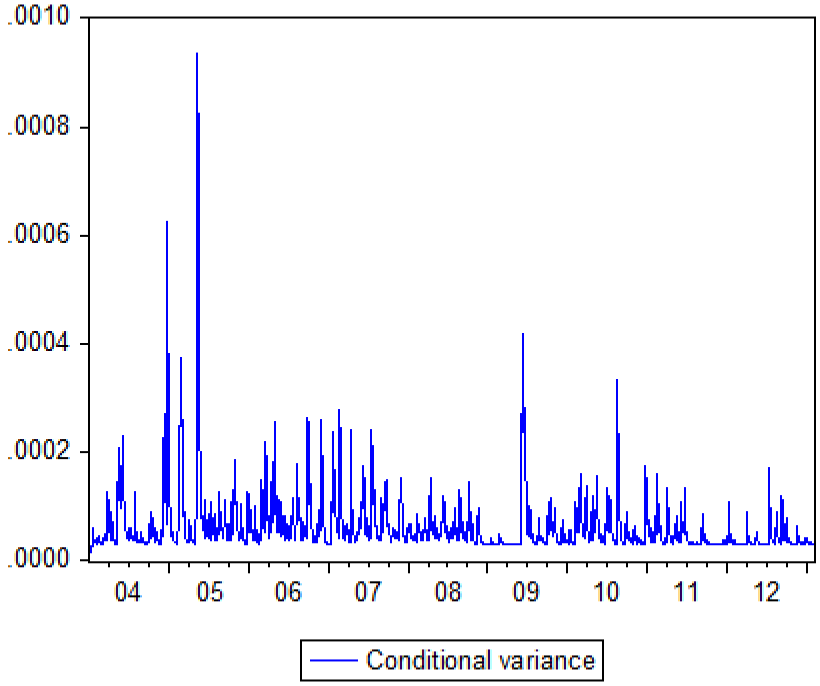

FIGURE 2.28: Bahrain insurance sector GARCH (1,1).

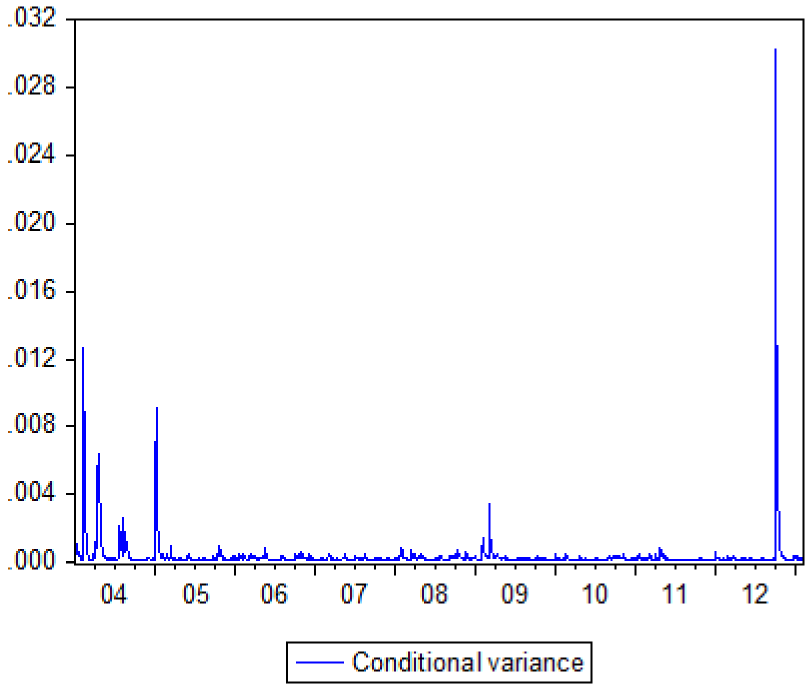

FIGURE 2.29: Kuwait insurance sector GARCH (1,1).

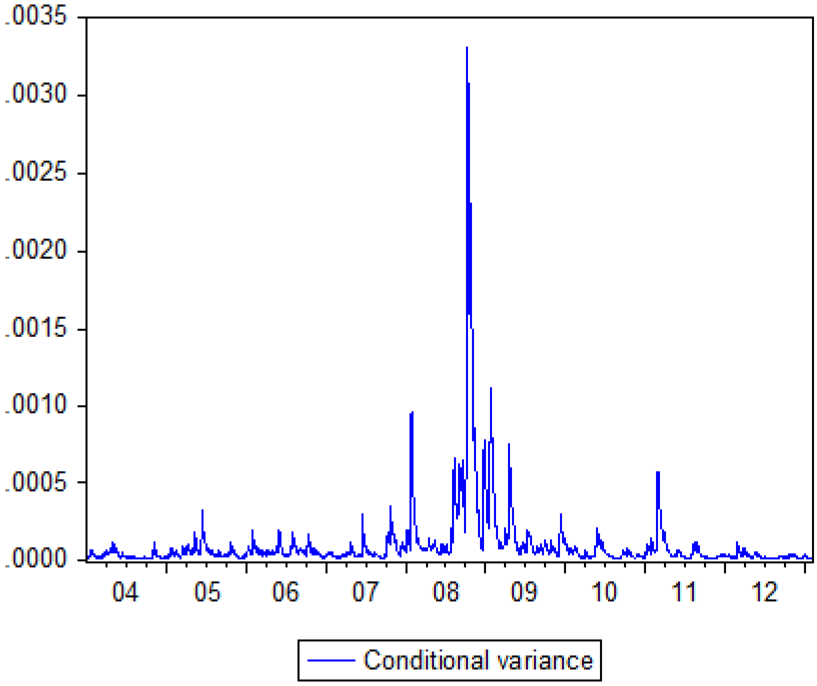

Figure 2.30: Oman insurance sector GARCH (1,1).

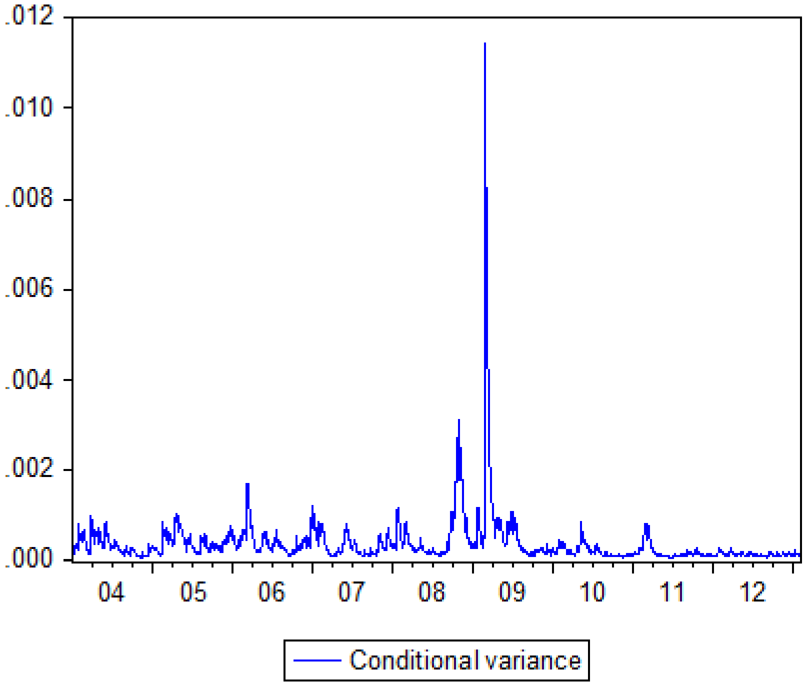

Figure 2.31: Qatar insurance sector GARCH (1,1).

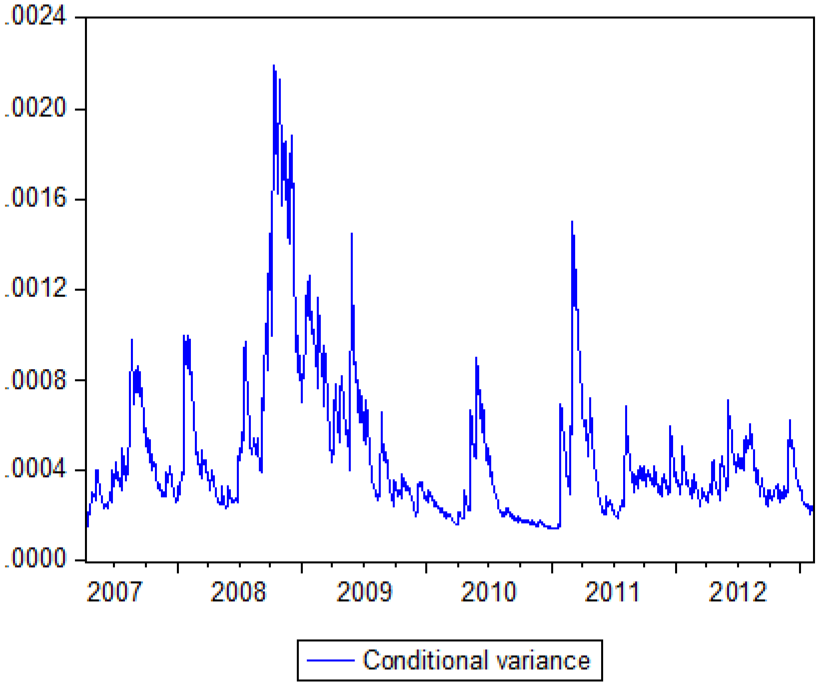

Figure 2.32: Saudi-Arabia insurance sector GARCH (1,1).

Chapter 3

GCC stock markets contagion: The effect of the recent financial crisis

3.1 Introduction

During the 1980s and 1990s, many developed and emerging economies experienced several economic crisis episodes, such as the 1987 U.S. stock market crash, which had a pronounced impact on many international stock markets; the 1994 Mexican peso collapse, with its effect on other Latin American stock markets; and the 1997 East Asian crisis, which rapidly transferred to world wide markets in European, North America, and the rest of Asian. These events imply that dramatic movements or shocks in one stock market can be transmitted and have truly significant effects on stock markets across boarders, leading many economists to examine stock market linkages across countries in periods of financial crisis to determine whether these linkages vary compared to those in non-crisis times.

Recently, the financial crisis of 2008-2009 was characterized as the worst financial crisis since the Great Depression of 1929-1932. Specifically, the New York Stock Exchange (NYSE) index lost about 46% of its value within a month of Lehman Brothers filling for bankruptcy. While the financial crisis initially originated in the U.S., its adverse effects rapidly spread to other developed and emerging markets around the world. The

GCC stock markets were not insulated from the negative impact of this financial crisis, which led to sharp drops in all GCC stock markets' indices, with decreases of around 14% in Bahrain, 26% in Kuwait, 21% in Oman, 30% in Qatar, 28% in Saudi Arabia, and 38% in the UAE from the beginning of September to October 15, 2008. Figure 3.1 graphs the GCC stock markets and U.S. stock market indices during the sample period under investigation. In addition, during this period, the GCC's total market capitalization fell dramatically by about 320 billion U.S. dollars, which was about 38% of the GCC's compound GDP for 2007 (Moosa (2010)). In fact, the GCC economies have strong economic and financial ties with the U.S. economy. These ties are expressed through three main channels: (i) they all shared similar exchange rate mechanisms, in that all currencies (except Kuwait) have had an exchange rate *de-facto* fixed to the U.S. dollar; (ii)the dollar peg provides the external anchor for monetary policy for all GCC countries; and (iii)the GCC countries rely heavily on oil, which is priced in U.S. dollars, as their main source of exports and revenue.

In this regard, studying contagion is of particular interest to policy makers as well as investors in the GCC to investigate the extent to which GCC stock markets are vulnerable to different international financial crises. If contagion exists, policy makers need to strengthen the ability of the financial system to absorb the adverse impact of any financial crisis. This can be done via improving regulations and supervisory frameworks at domestic levels, increasing the depth of GCC financial markets, pursuing a coordinated set of policies among the GCC countries as a bloc (which would also be beneficial for the formation of the GCC monetary union) in order to make the GCC capable of reducing the exposure to international financial contagions in periods of crisis. Understanding financial contagion is crucial to the fact that gains from international portfolio diversification are reduced when stock markets exhibit correlation, a revelation that will be informative for investors and help them make better decisions regarding portfolio diversification allocations. Finally, knowing that contagion has occurred between two stock markets after a crisis may serve as a "wake-up call" for investors, providing them with useful information for avoiding any future spreads of the crisis.

The purpose of this chapter is to investigate the effect of the recent global financial crisis, which originated in the U.S. stock market after the bankruptcy of the Lehman Brothers bank in September 2008, on the stock markets of the GCC countries, and to determine whether the sharp falls in the markets in these countries were due to the existence of "contagion" or were simply a reflection of the continuation of the strong economic and financial linkages between the GCC and U.S. economies, which exist in all states of the world, during good and bad times. In particular, this chapter aims to examine whether contagion exists from the U.S. stock market to the stock markets of the GCC by comparing two sub-periods before (stable) and after (turmoil) the collapse of Lehman Brothers, which was the largest bank to fill for bankruptcy in U.S. history and which has been widely used by many economists as a benchmark for the U.S. financial crisis (Bekaert et al. (2012)) and (Mishkin (2010)).[1]

There is no generally accepted definition of contagion, as meanings for the term vary widely across the literature. According to the World Bank, there are three different definitions of contagion, which can be categorized as follows.

1. **Broad definition**: Contagion is the cross-country transmission of shocks or general cross-country spillover effects. Contagion can take place during both "good times" and "bad times". Thus, though contagion does not need to be related to crises, However, it has been emphasized during crisis times.

2. **Restrictive definition**: Contagion is the transmission of shocks to other countries or the cross-country correlation, beyond any fundamental link among the countries and beyond common shocks. This definition is usually referred to as excess co-movement, commonly explained by herding behaviour.

3. **Very restrictive definition**: Contagion occurs when cross-country correlations increase during "crisis times" relative to "tranquil times".

In this chapter, I follow Forbes and Rigobon (2002) in defining contagion as a significant increase in cross-market linkages after a shock to one country or group of countries. According to this definition, if two stock markets exhibit a high degree of co-movement during periods of stability, even if these two markets continue to be highly correlated after a shock to one market, their relation may not constitute contagion. It is only contagion if cross-market co-movements increase significantly after the shock. Thus, if the co-movements do not increase significantly, any continued

[1]Another definition of the starting of the U.S. financial crisis will be used in the sensitivity analysis later in this chapter.

cross-market correlation at high levels suggests a continuation of the strong linkages between the two markets that exist in all states of the world. In such cases, the term "interdependence" is more aptly employed to evaluate the situation between the two stock markets.

As argued in their paper, Forbes and Rigobon (2002)'s definition has a number of advantages. First, it provides a straightforward framework for testing the existence of contagion by directly and simply comparing cross-market linkages (such as cross-market correlation coefficients) between two stock markets during a relatively stable period with cross-market linkages after a crisis. Contagion occurs whenever there exists a significant increase in these cross-market linkages after the shock. Second, this definition offers a straightforward method of distinguishing between alternative explanations for how crises are transmitted across stock markets, since the theoretical literature on the transmission channels of contagion is broadly divided into fundamentals linkages and irrational behaviour. In particular, some theories argue that most shocks are transmitted through economic fundamentals, such as trade, or financial linkages, while other theories relate the transmission of shocks to the "irrational behaviour" of investors, arguing that investors react differently after a large negative shock. By defining contagion as a significant increase in cross-market linkages after a shock to one country or group of countries, the Forbes and Rigobon (2002) definition avoids measuring or differentiating between various transmission mechanisms, which are extremely difficult to measure and estimate.

Despite the advantages mentioned above, it is worth mentioning that this definition of contagion is not universally accepted. Some economists argue that if a shock to one country is transmitted to another country, even if there is no significant change in cross-market relationships, the transmission constitutes contagion (Calvo and Reinhart (1996)). Other economists argue that it is impossible to define contagion based on simple tests of changes in cross-market linkages. Instead, they argue that it is important to identify exactly how a shock is transmitted across countries, and that only certain types of transmission mechanisms, such as herding or irrational investor behaviour, entail contagion (Kodres and Pritsker (2002)).

Empirically, this chapter investigates the existence of contagion using the cross-market correlations tests pioneered by King and Wadhwani (1990) and developed by Forbes and Rigobon (2002), who criticized previous studies-in which the unadjusted correlation coefficients were used to investigate the presence of contagion across stock markets-for the heteroskedasticity resulting from the bias in stock market returns of the crisis country. This bias overestimates actual cross-market correlations, particularly during the turmoil period, during which the volatility of stock market returns in the crisis country increases. Hence, the existence of heteroskedasticity in stock market returns has a significant effect on the estimation of cross-market correlations. As a result, tests based on these unadjusted correlation coefficients exaggerate the value of the estimated cross-market correlations and thus falsely find evidence of contagion, even if the underlying transmission mechanism does not change between the two stock markets. In order to overcome the problem of heteroskedasticity, Forbes and Rigobon (2002) introduced the adjustment cross-market correlation coefficient, which does not depend on the volatility (variance) of the crisis country, especially during the turmoil period.

Findings show that, for both tests (based on(i) unadjusted and (ii) adjusted correlations coefficients), there is some evidence of contagion from the U.S. stock market to the stock markets of Oman, Qatar, Saudi Arabia, and the UAE after the collapse of Lehman Brothers. In the case of Kuwait, however, the empirical investigation suggests that when the conditional correlation is applied, contagion exists from the U.S. stock market, but that when the contagion test based on the adjusted correlation is used, there is no significant increase in cross-market correlation between the Kuwait and U.S. stock markets after the collapse of Lehman Brothers. Hence, the relationship between the two markets is rather interdependent, and no contagion has occurred from the U.S. financial crisis to Kuwait stock market. According to the theory of “fundamentals-based contagion”, which demonstrates that contagion is transmitted across countries through real or financial linkages, the results in the case of Kuwait might be due to the fact that the Kuwait economy is relatively less linked to the U.S. economy than the other GCC economies, in the sense that Kuwait is the only GCC country that does not fix its currency exchange rate to the U.S. dollar and that Kuwait has a more independent monetary policy than its GCC counterparts. This is also supported by the empirical analyses in that Kuwait has the smallest (after Bahrain) cross-market correlation among the GCC countries after the turmoil period. Finally, in the case of Bahrain, neither the contagion tests based on unadjusted correlation coefficients nor the tests based on adjusted correlation coefficients found any contagion between Bahrain and U.S. stock markets. The linkage between the U.S. stock market as a crisis country and the Bahrain stock market as a non-crisis country remained relatively the same after the crisis period, meaning that no contagion has occurred. From this, one can conclude that the recent U.S. financial crisis has not affected the Bahrain stock market. These results might be due to the fact that the Bahrain stock market is one of the smallest and most illiquid stock market when compared to the other GCC stock markets.

While an extensive research agenda has been devoted to the recent financial crisis and its impact on both advanced and emerging markets (Chudik and Fratzscher (2011), Ehrmann et al. (2011), Rose and Spiegel (2012), among others), only a few researches have tried to identify a possible transmission to the GCC stock markets. In this regard, this chapter contributes to the recent literature on contagion across stock markets after the global financial crisis by providing empirical evidence in the context of the GCC stock markets. To the best of my knowledge, this is the first study to investigate the impact of the U.S. financial crisis on the GCC stock markets using Forbes and Rigobon (2002)'s definition of contagion and employing the adjusted cross-market correlation coefficients methodology. The remainder of this chapter is organized as follows: Section 3.2 presents a brief overview of the relevant literature on contagion. Section 3.3 describes the methodology adopted to estimate cross-market correlation coefficients. Section 3.4 provides the data and the empirical results analysis. Section 3.5 concludes the chapter.

3.2 Review of literature

There has been widespread disagreement and debate among economists with regard to the definition of contagion and the empirical methodology used to measure it. King and Wadhwani (1990) were the first to define contagion as a significant increase in the correlation between two stock markets. In their seminal paper, they investigated the correlation between the US, UK, and Japan stock markets after the U.S. stock market crash of October 1987 and found that the level of correlation between these three markets increased after the October crash, resulting in contagion.

Recently, Forbes and Rigobon (2002) defined contagion as a significant increase in market co-movements after a shock to one country or group of countries and used this definition to test for stock market contagion during the 1997 East Asian crisis, the 1994 Mexican peso devaluation, and the 1987 U.S. market crash. The authors criticized the findings of the earlier studies concerning measure of contagion, arguing that statistical tests for cross-market correlation coefficients used in these papers were biased because the correlation coefficients were conditional on market volatility over the time period under investigation. Hence, during a period of crisis, the stock market volatility increased and the unadjusted market correlation was biased upward. Taking the bias caused by heteroscedasticity into account, Forbes and Rigobon (2002) developed an adjusted correlation coefficient and found evidence that-unlike the findings of previous studies-that there was no significant increase in the correlation coefficients between stock markets during the three crises mentioned above and that the contagion found in previous studies did not exist.

Loretan and English (2000) used the same approach as Forbes and Rigobon (2002), in which they calculated the cross-country correlations for three pairs of asset returns-namely, equities, bonds, and foreign exchange-between UK and Germany during the 1990s, when two crises occurred: the Mexican crisis of December 1994 and the Russian default of August 1998. The authors found that a significant proportion of the changes in correlations over time were explained by the differences in sample volatilities. After correcting for the bias in the correlation coefficients using a method that, after some algebraic manipulation, was the same as the correction proposed by Forbes and Rigobon (2002), the adjusted correlation coefficients showed only one case of contagion among the three series, which was in the case of the exchange rates after the Mexican crisis.

On the other hand, an alternative definition of contagion has also been used in the literature. Calvo and Reinhart (1996) defined contagion as the cross-country transmission of shocks or general cross-country spillover effects (broad definition). This definition emphasizes contagion caused by the normal interdependence among economies, which means that shocks are transmitted across countries through their real or financial linkages. Calvo and Reinhart (1996) called this type of contagion a “fundamentals-based contagion”. In this case, the forms of assets’ co-movements are not considered contagion because they reflect continuation of normal interdependence, but just during periods of crisis. In order to investigate the issue of contagion, Calvo and Reinhart (1996) focused on the equity markets of Latin America and Asian emerging markets. After employing principle component analysis, they found evidence that the degree of co-movements across weekly returns on Latin America and Asian equity markets increased after the Mexican crisis. They Also found that, while the degree of co-movements following the crisis increased in both Asia and Latin America, regional patterns differed, which suggested that contagion may be more regional than global.

Bekaert et al. (2005) adopted yet another approach, defining contagion as excess correlation over and above what one would expect from economic fundamentals (restrictive definition). To investigate the existence of contagion during crisis periods, Bekaert et al. (2005) applied a two-factor model to stock markets in three regions-namely, Europe, Southeast Asia and Latin America-and defined contagion as a cross-country correlation of the model residuals. The authors found no evidence for increasing in correlations after the Mexican crisis, though they found some evidence of contagion after the Asian crisis.

Finally, with regard to the GCC stock markets, to the best of my knowledge, there is only one paper, authored by Moosa (2010), to address the impact of the U.S. sub-prime crisis on the GCC stock markets. The main hypothesis of this study was that the collapse of the GCC stock markets during the sub-prime crisis did not result from the contagion. Moosa implied that the empirical results of the paper showed rather limited evidence for the effect of U.S. stock prices on the GCC stock markets and a much more important role for oil prices. However, neither of these variables alone can explain the behaviour of the GCC stock markets during the period 2007-2008 because of the role played by the domestic factors that caused “bubbles and crashes”. The methodology used in this paper was based on the structural time series model.

3.3 Methodology

Tests based on cross-market correlation coefficients have been the heart of the methodologies used to empirically test for stock market contagion. These tests measure correlation in returns between two stock markets during a stable period and then test for a significant increase in correlation coefficients after a shock or crisis. If a correlation coefficient increases significantly after a crisis, it suggests that the transmission mechanism between the two markets increased after the shock and contagion occurred.

This study builds on the previous work of Forbes and Rigobon (2002), who showed that cross-market correlation coefficients are biased upward in the presence of heteroskedasticity and that this bias is large during periods of crisis and thus overestimates actual cross-market correlation coefficients. This bias is due to the fact that the volatility (variance) of the stock returns of the crisis source country (U.S.) increases, particularly after the turmoil period (the crisis). Thus when the sample is divided into two sub-periods (the stable period and the turmoil period) this high volatility results in higher correlation between the two stock markets after the turmoil period, even when the actual correlation transmission mechanism is constant or does not change. Hence, cross-market correlation is conditional on the volatility of stock market returns in the crisis market, and the increase in cross-market correlations does not result from contagion, but rather is caused by the higher volatility of stock market returns in the crisis source country, as is shown in equation 3.2. Accordingly, tests using unadjusted (conditional) cross-market correlation coefficients are inaccurate because heteroskedasticity overstates the magnitude of the cross-market correlation and thus wrongly finds evidence of contagion, even when the transmission mechanism is constant or does not change and no significant increase actually happens between the two markets after the crisis. These cross-market correlation coefficients need to be adjusted for volatile periods such as crises in order to solve for this bias (Forbes and Rigobon (2002)).

As we will see later in the formal proof, Forbes and Rigobon (2002) introduced an adjusted (unconditional) correlation coefficient ρ, which does not depend on the volatility of the crisis market after the turmoil period, as in equation 3.1.

$$\rho = \frac{\rho^*}{\sqrt{1 + \delta[1 - (\rho^*)^2]}} \tag{3.1}$$

where ρ^* is the unadjusted correlation coefficient, which varies with high-and low-volatility periods and is thus conditional on the volatility of the crisis market returns as shown in equation 3.2.

$$\begin{aligned}
\rho^* &= corr(y,x) = \frac{cov(y,x)}{\sqrt{var(y)var(x)}} \\
&= \frac{\beta_1 var(x)}{\sqrt{\{\beta_1^2 var(x) + var(\epsilon_t)\}var(x)}} \\
&= \{1 + \frac{var(\epsilon_t)}{\beta_1^2 var(x)}\}^{-1/2}
\end{aligned} \tag{3.2}$$

where y and x are the stock returns in the non-crisis country (each of the GCC stock markets) and the crisis country (the U.S. stock market) in the equation $y_t = c + \beta_1 x_t + \epsilon_t$, respectively; δ is the relative increase in the variance of x ($\delta \equiv \frac{\sigma_{xx}^h}{\sigma_{xx}^l} - 1$); and σ_{xx}^h and σ_{xx}^l are the crisis country variances during turmoil and stable periods, respectively. Equation 3.2 clearly shows that, for a given *var*(ϵ_t), ρ^* is an increasing function of the variance of the crisis country's market returns and is thus conditional on the volatility of the crisis country stock returns $var(x)$. More specific, an increase in $var(x)$ leads to an increase in the cross-market correlation ρ^*. As a result, Forbes and Rigobon (2002) argued that tests based on unadjusted (conditional) correlation coefficients will be biased upward and will provide misleading and inaccurate results when used to test for the existence of contagion.

3.3.1 Proof of the bias and a proposed adjustment

The following simple model clarifies how heteroskedasticity affects the cross-market correlation coefficient between two markets as suggested by Forbes and Rigobon (2002). Assume x and y are stochastic variables representing stock market returns for two different markets and that these returns are related, as in equation 3.3:

$$y_t = \alpha + \beta x_t + \epsilon_t, \tag{3.3}$$

where

$$E[\epsilon_t] = 0, \tag{3.4}$$

$$E[\epsilon_t^2] = c < \infty \text{ where c is a constant, and} \tag{3.5}$$

$$E[x_t \epsilon_t] = 0. \tag{3.6}$$

Since markets tend to be more volatile after a shock or crisis, I split the sample into two groups-stable (l), or before crisis, and turmoil (h), or after crisis-so that the variance of x_t is lower in the period of stability and higher in the period of turmoil. By assumption in equation 3.6, the Ordinary Least Squares (OLS) estimates of equation 3.3 are consistent for both groups, and $\beta^h = \beta^l$.
By construction, we know that $\sigma^h_{xx} > \sigma^l_{xx}$ and define

$$\delta \equiv \frac{\sigma^h_{xx}}{\sigma^l_{xx}} - 1 \text{ as a relative increase in the variance of } x \text{ in the turmoil period.} \tag{3.7}$$

According to equation 3.3, the variance of y is:

$$\begin{aligned} \sigma^h_{yy} &= \beta^2 \sigma^h_{xx} + \sigma_{ee} \\ &= \beta^2 (1+\delta) \sigma^l_{xx} + \sigma_{ee} \\ &= (\beta^2 \sigma^l_{xx} + \sigma_{ee}) + \delta \beta^2 \sigma^l_{xx} \\ &= \sigma^l_{yy} + \delta \beta^2 \sigma^l_{xx} \\ &= \sigma^l_{yy} \left(1 + \delta \beta^2 \frac{\sigma^l_{xx}}{\sigma^l_{yy}}\right) \end{aligned} \tag{3.8}$$

when equation 3.8 is combined with the standard definition of the correlation coefficient (equation3.9):

$$\rho = \frac{\sigma_{xy}}{\sigma_x \sigma_y} = \beta \frac{\sigma_x}{\sigma_y} \tag{3.9}$$

Note that the standard definition of β is:

$$\beta = \frac{\sigma_{xy}}{\sigma_{xx}} \tag{3.10}$$

Then, from equations 3.8 and 3.9,

$$\sigma^h_{yy} = \sigma^l_{yy} (1 + \delta [\rho^l]^2) \tag{3.11}$$

Therefore,

$$\begin{aligned}\rho^h &= \frac{\sigma^h_{xy}}{\sigma^h_x \sigma^h_y} \\ &= \frac{(1+\delta)\sigma^l_{xy}}{(1+\delta)^{1/2}\sigma^l_x (1+\delta[\rho^l]^2)^{1/2}\sigma^l_y} \\ &= \rho^l \sqrt{\frac{1+\delta}{1+\delta[\rho^l]^2}}\end{aligned} \tag{3.12}$$

Equation 3.12 clearly shows that the correlation coefficient is an increasing function of δ. In other words, the estimated correlation coefficient between x and y increases when the variance of x increases (i.e., during periods of high volatility in market x), even when the actual relationship, represented by β, between the two markets is constant or does not change. Hence, estimates of the cross-market correlation coefficient are biased and conditional on the variance of x, and this conditional correlation can be written as in equation 3.13,

$$\rho^* = \rho\sqrt{\frac{1+\delta}{1+\delta\rho^2}} \tag{3.13}$$

where ρ^* is the conditional correlation coefficient, which depends on the variance of x, the crisis source country; ρ is the unconditional correlation coefficient; and δ is the relative increase in the variance of x ($\delta \equiv \frac{\sigma^h_{xx}}{\sigma^l_{xx}} - 1$).

Forbes and Rigobon (2002) demonstrated that conditional correlation coefficients, as in equation 3.13, have a direct effect on tests for contagion using cross-market correlation coefficients, and that this effect comes from the fact that markets tend to be more volatile after a shock or crisis. Hence, when the crisis source market is more volatile, the conditional correlation (ρ^*) will be greater than it should be after a shock, even if the unconditional correlation (ρ) remains the same as in stable periods. Therefore, heteroskedasticity in market returns biases the cross-market correlation coefficients results, especially after a shock or crisis. This bias is adjusted after solving for the unconditional correlation, which does not depend on the variance of x, from equation (3.13) yielding:

$$\rho = \frac{\rho^*}{\sqrt{1+\delta[1-(\rho^*)^2]}} \tag{3.14}$$

It is worth mentioning that Forbes and Rigobon (2002) stated that there is one potential problem with this adjustment for heteroskedasticity, in which it is assumed that there are no omitted variables or endogeneity between the crisis and non-crisis stock markets, as in equations 3.4 and 3.6. In particular, the proof of this bias and the adjustment is only valid if there are no exogenous global shocks or no feedback from the stock market of the non-crisis country to that of the crisis country.

3.3.2 Base model

After showing the bias of the cross-market correlation coefficients and demonstrating how to adjust for this bias, I utilize a Vector Autoregression framework (VAR) to estimate cross-market correlations between the U.S. stock market and each of the GCC stock markets, as follows:[2]

$$x_t^c = \sum_{j=1}^{p} b_j^c x_{t-j}^c + \sum_{j=1}^{p} b_j^n x_{t-j}^n + \epsilon_t^c$$

$$x_t^n = \sum_{j=1}^{p} b_j^n x_{t-j}^n + \sum_{j=1}^{p} b_j^c x_{t-j}^c + \epsilon_t^n$$

Which can be re-written as:

$$X_t = \phi(L) X_t + \epsilon_t \tag{3.15}$$

$$X_t \equiv \{x_t^c, x_t^n\}' \tag{3.16}$$

where x_t^c is the stock market returns in the crisis country (U.S), x_t^n is the stock market returns in another market (each GCC stock market), $\phi(L)$ is a vector of lags for both stock market returns, and ϵ_t is a vector of reduced disturbances, which are now assumed to have constant variances. I first use the (VAR) model (equations 3.15 and 3.16) to estimate the variance-covariance matrices (equation 3.17) for each pair of countries during the stable period (before crisis) and turmoil period (after crisis).

$$\hat{\Omega} = \begin{bmatrix} \hat{\sigma}_{11} & \hat{\sigma}12 \\ \hat{\sigma}_{21} & \hat{\sigma}_{22}^2 \end{bmatrix} \tag{3.17}$$

where $\hat{\sigma}_{11}^2 = Var(\hat{\epsilon}_t^c) = \frac{\sum \hat{\epsilon}_{c,t}^2}{T}$ is the variance of the crisis country residual, $\hat{\sigma}_{22}^2 = Var(\hat{\epsilon}_t^n) = \frac{\sum \hat{\epsilon}_{n,t}^2}{T}$ is the variance of the non-crisis country residual, and $\hat{\sigma}_{12,21} = Cov(\hat{\epsilon}_t^c, \hat{\epsilon}_t^n) = \frac{\sum \hat{\epsilon}_{c,t} \hat{\epsilon}_{n,t}}{T}$ is the covariance between both countries' residuals. After that, I

[2] In the sensitivity analysis, pairwise simple correlations between stock markets returns (instead of using the VAR residual-based variance-covariance matrix) are employed to estimate the correlation coefficients.

use the estimated variance-covariance matrices to calculate the cross-market conditional correlation coefficients (ρ^*) between the U.S and each of the GCC stock markets for each period (namely, the stable period (ρ^{*l}) and the turmoil period (ρ^{*h})) as in equations 3.18 and 3.19, respectively.

$$\rho^{*l} = \frac{Cov(\hat{\epsilon}_t^c, \hat{\epsilon}_t^n)^l}{\sqrt{Var(\hat{\epsilon}_t^c)^l Var(\hat{\epsilon}_t^n)^l}} \tag{3.18}$$

$$\rho^{*h} = \frac{Cov(\hat{\epsilon}_t^c, \hat{\epsilon}_t^n)^h}{\sqrt{Var(\hat{\epsilon}_t^c)^h Var(\hat{\epsilon}_t^n)^h}} \tag{3.19}$$

Furthermore, in order to investigate how heteroskedasticity biases tests for contagion, I estimate the unconditional correlation coefficients (ρ) for each pair of stock markets and for each period, stable and turmoil (equations 3.20 and 3.21, respectively).

$$\rho^l = \frac{\rho^{*l}}{\sqrt{1 + \delta[1 - (\rho^{*l})^2]}} \tag{3.20}$$

$$\rho^h = \frac{\rho^{*h}}{\sqrt{1 + \delta[1 - (\rho^{*h})^2]}} \tag{3.21}$$

After calculating the conditional and unconditional correlation coefficients for both stable and turmoil periods, I perform the test statistic to investigate the existence of contagion from the U.S. stock market to each of the GCC stock markets. More specifically, I use t-test statistics to evaluate whether there is a significant increase in correlation coefficients (both the conditional and unconditional) during the turmoil period for each pair of stock markets. The hypothesises tests for conditional and unconditional correlations are given in equations 3.22 and 3.23:

$$H_0 : \rho^{*l} \geq \rho^{*h} \tag{3.22}$$

$$H_1 : \rho^{*l} < \rho^{*h}$$

$$H_0 : \rho^l \geq \rho^h \tag{3.23}$$

$$H_1 : \rho^l < \rho^h$$

where ρ^{*l} and ρ^l are the conditional and unconditional correlations during the stable period and ρ^{*h} and ρ^h are the conditional and unconditional correlations during the turmoil period.

In this situation, Forbes and Rigobon (2002) have suggested using the Fisher transformation of correlation coefficients in order to improve the finite sample properties of test statistics (Kendall and Stuart (1961)). The test statistic has the following form (equation 3.24):[3]

$$T = \frac{\frac{1}{2}ln[\frac{1+\hat{\rho}^h}{1-\hat{\rho}^h}] - \frac{1}{2}ln[\frac{1+\hat{\rho}^l}{1-\hat{\rho}^l}]}{\sqrt{\frac{1}{N_h-3} + \frac{1}{N_l-3}}} \tag{3.24}$$

where $\frac{1}{2}ln[\frac{1+\hat{\rho}^h}{1-\hat{\rho}^h}]$ and $\frac{1}{2}ln[\frac{1+\hat{\rho}^l}{1-\hat{\rho}^l}]$ are Fisher transformations of the cross-market correlation coefficients after and before the crisis, respectively, and N_h and N_l are the number of observations after and before the crisis, respectively. Under the null hypothesis of no contagion, Forbes and Rigobon (2002) suggested that the Fisher transformation test statistic is approximately normally distributed and can be compared by applying standard t-tests. This is a one-sided t-test, with positive values greater than any of the critical values (10%, 5% or 1%) representing evidence of a significant increase in cross-market correlation coefficients and thereby providing support for the existence of contagion. Therefore, contagion occurs if we reject the null hypothesis at a reasonable level of significance (i.e., the test statistic result is greater than the critical value); otherwise the test indicates interdependence.

It is worth-mentioning that we should be cautioned that the variance used in construction of the test statistic in equation 3.24 is in fact ignores the possibility of dependence between the two portions of the sample (non-crisis and crisis). In addition, Forbes and Rigobon (2002) actually did not derive the asymptotic normal distribution of equation 3.24 but rather used the Fisher z-transformation, which states that under the assumption that two samples are drawn from two independent bivariate normal distributions with the same correlation coefficient, the difference between $\frac{1}{2}ln[\frac{1+\hat{\rho}^h}{1-\hat{\rho}^h}]$ and $\frac{1}{2}ln[\frac{1+\hat{\rho}^l}{1-\hat{\rho}^l}]$ for the two samples converges to the normal distribution $N(0, \frac{1}{N_h-3} + \frac{1}{N_l-3})$.

[3]The Fisher z-transformation is generally defined as $T = \frac{z_h - z_l}{var(z_h - z_l)}$.

3.4 Data and empirical results

The empirical analysis of this chapter uses continuously compounded daily closing prices (obtained from data-stream) for general market indices of the six GCC stock markets and the U.S. stock market, namely, the Bahrain Stock Exchange (BSE) all-share index, the Kuwait Stock Exchange (KSE), the Oman Muscat Securities Market (MSM) index, the Qatar Doha Securities Market (DSM) index, the Saudi stock market (Tadawul) all-share index, the United Arab of Emirates Dubai Financial Market (DFM) index, and the New York Stock Exchange (NYSE). The data cover the period from January 2, 2003, to May 31, 2013, for each GCC stock market as well as the NYSE. I divided the data into two sub-samples: before and after the global economic and financial crisis.

The goal of this chapter is to investigate the effect of the recent financial crisis, which originated in the U.S. stock market after the bankruptcy of the Lehman Brothers bank in September 2008, on the stock markets of the GCC countries, and to determine whether the sharp falls in these markets were due to the existence of contagion or whether they just reflected a continuation of the strong economic and financial linkages between the GCC and the U.S. economies that exist in all state of the world, during good and bad times.

Using the date of Lehman Brothers's declaration of bankruptcy as a benchmark for the crisis date of the contagion test, I split the sample period under investigation into two sub-periods: the stable period (before crisis), which is the period from January 2, 2003, to September 14, 2008, and the turmoil period (after crisis), which is the period from September 15, 2008, until the end of the sample. Then, the VAR model is estimated as in equations 3.15 and 3.16, using the Schwarz Information Criteria (SIC) for the two sub-periods (Tables 3.1 *and* 3.2). After that, I calculate the cross-market correlation coefficients (conditional and unconditional) between the U.S. and each of the GCC counties' stock markets using the variance-covariance matrix estimates for the stable period, the turmoil period, and the full period. Finally, I test for the existence of contagion as a significant increase in the correlation coefficients during the turmoil period using the Fisher transformation, as in equation 3.24.

As a starting point, I would like to show how, when applying the conditional correlation, heteroskedasticity can bias the cross-market correlation coefficients upwards from the GCC stock markets' perspective, compared to when the adjusted or unconditional correlation coefficients are employed. As argued by Forbes and Rigobon (2002), using the unadjusted or conditional correlation coefficients can be misleading and inappropriate in the sense that the estimated correlation coefficients are considered an increasing function of the variance of the crisis country's asset returns. So when the sample is divided into two sub-periods (stable and turmoil periods) the unadjusted correlation coefficients are biased upwards, especially after the turmoil period, since volatility tends to be higher in crisis time than in tranquil times, which can lead to false inferences when testing contagion across markets.

In this regard, Figures 3.2 : 3.7 plot the conditional, or unadjusted, correlations (red line) and the unconditional, or adjusted, correlations (blue line) between the U.S stock market (NYSE) and each of the GCC stock markets of Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the UAE. The conditional and unconditional correlation coefficients are calculated as a fixed rolling window for 90 trading days, using equation 3.13 for the conditional correlation and its adjustment specification (equation 3.14) for the unconditional correlation.

As shown in the six graphs mentioned above, the conditional and the unconditional correlations seem to move together; however, especially after the collapse of of the Lehman Brothers (which is defined as the crisis period), the conditional correlation is significantly greater than the unconditional correlation in absolute values, which proves the upward bias in all cases of the six GCC stock markets. These examples verify Forbes and Rigobon (2002)'s criticism of previous studies, in which the conditional correlation coefficients were used to investigate the existence of contagion across stock markets due to the heteroskedasticity resulted from the bias in stock market returns.

Before proceeding to the empirical results in detail, I would like to summarize the main findings of this section. Despite the obvious upward trend of the conditional correlation coefficients in the graphs 3.2 : 3.7, as will be shown later in this section, the tests based on both the conditional and unconditional correlation coefficients between U.S. and each of the GCC stock markets do not contradict in their conclusions, and both tests find a significant increase in cross-market correlations for Oman, Qatar, Saudi Arabia, and the UAE. These results mean that the bias caused by heteroskedasticity does not affect contagion results for these four stock markets and that one can conclude that contagion was transmitted from the U.S. stock market to the stock markets of Oman, Qatar, Saudi Arabia, and the UAE after the global economic and financial crisis in 2008. On the other hand, in the case of Kuwait, I find some evidence of contagion from the U.S. stock market after the Lehman Brothers collapse when conditional correlation is applied, but when the contagion test based on the adjusted correlation is used, I do not find any significant increase in cross-market correlation between Kuwait and U.S. stock markets after the collapse of Lehman Brothers. Hence, the relationship between the two markets is rather interdependent, and no contagion has occurred from the U.S. financial crisis to Kuwait's stock market. This result can be considered supportive evidence for Forbes and Rigobon (2002), in that the bias in the cross-market conditional correlation coefficients generated by the heteroskedasticity in U.S. stock market returns caused this conflicting conclusion. Finally, in the case of Bahrain, neither the contagion test based on conditional correlation coefficients nor the test based on unconditional correlation coefficients find any contagion between the Bahrain and U.S. stock markets. Hence, the linkage between the U.S. stock market as a crisis country and Bahrain's stock market as a non-crisis country remained relatively the same after the crisis period, and no contagion has occurred. From this, one can conclude that the recent U.S. financial crisis has not affected the Bahrain stock market.

Table 3.3 reports the estimated conditional (unadjusted) correlation coefficients for the U.S. and each of the GCC country pairs during the three periods (stable, turmoil, and full sample periods) as well as the test statistic results by which contagion is indicated. Contagion has occurred if the value of the test statistic is greater than the critical value of the t-test at a significant level of 10%, 5%, or 1%. Therefore, any test statistic value greater than any of these critical values denotes contagion; on the other hand, any test statistic value less than or equal to any of these critical values suggests no contagion.

Surprisingly, and despite the the strong economic and financial linkages between the U.S. economy and the economies of the GCC countries, the cross-market correlation coefficients between U.S. stock markets and each of the GCC stock markets during the stable period (before crisis) are relatively low. In particular, the conditional correlation coefficients vary, with the highest (.07) being found for Kuwait, .05 for Bahrain, .03 for Oman, .02 for the UAE, and -.01 for both Qatar and Saudi Arabia. However, the picture has changed dramatically since the financial crisis. The cross-market conditional correlation coefficients between the U.S. and all the GCC stock markets-except Bahrain-have increased since the turmoil period, which is considered a prerequisite for the existence of contagion. This change is especially remarkable in the cases of Saudi Arabia and the UAE-in which the conditional correlation coefficients increase significantly from -.01 to .55 and from .02 to .42, respectively-as these two markets are the largest of the GCC stock markets with regard to total market capitalization. In the case of Qatar, the conditional correlation coefficient increases from -.01 during the stable period (before crisis) to .30 after the crisis period; with regard to Kuwait and Oman, the conditional correlation coefficient increases from .07 to .14 and from .03 to .23, respectively. Finally, Bahrain is the only case whose conditional correlation coefficient remains stable or slightly decreases after the turmoil period, decreasing from .05 to .04.

Furthermore, the t-test results in Table 3.3 suggest a significant increase in the conditional correlation coefficients after the turmoil period, such that the null hypothesis of no contagion is rejected at 1% significance level in the case of the stock markets of Oman, Qatar, Saudi Arabia, and the UAE and at a 5% significance level in the case of Kuwait. According to the contagion definition adopted in this chapter, these empirical results imply that contagion has occurred from the U.S. financial crisis (labelled by the collapse of Lehman Brothers) to the stock markets of Kuwait, Oman, Qatar, Saudi Arabia, and the UAE. However, in the case of Bahrain, the t-test results show that the null hypothesis of no contagion from the U.S. stock market to the Bahrain stock market is failed to be rejected at any conventional level of significance. This result indicates that the Bahrain stock markets was not affected by the U.S. financial crisis due to the fact that Bahrain stock market is the smallest and one of the most illiquid stock markets of all the GCC stock markets.

However, as mentioned before, these tests, which are based on the conditional correlation coefficients, may be inappropriate and inaccurate due to the bias caused by heteroskedasticity in the market returns. This estimated increase in the correlation coefficients might reflect either an increase in cross-market linkages and/or an increase in market volatility (Forbes and Rigobon (2002)). In order to investigate the extent to which the bias in the correlation coefficients may change or affect the test results for contagion, I repeat the above analysis using the adjusted or unconditional correlation coefficients proposed by Forbes and Rigobon (2002).

Table 3.4 reports the unconditional cross-market correlation coefficients between the U.S. and each of the GCC stock markets during stable, turmoil, and full periods, as well as the test statistic results by which one can examine whether there is a significant increase in cross-market correlation coefficients after the turmoil period. It is obvious that, after adjusting for the bias, there is a substantial change in the values of the estimated correlation coefficients compared to the values of the estimated conditional correlation coefficients in Table 3.3 for all the GCC countries. In particular, the unconditional correlation coefficients are significantly smaller than the conditional correlation coefficients, with reduction of about 50% of their values, especially after the turmoil period. More specifically, in the cases of Qatar, Saudi Arabia, and the UAE, the unconditional correlation coefficients' values after the crisis period are .16, .32, and .23, respectively, while the conditional correlation coefficients for the same period (Table 3.3) are .30, .55, and .42, respectively. In the cases of Bahrain, Oman, and Kuwait, the unconditional correlation coefficients' values after the turmoil period reach .02, .07, and .12 respectively, while the values of the conditional correlation coefficients were .04, .14, and .23, respectively, for the same period (Table 3.3).

Interestingly, and despite the notable changes in the values of the correlation coefficients after adjusting for the bias resulting from the heteroskedasticity as shown in Table 3.4, the test statistic results still show a significant increase in cross-market correlation coefficients and reject the null hypothesis of no contagion at the 1% level of significance for Oman, Qatar, Saudi Arabia, and the UAE, which indicates the existence of a contagion effect from the U.S. stock market to these markets. These results imply that, on contrary to Forbes and Rigobon (2002), although the adjusting for the bias affects cross-market correlation values, the adjustments do not affect the contagion test results obtained when the conditional correlation coefficients are employed for these four stock markets. Hence, one can reach a conclusion that there has been a contagion effect from the U.S. stock market to the stock markets of Oman, Qatar, Saudi Arabia, and the UAE after the global economic financial crisis.

On the other hand, Kuwait is the only case that has a different conclusion than of what I previously found when applied the contagion tests based on the conditional correlation coefficients. Findings show that, in line with Forbes and Rigobon (2002), there is no significant increase in the cross-market correlation coefficient after the crisis period and the null hypothesis of no contagion is failed to be rejected when adjusting for the bias in the conditional correlation coefficients and applying the unconditional correlation. This result implies that no contagion occurred between the U.S. stock market and the Kuwait stock market after the global financial crisis and that the linkage between the two markets can be characterized as, rather, an interdependence. The explanation behind finding no contagion between the U.S. market and the Kuwait market after the U.S. financial crisis can be attributed to the theory of "fundamentals-based contagion", which demonstrates that contagion is transmitted across countries through their real or financial linkages. More specifically, the results in the case of Kuwait might be due to the fact that the Kuwait economy, compared to the other GCC economies, is relatively less linked to the U.S. economy in the sense that Kuwait is the only GCC country that does not fix its currency exchange rate to the U.S. dollar and that Kuwait has a more independent monetary policy than its GCC counterparts. This is also supported by the empirical analyses in that Kuwait has the smallest (after Bahrain) cross-market correlation among the GCC countries after the turmoil period. Furthermore, this result can be considered supportive evidence for what Forbes and Rigobon (2002) argued about regarding the effect of the bias generated by heteroskedasticity on contagion tests based on conditional correlation coefficients. In other words, in the case of Kuwait, due to the bias effect, findings show two different conclusions when testing for the existence of contagion. According to tests based on conditional correlation coefficients, contagion is detected; however, when tests based on unconditional correlation coefficients are applied, the contagion effect disappears and there is no evidence of contagion between the two markets after the global financial crisis.

Finally, in the case of Bahrain, the results do not conflict with what I previously found when using the conditional correlation coefficients. In particular, the test results in Table 3.4 do not reject the null hypothesis at any level of significant and, hence, one can conclude that no contagion occurred between U.S. and Bahrain stock markets after the global financial crisis.

As a robustness check and in order to examine the extent to which any modifications in the base analysis would affect the main results of contagion, as shown in Tables 3.3 and 3.4, I first change the definition of the crisis period. It is widely believed that the global financial crisis was initially triggered by the eruption of the U.S. mortgage bubble (housing market) (Phillips and Yu (2011), Mishkin (2010), and Bekaert et al.

(2012)). In this scenario, however, the sub-prime crisis of August 2007 is defined as an alternative starting point to the financial crisis. Hence, the definitions for the stable and turmoil periods are modified to be January 2, 2003, to July 31, 2007, and August 1, 2007 to May 31, 2013, respectively. As shown in Tables 3.5 and 3.6, these modifications do not alter the primary results previously shown in Tables 3.3 and 3.4. In particular, when I apply contagion tests based on the conditional correlation coefficients, there is evidence of contagion in the same five countries-namely, Kuwait, Qatar, Oman, Saudi Arabia, and the UAE-and no evidence for contagion in the case of Bahrain. On the other hand, the test also shows-as I found previously-that Kuwait is the only case that has contradictory results between the conditional and unconditional correlations in that the evidence of contagion disappears when unconditional correlation coefficient is used.

For a second set of sensitivity tests, I apply other test specifications. More specifically, I compare the cross-market correlation coefficients during the turmoil period with those of the full period rather than the stable period for both conditional and unconditional correlation coefficients, as was previously tested in the base analysis. These test specifications do not have any significant impact on the main results, as shown in Table 3.7. In the final set of robustness checks, instead of using the VAR model to estimate the residual-based variance-covariance matrices (by which the cross-market correlation coefficients are estimated), I use pairwise simple correlations to estimate both the conditional and the unconditional cross-market correlations of the stock markets returns between the U.S. stock market and each of the GCC stock markets. Tables 3.8 and 3.9 report the estimated cross-market correlation coefficients during the stable, turmoil, and full periods as well as the results for testing the null hypothesis of no contagion for each pair of countries. Using the pairwise simple correlation between stock markets returns in fact confirms the previous overall findings obtained when the VAR model was used and, hence it does not have any significant impact on the main results.

3.5 Conclusion

The main findings of this chapter are that tests based on both the conditional and unconditional correlation coefficients between the U.S. stock market and each of the

GCC stock markets did not contradict in their conclusions in that both tests found a significant increase in cross-market correlations for Oman, Qatar, Saudi Arabia, and the UAE. These results mean that the bias caused by heteroskedasticity did not affect the contagion results for these four stock markets and that one can conclude that contagion has been transmitted from the U.S. stock market to the stock markets of Oman, Qatar, Saudi Arabia, and the UAE after the global economic and financial crisis. On the other hand, in the case of Kuwait, I found some evidence of contagion from the U.S. stock market after the Lehman Brothers collapse when conditional correlation was applied, but I did not find any significant increase in cross-market correlation between the Kuwait and U.S. stock markets when the contagion test based on the adjusted correlation was used. Hence, the relationship between the two markets is rather independent, and no contagion has occurred from the U.S. financial crisis to Kuwait. This result can be considered supportive evidence for Forbes and Rigobon (2002) in that the bias in the cross-market conditional correlation coefficients generated by the heteroskedasticity in the U.S. stock market returns caused this conflicting conclusion. Finally, for Bahrain, neither the contagion test based on conditional correlation coefficients nor the test based on unconditional correlation coefficients found any contagion between the Bahrain and U.S. stock markets. Hence, the linkage between the U.S. stock market as a crisis country and the Bahrain stock market as a non-crisis country has remained relatively the same after the crisis period, and no contagion has occurred. From this, one can conclude that the recent U.S. financial crisis has not affected the Bahrain stock market.

Furthermore, as a policy implication, findings suggest that policy makers in the GCC countries need to strengthen the ability of the financial system to absorb the adverse impact of any financial crisis. This can be done by improving regulations and supervisory frameworks at domestic levels, increasing the depth of the GCC financial markets, and pursuing a coordinated set of policies among the GCC countries as a bloc (which would also be beneficial for the formation of the GCC Monetary Union) in order to be capable of reducing the exposure to international financial contagions in periods of crisis.

Country	USA	BA	KU	OM	QA	SA	DU
BA_{-1}	-.009	.15⊗					
USA_{-1}	-.09⊗	.004					
KU_{-1}	-.02		-.07⊗				
USA_{-1}	-.09⊗		.08⊗				
OM_{-1}	.00			.09⊗			
USA_{-1}	-.09⊗			-.01			
QA_{-1}	-.01				.33⊗		
USA_{-1}	-.09⊗				.07**		
SA_{-1}	-.00					.05**	
USA_{-1}	-.09⊗					.15⊗	
DU_{-1}	.00						.02
USA_{-1}	-.09⊗						.16⊗

∗,∗∗ and ⊗ indicates significant at 10, 5, and 1% levels, respectively.

Table 3.1: Vector Auto-Regression (VAR) estimates for each GCC stock market and the NYSE market before crisis (2-1-2003 to 14-9-2008).

Country	USA	BA	KU	OM	QA	SA	DU
BA_{-1}	-.02	.14⊗					
USA_{-1}	-.09⊗	.04⊗					
KU_{-1}	-.00		.14⊗				
USA_{-1}	-.09⊗		.09⊗				
OM_{-1}	-.02			.20⊗			
USA_{-1}	-.09⊗			.22⊗			
QA_{-1}	.031				.09⊗		
USA_{-1}	-.09⊗				.32**		
SA_{-1}	.14⊗					-.04	
SA_{-2}	.00					.02	
USA_{-1}	-.13⊗					.25⊗	
USA_{-2}	-.09⊗					.07**	
DU_{-1}	.00						-.01
DU_{-2}	.00						.12⊗
USA_{-1}	-.10⊗						.27⊗
USA_{-2}	-.52						.02

∗,∗∗ and ⊗ indicates significant at 10, 5, and 1% levels, respectively.

Table 3.2: Vector Auto-Regression (VAR) estimates for each GCC stock market and the NYSE market after crisis (15-9-2008 to 31-5-2013).

Country	Bahrain	Kuwait	Oman	Qatar	Saudi Arabia	UAE
$\rho_{pre-crisis}$	.05	.07	.03	-.01	-.01	.02
$\rho_{post-crisis}$	.04	.14	.23	.30	.55	.42
$\rho_{full-period}$	.05	.10	.16	.18	.28	.27
Test Statistics	-0.22	1.79**	5.43$^{\otimes}$	8.41$^{\otimes}$	16.5$^{\otimes}$	10.36$^{\otimes}$
Contagion	NO	YES	YES	YES	YES	YES
N $_{pre-crisis}$	1485	1485	1485	1485	1485	1226
N $_{post-crisis}$	1230	1230	1230	1230	1230	1230

*,** and ⊗ indicates significant at 10, 5, and 1% levels, respectively.

TABLE 3.3: Lehman Brothers bankruptcy: Conditional correlation coefficients.

Country	Bahrain	Kuwait	Oman	Qatar	Saudi Arabia	UAE
$\rho_{pre-crisis}$	.02	.03	.01	-.00	-.00	.01
$\rho_{post-crisis}$	.02	.07	.12	.16	.32	.23
$\rho_{full-period}$	.02	.05	.08	.09	.15	.14
Test Statistics	-0.11	.92	2.80$^{\otimes}$	4.36$^{\otimes}$	8.84$^{\otimes}$	5.45$^{\otimes}$
Contagion	NO	NO	YES	YES	YES	YES
N $_{pre-crisis}$	1485	1485	1485	1485	1485	1226
N $_{post-crisis}$	1230	1230	1230	1230	1230	1230

*,** and ⊗ indicates significant at 10, 5, and 1% levels, respectively.

TABLE 3.4: Lehman Brothers bankruptcy: Unconditional correlation coefficients.

Country	Bahrain	Kuwait	Oman	Qatar	Saudi Arabia	UAE
$\rho_{pre-crisis}$	.04	.09	.004	-.02	-.16	-.04
$\rho_{post-crisis}$	.06	.14	.23	.30	.55	.42
$\rho_{full-period}$	.05	.11	.18	.20	.31	.32
Test Statistics	.53	1.41*	$5.99^{\otimes}$	$8.59^{\otimes}$	$19.9^{\otimes}$	$11.76^{\otimes}$
Contagion	NO	YES	YES	YES	YES	YES
N $_{pre-crisis}$	1192	1192	1192	1192	1192	933
N $_{post-crisis}$	1523	1523	1523	1523	1523	1523

$*$,$**$ and $\otimes$ indicates significant at 10, 5, and 1% levels, respectively.

TABLE 3.5: U.S. sub-prime crisis: Conditional correlation coefficients.

Country	Bahrain	Kuwait	Oman	Qatar	Saudi Arabia	UAE
$\rho_{pre-crisis}$	.02	.03	.01	-.00	-.00	.01
$\rho_{post-crisis}$	.02	.07	.12	.16	.32	.23
$\rho_{full-period}$	.02	.05	.08	.09	.15	.14
Test Statistics	.25	.64	$2.74^{\otimes}$	$3.95^{\otimes}$	$9.43^{\otimes}$	$5.45^{\otimes}$
Contagion	NO	NO	YES	YES	YES	YES
N $_{pre-crisis}$	1192	1192	1192	1192	1192	933
N $_{post-crisis}$	1523	1523	1523	1523	1523	1523

$*$,$**$ and $\otimes$ indicates significant at 10, 5, and 1% levels, respectively.

TABLE 3.6: U.S. sub-prime crisis: Unconditional correlation coefficients.

Country	$H_0 : \rho_C^l > \rho_C^h$	$H_0 : \rho_C^f > \rho_C^h$	$H_0 : \rho_{UN}^l > \rho_{UN}^h$	$H_0 : \rho_{UN}^f > \rho_{UN}^h$
Bahrain	-.22	-.08	-.11	-0.04
Kuwait	1.78**	1.47*	.92	.58
Oman	5.43⊗	2.28**	2.80⊗	1.19
Qatar	8.41⊗	3.82⊗	4.36⊗	2.10**
Saudi-Arabia	16.5⊗	9.70⊗	8.84⊗	5.33⊗
UAE	10.36⊗	4.67⊗	5.45⊗	2.60⊗

∗,∗∗ and ⊗ indicates significant at 10, 5, and 1% levels, respectively.

Table 3.7: Comparing contagion test hypothesis using stable-period (l) vs turmoil-period (h), and full-period (f) vs turmoil-period for both conditional (ρ_C) and unconditional (ρ_{UN}) cross-market correlations.

Country	Bahrain	Kuwait	Oman	Qatar	Saudi Arabia	UAE
$\rho_{pre-crisis}$	.05	.01	.05	-.03	-.02	.008
$\rho_{post-crisis}$	.02	.10	.15	.22	.48	.35
$\rho_{full-period}$	.03	.06	.12	.13	.27	.23
Test Statistics	-1.06	2.20**	2.61⊗	6.31⊗	14.06⊗	8.84⊗
Contagion	NO	YES	YES	YES	YES	YES
$N_{pre-crisis}$	1485	1485	1485	1485	1485	1226
$N_{post-crisis}$	1230	1230	1230	1230	1230	1230

∗,∗∗ and ⊗ indicates significant at 10, 5, and 1% levels, respectively.

Table 3.8: Lehman Brothers bankruptcy: Conditional correlation coefficients using pairwise simple correlations between the U.S. and the GCC stock markets returns.

Country	Bahrain	Kuwait	Oman	Qatar	Saudi Arabia	UAE
$\rho_{pre-crisis}$	.03	.006	.025	-.01	-.008	.004
$\rho_{post-crisis}$	.009	.05	.08	.12	.27	.19
$\rho_{full-period}$	.03	.03	.01	-.005	-.006	.01
Test Statistics	-0.54	1.11	1.56^{*}	$3.38^{\otimes}$	$7.38^{\otimes}$	$4.67^{\otimes}$
Contagion	NO	NO	YES	YES	YES	YES
N $_{pre-crisis}$	1485	1485	1485	1485	1485	1226
N $_{post-crisis}$	1230	1230	1230	1230	1230	1230

$*$,$**$ and $\otimes$ indicates significant at 10, 5, and 1% levels, respectively.

TABLE 3.9: Lehman Brothers bankruptcy: Unconditional correlation coefficients using pairwise simple correlations between the U.S. and the GCC stock markets returns.

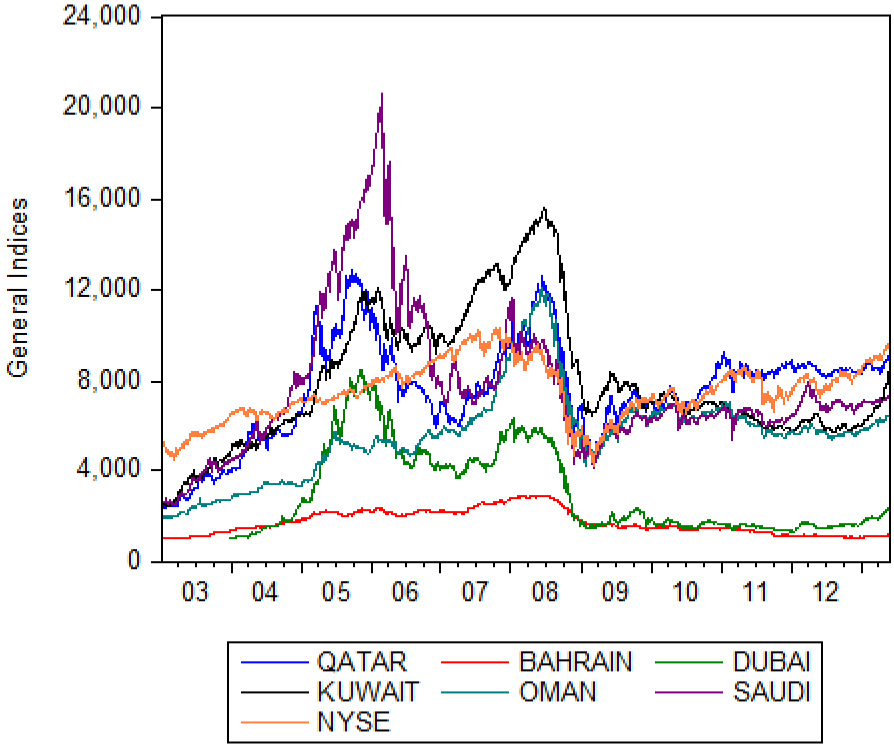

FIGURE 3.1: GCC Stock market general indices.

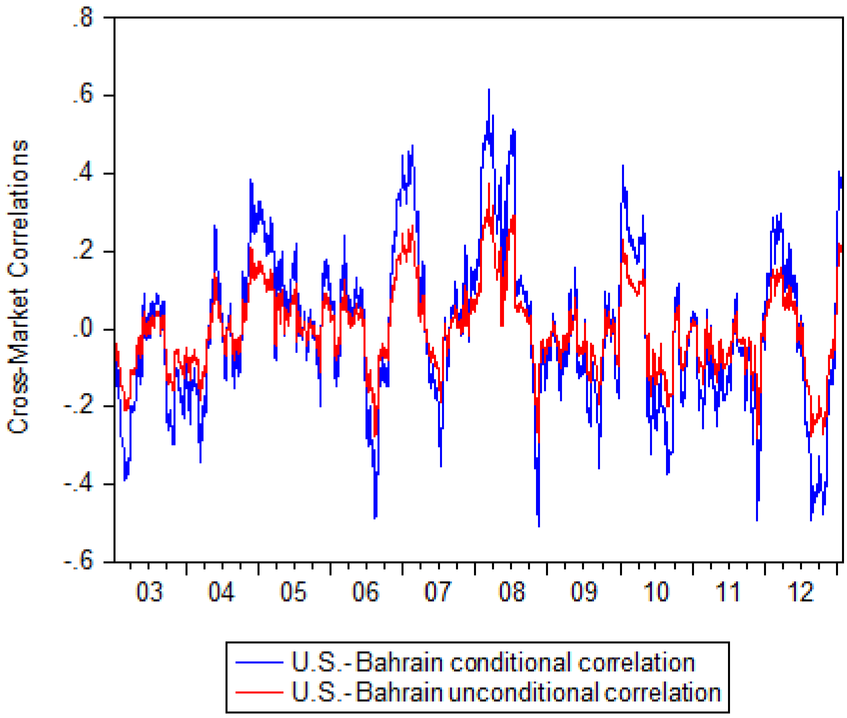

FIGURE 3.2: Cross-Market Correlation between the U.S and Bahrain stock markets.

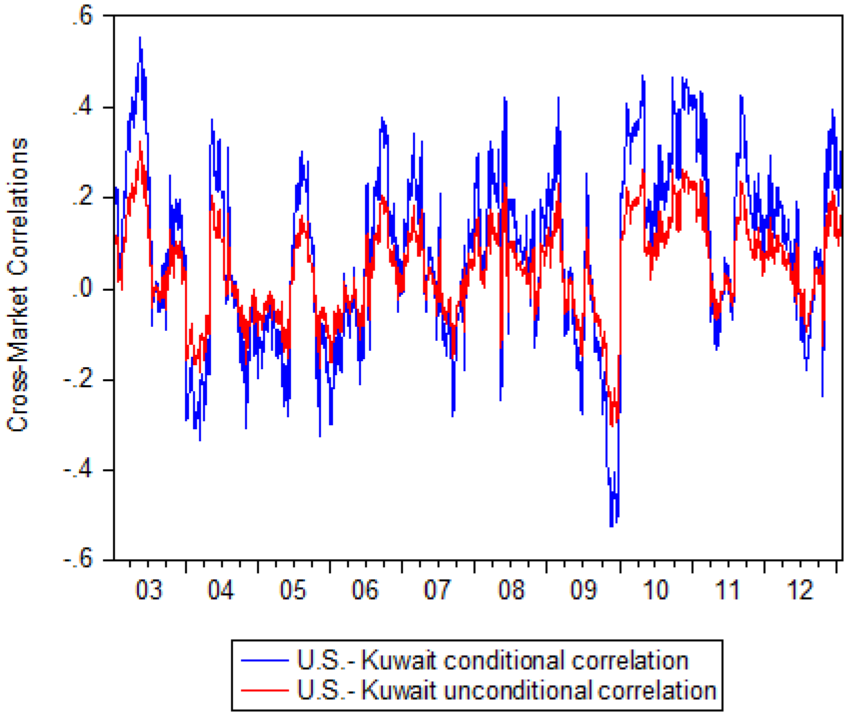

FIGURE 3.3: Cross-Market Correlation between the U.S and Kuwait stock markets.

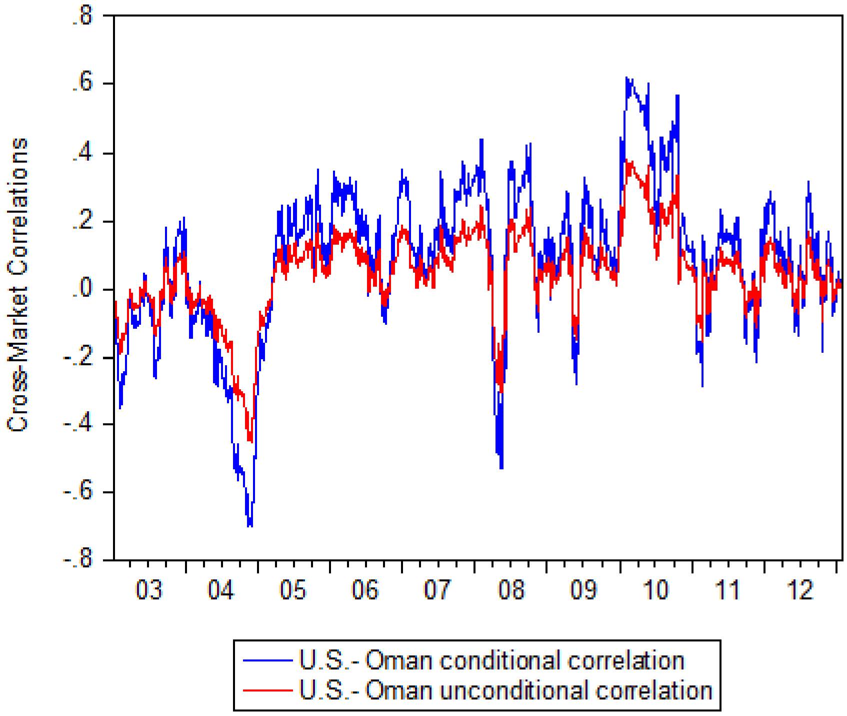

FIGURE 3.4: Cross-Market Correlation between the U.S and Oman stock markets.

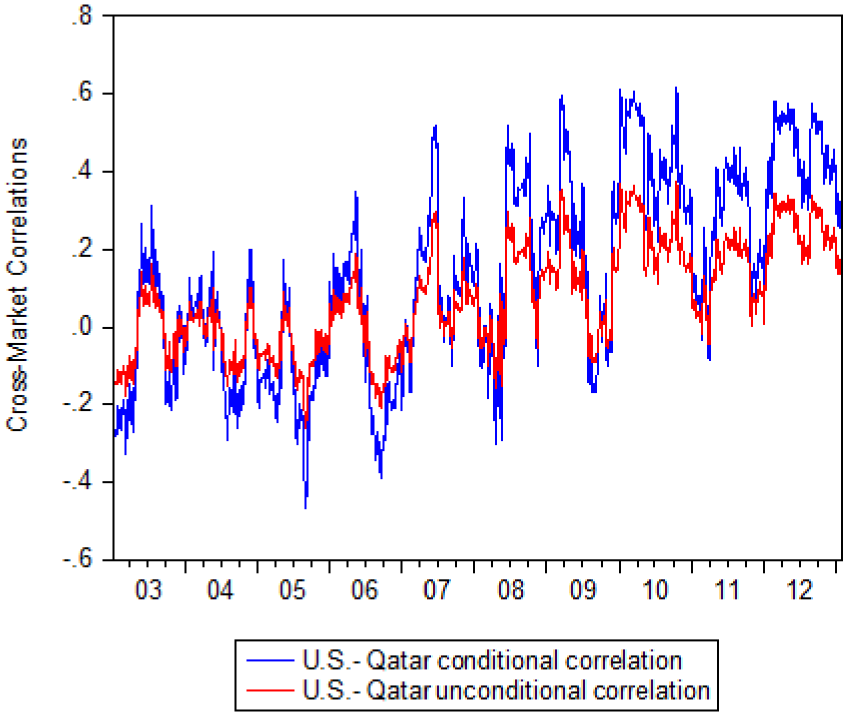

FIGURE 3.5: Cross-Market Correlation between the U.S and Qatar stock markets.

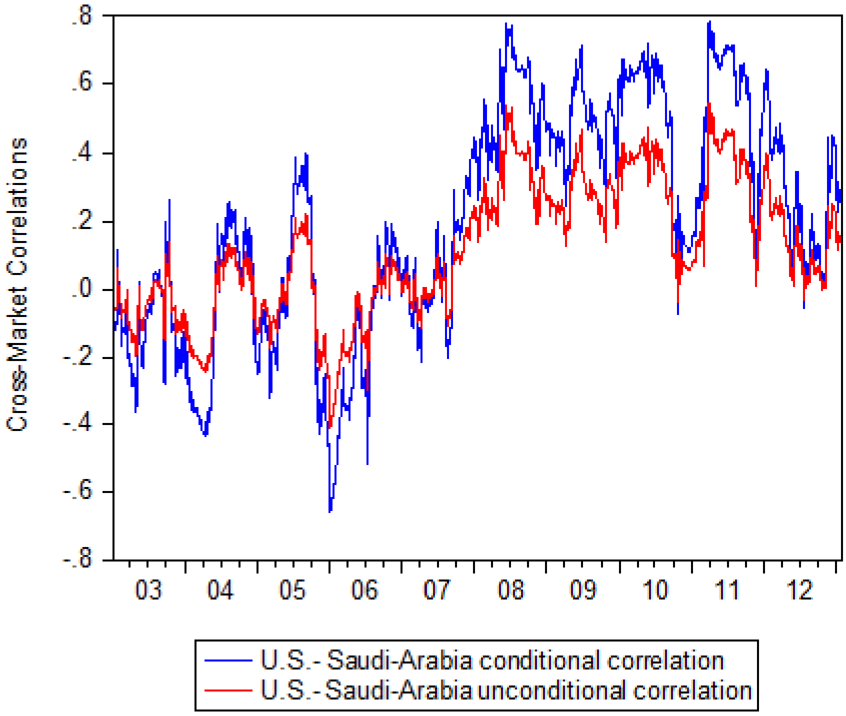

FIGURE 3.6: Cross-Market Correlations between the U.S and Saudi Arabia stock markets.

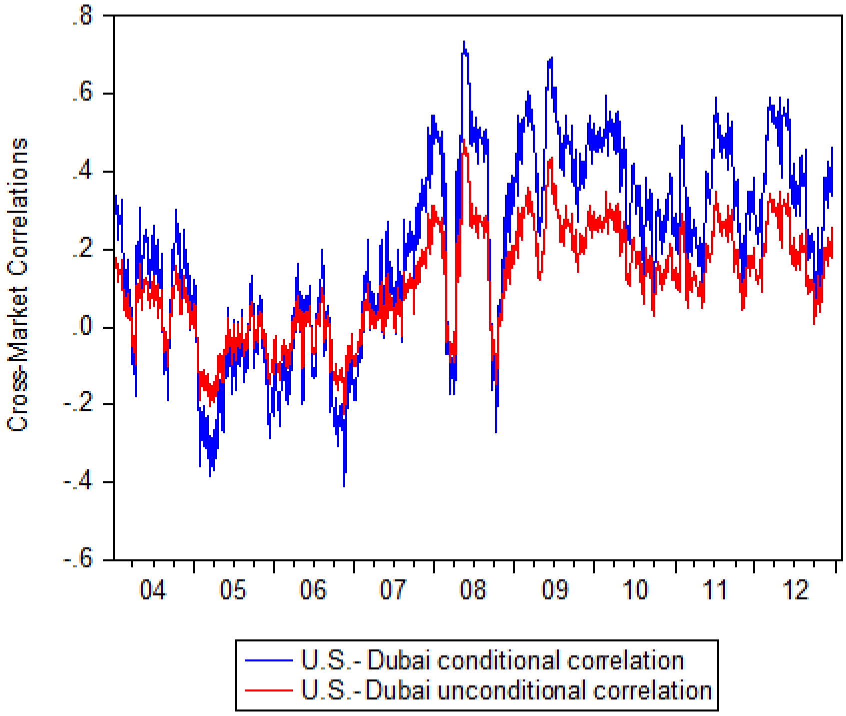

Figure 3.7: Cross-Market Correlations between the U.S and UAE stock markets.

Chapter 4

GCC Monetary Policies: Does the peg matter?

4.1 Introduction

Policy makers in open economies (GCC countries are well known in the literature of international economics as open but rather small economies (Khan (2009), Willett et al. (2010))) are faced with a choice in terms of the impossible trinity-also known as the open economy trilemma (Obstfeld and Taylor (1999))-which is to simultaneously achieve three incompatible policy goals: an independent monetary policy, free capital movement, and a fixed exchange rate. A country can choose only two of the above three goals, while the third goal has to be sacrificed. In other words, under a fixed exchange rate regime and free capital mobility, it becomes impossible to use monetary policy for the purpose of stabilising the domestic economy. Moreover, the domestic nominal interest rate must follow the nominal interest rate of the base country-the country to which the exchange rate is pegged. In contrast, a flexible exchange rate regime allows the domestic central bank to pursue its own monetary policy, even if capital mobility is perfect and the domestic interest rate is set independently of international or foreign interest rates.

This chapter explores the joint dynamics of domestic and base country interest rates in the context of the GCC countries whose exchange rates have been pegged to the U.S. dollar throughout either the entire history of data availability or over given sub-periods of this history. An extensive research agenda in international economics literature has sought to document the extent of co-movements in interest rates experienced by pegged versus non-pegged countries and whether non-pegged currencies truly have a greater degree of autonomy, given the high degree of capital market integration. In a recent debate, Hausmann et al. (1999), Frankel et al. (2004), and Calvo Guillermo and Reinhart (2002) argued that neither pegged countries nor non-pegged (or floating) countries, other than the major economies of the U.S., the EU, Japan, and UK, have monetary autonomy. Hence, all countries must follow the changes in the interest rates set by the major currencies. This debate has led to disagreements and mixed results amongst economists with regard to the implications of fixing exchange rates on monetary policy. In other words, with the exception of the largest economies, all countries lack monetary independence, with no differences between fixed and non-fixed exchange rate countries. Hence, fixing the exchange rate does not lead to a loss of monetary freedom because countries do not have flexible monetary policies even if they float their currencies. Moreover, it has been argued that interest rates in flexible developing countries' regimes may be more sensitive to U.S. interest rates movements than those in pegged countries. Shambaugh (2004), however, disagreed with these views. The author found evidence showing that countries with fixed exchange rates follow the interest rate of the base country more closely than countries with flexible exchange rates and that those countries with floating exchange rates have more monetary autonomy than those with pegged exchange rates.

The goal of this chapter is to investigate the linkages between domestic and U.S. short-term interest rates in the context of six GCC countries, to explore their distinguishing features, and to analyse country-specific factors that may affect the strength of such co-movements. In other words, this chapter aims to assess the sensitivity of the GCC countries' interest rates to the U.S. rate, since the theory of interest parity suggests that fixing GCC exchange rates to the U.S. dollar should force GCC domestic interest rates to equal the U.S. interest rate. This chapter will also, interestingly, attempt to assess the stability of this sensitivity across time and to investigate whether there exists a pronounced decoupling for some GCC countries over some sub-periods. Moreover, the fact that some of the GCC countries (e.g., Kuwait) have pegged their currencies to the U.S. dollar over specific sub-periods, then moved away from the peg over other sub-periods, also gives us a rich setting in which to investigate the implications of fixing the exchange rate on monetary policy and to determine whether a country's interest rate has a stronger association with a base country's interest rate under a pegged period than under a non-pegged period. Also, studying the linkages between domestic and U.S. short-term interest rates in the context of six GCC countries is an important issue, since the harmonization of monetary policy among the GCC countries is a priority if the planned monetary union is to be achieved, especially with the existence of a common central bank, which will be in charge of conducting a single monetary policy among the member states. This is because, if it turns out that all the GCC countries follow the U.S. monetary policy equally, one can conclude that the GCC countries have achieved a harmonization in their monetary policies that is required to make the common currency a success and to allow all members to reap full benefits from it.

To the best of my knowledge, this is the first study to investigate the effect of fixing the exchange rate regime on monetary policy in the context of the GCC countries using the Uncovered Interest Parity (UIP). In addition, none of the existing literature on the GCC has empirically tackled the issue of whether fixing GCC exchange rates to the U.S. dollar enforces a harmonization among their monetary policies. The absence of such a reliable empirical investigation of the integration of GCC monetary policies makes it extremely difficult to conclude that the GCC monetary policies are integrated due to the countries fixing their currencies to the U.S. dollar.

Empirically, this chapter utilizes the Ordinary Least Squares (OLS) level regression for the UIP to investigate the implications of fixing the exchange rate on the autonomy of monetary policy in the context of the GCC countries, using the three-month U.S. LIBOR as well as monthly data for the three-month interbank rates over the period from January 1993 to June 2013 for all the GCC countries (except Oman).[1] [2] The choice to use the interbank rates as a proxy for monetary policy rates derives from the fact that the GCC central banks conduct monetary policy by using a diverse range of direct instruments, for which the data are not available over a long horizon period. In particular, the central bank overnight rate for Bahrain; the repo and discount rate for Kuwait; the overnight central bank and certificates of deposit rates for Oman; the Qatar Central Bank lending and deposit rates for Qatar, the reverse repo rate for

[1] As a sensitivity analysis, I will use another base country's interest rate, which is the U.S. three-month treasury bill rate.

[2] Due to data unavailability, the Oman interbank series runs from January 1993 to June 2009.

Saudi Arabia; and the certificates of deposit rate for the UAE are not available. Additionally, the interbank interest rate has been widely used as a reflection of monetary policy transmission, and due to the fact that the three-months interbank rate is the only short-term interest rate series that is available for all the GCC countries over the entire sample from 1993 to 2013. Hence, the interbank rates can be considered quite a good indicator of the monetary policy stance of GCC central banks and monetary authorities (Espinoza and Prasad (2012)). Furthermore, I apply the Quandt-Andrews procedure pioneered by Quandt (1960) (also called Sup-Wald statistic) in order to assess the stability of the interest rate sensitivity of each individual GCC interest rate to that of the U.S. rate as a base country across time and to determine the timing of any potential structural breaks at which these interest rates sensitivities change. Finally, I apply the Error Correction Model (ECM) in order to capture the long-run dynamic behaviours between the GCC and the U.S. interest rates.

Findings show that, except for Qatar and the UAE, the parity condition holds for the GCC countries, and the GCC countries' interest rates precisely follow the U.S. rate for the entire sample under investigation. On the other hand, the empirical results confirm that, for some countries (e.g., Qatar, Saudi Arabia, and the UAE) over some periods, particularly after the collapse of Lehman Brothers, there exists a pronounced decoupling from the base country interest rate (U.S. rate), which is considered a contradiction to the theory of interest parity. This remarkable deviation from the U.S. interest rate is attributed to some external factors (e.g., the financial crisis) as well as some country-specific factors(e.g., inflation and the risk premium). More specifically, while monetary authorities in the U.S. continued to lower interest rates after the global economic and financial crisis in 2008, the Qatar, Saudi Arabia, and UAE economies witnessed double-digit inflation rates in the year of 2008 (with rates of 15%, 10%, and 13%, respectively). These high inflation rates are caused by some country-specific domestic factors, such as the increases in the supply of credit, strong domestic demand, and a lack of supply in the real estate market (Morsy and Kandil (2009)). In order to curb such high inflation rates, the monetary authorities of Qatar, Saudi Arabia, and the UAE did not follow the U.S.'s lead in reducing interest rates, which explains their departures from the interest rate parity during this sub-period. With regard to Kuwait, I find strong evidence consistent with the findings of Shambaugh (2004). In particular, the Kuwait interest rate was more sensitive to the U.S. rate during the pegged period than during the other two periods (the pre-pegged period and the de-pegged period). Hence, one can conclude that pegging the exchange rate forces countries to follow the base country interest rate more than they would do if the exchange rate was not pegged.

This chapter is organized as follows. Section 4.2 undertakes a brief survey of the relevant literature. Section 4.3 describes the methodology adopted for the study and presents the empirical results. Section 4.4 concludes the chapter.

4.2 Literature review

In recent work, monetary autonomy has been at the heart of a debate over the nature of exchange rate regimes and their implications on monetary policy. This debate has led to mixed results and disagreements amongst economists. Empirically, this issue has been investigated through comparisons of the sensitivity of a domestic country's interest rate to changes in a base country's interest rate across pegged and non-pegged exchange rate regimes. Some studies have found evidence consistent with an alternative view, which argues that countries with fixed exchange rate regimes are less sensitive to changes in a base country's interest rate than those with floating exchange rate regimes. In one of these studies, Hausmann et al. (1999) investigated the sensitivity of domestic interest rates in three Latin American economies with different exchange rate regimes to foreign interest rates from 1997 to 1999. The authors found that Mexico, which floats its exchange rate, was the most sensitive to U.S. interest rate changes, while Argentina, which has a fixed exchange rate, reacted the least to U.S. interest rate changes. In addition, the study concluded that there was no evidence to suggest that floating exchange rates are better at insulating domestic interest rates from foreign rate movements, signalling that floating exchange rate economies do not have monetary autonomy. Furthermore, in his earlier work, Frankel (1999) conducted a similar investigation on the effect of changes in the U.S. interest rate as a base country on the domestic rates for Mexico, Argentina, Brazil, Hong Kong, and Panama during the period from 1993 to 1998 and found some evidence in line with the alternative view. In particular, the author found that the effect of changes in the U.S. interest rate as a base country is larger in countries with floating exchange rate regimes (e.g., Mexico and Brazil), than in countries with fixed exchange rate regimes (e.g., Argentina, Hong Kong, and Panama). By contrast, in their recent study, Frankel et al. (2004) used level regression to examine whether the choice of exchange rate regime affects the sensitivity of domestic interest rates to international interest rates using a sample of 46 countries (18 industrial and 28 developing) during the period from 1970 to 1990. The study found that the interest rates of pegged countries followed the interest rate of the base country more closely than those of non-pegged countries. However, the authors argued that, over the last decade, all exchange rate regimes showed high sensitivities of domestic interest rates to international rates, regardless of their exchange rate regimes. Finally, the authors found that only Germany and Japan did not have long-term relationships with the U.S. interest rate, since these two countries were the only countries that could benefit from independent monetary policies in the 1990's. This last result is consistent with the "fear of floating" phenomenon pioneered by Calvo Guillermo and Reinhart (2002), which stated that only major economies can benefit or choose to benefit from an autonomous monetary policy. These authors showed that many countries that declare a floating exchange rate regime in fact limit their exchange rate flexibility and may not have or use the autonomy attributed to floating rates.

Yet, in his recent paper, Shambaugh (2004) reported some evidence consistent with the traditional view that the interest rates of pegged exchange rate countries should follow the base country's interest rates more than those of non-pegged countries. The author conducted a study of 100 developing and industrial countries from 1993 to 2000. Instead of following the exchange rate regime reported by the International Monetary Fund (IMF), the author created a de facto coding system focusing on the volatility of the exchange rate and divided countries into pegged and non-pegged. The study utilized panel data analysis to examine the interest rate behaviours of pegged economies compared to those of non-pegged economies. The empirical findings of the study showed some strong evidence that pegged countries' interest rates followed changes in the base country's interest rate more closely than those of non-pegged countries. Moreover, using co-integration analysis, the author suggested that, in the long run, interest rates of pegged countries tend to react more quickly to changes in the base country's interest rate than those of non-pegged countries.

Finally, despite the considerable number of studies investigating the implications of exchange rate regimes on monetary policy independence for developed and emerging economies, the GCC economies have received a very little attention from researchers. Only a few researchers have examined the effect of fixing exchange rates on monetary policy in the context of the GCC countries whose exchange rates have been fixed to the U.S. dollar for a long time. To the best of my knowledge, only two studies have tackled this issue. In particular, Abraham (1999) investigated the behaviours of interest rates in a fixed exchange rate regime, especially with respect to the ability of the central bank to maintain its credibility and avoid speculative attacks on government stocks. More specifically, the author examined the possibility of co-integration between the interest rates of a pegged country and that of the base country by studying whether short-term rates in Saudi Arabia and the U.S. could be modelled as a co-integration system from January 1988 to March 1994. The results showed that the null hypothesis of no co-integration between the two interest rates series was not rejected, which indicated that there was no long-run relationship between the Saudi Riyal interest rate and the U.S. rate, despite Saudi Arabia being a pegged country to the U.S. dollar. On the other hand, Esponza et al. (2010) assessed money market integration among the GCC countries from 1993 to 2009 using the measures of interest rate convergence, namely beta-convergence and sigma-convergence. Beta-convergence evaluates whether interest rates in countries with relatively high spreads have a tendency to decrease rapidly compared to those in countries with low spreads. Sigma-convergence is drawn from the growth literature and tests whether cross-country standard deviations of interest rates have a declining trend. Using Saudi Arabia as a country of reference, the authors found strong evidence of convergence among the interest rates of the GCC countries with, estimated half-lives ranging from two to five months in deviation from the Saudi Arabia interest rate, suggesting a fast convergence. With respect to sigma-convergence, they found that convergence slowed down after 2000 as the cross-sectional variation in interest rate spreads increased, especially with the start of the global financial crisis.

4.3 Methodology and empirical results

The goals of this chapter are to investigate the linkages between domestic and U.S. short-term interest rates in the context of six GCC countries, to explore their distinguishing features, and to analyse country- specific factors that may affect the strength of such co-movements. The theory of interest parity suggests that fixing the GCC exchange rate to the U.S. dollar should force the GCC domestic interest rates to equal the U.S. interest rate. Figure 4.1 plots the co-movements of the GCC interest rates and the U.S. interest rate for the entire sample under investigation. The UIP is used to illustrate the mechanism of how the exchange rate regime affects monetary autonomy. Interest parity is a key element in most macroeconomic models for open economies and has been widely used in the field of international economics analysis. The UIP states that, based on the logic of arbitrage, the interest rate differential between two countries has to equal the expected change in their bilateral exchange rate (Isard (1991)). Hence, the hypothesis of the UIP can be expressed as follows when capital markets are open:

$$(1 + i_t) = (1 + i_t^*)E_t(S_{t+1})/S_t \tag{4.1}$$

where $E_t(.)$ is the expectation operator conditional on the information set available at time t; S is the spot exchange rate (the domestic currency price of a unit of foreign exchange); and i_t and i_t^* are the domestic and base country interest rates, respectively.

The derivation of Equation 4.2 follows the literature by assuming rational expectations, taking natural logarithms, and adding the risk premium (keeping in mind that $log(1 + x) \approx x$). Also, note that when Jensen's inequality (Siegel's Paradox) is ignored and any error related to this is negligible, the approximation $lnE_t(S_{t+1}) \approx E_t(lnS_{t+1}) = E_t(s_{t+1})$ is used.[3]

$$i_t = i_t^* + E_t(s_{t+1} - s_t) + \rho \tag{4.2}$$

where s is the natural logarithm of the spot exchange rate S and ρ is the difference in risk of the two assets (the risk premium).

Within a credible pegged exchange rate regime, $E_t(s_{t+1}) = s_t$ because there is no expected change in the exchange rate, and any risk associated with currency volatility disappears. Hence, assuming the risk premium is very small or does not vary with the change in interest rates, the theory of interest parity suggests that the domestic rate

[3] Jensen's inequality implies that the expectation of the natural log of the future exchange rate is different than the natural log of the expectation of the future exchange rate $logE_t(S_{t+1}) > E_t(logS_{t+1}) = E_t(s_{t+1})$

should move one-to-one with the base rate, as in equation 4.3 (Shambaugh (2004)).

$$i_t = i_t^* \tag{4.3}$$

On the other hand, when the exchange rate is not a hard peg, meaning that it is not pegged precisely, but rather is allowed to fluctuate within a small band, the tendency of the domestic rate to follow the base rate precisely is reduced because $E_t(s_{t+1} - s_t)$ is not equal to zero any more, even if the peg is credible (Svensson (1994)). In this scenario, allowing the spot exchange rate to float within small bands gives some room for monetary autonomy in the short-run, meaning that interest rates do not have to exactly respond to changes in the the base country's interest rate. In the long-run, however, monetary independence is completely lost in order to keep the parity credible, which means that domestic interest rates should exactly follow those of the base country.

Finally, under a floating exchange rate, there is nothing to force domestic interest rates to respond to changes in the base country's interest rate. Rather, the mechanism allows the spot exchange rate to adjust in a way that lets the expected change in the exchange rate (the left-hand side in equation 4.4) equal any interest rate differential (the right-hand side).

$$E_t(s_{t+1} - s_t) = (1 + i_t) - (1 + i_t^*) - \rho \tag{4.4}$$

In this regard, GCC countries are considered a natural experiment when studying the implications of fixing the exchange rate on monetary policy. This is due to the long history of GCC countries pegging their currencies to the U.S. dollar. In fact, GCC currencies have been pegged to the U.S. dollar for three decades without any significant realignment. Consequently, and also due to the substantial amount of foreign exchange reserves that the GCC countries have from oil revenue (which discourages any speculation against their currencies), one could conclude that the fixed exchange rate regime in GCC countries be classified as a credible peg. From 1980 to 2002, Bahrain, Qatar, Saudi Arabia, and the UAE were *dejure* (formally) pegged to the IMF's Special Drawing Rights basket but *defacto* (effectively) pegged to the U.S. dollar. Meanwhile, Oman was *defacto* pegged to the U.S. dollar and Kuwait to an undisclosed basket of major world currencies of its main trading and financial partners. In January 2003, all the GCC countries, including Kuwait, officially declared that their national currencies were to be *dejure* and *defacto* pegged to the U.S. dollar as a step towards monetary integration. This decision was taken (since all but Kuwait were already *defacto* pegged to the U.S. dollar) in order to maintain stability and strengthen confidence in the GCC economies (Khan (2009)). In May 2007, Kuwait announced that it would abandon the dollar peg and return to its previous exchange rate regime due to the inflationary pressure caused by the continuing depreciation of the U.S. dollar against the other major currencies. Furthermore, the option of pegging the GCC currencies to the U.S. dollar was chosen due to the importance of oil revenue, which has a dominant influence on the GCC economies' GDPs, government revenues, and exports. Pegging to the U.S. dollar without any significant current and capital account restrictions has led to a monetary policy coordination among the GCC countries and has set common narrow limits for the scope of domestic central bank interventions, as well as for interest rate and foreign reserve policies (Abed et al. (2003)). The dollar peg has helped the GCC economies remain stable, especially during significant volatility in oil prices. It has also helped in reducing exchange rate risk and served to stabilize fluctuations in financial wealth, which is largely dollar-dominated. Moreover, the choice of the U.S. dollar as an external anchor for GCC monetary policies is viewed as credible and was serving the GCC well in maintaining stable economies until the past couple of years, when inflationary pressure has risen due to the depreciation of the U.S. dollar. The choice has also helped GCC economies simplify trade and financial transactions and avoid nominal shocks from geopolitical risks feeding in the economy (Khan (2009)).

Therefore, after taking into account the special consideration of the time series properties of the data by applying the unit root and co-integration tests, I consider the following techniques:

- $\mathbf{A}_1$ I test equation 4.5 on levels for the entire sample for each individual GCC country in order to assess the sensitivity of each country's interest rate to that of the U.S., such that:

$$i_t = \alpha + \beta i_t^* + \varepsilon_t \tag{4.5}$$

  where i_t is the domestic country's interest rate for each GCC country, i^* is the base country's interest rate (U.S. rate), β is the elasticity or sensitivity of the domestic country's interest rate to the base country's rate, and ε_t is the error term, which is assumed to have a zero mean and to be independently distributed.

- $\mathbf{A}_2$ I utilize the Quandt Likelihood Ratio (QLR) statistic, also called the Sup-Wald statistic, to test for the presence of a break in the sensitivity coefficients (β) in order to investigate the stability of the β coefficient's sensitivity over time.
- $\mathbf{A}_3$ I consider an Error Correction Model (ECM) that will allow me to explicitly model the transition dynamics between the interest rates of GCC countries and the U.S. to a long-run equilibrium of the type stated in equation 4.5.

4.3.1 Time series properties of the interest rate

The data used in this chapter are monthly observations of three-month interbank interest rates for the GCC countries as well as the three-month U.S. LIBOR over the period from January 1993 to June 2013 for all the GCC countries, except for Oman and Bahrain. Due to data unavailability, the Bahrain interbank rate series covers the period from January 1993 to May 2011 and the Oman interbank series covers the period from January 1993 to June 2009. The data for the GCC interest rates are obtained from the Saudi Arabian Monetary Authority's monthly statistical bulletin from 1993 to 2009, and I update the data up to June 2013 using the International Financial Statistics. The choice to use the interbank rate as a proxy for the monetary policy rate derives from the fact that GCC central banks conduct monetary policy using a diverse range of direct instruments; thus, the data for these series are not available over a long horizon period. In particular, the central bank overnight rate for Bahrain; the repo and discount rates for Kuwait; the overnight central bank and certificates of deposit rates for Oman; the Qatar Central Bank lending and deposit rates for Qatar; the reverse repo rate for Saudi Arabia; and the certificates of deposit rate for the UAE are not available. Additionally, the interbank interest rate has been widely used as a reflection of monetary policy transmission, and due to the fact that the three-months interbank rate is the only short-term interest rate series available for all the GCC countries over the entire sample from 1993 to 2013. Hence, the interbank rates can be considered very good indicators of the monetary policy stances of the GCC central banks and monetary authorities (Espinoza and Prasad (2012)).

This chapter pays careful attention to the time series properties of the interest rate data, especially their stationarity, because levels regressions on non-stationary data and non-co-integrated variables could be problematic and may create incorrect results. Differencing the data helps to avoid this problem, in a sense that levels regression will be inadequate (spurious) because statistical tests will overestimate the dependency between domestic and base country interest rates. On the other hand, if the variables under investigation are stationary, levels regression will be adequate. Finally, if it turns out that the data have unit roots and that the domestic and base interest rates are co-integrated, the error correction specification will be considered in order to model the transition dynamics between the GCC countries and the U.S. interest rates to a long-run equilibrium .

Therefore, special considerations should be taken with regard to the important properties of the interest rates. There is a debate about the uncertainty of interest rate data persistence and how to treat interest rates in terms of stationarity in empirical work. One view suggests that interest rates cannot be treated as an I(1) process (Nicolau (2002), Cochrane (1991), and Stanton (1997)). This is because interest rates are bounded below zero (they cannot be negative) and bounded above (they do not exceed 100% in practice). Thus, we cannot treat them as pure unit root processes. It can also be argued that unit root tests suffer from low power in finite samples and have difficulty in discriminating unit roots processes from highly persistent data, such as interest rate data. The unit root tests may not reject the existence of a unit root often enough if the data are highly persistent (Caner and Kilian (2001)). An alternative view states that, even if the interest rates are highly persistent processes or near unit root, it is preferable to treat these series as if they had unit roots (Wu and Zhang (1997) and Phillips (1988)).

Against this background, the proper choice of the methodology technique adopted in this chapter crucially depends on the presence or absence of a unit root in the data. Therefore, I employ the Augmented-Dickey Fuller (ADF) test (equation 4.6) with a suitable number of lagged dependent variables, which are chosen following the Schwarz Information Criterion (SIC) and a fitted constant only (since a linear trend would not be meaningful with the nature of the interest rates data) for each interest rate series over the entire sample to test whether the data have unit roots.

$$\Delta i_t = \alpha + \gamma i_{t-1} + \sum_{k=1}^{p} \beta_k \Delta i_{t-k} + \varepsilon_t \tag{4.6}$$

where i_t is the interest rate series of each country, p denotes the number of lags used, and ε_t is a white-nose error term with a zero mean and a constant variance. Then, I test the null hypothesis of the existence of a unit root ($H_0 : \gamma = 0$).

The findings, presented in Table 4.1, show that the ADF unit root test hypothesis is failed to be rejected at any reasonable significance level for all the interest rate series under investigation, implying that these interest rates are non-stationary. However, when the first difference is considered, the empirical results suggest that the existence of a unit root is rejected at the 1% significance level for all the interest rate series, which indicates that all the interest rate data are integrated of order one (I(1)).

4.3.2 Level regression empirical results

Having tested the stationarity of each time series of the interest rate data and confirmed that all of the series are integrated by the same order (I(1)), and in order to gain further insights about the long-run relationships between each of the GCC countries' interest rates and the U.S. interest rate, I next test for the existence of co-integrated relationships between each pair by applying the Johansen method (Johansen (1988)). In order to perform the Johansen method, I consider the following VAR representation of order p for each pair of GCC domestic's interest rate and the U.S. rate, as in equation 4.7, where the optimal number of lags (p) is identified using the SIC.

$$i_t = \mu + A_1 i_{t-1} + A_2 i_{t-2} + ... + A_p i_{t-p} + \epsilon_t \tag{4.7}$$

where i_t is an $n \times 1$ vector of interest rate variables (in our case, n = 2 : the domestic and the base interest rates) that are integrated of the same order (I(1)), and ϵ_t is an $n \times 1$ vector of innovations. The VAR representation can be re-written as:

$$\Delta i_t = \mu + \Pi i_{t-1} + \sum_{k=1}^{p-1} \Gamma_k \Delta i_{t-1} + \epsilon_t \tag{4.8}$$

where

$$\Pi = \sum_{k=1}^{p} A_k - I \text{ and } \Gamma_k = - \sum_{j=k+1}^{p} A_j. \tag{4.9}$$

If the coefficient matrix Π has reduced rank $r < n$, then there exist $n \times r$ matrices α and β, each with rank r, such that $\Pi = \alpha\beta'$ and $\beta' i_t$ is stationary (I(0)). r is the number of co-integration relationships (the co-integration rank), each column of β is a co-integrating vector, and the elements of α are known as the adjustment parameters in the Vector Error Correction Model. Hence, the Johansen method is to estimate the Π matrix from an unrestricted VAR and to test whether one can reject the restrictions implied by the reduced rank of Π. In this respect, Johansen and Juselius (1990) suggest two types of test statistics-the trace and the maximum eigenvalue statistics-in order to determine the number of co-integration vectors.

$$J_{trace} = -T \sum_{i=r+1}^{n} ln(1 - \hat{\lambda}_i) \tag{4.10}$$

$$J_{max} = -Tln(1 - \hat{\lambda}_i) \tag{4.11}$$

where T is the sample size and $\hat{\lambda}_i$ is the i^{th} largest eigenvalue of the Π matrix. The trace statistic tests the hypothesis that there are, at most, r co-integrating vectors against the alternative hypothesis of that there are n (full rank) co-integrating vectors, while the maximum eigenvalue statistic tests the null hypothesis that there are r co-integrating vectors against the alternative hypothesis of $r + 1$ co-integrating vectors. Johansen and Juselius (1990) suggested the use of the trace statistic instead of the maximum eigenvalue statistic in cases where the two tests give contradictory results. Cheung and Lai (1993) also demonstrateed in a Monte Carlo experiment that the trace statistic is more robust than the maximum eigenvalue statistic. It is worth mentioning that, through out the analysis of co-integration between the GCC interest rates and the U.S. rate, the trace and maximum eigenvalue statistics do not show any contradictory results. Hence, this chapter utilizes the co-integration results based on the trace statistic test. Table 4.2 reports the empirical results of the Johansen and Juselius (1990) trace statistic, which tests the null hypothesis that there is no co-integration between each GCC interest rate and the U.S. rate ($r = 0$) against the alternative hypothesis that there is at most one co-integration vector between each pair. If the estimated values of the trace statistic are greater than the corresponding critical value at any convenient level of significance, then the null hypothesis is rejected. In particular, for the cases of Bahrain, Oman, and Saudi Arabia, the trace statistic values are 32.47, 25.67, and 24.48, respectively, indicating that that the null hypotheses regarding these three interest rates and the U.S. rate are rejected at the 1% level of significance for Bahrain and Oman and at the 2.5% level for Saudi Arabia. These results imply that there exists only a single co-integrating vector ($r = 1$) between these three GCC countries' interest rates and the U.S. interest rates, which is considered strong evidence of the existence of a long-term relationship between these GCC countries' interest rates and the U.S. rate during the entire sample. On the other hand, trace statistic values for Qatar and the UAE are 19.05 and 20.08, respectively, which implies that their null hypotheses are rejected at the 10% significance level. These interesting findings indicate that, with respect to co-integration strength, both Qatar and the UAE have the lowest levels of significance-compared with the other GCC countries-for rejecting the null hypothesis of no co-integration with the U.S. for the entire sample, signalling that neither country's interest rate precisely follows the U.S. interest rate.

After confirming that each GCC country's interest rate is co-integrated with the U.S. rate, I next use the OLS regression on levels to estimate equation 4.12 by regressing each individual GCC interest rate series on the U.S interest rate series to assess the sensitivity of the GCC countries' interest rates to the U.S. rate. The theory of interest parity suggests that fixing the GCC exchange rateS to the U.S. dollar should force the GCC domestic interest rates to equal the U.S. interest rate. Hence, rather than using a cross-section analysis, this chapter uses time dynamics for each individual country episode, as follows:

$$i_t = \alpha + \beta i_t^* + \varepsilon_t \tag{4.12}$$

where i_t is the domestic country interest rate for each GCC country; i^* is the U.S. interest rate as a base country; β is the elasticity or sensitivity of the domestic interest rate to the base country rate; and ε_t is the error term, which is assumed to have a zero mean and to be independently distributed. As the theory predicts, when the exchange rate is a hard peg and credible, capital markets are open, risk premium is very small, arbitrage is costless, and investors are optimizing, the estimated β coefficient should equal one and the parity holds (Shambaugh (2004)).

After estimating equation 4.12, I am interested in two parameters: the sensitivity of the domestic interest rate to that of the base country (β) and the constant (α), which can be defined as a country-specific effect or the level of the domestic interest rate after controlling for the base rate. Hence, α can be viewed as reflecting the level of country risk premium not captured by the other variable (the base rate).

Table 4.3 reports the estimated parameters $(\hat{\alpha}, \hat{\beta})$ of equation 4.12 for each GCC country, the results of testing the null hypothesis of $\beta = 1$, its 95% confidence interval, and the R^2 for the entire sample under investigation. More specifically, findings show that the estimated slope of the sensitivity coefficient's $\hat{\beta}$ values are significant at the 1% level and are close to one for just three countries: Bahrain (.97), Oman (.99), and Saudi Arabia (.97). Furthermore, the results from testing the null hypothesis that the slopes of the sensitivity coefficients (β) are equal to one $(H_0 : \beta = 1)$ indicate that this hypothesis is failed to be rejected. Hence none of the sensitivity coefficients is different from one for these three countries.[4] This can be seen as an evidence that the parity condition is enforced perfectly and holds for the interest rates of these three countries and that their interest rates correspond to the U.S. rate through a one-to-one relationship. Finally, another piece of evidence that the interest rates of the three GCC countries mentioned above precisely follow the U.S. rate is the high values R^2 throughout the entire sample, which can be explained by the considerable amount of observed variation in the domestic rates related to the base country rate. Hence, the U.S. rate is a dominant part of the interest rate policies of these GCC countries. On the other hand, the estimated sensitivity coefficients $(\hat{\beta})$ for both Qatar (.83) and the UAE (.76), though high and significant, are not close to one and the null hypothesis that $\beta = 1$ is rejected at any convenient level of significance. These findings of a pronounced deviation from the anchor currency interest rate for both Qatar and the UAE, which are consistent with the co-integration results shown above, indicate that the neither country's interest rate exactly follows the base rate. This decoupling can be seen as a sign that these two countries do not cede as much of their monetary autonomy as their GCC counterparts, which might be due to their risk premium and some country-specific factors such as inflation.

By the same token, in order to assess the stability of the sensitivity of each individual GCC interest rate to that of the U.S. as a base country across time, I utilize the Quandt Likelihood Ratio statistic (QLR), also called Sup-Wald statistic, pioneered by Quandt (1960), for the entire sample in order to determine the timing of any potential structural break at which the estimated interest rates' sensitivity coefficients $(\hat{\beta})$ change. Hence, from equation 4.13, I am concerned with testing the null hypothesis of no structural break or, formally, $H_0 : \beta_1 = \beta_2$, when k is an unknown point of time.

[4] For Saudi Arabia, the 95% confidence interval is (.951-.994), which is very close to one.

Following Andrews (1993), the first and the last 15% of the sample is excluded, assuming that the break does not occur during that time. The findings in Table 4.4 show that the null hypothesis of no structural break is rejected for all the GCC countries, with the estimated break date being July 2008 for Bahrain, July 2006 for Oman, January 2009 for Qatar, February 2009 for Saudi Arabia, and November 2008 for the UAE. These interesting, but not particularly surprising, findings indicate that the break dates for all the GCC countries (except for Oman due to data unavailability) are very close to each other and occur very soon after the commencement of the 2008-2009 global economic and financial crisis, particularly, after the collapse of Lehman Brothers.

$$i_t = \begin{cases} \alpha_1 + \beta_1 i_t^* + \varepsilon_t & t \leq k \\ \alpha_2 + \beta_2 i_t^* + \varepsilon_t & t > k \end{cases} \tag{4.13}$$

Based on the estimated break dates in Table 4.4, I split the entire sample into two sub-periods, namely, the periods before and after the break for each GCC country. Having done that, I estimate equation 4.12 for each GCC country and each sub-period in order to assess the stability of the sensitivity coefficients ($\hat{\beta}$) with regard to these two sub-periods. According to the before-break sub-period, empirical findings in Table 4.5 show similar results to those for the entire sample obtained previously with respect to Bahrain, Oman, and Saudi Arabia. In particular, the estimated coefficients values are very close to unity for Bahrain (1), Oman (.99), and Saudi Arabia (.97), and one cannot reject the null hypothesis that these sensitivity coefficients are equal to one. On the other hand, in the cases of Qatar and the UAE, the picture changes significantly compared to the results from the entire sample. More specifically, the estimated sensitivity coefficients ($\hat{\beta}$) are much higher and relatively close to one, with a value of .95 for both Qatar and the UAE, compared to their previous values of .84 and .76, respectively, for the entire sample. Despite the fact that the $\hat{\beta}$ values for Qatar and the UAE are very close to one, the null hypothesis that their values are actually equal to one is still rejected, and therefore the interest parity does not hold for these two countries' interest rates.

With regard to the after-break sub-period, the findings in Table 4.5 show that the estimated interest rates' sensitivity coefficients ($\hat{\beta}$) vary across countries, with a pronounced decoupling from the U.S. rate for Qatar (1.81), Saudi Arabia (.26), and the UAE (1.67), for which the null hypothesis of β coefficients being equal to unity is rejected at any reasonable level of significance. Figures 4.2 through 4.6 plot the interest rate co-movements between each individual GCC country and the U.S., indicating that the deviations from the base rate for Qatar, Saudi Arabia, and the UAE occur solely after the 2008-2009 global economic and financial crisis, in particular, after the collapse of Lehman Brothers in September 2009. These findings indicate that the monetary authorities in these three countries do not surrender their monetary autonomy and that the theory of interest parity does not hold in their cases during this sub-period. My interpretation of this remarkable decoupling is that these results depend on some external factors, such as the oil prices boom and the recent economic and financial crises, as well as some country-specific factors, such as inflation and the risk premium. In particular, while monetary authorities in the U.S. continued to lower interest rates after the economic and financial crisis in 2008-2009, the economies of Qatar and Saudi Arabia witnessed double-digit inflation rates of about 15% and 10%, respectively, in 2008, (Figure 4.7). In order to curb such high inflation rates the monetary authorities of Qatar and Saudi Arabia did not follow the U.S.'s suit in reducing interest rates, which explains the departure from the interest rate parity during this sub-period. In fact, the policy rates in some countries (e.g., Qatar) which are conducted by the central banks, did not change between September 2008 and August 2010. However, the U.S. Federal Reserve continued reducing its policy rate to levels very close to zero during the same period. In the case of the UAE, in addition to the high rate of inflation (13%), which also occurred in Qatar and Saudi Arabia, the Dubai debt crisis of 2009 also played a key role in the UAE interest rate decoupling from that of the U.S. In particular, in November 2009, Dubai proposed delaying the repayment of its debt of 59 billion U.S. dollars, which raised the risk premium in the UAE due to the fear of government default. Hence, the theory of interest parity does not hold in this case due to the violation of the assumption that the risk premium does not change, as previously assumed in equation 4.2.

Furthermore, in order to double check whether the sensitivity coefficients are stable across time, it may be visually useful to estimate equation 4.12 recursively and plot the recursive estimates of the estimated sensitivity coefficients ($\hat{\beta}$) on a graph in which each estimated coefficient is updated for each new observation. In particular, I estimate the ($\hat{\beta}$) coefficients for each GCC country by applying the sequential (recursive) regression to equation 4.12 using observations [1, t], [1, t+1], [1, t+2],....., and [1, T], where t is the length of the first estimation period, which is 20 months, and T is the number of observations in the entire sample. Figure 4.8 plots the recursively estimated sensitivity coefficients for each GCC country across time, implying that the estimated coefficients are quite stable, especially during the period between 2003 and the beginning of 2008, and that their values are close to one. These findings are attributed to the fact that the GCC countries officially announced pegging their currencies to the U.S. dollar in 2003, and that the GCC policy makers agreed on the key convergence criteria to be met by all GCC countries, including convergence among their interest rates, as a step towards the adoption of a single currency. As a result, the interest rates of these countries follow the U.S. interest rate more closely during this period.[5] However, after the second half of 2008, and in the aftermath of the global economic and financial crisis, the sensitivity coefficients for Qatar and the UAE significantly decreased, indicating that these two coefficients were less sensitive to the U.S. rate after this period. These results support the estimated break dates previously found by applying the QLR test.

It is worth mentioning that, following Shambaugh (2004), I difference the interest rates data and then apply the same steps as above with regard to estimating equation 4.14 for the entire sample as well as the two sub-periods obtained from applying the structural break test (on differences, not on levels).

$$\Delta i_t = \alpha + \beta \Delta i_t^* + \varepsilon_t \tag{4.14}$$

where the estimated $\hat{\alpha}$ is expected to be zero, otherwise there is a trend in interest rate differentials. As shown in Tables 4.6 and 4.7, the findings suggest that neither the sensitivity coefficients (which are not close to one) nor the P-values from testing the null hypothesis ($H_0 : \beta = 1$) provide evidence that the GCC countries' interest rates follow that of the U.S. as a base rate, except for in the cases of Bahrain and Saudi Arabia in the before-break sample and Oman in the after-break sample. In addition, the R^2 values are relatively low for all the GCC countries in both the entire sample and the two sub-samples. In this regard, the model in (equation 4.14) is misspecified and, therefore, its results are not accurate, since differencing the data leads to a misspecification error if the variables are co-integrated by causing losses in long-run information in the data (Enders (2008)). In other words, the fact that the domestic

[5] As mentioned before, the peg to the U.S. dollar was unofficially adopted much earlier, such that all the GCC countries except Kuwait were *de facto* pegged to the U.S. dollar.

and base countries' interest rate series are integrated of the same order and that they are co-integrated suggests that the model in first difference in equation 4.14 will be misspecified, since it will be missing the error correction term.

4.3.3 Long-run and short-run dynamics: Error Model Correction (ECM) representation

In order to capture the long-run dynamic behaviours of the domestic and the base interest rates, I consider the Error Correction Model (ECM) that will explicitly allow me to model the transition dynamics between the GCC countries' and the U.S.'s interest rates to a long-run equilibrium of the type stated in equation (4.12). Hence, I estimate the ECM using the two-step procedure outlined by Engle and Granger (1987), as follows:

$$\Delta i_t = \alpha + \beta \Delta i_t^* + \theta z_{t-1} + \sum_{k=1}^{p} \gamma_k \Delta i_{t-k}^* + \sum_{j=1}^{p} \phi_j \Delta i_{t-j} + \varepsilon_t \tag{4.15}$$

where Δ is the difference operator, p is the number of lags of the two variables (domestic and base interest rates respectively (i and i^*)), and z_t is the residual from regressing i_t on i_t^* from equation 4.12 (Figures 4.9 : 4.13).

$$z_t = i_t - \beta i_t^* - \alpha \tag{4.16}$$

The θ coefficient is of particular interest. It captures the long-run relationship between domestic and base countries' interest rates. In other words, θ is the speed of adjustment at which the GCC domestic interest rates are adjusted back from their decoupling to their long-run equilibrium relationship with the U.S. interest rate as a base country. The larger the absolute value of θ, the faster the adjustment.

Empirical findings in Table 4.8 show that the estimated speed of adjustment ($\hat{\theta}$) has a negative sign, as expected, and is highly significant at the 1% level for all the GCC countries, which indicates that the GCC countries' domestic interest rates have to decline in order to move back to their long-run equilibrium with the U.S. rate. However, the values of $\hat{\theta}$ vary among the GCC countries, with a high value of 23% for Bahrain, 10% for Oman, 11% for Qatar, 18% for Saudi Arabia, and 6% for the UAE. In addition, I compute the half-life coefficient ($\frac{ln(.5)}{ln(1+\theta)}$) for each individual GCC interest rate. This coefficient measures the time required for the GCC rates to adjust back from their deviations to their long-run equilibrium level with the U.S. interest rate by half (50%). In this regard, the results in Table 4.8 imply that it takes about 2.5 months for Bahrain interest rate to adjust to its long-run equilibrium relationship with the U.S., 6.5 months for Oman, 6 months for Qatar, 3.5 months for Saudi Arabia, and about 11 months for the UAE. These findings are consistent with the previous results of testing the GCC interest rate sensitivity to the U.S. rate for the entire sample, in that the interest rates for Qatar and the UAE are the slowest to adjust back from their pronounced deviations to their long-run relationship with the U.S. interest rate [6].

Furthermore, I split the entire sample period into two sub-periods for each GCC country based on the estimated break date previously obtained from Table 4.4. I then apply the ECM representation in equation 4.15 to each GCC interest rate and to each sub-period. With respect to the before-break sub-period, estimates in Table 4.9 suggest that the speed of adjustment for interest rates in Oman(10%) and Saudi Arabia (18%) interest rates does not change compared to its estimated values over the entire sample period. However, in the cases of Bahrain, Qatar, and the UAE, findings in Table 4.9 indicate that the estimated speed of adjustment is much faster than its previously estimated values over the full sample period. In particular, before the onset of the global financial and economic crisis, Bahrain and Qatar interest rates were the quickest to adjust to their equilibrium with the U.S. rate, taking less than two months (compared to 2.5 months for the Bahrain rate and 6 months for the Qatar rate over the entire sample), while it took the UAE interest rate about 6 months to adjust in this sub-period (compared to 11 months over the entire sample).

Finally, empirical results in Table 4.10 imply that the speed of adjustment for the Qatar, Saudi Arabia, and UAE interest rates, though insignificant, has reduced and become much slower in the after-break sub-period compared to their values in the before-break sub-period. More specifically, the UAE interest rate has the slowest adjustment speed (34 months), followed by the interest rate adjustment speeds of Saudi Arabia (17 months), and Qatar (10 months). These findings confirm the previous evidence of the remarkable departure of these three countries' interest rates, from the U.S. rate, particularly, after Lehman Brothers filled for bankruptcy, in that it took

[6] Oman also has a slow speed of adjustment, despite the fact that the Oman interest rate precisely follows the U.S. rate throughout the entire sample.

much longer for these countries' interest rates to adjust to their long-run equilibrium levels with the base interest rate after the financial crisis than before the crisis.

To sum up, the overall empirical results suggest that there exists a pronounced decoupling from the U.S. interest rate as a base country in the case of the Qatar and UAE interest rates over the entire sample under investigation, with the slowest speeds of adjustment to their long-run equilibrium with the U.S. rate estimated at 6 and 11 months, respectively. However, the theory of interest parity holds perfectly in the case of Bahrain, Oman, and Saudi Arabia, in that fixing their exchange rates to the U.S. dollar forced their interest rates to precisely follow the U.S. interest rate. Furthermore, with regard to the assessment of the stability of the sensitivity of the GCC countries' interest rates, findings show that after the global financial and economics crisis, which is labelled by the collapse of Lehman Brothers, there are varying degrees of notable deviation from the U.S. interest rate with respect to Qatar, Saudi Arabia, and UAE interest rates. This deviation is attributed to the fact that the monetary authorities in these three countries have decided to delay reductions in their domestic interest rates and to not follow the U.S's interest rate due to inflationary pressures, from which their economies suffered during this particular sub-period, as well as to the effect of the Dubai debt crisis on increasing the risk premium in the UAE, which violates the validation of the theory of interest parity.

4.3.4 The effect of pegging the Kuwaiti dinar to the U.S. dollar on Kuwait monetary policy

One of this chapter's goals is to investigate the debate regarding the implications of fixing exchange rates on monetary policy and to determine whether a country's interest rate has a stronger association with that of a base country under a pegged period than under a non-pegged period. In this regard, Kuwait is considered a natural experiment that gives us further insights when studying the implications of fixing exchange rates on monetary policy autonomy due to the fact that Kuwait has pegged its exchange rate regime to the U.S. dollar over a particular sub-period, then moved away from the peg over another sub-period. Hence, in this sub-section, I aim to explore the effect of pegging the exchange rate on monetary policy in the context of Kuwait by comparing three sub-periods, namely, before the peg (pre-pegged period), during the peg (pegged period), and after moving away from the peg (de-pegged period). In particular, until 2002, the Kuwait exchange rate regime was different than those of the other GCC countries. The Kuwaiti dinar was pegged to an undisclosed basket of its major trading and financial partners. Despite the fact that the weights on the compositions of this basket were not disclosed, it was strongly believed that the U.S. dollar had the largest share of this basket due to the fairly small fluctuations that occurred vis-*à*-vis the U.S. dollar (Sturm and Siegfried (2005)).

After more than 25 years, on the first of January 2003, analogous to the other GCC countries, Kuwait officially pegged its national currency to the U.S. dollar with a margin (band) of ±3.5%. This step was taken as a part of Kuwait's commitment, along with the commitments of the other GCC countries, towards the formation of a GCC monetary union and the launching of a single GCC currency. However, Kuwait moved away from the dollar peg in May 2007 and returned back to its previous exchange rate regime in order to reduce the inflationary pressure caused by the severe depreciation of the U.S. dollar against the major currencies. This action has been considered one of the obstacles to the GCC monetary union preparation.

In order to investigate the implications of fixing the Kuwaiti dollar to the U.S. dollar on Kuwait monetary policy, I repeat the methodologies applied in sections (4.3.1, 4.3.2, and 4.3.3) with respect to Kuwait, comparing the three sub-periods mentioned above. More specifically, I first check whether the Kuwait interest rate series has a unit root by applying the ADF unit root test. Then, I utilize the Johansen method to test for the existence of a co-integration relationship between Kuwait and U.S. interest rates over the three sub-periods and explore whether fixing the Kuwait exchange rate affects the strength of co-integration between the two interest rates. After confirming that the Kuwait and U.S. interest rates are co-integrated, I test equation 4.17 on levels-as done before for the other GCC countries-to investigate whether the Kuwait interest rate under the pegged sub-period has a stronger linkage with the U.S. rate than it does under the other two non-pegged sub-periods, as the theory of interest parity predicts. Figure 4.14 plots the interest rate co-movements between Kuwait and the U.S. over the entire sample, which visually indicating that the Kuwait interest rate follows that of U.S. more closely under the pegged period than it does under the two non-pegged periods.

$$i_t^{ku} = \alpha + \beta i_t^{us} + \varepsilon_t \tag{4.17}$$

where i_t^{ku} is Kuwait's domestic interest rate; i_t^{us} is the U.S. interest rate as a base country; β is the sensitivity of the Kuwait interest rate to the base country rate; and ε_t is the error term, which is assumed to have a zero mean and to be independently distributed. Finally, I apply the ECM specification (equation 4.18) to capture the long-run dynamic behaviour between Kuwait and U.S. interest rates and to evaluate whether the estimated speed of adjustment $(\hat{\theta})$ of the Kuwait rate to its long-run equilibrium with the U.S. rate would be faster under the pegged period than under the other two sub-periods.

$$\Delta i_t^{ku} = \alpha + \beta \Delta i_t^{us} + \theta z_{t-1} + \sum_{k=1}^{p} \gamma_k \Delta i_{t-k}^{us} + \sum_{j=1}^{p} \phi_j \Delta i_{t-j}^{ku} + \varepsilon_t \tag{4.18}$$

where Δ is the difference operator, p is the number of lags of the two variables (domestic and base interest rates, respectively (i^{ku} and i^{us})), (θ) is the speed of adjustment, and z_t is the residual from regressing i^{ku} on i_t^{us} from equation (4.17)(Figures 4.15 : 4.17).

$$z_t = i_t - \beta i_t^{*} - \alpha \tag{4.19}$$

The empirical results in Table 4.11 show that the ADF null hypothesis of the presence of a unit root in the Kuwait interest rate series in level is failed to be rejected at any convenient level of significance over the entire sample period or over any of the three sub-periods mentioned above. On the other hand, when testing the first difference, the null hypothesis of the ADF unit root test is rejected at the 1% level of significance, implying that Kuwait interest rate is I(1). Moreover, findings in Table 4.11 show that there exists only one co-integrated vector between the two interest rates for all the sub-periods and for the entire sample as well. However, the strength of the co-integration is stronger during the pegged sub-period than during the other two non-pegged sub-periods. In particular, the trace statistic value for the pegged sub-period is 22.6, compared with 18.62 and 18.99 for the pre-pegged and de-pegged sub-periods respectively, indicating that the null hypothesis of no co-integration is rejected at the 2.5% level for the pegged period and at the 10% level for the other two sub-periods. These results can be seen as further supportive evidence with regard to the implications of fixing the exchange rate on the monetary policy, showing that a country's interest rate has a stronger association with that of a base country under a pegged period than under a non-pegged period. Furthermore, I look at the interest rate spreads between Kuwait and U.S. interest rates ($i_{KU} - i_{US}$) during the three sub-periods. The data in Table 4.12 show that the mean of the of the spread is smaller under the pegged sub-period (January 2003 to May 2007) than over the pre-pegged sub-period (January 1993 to December 2002) and that the values are .032 and .12, respectively. This result suggests that fixing the Kuwaiti dinar to the U.S. dollar narrowed the interest rate gap between the domestic (Kuwait) and base (U.S.) interest rates. However, comparing the spread within the pegged and the de-pegged sub-periods tells us a different story, in that the interest rate differential is wider, though only slightly, under the pegged sub-period than under the de-pegged sub-period, with values of .03 and .027, respectively. One possible reason for this result is that the de-pegged sub-period (2007-2013), includes the global economic and financial crisis, which affected many economies around the world, including these two economies. This crisis led the policy makers in both economies to take some extraordinary actions, such as loosening their monetary policies and reducing short-term interest rates to near-zero levels in order to help stabilize their economies and their financial systems.

Having confirmed that both U.S. and Kuwait interest rate series are integrated of order I(1) and co-integrated, I estimate equation 4.17 on levels for the three sub-periods mentioned above as well as for the entire sample. I then test the null hypothesis that $H_0 : \beta = 1$ for each sub-period in order to investigate the effects of fixing the Kuwait exchange rate to the U.S. dollar on the Kuwait monetary policy autonomy. The findings in Table 4.12 show that the sensitivity coefficient $\hat{\beta}$ of the Kuwait interest rate to that of the U.S. as a base country is higher under the pegged period (.84) than under the other two sub-periods, which were the pre-pegged period and the de-pegged period (.71 and .70, respectively). This finding, which is in line with Shambaugh (2004), is considered supportive evidence for the theory of interest parity that a domestic country's interest rate is more sensitive to that of the base country under a pegged period than under a non-pegged period and that a pegged country's interest rate follows that of the base country more closely than the interest rates of non-pegged countries do. On the other hand, the null hypothesis testing whether the sensitivity coefficient is actually equal to one ($H_0 : \beta = 1$) is rejected even under the pegged sub-period, which indicates that the theory of interest parity does not hold and that the Kuwait interest rate does not precisely follow the U.S. interest rate under the pegged sub-period. This result can be attributed to the fact that, under the pegged period, the Kuwaiti dinar was pegged to the U.S. dollar within a band of ±3.5%, which made the Kuwait domestic interest rate less sensitive to changes in the U.S. rate. In particular, since the Kuwaiti dinar was not a hard peg but rather a floating peg within a band of ±3.5%, so when we go back to equation (4.2) [$i_t = i^*_t + E_t(s_{t+1} - s_t)$], the second component in the right hand side ($E_t(s_{t+1} - s_t)$) is not zero any more, as it was in the case of the hard peg. Thus, there is no reason to force the Kuwait interest rate to respond exactly to changes in U.S. interest rate as a base country. Rather, any changes in the U.S. rate allow Kuwait's spot exchange rate (s_t) to adjust within this band in a way that lets the expected change in the exchange rate equal any interest rate differential between the two interest rates [$E_t(s_{t+1} - s_t) = i_t - i^*_t$]. This mechanism provides more room for Kuwait monetary policy autonomy in the short-run, which means that the Kuwait interest rate does not have to exactly follow the U.S. rate.

Finally, I apply the Error Correction Model (ECM) specification to capture the long-run dynamics behaviour of Kuwait and U.S. interest rates (equation 4.18). According to the results in Table 4.12, the speed of adjustment coefficient ($\hat{\theta}$) under the pegged sub-period is faster than that of the pre-pegged sub-period (-.19 vs -.06), implying that it takes about 3 months for the Kuwait interest rate to adjust to its long-run equilibrium level with the U.S. rate under the pegged sub-period, compared to 11 months over the pre-pegged sub-period, according to the half-life estimation. This finding adds further supportive evidence to the theory of interest parity, as well as to the previous findings, in that the interest rate is more sensitive to that of the base country under a pegged period than under the non-pegged period. However, findings in Table 4.12 show that the speed of adjustment over the pegged and de-pegged sub-periods are relatively very close to each other and that it takes about 3 months for the Kuwait interest rate to adjust in both sub-periods. This, as mentioned before, can be interpreted as a cause for the worldwide financial and economic crises in 2008-2009, which affected both economies through a common shock in which global interest rates, including those of the U.S. and Kuwait, were kept at very low levels. All in all, the overall findings in the case of Kuwait support the theory of interest parity as well as the previous work of Shambaugh (2004). From this, one can infer that pegging the exchange rate forces the interest rates of pegged countries to follow the base country's interest rate more closely than the interest rates of non-pegged countries and that, therefore, countries with hard peg exchange rates do not have monetary policy autonomy.

Finally, as a robustness check and in order to examine the extent to which any modifications in the base analysis with regard to the choice of the base interest rate would affect the main results, I use the U.S. treasury bill (T-bill) rate as a base rate instead of the U.S. LIBOR rate and repeat all the methodologies done throughout this chapter for the GCC countries as well as for the special case of Kuwait. As shown in Tables 4.13, 4.14, and 4.15, changing the base rate does not alter the main findings obtained previously. More specifically, when considering U.S. T-bill as a base rate, findings in Tables 4.13 and 4.14 show that, except for in the cases of Qatar and the UAE, the parity condition holds for the GCC countries, and the GCC countries' interest rates precisely follow the U.S. rate for the entire sample under investigation. On the other hand, the empirical results confirm that, for some countries (e.g., Qatar, Saudi Arabia, and the UAE) over some periods, particularly, after the collapse of Lehman Brothers, there exists a pronounced decoupling from the base country interest rate (U.S. rate), which is considered to be a contradiction to the theory of interest parity. With regard to Kuwait, I find strong evidence in Table 4.15 consistent with the findings of Shambaugh (2004). In particular, under the pegged period, Kuwait's interest rate is more sensitive to the U.S. rate than it is under the other two periods (the pre-pegged and the de-pegged periods). Hence, one can conclude that pegging the exchange rate forces countries' interest rates to follow the base country interest rate more closely than they would under non-pegged exchange rate regimes.

4.4 Conclusion

In this chapter, I investigated whether fixing the exchange rate affected monetary policy independence in the context of GCC countries. In particular, I tested whether the GCC interest rates precisely followed the U.S. interest rate as a base country. This chapter found strong evidence that there exists a pronounced decoupling from the U.S. interest rate as a base country in the cases of the Qatar and UAE interest rates over the entire sample under investigation, with their slowest speed of adjustment to long-run equilibrium with the U.S. rate estimated at 6 and 11 months, respectively. On the other hand, findings show that the theory of interest parity holds perfectly in the cases of Bahrain, Oman, and Saudi Arabia, in that fixing these countries' exchange rates to the U.S. dollar enforced their interest rates to precisely follow the U.S. interest rate. Furthermore, with regard to the assessment of the stability of the sensitivity of the GCC countries' interest rates, findings show that, in the aftermath of the global financial and economics crisis, which labelled by the collapse of Lehman Brothers, there were varying degrees of notable deviation from the U.S. interest rate with respect to the Qatar, Saudi Arabia, and UAE interest rates. This remarkable deviation is attributed to the high inflation rates faced by these countries, which were caused by some specific domestic factors such as increases in the supply of credit, strong domestic demand, and a lack of supply in real estate markets (Morsy and Kandil (2009)); and to the effect of the Dubai debt crisis on increasing the risk premium in the UAE (which violates the validation of the theory of interest parity in the case of UAE). More specifically, while the U.S. monetary authorities continued to lower interest rates in order to curb high levels of inflation, monetary authorities in Qatar, Saudi Arabia, and the UAE did not follow these reductions. Hence, in order to make the GCC monetary union a success, policy makers in these countries may consider adopting some policies that might help in curbing inflation, which caused a distortion in a country's monetary integration with its GCC peers over specific periods. Options of these policies include increasing the supply of real estate by encouraging private investment in this sector and slowing down the growth of private credit. Finally, in the case of Kuwait, this chapter found strong evidence consistent with the findings of Shambaugh (2004), in that the Kuwait interest rate responded to the U.S. rate as a base country more closely under the pegged sub-period than under the two non-pegged sub-periods, implying that countries do not have monetary autonomy under pegged exchange rate regimes. Moreover, according to the long-run dynamics behaviour between Kuwait and U.S. interest rates, the speed of adjustment coefficient ($\hat{\theta}$) under the pegged sub-period is faster than that of the pre-pegged sub-period (-.19 vs -.06), implying that it took about 3 months for the Kuwait interest rate to adjust to its long-run equilibrium level with the U.S. rate under the pegged sub-period (compared to 11 months under the pre-pegged sub-period), according to the half-life estimation. However, findings show that the speed of adjustment over the pegged and de-pegged sub-periods are relatively very close to each other and that it takes about 3 months for the Kuwait interest rate to adjust in both sub-periods. This, as mentioned before, can be interpreted as a cause for the worldwide financial and economic crises in 2008-2009, which affected both economies through a common shock in which global interest rates, including those of the U.S. and Kuwait, were kept at very low levels.

Country	Levels	First Difference
Bahrain	-.80	-12.18$^{\otimes}$
Oman	-1.18	-11.19$^{\otimes}$
Qatar	-1.67	-5.27$^{\otimes}$
Saudi Arabia	-1.46	-7.87$^{\otimes}$
UAE	-1.95	-6.38$^{\otimes}$
USA	-.98	-11.02$^{\otimes}$

MacKinnon critical values are -2.87 and -3.45 for the 5% and 1% levels, respectively.
$\otimes$ indicates rejection of the null of a unit root test at the 1% level of significance.
The lag length is chosen using (SIC).

Table 4.1: ADF unit root tests on levels and first difference for each GCC country and the U.S. interest rates series over the entire sample.

Country	J_{trace} (r=0)	J_{trace} (r=1)
Bahrain	32.47$^{\otimes}$	1.22
Oman	25.67$^{\otimes}$	1.76
Qatar	19.05*	4.18
Saudi Arabia	24.48$^{\mp}$	1.40
UAE	20.08*	5.76

$*$, $\mp$ and $\otimes$ indicates rejection of the null hypothesis of no co-integration at the 10, 2.5, and 1% levels, respectively.
(17.98), (20.26), (22.40), and (25.07) are the critical values of the null hypothesis for 10, 5, 2.5 and 1% significance levels respectively.

Table 4.2: Johansen Co-integration Test between the GCC and U.S. interest rates over the entire sample: Trace Statistic.

Country	$\hat{\alpha}$	$\hat{\beta}$	$H_0 : \beta = 1$	95% Conf. Interval for $\hat{\beta}$	R^2
Bahrain	.02$^{\otimes}$	.97$^{\otimes}$	.06	[.94 1.00]	.96
Oman	.03$^{\otimes}$	.99$^{\otimes}$	.70	[.94 1.03]	.83
Qatar	.03$^{\otimes}$	.84$^{\otimes}$	0.0	[.80 .88]	.87
Saudi	.04$^{\otimes}$	.97$^{\otimes}$	.015	[.95 .99]	.96
UAE	.09$^{\otimes}$	.76$^{\otimes}$	0.0	[.73 .79]	.90

$*$,$**$ and $\otimes$ indicates rejection of the null that $\hat{\alpha}$ or $\hat{\beta} = 0$ at 10, 5, and 1% levels, respectively. Robust standard errors are used in the computation of the t-ratios when testing $H_0 : \beta = 1$.

Table 4.3: GCC interest rates' sensitivity to that of the U.S. in levels over the entire sample.

Country	Break date ($\hat{k}$)	P-value
Bahrain	July-2008	0.0001
Oman[a]	July-2006	0.0000
Qatar	January-2009	0.0000
Saudi	February-2009	0.0000
UAE	November-2008	0.0000

Table 4.4: Sup-Wald test for the stability of the sensitivity coefficients ($\hat{\beta}$).

[a]The apparent earlier Sup-Wald break date for Oman is influenced by the restricted sample.

	Before break						After break					
Country	# obs	$\hat{\alpha}$	$\hat{\beta}$	$H_0 : \beta = 1$	95% Conf. Interval	R^2	# obs	$\hat{\alpha}$	$\hat{\beta}$	$H_0 : \beta = 1$	95% Conf. Interval	R^2
Bahrain	187	.007	$1^{\otimes}$	.34	[.99 1.03]	.97	34	.02**	$1.18^{\otimes}$	.28	[.92 1.46]	.71
Oman	163	-.01**	$.99^{\otimes}$	.69	[.93 1.05]	.87	34	-.06*	$.9^{\otimes}$	.19	[.73 1.07]	.78
Qatar	193	-.01	$.95^{\otimes}$	.003	[.92 .98]	.94	53	$.05^{\otimes}$	$1.81^{\otimes}$	.009	[1.20 2.42]	.22
Saudi Arabia	194	$.04^{\otimes}$	$.97^{\otimes}$	.053	[.92 1.00]	.93	52	$.03^{\otimes}$	$.26^{\otimes}$	.00	[.09 .42]	.15
UAE	191	.009*	$.95^{\otimes}$	0.0	[.92 .97]	.96	55	$.10^{\otimes}$	$1.67^{\otimes}$	0.0	[1.36 1.99]	.58

*,** and $\otimes$ indicates significant at 10, 5, and 1% levels, respectively.
The 95% Confidence Interval is for testing the null hypothesis of $\hat{\beta} = 1$ ($H_0 : \beta = 1$).

TABLE 4.5: GCC interest rates' sensitivity coefficients ($\hat{\beta}$) to that of the U.S. in levels.

Country	$\hat{\alpha}$	$\hat{\beta}$	$H_0 : \beta = 1$	R^2
Bahrain	-0.0	$.63^{\otimes}$	.008	.28
Oman	-0.0	$.62^{\otimes}$	.003	.22
Qatar	-0.00	$.60^{\otimes}$	.007	.20
Saudi	-0.00	$.71^{\otimes}$	.008	.34
UAE	0.00	$.74^{\otimes}$	.01	.60

$\otimes$ indicates significant at 1%

TABLE 4.6: GCC interest rates' sensitivity coefficients ($\hat{\beta}$) to that of the U.S. in differences over the entire sample.

		Before break				After break			
Country	Break date	$\hat{\alpha}$	$\hat{\beta}$	$H_0 : \beta = 1$	R^2	$\hat{\alpha}$	$\hat{\beta}$	$H_0 : \beta = 1$	R^2
Bahrain	March-1996	$0^{\otimes}$	$.84^{\otimes}$	.49	.44	0	$.60^{\otimes}$	.01	.25
Oman	October-1999	0.0	-.08	0.0	.002	-0.00	$.73^{\otimes}$	.073	.35
Qatar	December-2007	-.01**	$.97^{\otimes}$	.035	.96	.002	.37	.009	.20
Saudi Arabia	February-2002	-0.00	$1.31^{\otimes}$	.27	.46	-0.00	$.62^{\otimes}$	0.0	.33
UAE	August-2008	0.00	$.85^{\otimes}$	0.00	.67	.00	.55**	.05	.46

*,** and $\otimes$ indicates significant at 10 , 5 and 1% respectively.

TABLE 4.7: GCC interest rates' sensitivity coefficients ($\hat{\beta}$) to that of the U.S. in differences.

	$p=0$		$p=1$		$p=2$		
Country	$\hat{\beta}$	$\hat{\theta}$	$\hat{\beta}$	$\hat{\theta}$	$\hat{\beta}$	$\hat{\theta}$	half-life (in months)
Bahrain	.67$^{\otimes}$	-.21$^{\otimes}$	.63$^{\otimes}$	-.22$^{\otimes}$	.62$^{\otimes}$	-.23$^{\otimes}$	2.65
Oman	.64$^{\otimes}$	-.083$^{\otimes}$	.6$^{\otimes}$	-.089$^{\otimes}$	.59$^{\otimes}$	-.10$^{\otimes}$	6.5
Qatar	.72$^{\otimes}$	-.27$^{\otimes}$	.68$^{\otimes}$	-.14$^{\otimes}$	.68$^{\otimes}$	-.11$^{\otimes}$	5.9
Saudi	.82$^{\otimes}$	-.16$^{\otimes}$	.74$^{\otimes}$	-.17$^{\otimes}$	.70$^{\otimes}$	-.18$^{\otimes}$	3.5
UAE	.72$^{\otimes}$	-.05$^{\otimes}$	.64$^{\otimes}$	-.04**	.60$^{\otimes}$	-.06$^{\otimes}$	11.2

$**$ and $\otimes$ indicates significant at 5 and 1% levels, respectively.
half-life is calculated using $\hat{\theta}$ from the ECM with 2-lags ($p=2$).

Table 4.8: Long-run dynamics between GCC domestic and U.S. interest rates over the entire sample:ECM representation.

	$p=0$		$p=1$		$p=2$		
Country	$\hat{\beta}$	$\hat{\theta}$	$\hat{\beta}$	$\hat{\theta}$	$\hat{\beta}$	$\hat{\theta}$	half-life (in months)
Bahrain	.96$^{\otimes}$	-.29$^{\otimes}$	.91$^{\otimes}$	-.27$^{\otimes}$	.91$^{\otimes}$	-.30$^{\otimes}$	1.9
Oman	.57$^{\otimes}$	-.10$^{\otimes}$	.64$^{\otimes}$	-.11$^{\otimes}$	.58$^{\otimes}$	-.10$^{\otimes}$	6.6
Qatar	.76$^{\otimes}$	-.68$^{\otimes}$	.72$^{\otimes}$	-.46$^{\otimes}$	.71$^{\otimes}$	-.35$^{\otimes}$	1.6
Saudi	.82$^{\otimes}$	-.17$^{\otimes}$	.74$^{\otimes}$	-.17$^{\otimes}$	.70$^{\otimes}$	-.18$^{\otimes}$	3.5
UAE	.74$^{\otimes}$	-.09**	.62$^{\otimes}$	-.07*	.61$^{\otimes}$	-.11$^{\otimes}$	5.9

$*$, $**$, and $\otimes$ indicate significant at 10, 5, and 1 % respectively.
half-life is calculated using $\hat{\theta}$ from the ECM with 2-lags($p=2$).

Table 4.9: Long-run dynamics between GCC domestic and U.S. interest rates over before-break sub-period:ECM representation.

	$p=0$		$p=1$		$p=2$		
Country	$\hat{\beta}$	$\hat{\theta}$	$\hat{\beta}$	$\hat{\theta}$	$\hat{\beta}$	$\hat{\theta}$	half-life (in months)
Bahrain	$.14^{**}$	$-.39^{\otimes}$	.32	$-.51^{\otimes}$	$-.49^{**}$	$-.66^{\otimes}$	.64
Oman	$.76^{\otimes}$	$-.19^{*}$	$.67^{\otimes}$	$-.24^{**}$	$.66^{\otimes}$	$-.25^{*}$	2.4
Qatar	.31	$-.07^{*}$	.07	-.06	$.30^{\otimes}$	-.07	9.6
Saudi	$.39^{\otimes}$	-.02	$.21^{\otimes}$	$-.06^{**}$	.12	-.04	16.9
UAE	$.61^{\otimes}$	-.04	$.02^{\otimes}$	-.02	$.60^{*}$	-.02	34.3

$*$, $**$, and $\otimes$ indicate significant at 10, 5, and 1% levels, respectively.
half-life is calculated using $\hat{\theta}$ from the ECM with 2-lags ($p=2$).

Table 4.10: Long-run dynamics between GCC domestic and U.S. interest rates over after-break sub-period:ECM representation.

Test	Full sample	pre-pegged period	pegged period	de-pegged period
Unit root(levels)	-1.35	-.16	-1.22	-2.12
Unit root(first difference)	$-9.67^{\otimes}$	$-7.35^{\otimes}$	$-4.45^{\otimes}$	$-6.53^{\otimes}$
J_{trace} (r=0)	21.9^{**}	18.62^{*}	$22.6^{\mp}$	18.99^{*}
J_{trace} (r=1)	1.72	1.87	6.9	4.35

The lag length is chosen using (SIC).
$*$, $**$, $\mp$ and $\otimes$ indicate rejection of the null hypothesis of no co-integration at 10, 5, 2.5 and 1% levels, respectively.

Table 4.11: Johansen Co-integration between Kuwait and U.S. interest rates as well as ADF unit root test on levels.

statistic	pre-pegged period	pegged period	de-pegged period
Mean Spreads	.121	.03	.027
Std	.089	.068	.07
Min	-.015	-.147	-.126
Max	.463	.122	.138
$\hat{\alpha}$	$.24^{\otimes}$	$.07^{\otimes}$	$.06^{\otimes}$
$\hat{\beta}$	$.71^{\otimes}$	$.84^{\otimes}$	$.70^{\otimes}$
R^2	.54	.78	.84
$H_0 : \beta = 1$	0.0	0.0	0.0
<u>ECM</u>			
$\hat{\beta}_{short-run}$	$.34^{\otimes}$	.7	$.32^{\otimes}$
$\hat{\theta}$	$-.06^{\otimes}$	$-.19^{\otimes}$	$-.23^{\otimes}$
half-life (in months)	11.20	3.2	2.7

$\otimes$ indicates significant at 1% level.

Table 4.12: Impact of pegging Kuwaiti dinar to U.S. dollar on Kuwait monetary policy.

		Full sample		Before break		After break	
Country	Break date	$\hat{\beta}$	$H_0 : \beta = 1$	$\hat{\beta}$	$H_0 : \beta = 1$	$\hat{\beta}$	$H_0 : \beta = 1$
Bahrain	July-2008	$.97^{\otimes}$	.31	$1.06^{\otimes}$	.00[a]	$1.29^{\otimes}$	.52
Oman	June-2001	$.98^{\otimes}$	.64	$.73^{\otimes}$	.00	$.83^{\otimes}$	.00
Qatar	November-2008	$.88^{\otimes}$	.00	$.98^{\otimes}$	.43	$.9.8^{\otimes}$	.00
Saudi Arabia	July-2008	$.98^{\otimes}$	.36	$1.02^{\otimes}$	.21	$2.4^{\otimes}$	.00
UAE	October-2008	$.76^{\otimes}$	.00	$.93^{\otimes}$	.09	$6.7^{\otimes}$	.00

$\otimes$ indicates significant at 1%.

TABLE 4.13: GCC interest rates' sensitivity coefficients to the U.S. 3-month T-bill rate in levels.

[a] The 95% confidence interval for the sensitivity coefficient for Bahrain is [1.04 1.09]which is very close to 1.

	Full sample		Before break		After break	
Country	$\hat{\theta}$	half-life in months	$\hat{\theta}$	half-life in months	$\hat{\theta}$	half-life in months
Bahrain	-.14$^{\otimes}$	4.6	-.25$^{\otimes}$	2.4	-.22$^{\otimes}$	2.8
Oman	-.12$^{\otimes}$	5.4	-.09**	7.3	-.26$^{\otimes}$	2.3
Qatar	-.09$^{\otimes}$	7.3	-.19$^{\otimes}$	3.2	-.04$^{\otimes}$	17
Saudi Arabia	-.15$^{\otimes}$	4.2	-.15$^{\otimes}$	4.2	-.13$^{\otimes}$	5
UAE	-.08$^{\otimes}$	8.3	-.07	9.5	-.09$^{\otimes}$	7.3

** and $\otimes$ indicate significant at 5% and 1% respectively.

TABLE 4.14: Long-run dynamics between GCC domestic interest rates and U.S. 3-month T-bill rate.

sub-period	$\hat{\beta}$	$\hat{\theta}$	half-life in months
pre-pegged	.79$^{\otimes}$	-.06$^{\otimes}$	11.2
within pegged	.87$^{\otimes}$	-.16$^{\otimes}$	3.9
de-pegged	.81$^{\otimes}$	-.19$^{\otimes}$	3.2

$\otimes$ indicates significant at 1% level.

Table 4.15: Impact of pegging Kuwaiti dinar to U.S. dollar on Kuwait monetary policy using U.S. 3-month T-bill rate as a base rate.

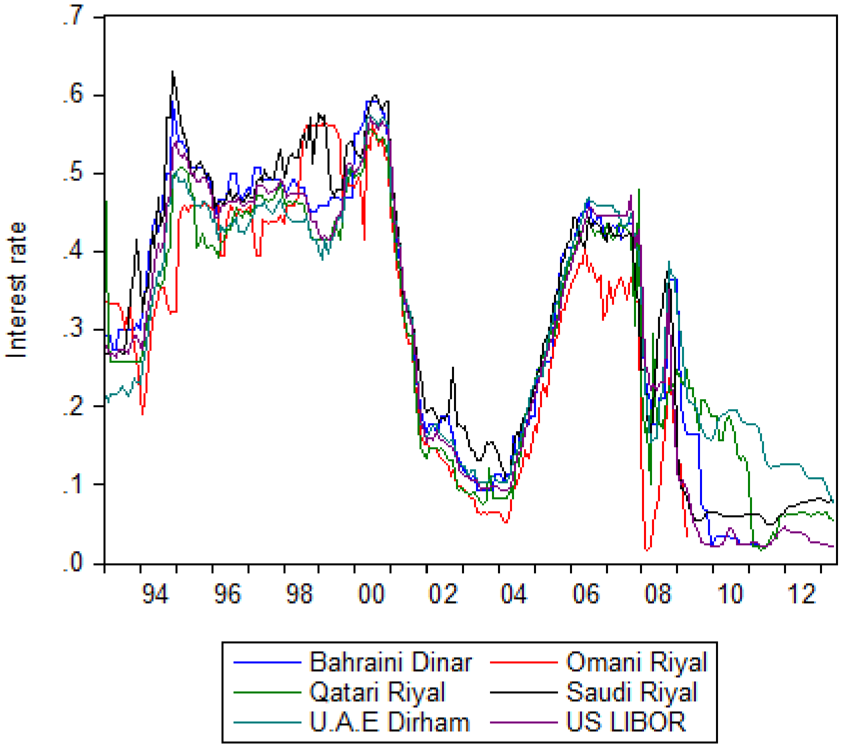

FIGURE 4.1: GCC and U.S. interest rates co-movement over the entire sample.

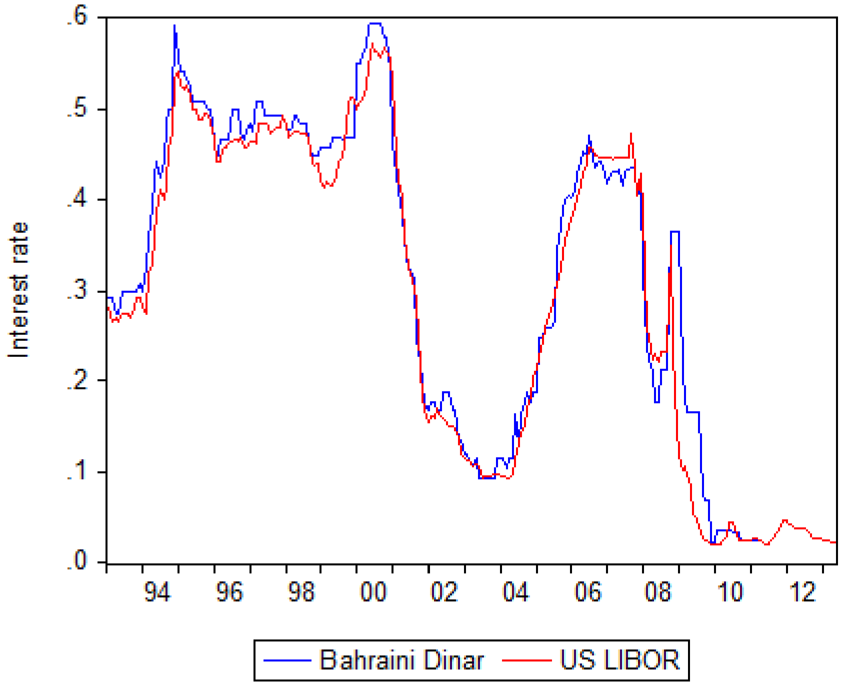

FIGURE 4.2: Bahrain and U.S.interest rates co-movement over the entire sample.

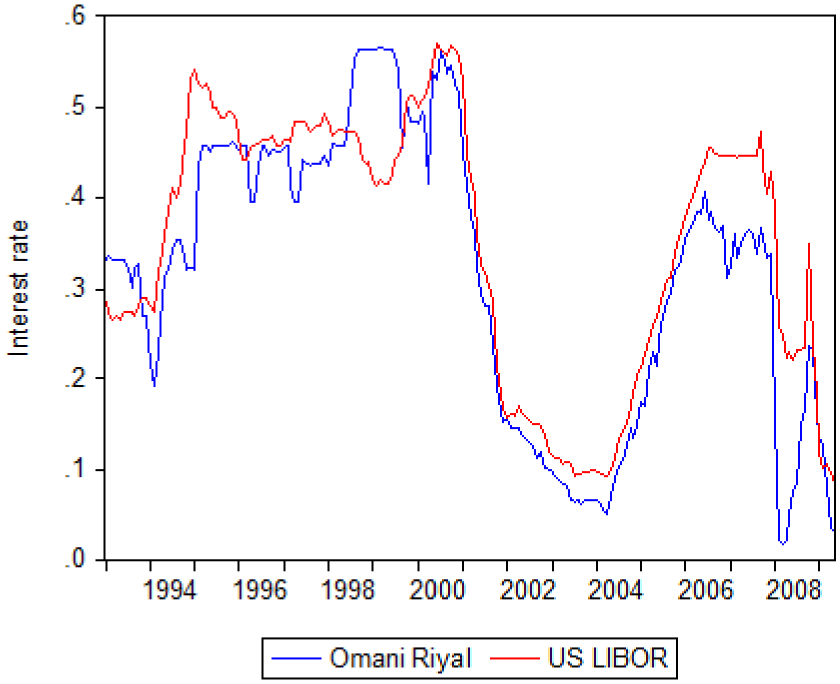

FIGURE 4.3: Oman and U.S. interest rates co-movement over the entire sample.

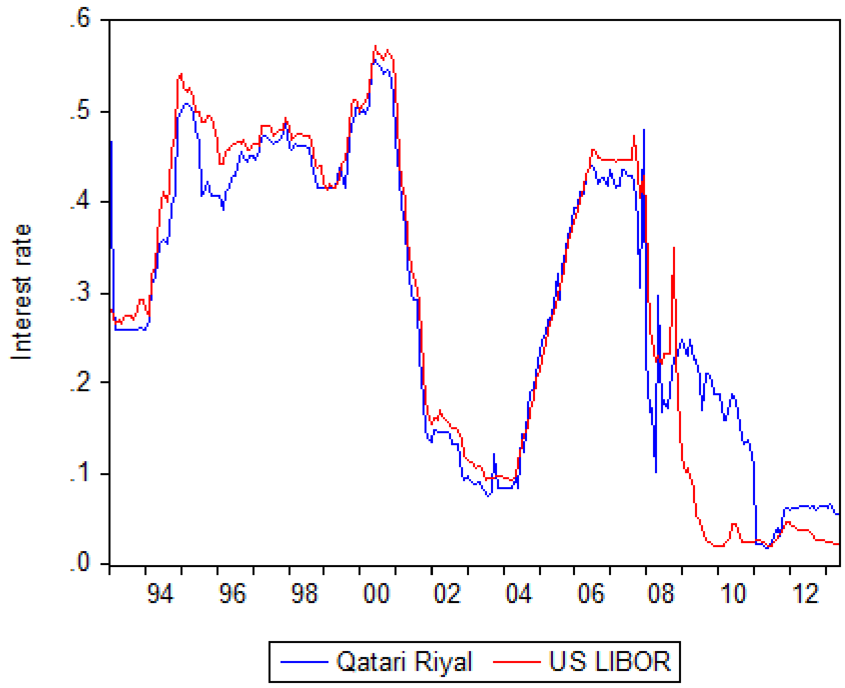

FIGURE 4.4: Qatar and U.S. interest rates co-movement over the entire sample.

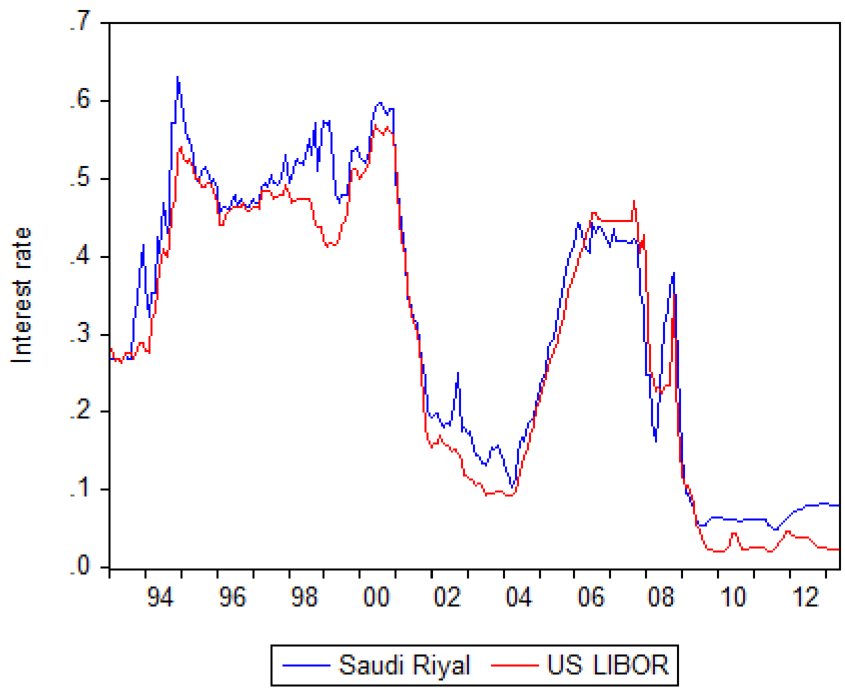

FIGURE 4.5: Saudi Arabia and U.S. interest rates co-movement over the entire sample.

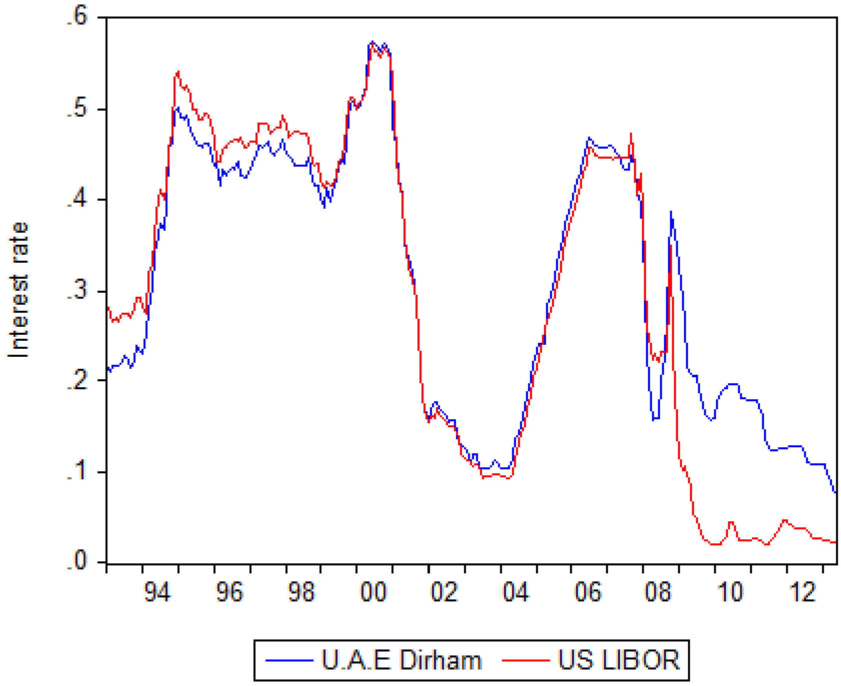

FIGURE 4.6: UAE and U.S. interest rates co-movement over the entire sample.

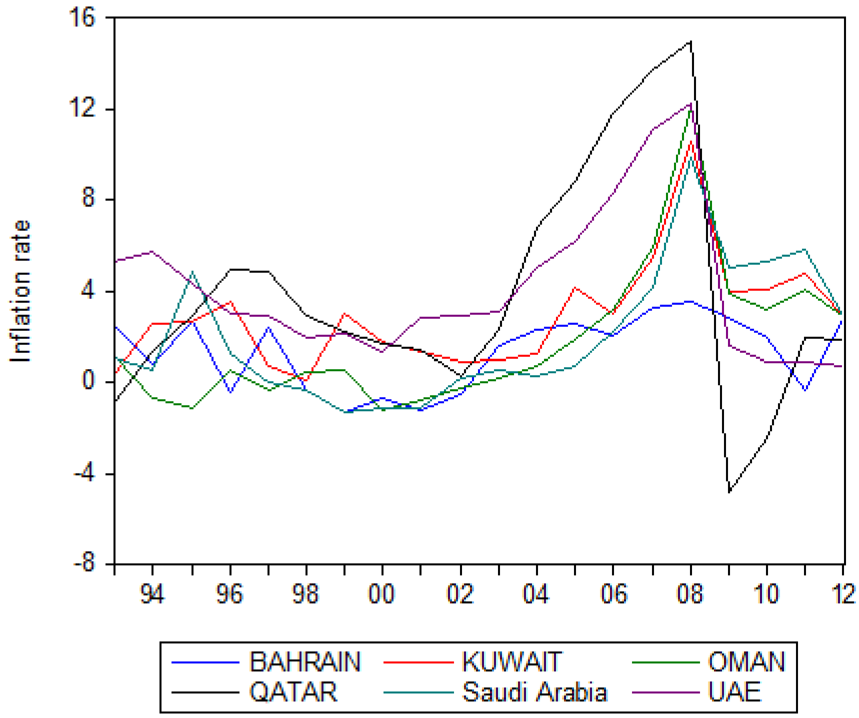

FIGURE 4.7: GCC inflation rates over the entire sample.

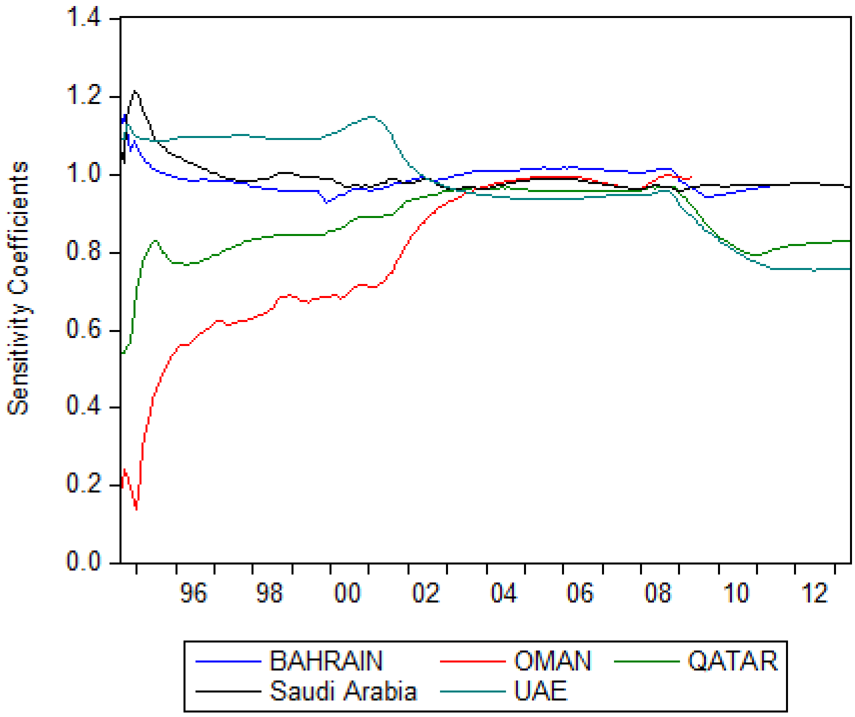

FIGURE 4.8: GCC recursively estimated sensitivity coefficients over the entire sample.

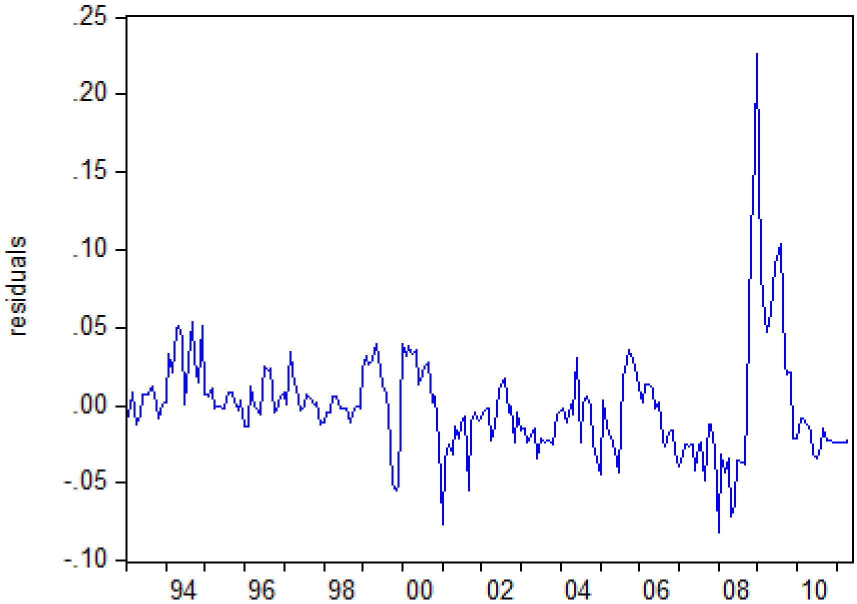

FIGURE 4.9: Bahrain residuals for the entire sample.

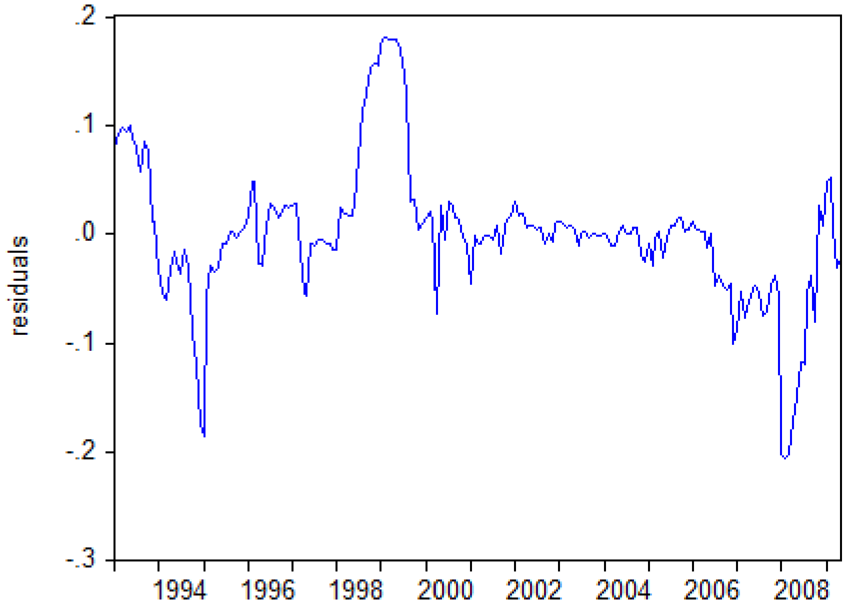

FIGURE 4.10: Oman residuals for the entire sample.

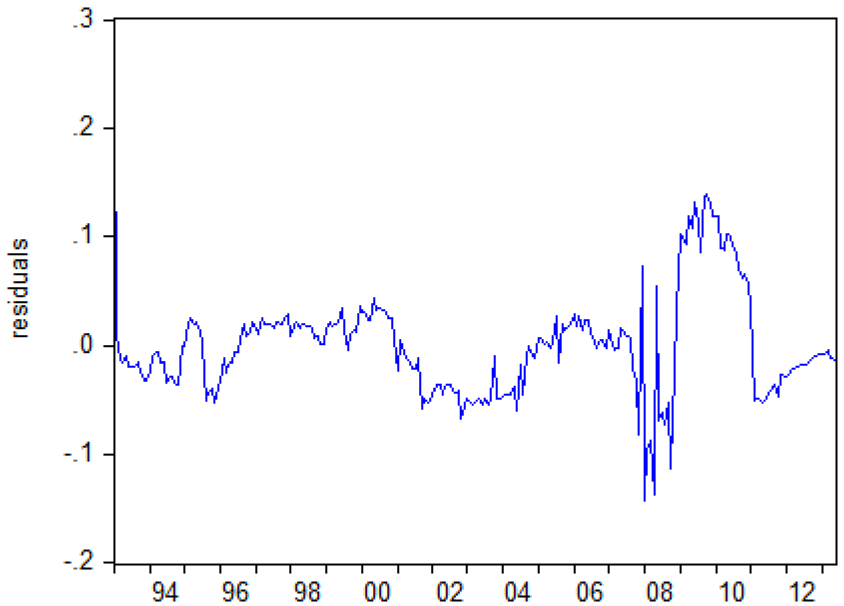

FIGURE 4.11: Qatar residuals for the entire sample.

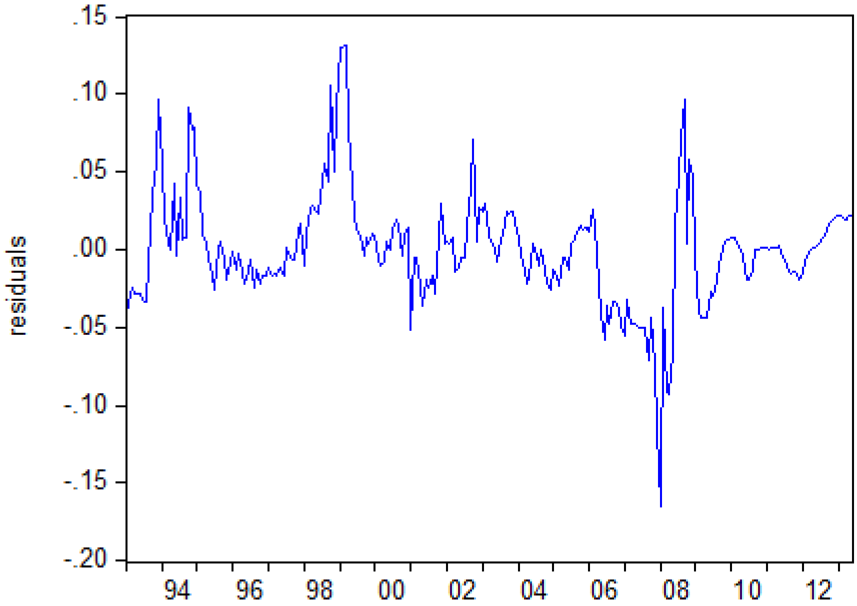

FIGURE 4.12: Saudi Arabia residuals for the entire sample.

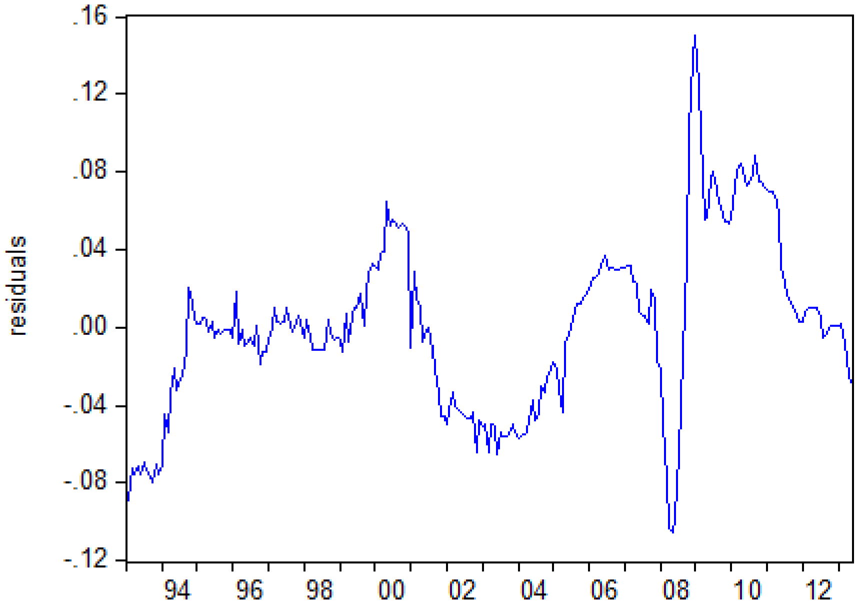

FIGURE 4.13: UAE residuals for the entire sample.

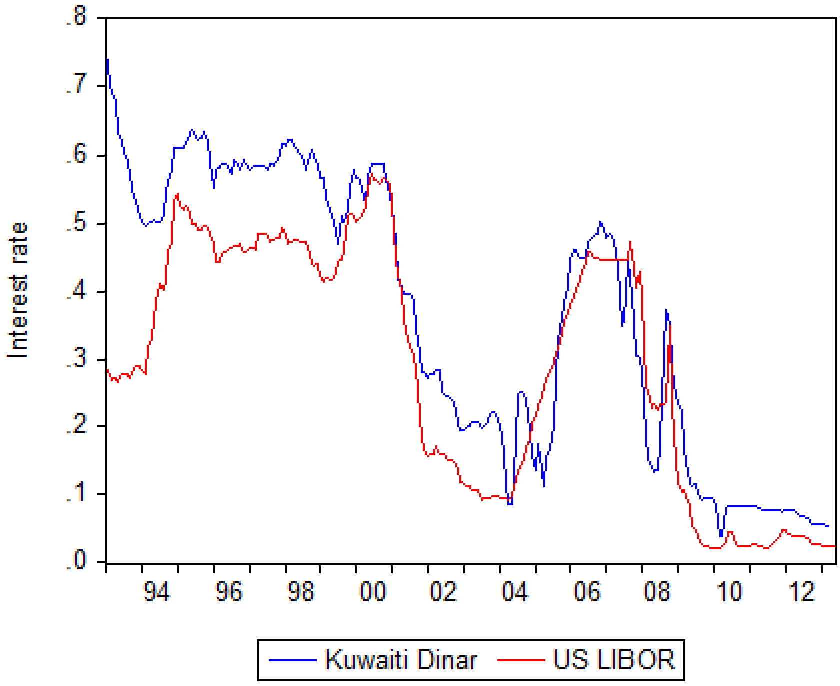

FIGURE 4.14: Kuwait and U.S. interest rates co-movement over the entire sample.

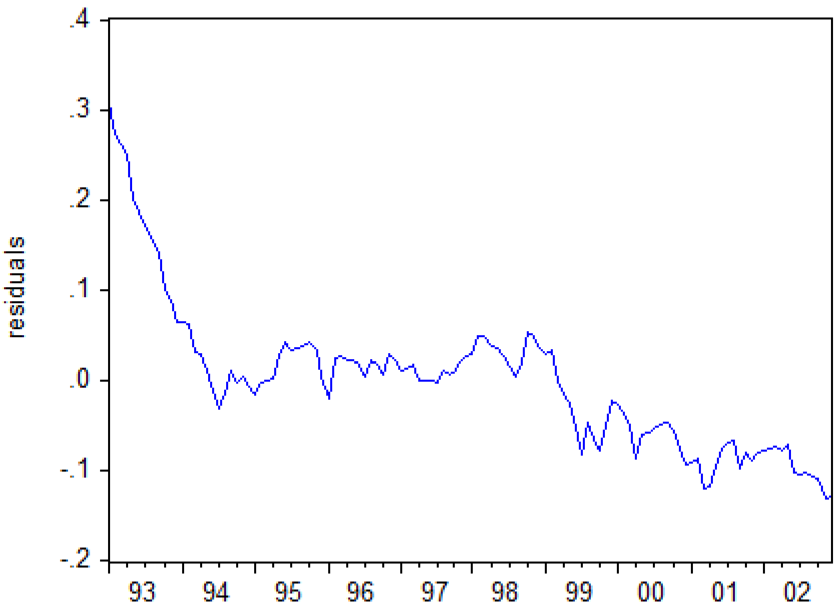

FIGURE 4.15: Kuwait residuals before pegged to the U.S. dollar.

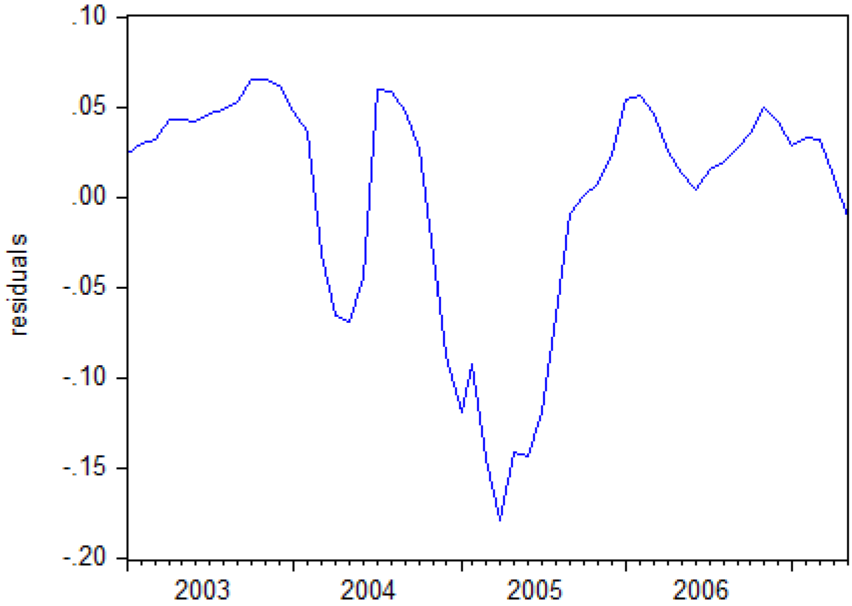

Figure 4.16: Kuwait residuals within the pegged to the U.S. dollar.

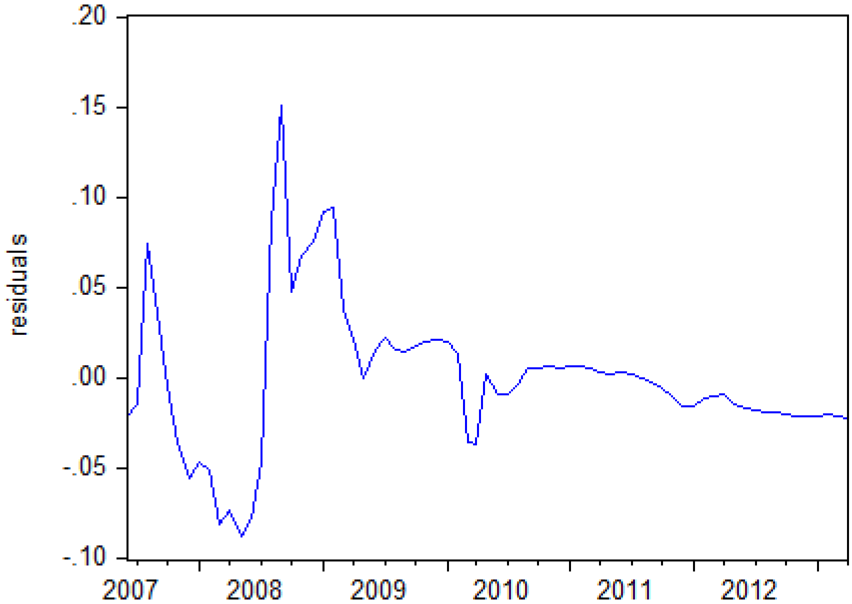

Figure 4.17: Kuwait residuals after the de-pegged from the U.S. dollar.

Chapter 5

Conclusion

Economic integration has been pursued by Gulf Cooperation Council countries (GCC) for more than three decades, ever since the six member states agreed to establish the GCC in 1981. In 1982, the Unified Economic Agreement (UEA) among the GCC countries was signed, aiming to coordinate the GCC economic, monetary, and financial policies, with the ultimate objective of adopting a common currency for the six countries. In 2001, the UEA was replaced by a new economic agreement, in which the initiative of forming the GCC monetary union by 2010 was officially declared and a particular timetable was laid down in order to accomplish the necessary requirements for the planned monetary union.

This dissertation aimed to explore economic integration in the context of the GCC countries, which planned to form a monetary union, by assessing three different but related empirical research questions regarding GCC financial markets and monetary policies. Investigating the linkages between stock markets in the context of the GCC countries is a central issue by which GCC policy makers gain further insights on how and to what extent the GCC financial markets are integrated. Financial integration among the GCC countries is a vital issue, especially in the critical stage before introducing the GCC common currency, to determine whether these countries fulfil one of the main requirements of the potential monetary union, which enhances the union's macroeconomic stabilization. Moreover, financial integration improves risk sharing among the member states and the financial stability of such a union, which are very important aspects to be considered by GCC policy makers in order to avoid any negative impacts and spillovers to the monetary union as a whole. Furthermore, GCC-integrated stock markets will enhance the efficiency of capital allocation as well as the liquidity of stock markets within the GCC region. For example, when the GCC markets are integrated, the liquidity of the stock markets will be improved due to increases in the trading of individual financial assets caused by increases in cross-boarder flows of funds. This improvement in stock markets liquidity will, in turn, lead to a decrease in the cost of capital for companies willing to raise capital and lower transaction costs for GCC investors.

On the other hand, investigating GCC stock markets contagion is of particular interest to GCC policy makers as well as GCC investors to investigate the extent to which the GCC stock markets are vulnerable to different international financial crises, which may cause destabilizations in the GCC economies. With regard to GCC investors, understanding financial contagion is crucial to the fact that gains from international portfolio diversification are reduced when stock markets exhibit correlation, and thus will be informative for investors in helping them to make better decisions regarding their portfolio diversification allocations. Finally, studying the co-movements between domestic and U.S. short-term interest rates in the context of six GCC countries is an important issue, since the harmonization of monetary policies among the GCC countries is a priority if the planned monetary union is to be achieved, especially with the existence of a common central bank, which will be in charge of conducting a single monetary policy among the member states.

The overall conclusion that can be drawn from the empirical findings of this dissertation is that, while the peg to the U.S. dollar has resulted in notable monetary integration among the GCC countries in the long-term by converging their monetary policies (though short-term divergence has been found for some countries over some periods), the GCC's financial integration is still in its primitive stage, and significant efforts are needed to promote financial integration among the GCC countries in order to enhance the success of the planned monetary union, if such a union is to be achieved. In this context, in order to promote financial integration among GCC countries, GCC policy makers are advised to adopt a comprehensive set of policies and regulations to improve the depth of the GCC financial markets; strengthen convergence across GCC financial systems; increase cross-listed stocks; relax the stock ownership restrictions facing both GCC and foreign investors; and, most importantly, put the

GCC common market process into practice. In addition, given the evidence found in the second essay regarding the existence of contagion from the U.S. stock market to the GCC stock markets after the global economic and financial crisis originating in the U.S., GCC policy makers need to set some coordinated and precautionary policies to strengthen the ability of their financial systems to absorb the adverse impacts of any future financial crisis and to be capable of reducing the exposure to international financial contagions, which might cause destabilizations in the GCC economies. On the other hand, in order to make the GCC monetary union a success, policy makers in Qatar, Saudi Arabia, and the UAE (if UAE reconsiders re-joining the GCC monetary union), may consider adopting policies that might help in curbing inflation, which causes a distortion in the country's monetary integration with peers over specific periods. Among these policies are the options of increasing the supply of real estate by encouraging private investment in this sector and slowing down the growth of private credit.

More specifically, the first essay, which was presented in Chapter 2, investigated the pairwise linkages and volatility spillover between the GCC stock markets. In particular, the goal of Chapter 2 was to investigate the extent to which past volatility is transmitted from one GCC stock market to another at the aggregate level (e.g., the general stock markets' price indices), and, at a more disaggregate level, among equivalent sectors across the GCC stock markets (namely, the banking, industrial and insurance sectors). The empirical results of Chapter 2 suggested that, on the aggregate level, except for few cases, each GCC stock market is vulnerable to past shocks that have happened in other GCC stock markets, confirming the existence of a pronounced volatility transmission across the six GCC stock markets. These findings reflect the fact that the GCC countries share strong economic and financial linkages and policy coordination, such that stock markets in the region respond similarly to common shocks. Furthermore, results of the equity sectors analysis indicated that volatility spillover across the six stock markets studied is driven mainly by the linkages and spillover effects between banking sectors, and to lesser extent, industrial sectors, while the insurance sectors played no role in the volatility spillover effects across these markets. These results reveal that the banking sector is the most vital sector among the GCC stock markets sectors, which is due to its dominating role in the financial sectors within the GCC region as well as its market capitalization, which is the highest of all sectors in the GCC stock markets. Meanwhile, the industrial sector plays a relatively modest role in causing spillover effects among the GCC stock markets. This is due to the fact that the industrial sector is highly dependent on the oil market's basic variations and price fluctuations, leading this sector to be more vulnerable to these developments than to the intra-sector spillover within the GCC region. Finally, the insurance sector plays no role in volatility spillover transmission among the GCC stock markets, which is due to the fact that the insurance sector is characterised by having the smallest market capitalization of all GCC sectors, as well as having low trading activities and little investment interest from GCC investors. This leads to the fact that the insurance sectors in some GCC stock markets have had many days with no trading.

Chapter 3, the second essay, examined the effect of the recent global financial crisis originating in the U.S. stock market on the stock markets of the GCC countries and determined whether the sharp falls in these markets were due to the existence of "contagion" or they just reflected a continuation of the strong economic and financial linkages between the GCC and the U.S. economies that exist in all states of the world, during good and bad times. The results of Chapter 3 found some evidence of contagion from the U.S. stock market to the stock markets of Oman, Qatar, Saudi Arabia, and the UAE after the collapse of Lehman brothers. However, in the case of Kuwait, I did not find any significant increase in cross-market correlation between the Kuwait and U.S. stock markets after the collapse of Lehman Brothers. Hence, the relationship between the two markets is rather interdependent, and no contagion has occurred from the U.S. financial crisis to Kuwait. According to the theory of "fundamentals-based contagion" which demonstrates that contagion is transmitted across countries through their real or financial linkages, the results in the case of Kuwait might be due to the fact that the Kuwait economy is relatively less linked to the U.S. economy than other GCC economies in the sense that Kuwait is the only GCC country that does not fix its currency exchange rate to the U.S. dollar and that Kuwait has a more independent monetary policy than its GCC counterparts. This is also supported by the empirical analyses in that Kuwait has the smallest (after Bahrain) cross-market correlation of the other GCC countries after the turmoil period. Finally, results did not find any contagion between the Bahrain and U.S stock markets. Hence, the linkage between the U.S. stock market as a crisis country and the Bahrain stock market as a non-crisis country remained relatively the same after the crisis period, and no contagion has occurred. From this, one can conclude that the recent U.S. financial crisis has not affected the Bahrain stock market. These results might be due to the fact that the Bahrain stock market is one of the smallest and most illiquid of all the GCC stock markets.

The last essay was presented in Chapter 4, in which I investigated the implications of fixing exchange rates on monetary policy in the context of the GCC countries whose exchange rate regimes have been fixed to the U.S. dollar for a long time. In particular, Chapter 4 aimed to assess the sensitivity of the GCC countries' interest rates to the U.S. rate, as the theory of interest parity suggests that fixing GCC exchange rates to the U.S. dollar should enforce the GCC domestic interest rates to equal the U.S. interest rate. In addition, Chapter 4 interestingly attempted to assess the stability of this sensitivity over time and to investigate whether there exists a pronounced decoupling for some GCC countries over some sub-periods. Furthermore, the fact that some of the countries (e.g., Kuwait) have pegged to the U.S. dollar over specific sub-periods, then moved away from the peg over other sub-periods, also gave us a rich setting in which to investigate the implications of fixing the exchange rate on monetary policy and to determine whether a country's interest rate has a stronger association with that of a base country under a pegged period than under a non-pegged period. The results of Chapter 4 showed that, except for Qatar and the UAE, the parity condition holds for the GCC countries, and the GCC countries' interest rates precisely follow the U.S. rate for the entire sample under investigation. On the other hand, the empirical results confirm that, for some countries (e.g., Qatar, Saudi Arabia, and UAE) over some periods, particularly, after the collapse of Lehman Brothers, there exists a pronounced decoupling away from the base country interest rate (the U.S. rate), which is considered to be a contradiction to the theory of interest parity. This remarkable deviation from the U.S. interest rate is attributed to some external factors (e.g., the financial crisis) as well as some country-specific factors (e.g., inflation and risk premiums). More specifically, while the monetary authorities in the U.S. continued to lower the interest rates after the economic and financial crisis of 2008, the Qatar, Saudi Arabia, and UAE economies witnessed double-digit inflation rates in the year 2008 (with rates of 15%, 10%, and 13%, respectively). These high inflation rates were caused by some country-specific domestic factors, such as increases in the supply of credit, strong domestic demand, and a lack of supply in real estate markets (Morsy and

Kandil (2009)). In order to curb such high inflation rates, the monetary authorities of Qatar, Saudi Arabia and the UAE did not follow the U.S.'s suit in reducing interest rates, which explains their departure from the interest rate parity during this sub-period. With regard to Kuwait, I found strong evidence consistent with the findings of Shambaugh (2004). In particular, Kuwait's interest rate was more sensitive to the U.S. rate under the pegged period than under the other two period (the pre-pegged period and the de-pegged period). Hence, one can conclude that pegging the exchange rate enforces countries to follow the base country's interest rate more than they would if their exchange rates were not pegged.

References

Abed, George T.Erbas, S. N., Guerami and Behrouz (2003), 'The GCC Monetary Union: Some Considerations for the Exchange Rate Regime', *IMF Working Papers* **NO. 03/66**, 1–25.

Abraham, A. (1999), 'Interest rate dynamics and speculative trading in a fixed exchange rate system', *International Review of Economics* **8(2)**, 213 – 222.

Abraham, A. and Seyyed, F. (2006), 'Information transmission between the Gulf equity markets of Saudi Arabia and Bahrain', *Research in International Business and Finance* **20(3)**, 276–285.

Al-Deehani, T. and Moosa, I. (2006), 'Volatility Spillover in Regional Emerging Stock Markets: A Structural Time-Series Approach', *Emerging Markets Finance and Trade* **42(4)**, 78–89.

Andrews, D. (1993), 'Tests for parameter instability and structural change with unknown change point', *Econometrica: Journal of the Econometric Society* **29**, 821–856.

Arouri, M. E. H. and Fouquau, J. (2009), 'On the short-term influence of oil price changes on stock markets in gcc countries: linear and nonlinear analyses', *Economics Bulletin* **29(2)**, 795–804.

Baele, L. (2005), 'Volatility spillover effects in european equity markets', *Journal of Financial and Quantitative Analysis* **40(02)**, 373–401.

Bartram, S. M., Taylor, S. J. and Wang, Y.-H. (2007), 'The Euro and European financial market dependence', *Journal of Banking and Finance* **31(5)**, 1461–1481.

Bekaert, G., Ehrmann, M., Fratzscher, M. and Mehl, A. J. (2012), 'Global crises and equity market contagion', *NBER working paper* **NO.17121**, 1–57.

Bekaert, G. and Harvey, C. (2003), 'Emerging markets finance', *Journal of Empirical Finance* **10(1)**, 3–55.

Bekaert, G., Harvey, C. R. and Ng, A. (2005), 'Market integration and contagion', *The Journal of Business* **78(1)**, 39–70,.

Bollerslev, T. (1986), 'Generalized autoregressive conditional heteroskedasticity,', *Journal of econometrics* **31(3)**, 307–327.

Calvo Guillermo, A. and Reinhart, C. (2002), 'Fear of Floating', *The Quarterly Journal of Economics* **117(2)**, 379–408.

Calvo, S. and Reinhart, C. (1996), 'Capital flows to latin america: Is there evidence of contagion effects?', *World Bank Policy Research Working Paper* **NO.1619**, 1–36.

Caner, M. and Kilian, L. (2001), 'Size distortions of tests of the null hypothesis of stationarity: evidence and implications for the ppp debate', *Journal of International Money and Finance* **20(5)**, 639–657.

Cheung, Y. and Ng, L. (1996), 'A causality-in-variance test and its application to financial market prices', *Journal of Econometrics* **72(1)**, 33–48.

Cheung, Y.-W. and Lai, K. S. (1993), 'Finite-sample sizes of johansen's likelihood ratio tests for cointegration', *Oxford Bulletin of Economics and statistics* **55(3)**, 313–328.

Chudik, A. and Fratzscher, M. (2011), 'Identifying the global transmission of the 2007–2009 financial crisis in a gvar model', *European Economic Review* **55(3)**, 325–339.

Cochrane, J. (1991), 'Pitfalls and opportunities: What macroeconomists should know about unit roots: Comment', *NBER macroeconomics annual* **6**, 201–210.

Edwards, S. and Susmel, R. (2001), 'Volatility dependence and contagion in emerging equity markets', *Journal of Development Economics* **66(2)**, 505–532.

Ehrmann, M., Fratzscher, M. and Rigobon, R. (2011), 'Stocks, bonds, money markets and exchange rates: measuring international financial transmission', *Journal of Applied Econometrics* **26(6)**, 948–974.

Enders, W. (2008), *Applied econometric time series*, John Wiley and Sons.

Engle, R. and Granger, C. (1987), 'Co-integration and error correction: representation, estimation, and testing', *Econometrica: Journal of the Econometric Society* **55(2)**, 251–276.

Espinoza, R. and Prasad, A. (2012), 'Monetary policy transmission in the gcc countries', *IMF Working Paper* **NO.12/132**, 1–31.

Esponza, R., Prasad, A. and Williams, O. (2010), 'Regional Financial Integration in the GCC', *IMF Working Paper* **NO.10/90**, 1–34.

Forbes, K. J. and Rigobon, R. (2002), 'No contagion, only interdependence: measuring stock market comovements', *The Journal of Finance* **57(5)**, 2223–2261.

Frankel, J. (1999), 'No single currency regime is right for all countries or at all times', *NBER Working Papers* **NO.7338**, 1–49.

Frankel, J., Schmukler, S. and Servén, L. (2004), 'Global Transmission of Interest Rates: Monetary Independence and Currency Regime', *Journal of International Money and Finance* **23(5)**, 701–733.

Gebka, B. and Serwa, D. (2007), 'Intra-and inter-regional spillovers between emerging capital markets around the world', *Research in International Business and Finance* **21(2)**, 203–221.

Hamao, Y., Masulis, R. and Ng, V. (1990), 'Correlations in price changes and volatility across international stock markets', *Review of Financial studies* **3(2)**, 281–307.

Hammoudeh, S. and Aleisa, E. (2004), 'Dynamic relationships among gcc stock markets and nymex oil futures', *Contemporary Economic Policy* **22(2)**, 250–269.

Hammoudeh, S. and Choi, K. (2006), 'Behavior of gcc stock markets and impacts of us oil and financial markets', *Research in International Business and Finance* **20(1)**, 22–44.

Hausmann, R., Gavin, M., Pages-Serra, C. and Stein, E. (1999), 'Financial turmoil and the choice of exchange rate regime', *Inter-American Development Bank, Research Department,* **NO.4170**, 1–35.

Hong, Y. (2001), 'A test for volatility spillover with application to exchange rates', *Journal of Econometrics* **103(1)**, 183–224.

Isard, P. (1991), 'Uncovered interest parity', *IMF Working Paper* **NO.91/51**, 1–12.

Johansen, S. (1988), 'Statistical analysis of cointegration vectors', *Journal of economic dynamics and control* **12(2)**, 231–254.

Johansen, S. and Juselius, K. (1990), 'Maximum likelihood estimation and inference on cointegration—with applications to the demand for money', *Oxford Bulletin of Economics and statistics* **52(2)**, 169–210.

Kendall, M. G. and Stuart, A. (1961), *The advanced theory of statistics. Vols. II and III.*, Hafner.

Khan, M. S. (2009), 'The gcc monetary union: Choice of exchange rate regime', *IMF Working Paper* **NO.09/1**, 1–14.

Kim, S. J., Moshirian, F. and Wu, E. (2005), 'Dynamic stock market integration driven by the European Monetary Union: An empirical analysis', *Journal of Banking and Finance* **29(10)**, 2475–2502,.

King, M. A. and Wadhwani, S. (1990), 'Transmission of volatility between stock markets', *Review of Financial Studies* **3(1)**, 5–33.

Kodres, L. E. and Pritsker, M. (2002), 'A rational expectations model of financial contagion', *The Journal of Finance* **57(2)**, 769–799.

Koutmos, G. and Booth, G. (1995), 'Asymmetric volatility transmission in international stock markets', *Journal of international Money and Finance* **14(6)**, 747–762.

Liu, Y. A. and Pan, M.-S. (1997), 'Mean and volatility spillover effects in the us and pacific-basin stock markets', *Multinational Finance Journal* **1(1)**, 47–62.

Loretan, M. and English, W. (2000), 'Evaluating correlation breakdowns during periods of market volatility', *Board of Governors of the Federal Reserve System International Finance Working Paper* **NO.658**, 1–33.

Malik, F. and Hammoudeh, S. (2007), 'Shock and volatility transmission in the oil, us and gulf equity markets', *International Review of Economics and Finance* **16(3)**, 357–368.

Mishkin, F. S. (2010), 'Over the cliff: from the subprime to the global financial crisis', *NBER working paper* **NO.16609**, 1–34.

Miyakoshi, T. (2003), 'Spillovers of stock return volatility to asian equity markets from japan and the us', *Journal of International Financial Markets, Institutions and Money* **13(4)**, 383–399.

Moosa, I. (2010), 'Stock market contagion in the early stages of the global financial crisis: the experience of the gcc countries', *International Journal of Banking and Finance* **7(1)**, 19–34.

Morsy, H. and Kandil, M. (2009), 'Determinants of Inflation in GCC', *IMF Working Papers* **NO.09/82**, 1–32.

Ng, A. (2000), 'Volatility spillover effects from japan and the us to the pacific–basin', *Journal of international money and finance* **19(2)**, 207–233.

Nicolau, J. (2002), 'Stationary processes that look like random walks—the bounded random walk process in discrete and continuous time', *Econometric Theory* **18(1)**, 99–118.

Obstfeld, M. and Taylor, A. (1999), 'The great depression as a watershed: International capital mobility over the long run', *National Bureau of Economic Research* **NO.5960**, 1–67.

Onour, A. (2010), 'Volatility Spillovers Across GCC Stock Markets', *Khartoum University Journal of Management Studies* **3(1)**, 1–34.

Phillips, P. (1988), 'Regression theory for near-integrated time series', *Econometrica: Journal of the Econometric Society* **56(5)**, 1021–1043.

Phillips, P. C. and Yu, J. (2011), 'Dating the timeline of financial bubbles during the subprime crisis', *Quantitative Economics* **2(3)**, 455–491.

Quandt, R. E. (1960), 'Tests of the hypothesis that a linear regression system obeys two separate regimes', *Journal of the American statistical Association* **55(290)**, 324–330.

Rose, A. K. and Spiegel, M. M. (2012), 'Cross-country causes and consequences of the 2008 crisis: early warning', *Japan and the World Economy* **24(1)**, 1–16.

Saadi-Sedik, T. and Williams, O. (2011), 'Global and regional spillovers to gcc equity markets', *IMF Working Papers* **NO.11/138**, 1–26.

Shambaugh, J. (2004), 'The effect of fixed exchange rates on monetary policy', *The Quarterly Journal of Economics* **119(1)**, 301–352.

Stanton, R. (1997), 'A nonparametric model of term structure dynamics and the market price of interest rate risk', *Journal of Finance* **52(5)**, 1973–2002.

Sturm, M. and Siegfried, N. (2005), 'Regional monetary integration in the member states of the Gulf Cooperation Council', *European Central Bank,Occasional Paper Series,* **NO.31**, 1–82.

Susmel, R. and Engle, R. F. (1994), 'Hourly volatility spillovers between international equity markets', *Journal of International Money and Finance* **13(1)**, 3–25.

Svensson, L. E. (1994), 'Why exchange rate bands? Monetary independence in spite of fixed exchange rates,', *Journal of Monetary Economics* **33(1)**, 157–199.

Willett, T., Al-Barwani, K. and El Hag, S. (2010), 'The GCC's Fixed Exchange Rate: A Major Anomaly for OCA Analysis', *The World Economy* **33(12)**, 1702–1717,.

Wu, Y. and Zhang, H. (1997), 'Do interest rates follow unit-root processes? evidence from cross-maturity treasury bill yields', *Review of Quantitative Finance and Accounting* **8(1)**, 69–81.