ARBITRAGE ACROSS THE FINANCIAL MARKETS OF THE GULF STATES AND THE PROSPECTS OF CURRENCY UNION

A thesis submitted for
the Degree of Doctor of
Philosophy

by
Asma Al Teneiji

Department of Economics and Finance
Brunel University

April 2018

ABSTRACT

As has been learned from the 2007-2008 Euro-area crisis the effect on certain economies considered to be quite strong and has been significant following the spill over between financial markets across those economies, which until the crisis, were seen to have a highly successful currency union. Much has been learned of the inter-relations between economies and their financial markets in response to the 2008 banking crisis. There was a failure of regulation, but this was at an international and a government level. No single country was able to counter the problem. This is why it is important to investigate the linkages between markets in the Gulf and the extent to which they work effectively to decide whether a currency union is appropriate for these economies. This leads to the building blocks of a successful union and relates to the efficient running of product and financial markets. The current thesis investigated whether the Gulf States are ready for a currency union and what needs to be done before this can occur. In particular, the primary proposition in international finance is that arbitrage can eliminate inefficiency in pricing across borders. This is investigated in terms of the United States (US) dollar ($) and the responsiveness of prices across the Gulf, the extent to which there may already be a common market for goods. This was investigated by looking at whether a common factor is driving pricing. The next section dealt with the efficiency of the money markets in relation to the United Arab Emirates (UAE) to determine whether interest rate pass through is effective and yields reflect an efficient market for debt. Finally, the financial markets were considered; first to determine whether any of the exchanges behave in an anomalous way, and then the extent to which these markets are integrated.

ACKNOWLEDGEMENTS

I would like to thank Dr. John Hunter for all of his great support and encouragement during my years of study. It has been amazing sharing his deep knowledge and having him provide me with excellent academic guidance. I faced and overcame some difficult obstacles and Dr. Hunter never stopped encouraging me or helping me to navigate these difficulties.

I definitely want to thank my lovely husband who was always there for me and supported me all the time. I would like to thank my little family; my two little princesses, my two beautiful daughters who sacrificed many of their school vacations for their mother's studies and always understood how important my Ph.D. is. I also want to thank my parents for their continuous motivation and prayers.

I would like to thank everyone who helped me to gather the data required for my thesis: Central Bank of UAE and the Arabic Monetary Fund based in the United Arab Emirates. They were extraordinarily helpful and were this was possible did not hesitate to send me information or data for my thesis.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1: INTRODUCTION

The broad context for this thesis lies in determining the possibility of having a currency union for the Gulf States by discussing the pre-conditions and building blocks and provide an analysis of the financial markets as a pre-condition. This leads to the idea that prior to any currency union, markets need to function effectively. The coming chapters will investigate if the Gulf countries financial markets are efficient enough and that would be through three important empirical chapters where one chapter will find out if there is PPP (Purchasing power parity) in the Gulf through prices indices, the next chapter will look at PPP and the financial markets through interest rates and the last chapter will investigate PPP again but through stock prices. All chapters will use different methods, financial data and periods` to determine efficiency. At the end, conclusions from these three chapters will help shed light on the currency union of the Gulf countries.

There are many pathways to find if the Gulf states financial markets are efficient enough and ready for a currency union. PPP or Purchasing power parity is one of the key concepts in testing market efficiency for any country. PPP may hold because of arbitrage is related to the Law of One Price which states that the price of any traded goods internationally should be the same anywhere in the world once expressed in a common currency. Law of one price exists due to arbitrage opportunities. This means that people can't make any profit or arbitraging by shipping the same goods from place to another if their prices are lower. If PPP hold, then it is indicator for a good currency union.

The intention in the current thesis was not to ignore the economy as a whole; but the available statistical data for the Gulf States makes it difficult to construct models to explain the complicated links between the financial and real economy and even more across the economies of the Gulf. In this current thesis, economics will be drawn upon to explain the proposition that a currency union may benefit the region and to discuss key papers in economics and finance to try to explain how feasible this mainly political idea of a common currency area might be. In some ways all the currencies follow the US $, so maybe the Gulf is already part of a currency area.

When the current research began, finding PPP across the gulf states seemed very interesting and important because no one researched it before in such way using this kind

of data, in addition of having a good understanding of this key area in international finance for this region. There is a high shortage of a deep research for PPP for this region. One of the main reasons might be the difficulty in finding a good span of data for the gulf countries being developing countries. Unfortunately, this was the biggest obstacle found in constructing this thesis and perhaps other researchers faced which makes deep empirical studies for the gulf countries are missing and not available. Few studies were done in this area and mainly using yearly figures or observations for the gulf countries and for few years like five or ten years maximum. It was a shocking fact at the beginning but never gave up of trying with several sources worldwide and gulf wide to find longer span of data but was never easy and took so long and months of trying. The gulf just started recently to pay attention and started building up gradually statistics from like 2010. After I found such short amount of data, I could not continue my study the way it started and had to change it slightly. The essential study was real exchange rates and PPP for the Gulf using prices and exchange rates with like a good long span of data but had to change it as exchange rates are pegged to the dollar for most of these countries and was not possible to do PPP through exchange rates. Also, prices were not available enough for all the gulf countries to build up a valid economic model and the maximum data found was yearly prices for just 30 years. To do a valid PPP study, adequate amount of observations should be available which is not the case for the Gulf countries. There was a deviation in the thesis and specially for the first empirical chapter. Although it was so outstanding and interesting to find if PPP would hold for the gulf, unfortunately was not possible with such short amount of data and fixed exchange rates. On the other hand, finding the PPP validity and holding was still possible and through developed countries which has enough and long span of data.

Taylor (1988) was one of the first people to examine purchasing power parity (PPP) in the long run using cointegration. In a further article by Taylor (2009), he reviewed 18 empirical studies and considered in a special edition the extent to which the current literature might support the principle of long run PPP and real exchange rates. Taylor (2009) discussed and summarized different studies, which showed the robustness of PPP as a long-run condition. The literature on PPP has a long history and is based on commonly found results. In the current thesis, there is more focus and debate drawing on the articles by Taylor and Taylor (2004) and Taylor (2002) amongst others. Of special interest is the article by Taylor (2002) that was investigating PPP for a hundred years of data and gives an indication as to how long this issue has been a focus for economic and

financial market research. The first empirical chapter in this dissertation investigates two areas, one is the law of one price in terms of PPP and the relation between prices across developed countries and another mini chapter about the Gulf region using variables where statistics data are quite limited, where the dollar is important.

The second empirical chapter looks at the money markets in the UAE as this is the researcher's country and enabled sourcing of reliable and very unique consistent interest rate data for the current study. It is about the term structure of interest rates using a range of different interrelated methods all in an attempt to find a stationary long-run relation using augmented dickey-fuller (ADF), error correction models (ECM) and autoregressive distributed lag (ARDL) Models. Finally, when these methods broke down, the approach of non-linear autoregressive distributed lag model (NARDL) based on very interesting paper of Greenwood-Nimmo et al., (2013) where different hypotheses for short and long run pass through were tested. In the final empirical chapter, the interrelatedness of stock markets for the Gulf will be examined.

As mentioned above there are three empirical chapters which form the basis of the main contributions of this piece of work. Evidence on arbitrage and the law of one price is provided using dollar rates for developed countries, and as proved here in the first empirical paper cross rates do not provide a basis for analyzing PPP across the developed countries nor the Gulf. Then there will be a mini chapter using yearly CPI prices for the Gulf over 30 years to conclude whether the law of one price holds in the long run from a panel analysis. Then a unique study using a specially collected series of data from the UAE considers interest rate pass through and the term structure using ECMs in an ARDL and NARDL approaches. To further understand how the markets work, the possible interrelatedness of stock markets is investigated across the financial markets of the Gulf States.

PPP, uncovered interest parity (UIP), interest rate behaviour, term structure of interest rates and interrelatedness of stock markets are all related to arbitrage, market efficiency and currency union. Each of the Gulf countries has a different currency and a different exchange rate, but they are mainly fixed and pegged to the dollar. The European Union and the Euro zone provide an example of how a currency union might operate and an insight into the real experience of a currency union, but it may also make sense to look at older unions. There is a vast collection of papers and reports that draw on what happened

before and after the Euro zone union and some of these have compared this to the Gulf currency project. In particular, Professor Wilhelm Buiter prepared a paper on the Political, and Institutional Prerequisites for Monetary Union among the Members of the Gulf Cooperation Council (GCC), but his paper was mainly theoretical and provided little quantitative analysis of the problem. This report by Buiter (2008), concluded that there seemed to be no overwhelming case for a union. He believed that the GCC did not define an integrated or common market. Buiter (2008) provided some more qualitative political arguments against monetary union. If the Gulf is compared with the European Union (EU) there is a political system to give support to further economic controls required to do direct economic policy such as setting interest rates. Buiter (2008) suggested that with "the absence of effective supranational political institutions there would not be effective political accountability of a GCC central bank".

Abu-Qarn and Abu-Bader (2008) looked at the optimality of a GCC Monetary Union using a structural Vector Auto-Regressive model (VAR). Findings on common trends and common cycles were viewed as evidence for the readiness of the GCC to establish a currency union, but based on their empirical research the authors could find little support for this proposition. An occasional paper was written by Sturm and Siegfried (2005) for the European Central Bank (ECB) to analyse regional monetary integration in the member states of the GCC. The authors looked at selected macroeconomic and institutional issues and key policy choices, and came up with some suggestions for integration to be successful. The authors did not undertake any empirical work, but considered the problem via an analysis of economic indicators and economic risk factors to determine how a monetary union might be brought about.

In a working paper for the International Monetary Fund (IMF) by Abed et al., (2003) looked at the most appropriate exchange rate regime for the GCC monetary union. They suggested that a basket pegged to shadow both the dollar and euro would provide the best mechanism for a conservative strategy towards a more flexible exchange rate policy. Al-Mansouri et al., (2006) discussed a proposal for what has been called "Gulfstat" by analyzing some of the preconditions for a currency union. Unfortunately, the sample of data used seems not to be enough to be confident of this analysis, so the study focused more on qualitative and theoretical methods and general economic analysis comparing the Gulfstat to other agencies like Eurostat and Afristat.

Article No17 written in May, 2003 by the Monetary and Economic Section of the UK Department of Business Information and Skills (BIS) discussed regional currency areas and the use of foreign currencies. In this paper Europe, Middle East and Africa were compared to other regions under different exchange rate regimes. Special interest was shown in relation to dollarization, where a national currency is effectively replaced by foreign currency like the US dollar. Normally, this is not a policy, but in certain countries, often due to hyperinflation, residents no longer have confidence in the currency and transactions are undertaken in US dollars or people hold dollar accounts. It was argued that, as the Gulf States rely heavily on oil, the acceleration to monetary union may strengthen the currency and allow the economies to diversify away from oil. It could be argued that many of the Gulf economies have been refocused towards construction, financial services and tourism.

On the other hand, the Gulf States are still developing and at this stage would like to counter the risks that may also follow from a fixed currency union as might be seen from the situation of Greece in the Euro zone. Any proposal to integrate effectively and form a currency union should be given support by an effective empirical analysis based on a good span of data. Most of these states are pegged to the dollar and fixed, so finding PPP for these countries is focused on finding whether arbitrage occurs between commodities across the Gulf. As exchange rates are fixed, it is not possible to directly analyse PPP because exchange rate flexibility needs to be a lever to bring prices into line. Gulf currencies being mainly fixed to the US dollar means that any analysis based on cross rates is limited with a reasonable span of data, comparisons might be made between price indices (Smith and Hunter, 1985). Any analysis of the long run should require a long span of data, but these countries lack a good statistical infrastructure. Here, the analysis is limited to annual data of 30 years.[1]

The first empirical chapter was supposed to be on Gulf States prices and PPP through prices and exchange rates, but after struggling for such a long time to extend the number of observation, the most reliable analysis seems still to be limited to 30 annual observations, and this is not enough to build any sort of macro econometric model.

[1] Having contacted a number of agencies and institutions in the Gulf, it was suggested that they are at this point in time just started working on improving and building statistics infrastructure.

Lothian and Devereux (2011) explained that PPP in the long run can be viewed as measuring the way in which prices can translate into a common currency and move together. The same procedure could be carried out on the United Arab Emirates and other Gulf States if data were available. These tests would determine the efficiency of the Gulf exchange rate. However, a direct analysis of exchange rates in the Gulf would make no sense as the results derive from results on the dollar rates. When only 30 years of annual price data are found, then the law of one price can only be investigated via panel methods. This will give an indication as to whether PPP might be valid as the exchange rate cannot move to bring prices in line.

To further investigate PPP, an analysis is considered using dollar rates, but only through developed economies, as the gulf currencies are pegged to the dollar, then any findings on these fixed currencies and PPP are an analysis that arises in direct proportion to the dollar. For example, trade between Dubai and Australia, the Eurozone or the UK is effectively a dollar transaction. Further, any analysis of long-run PPP for the Gulf countries in terms of the dollar is also not possible as the exchange rate is not only stationary but fixed. PPP is directly investigated using dollar rates for other developed countries like the Australian and New Zealand dollar, and UK pound. It is true that we are not investigating the PPP here in this first chapter directly for the Gulf countries, but we would assume here that for PPP to hold for the Gulf currencies pegged to the dollar also needs to hold for other developed countries exchange transactions against the US dollar. Otherwise, when PPP does not hold for the developed economies that we would study and monitor here, it might be seen as less likely to hold for developing countries.

There will be two main sections in chapter three. One section will investigate market efficiency and PPP for developed countries in terms of dollar exchange rates. It would be straightforward to compute exchange rates for the Dirham against the Australian dollar or the pound and compare this with the countries' relative prices. However, with official data there is a cross arbitrage restriction that at worst invalidates the analysis unless PPP is found across all rates or for correctly specified models implies results that depend on the results that follow exactly from the dollar (Smith and Hunter 1985). Cross arbitrage follows in practice from dealers trading currencies through the dollar rate, which is called - round tripping. To show what happens for an analysis in terms of the Gulf currencies, the long-run can be considered for cross rates related to the Australian dollar, New Zealand dollar and pound. The Gulf rates are then just a fixed proportion of the dollar

rates. The second section will be about the Gulf States price indices, but this is for a short span of data on a yearly basis and this seems best looked at using panel methods.

The second empirical chapter will relate to interest rate arbitrage and the yield curve. This will determine money market efficiency in terms of interest rates using a unique data set collected from the United Arab Emirates (UAE). Similar data could not be obtained for the other economies. However, finding that the money market is efficient for one state is a step towards finding efficiency across the Gulf. The term structure of a number of UAE interest rates is analysed to determine whether they are efficiently priced in the long-run.

The third empirical chapter is about the efficiency of the Gulf financial markets and also looks at stock price interdependence across the six states. Efficiency is analysed by looking for anomalies and non-linearity in stock prices. Finally, dependence in stock returns and stock indices will be looked at using the VAR model. Cointegration amongst these markets indicates whether they can be seen as a single financial market. Burke and Hunter (2012) looked at arbitrage in gasoline prices across the states and determined the breadth of this market. If a single trend drives all prices then the market is interrelated. The regional market for financial assets can be defined in a similar way to see whether stock prices are driven by a common sentiment across the Gulf States or if there is a common market for financial assets.

CHAPTER 2: PRELIMINARIES, REFLECTION ON THE GULF AND CURRENCY UNIONS

Before going into the first empirical chapter, it is important to briefly look at the preconditions, introduce the Gulf States and then consider currency unions. The Euro zone started in 2000 and at that time the idea of the currency union was supported by a fairly stable world economy. Around this time the same idea was born for the Gulf and some economists and politicians started to discuss the idea.

2.1 Global Economic and Financial Conditions

In terms of the financial markets crisis there was illegality in the mortgage market in the US and as a result some hedge funds were allowed to get away with shady operations as the crisis developed. Institutions such as the US Treasury and the Bank of England also missed some of the key signals that would have indicated the level of the problem and how it would develop. Cross border asset sales and mergers and acquisitions led to an intensification of the crisis as even the ability of the accounting profession to properly track the risks associated with these activities was called into doubt. In Europe the banking crisis and the economic policies that followed led to further failure (Hunter, 2014). This was before any economic tests or discussions of the way in which monetary policy and/or fiscal policy might operate.

2.2 Monetary Unions

Before going into the Gulf currency union and their exchange rate regimes, it is important to first briefly draw on the previous monetary unions for the Gulf and other world unions like the Euro Union. There are five monetary unions in the world; three of them are in Africa, Caribbean and Europe. The fourth is the Southern African Common Monetary Area (CMA) in which a common currency is in circulation and the fifth might be the Gulf currency.

Sam Vaknin (1995) stated that the first true monetary union was the Union of Colonial New England. The Union had four kinds of paper money: Connecticut, Massachusetts Bay, New Hampshire and Rhode Island that were legal until 1750. After other colonies were envious and started printing additional notes outside the union, Massachusetts faced

a threat of devaluation and inflation and then retired from the union. Another union attempt was the Latin Monetary Union (LMU). The French were obsessed by their declining geopolitical fortunes and monetary prowess so after its independence, Belgium adopted the French Franc in 1830, Switzerland joined in 1848 followed by Italy in 1861. After Greece and Bulgaria joined in 1867 a currency union was established based on a bimetallic silver and gold standard. LMU was the official form of the unofficial "Franc area". Later, after its peak, 18 countries adopted the Gold Franc as a legal tender or peg and the four founding members of the LMU agreed on a gold-to-silver conversion rate.

Europe, and in particular Germany and the UK, were switching to the gold standard, but LMU did not pay any attention and continued printing big quantities of gold and silver coins. In 1926 LMU was officially dismantled but expired long before that because silver became overvalued and the union had to suspend its use. The key arguments as to why the LMU ended were the lack of a common monetary policy and a common central bank.

Another failed union was the Scandinavian Monetary Union (SMU) formed in 1873 by Sweden, Denmark (1873) and Norway (1875). The SMU worked perfectly and there were no exchange rates between the three currencies. The SMU had an unofficial central bank with pooled reserves. As governments started to dump gold during World War I to finance their deficits central banks used the depreciated currencies to scoop up gold at cheap rates and as a result Sweden refused to continue selling its gold at a fixed price. Other members declared economic war and forced Sweden to purchase enormous quantities of its coins. Sweden had a situation where it was subsidizing an arbitrage against its own economy and ended importing from other members and the Union ended.

2.3 The History of the European Union

Until the most recent crisis in Europe and the Euro zone, the EU was considered to be one of the most successful currency unions in the world. A group of EU countries wanted to create integration and achieve a uniform system to remove a variety of barriers including physical, fiscal and technical and ensure a free flow of goods and services between them. Although this project took years of tremendous coordination and work to come to the stage of complete integration, it was proven to be successful and showed what was achievable. It is important to realize that the EU occurred before the euro and

many steps had taken place prior to the union like the Maastricht treaty that led to free movement of commodities and labour across the EU. In the end this is a highly political decision.

According to the history of the European Union in the EU official website[2], EU is divided into different stages. They called Europe as peaceful Europe from 1945 to 1959 because EU was created at that time to end all wars between the European countries after the second world war. Europe was one of the world's largest trading regions complicated by fragmented currencies. The EU is based on a rule of law and any action of the EU members has to be approved by all EU members and recorded in a treaty. There were many treaties in EU but some of them were important and have to be mentioned here due to the major impact they had on the Euro before coming to reality.

Before the Peaceful Europe stage, The League of Nations was formed as early as 1929 and contemplated an economic and monetary union, but World War II derailed those ambitions. The Lisbon Treaty is the latest, most up-to-date treaty based on how European institutions work, but there were other important treaties before that.

During the Peaceful Europe stage and by 1950, the European Coal and Steel Community Treaty was created between the six founders; Belgium, France, Germany, Italy, Luxembourg and the Netherlands. This treaty was created to ease the tensions of World War II and it stated that no country could mobilise its armed forces without informing others. Later and by 1957, the Treaty of Rome was established to set up the European Economic Community (EEC) and European Atomic Energy Community.

1960 to 1969 was called the ‘Swinging Sixties’ and a period of economic growth. The EU countries stopped trading custom duties with each other and they all had food production in joint control which soon led to a surplus in agricultural production. Also, the Brussels Treaty in 1965 was formed to streamline European institutions.

The next period (1970-1979) was of a growing community where Denmark, Ireland and the United Kingdom joined the EU in 1973. By 1981 Greece became a member of the EU and five years later Spain and Portugal joined.

[2] The European Union official website. https://europa.eu/european-union/about-eu/history_en

While the Single European Act of 1986 speeded up decision-making in preparation for the single market and remove borders across EU countries. By 1989 the Berlin wall was pulled down which made East and West Germany united for the first time in 28 years in October 1990. After the collapse of communism, Europeans became closer neighbours. In 1993, the Single Market was completed with the four freedoms of goods, services, people and money.

The 1990's was the decade of two important treaties, the 'Maastricht' Treaty in 1993 and Treaty of Amsterdam in 1999. People here focused on security, defence matters protecting the environment. In 1995, other EU countries joined as members, Austria, Finland and Sweden.

The participating nations converted to the Euro via triangulation and finally, in December 1998, it was determined that one ECU would equal one Euro. On January 1st 1999, the Euro was first circulated in non-cash transactions and in accounting terms with traveller's checks, stocks and mortgages. Then the national currencies for the Euro zone countries established a fixed rate with each other and national currencies went out of circulation. The transition to the Euro took three years until 2002 and by then enough euro notes and coins were in circulation. At the beginning, and after the launch, the euro performed well on January 5th at 1.19USD dealers were amazed by how quickly it replaced national currencies like the Deutsche Mark, which was expected to trade in parallel but disappeared almost immediately. However, 2007-2008 the financial crisis hit the world economy and then this affected the Euro zone.

When the Euro project started successfully, it provided encouragement to the Gulf States to think about such an idea, especially as the idea had been conceived decades ago in the Gulf. If it was possible to unify 27 countries of at least 450 million people and attract interest from more countries, this showed the Gulf States how it would be possible to unify the six Gulf members; Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and the UAE, and bring the concept of a single currency for the Gulf closer to reality.

After the U.S financial crisis starting in 2007, Europe and the world economy suffered a lot of obstacles. It started in one place and spread like a contagious disease. Many EU finance ministers had thought that the banking crisis was a problem for the US and the

UK, but it then became apparent that within the Euro zone, five of the region's countries- Portugal, Ireland, Greece and Spain and Italy were in trouble. A large element of the European crisis is related to the inability of these countries to pay back bondholders. It started with the slow growth of the global economy after the 2007 crisis, which affected the globe in varying degrees and the trust within the entire financial system was broken.

After the boom in the housing sector in the US, the crisis followed with the expansion in derivative markets especially complex assets like mortgage backed securities. The Fed raised the interest rates to cool off the overheated market in 2004-2006, the monthly interest payments for mortgages increased and the houses prices fell significantly. The homeowners could not pay the mortgage or sell the houses and defaulted. This impacted not only US market, but the whole world. After the housing bubble burst, there was regional bank default. Larger institutions were directly affected by the financial crisis through the credit crisis' impact on the value of mortgage debt. The story in Ireland was more straightforward with banks failing directly as a result of the collapse in the housing market. The UK government, was not a euro-area country, but still played a key role in support of some of these institutions. The case of Greece is directly linked to the overvaluation of their currency and the inability to recover from the recession that hit the Euro zone after the crisis.

2.4 The Gulf Monetary History:

The history of the Gulf States exchange rates or the currencies are reviewed, and it is found that they went through major changes throughout the past decades. Until 1959 the Indian rupee was the official currency within the Gulf States as they were mainly controlled by the British and governed from India. The Indian rupee kept circulating for many years until smuggled rupees were used to purchase gold in the Gulf making the currency redundant. In 1959 the Indian rupee was replaced by the Gulf rupee or External rupee by the Bank of England. It continued for many years in bullion coins like Maria Theresa dollars and British gold sovereigns.

The Gulf rupee was used in the states of the Arab Gulf for a number of years before becoming redundant and before Gulf States started their own currencies. Kuwait was the pioneer in starting its own currency in 1961 and Bahrain in 1965 while the first coinage

to replace the Indian coins was introduced and used in 1966. During this period the India rupee suffered a number of devaluations, which led to Saudi riyals going into more general circulation instead and then the Gulf rupee stopped being legal tender in all the Gulf States except Oman and Muscat. They traded heavily with India even after the devaluation of the Indian rupee and were the last places where Gulf rupees were circulated.

Many of the Gulf states have at one point shared a currency. In 1950s and early 1960s, before their independence from Britain, many states shared the external Indian rupee. After their independence, Qatar and Dubai both used the riyal for many years. Dubai and Qatar signed an agreement and introduced the first monetary union among the Gulf States in 1966. Abu Dhabi refused to introduce the Saudi riyal because of their dispute with Saudi Arabia and adopted the Bahraini dinar instead. Oman and Muscat used many currencies, including the Kuwaiti and Bahraini dinars; local baizas of Muscat and Maria Theresa dollars until 1970 when they then introduced their own national currency.

After a few years the Gulf States formed different currency regimes. The UAE pegged its dirham to IMF special drawing rights (SDR) in 1978, but since 1997 it has been pegged to the US dollar and this has not changed since then. Other countries like Bahrain have been pegged to the US dollar since 1980 and Saudi Arabia since 1986. The Omani riyal was pegged to the US dollar in 1973 while Qatar was pegged to SDRs in 1975 and to the dollar in 1980. Kuwait was pegged to a weighted currency basket from 1975 to 2003 and then pegged in 2007 to the US dollar with margins of ±3.5%. After 2007 it was pegged again to a currency basket.

Saudi Arabia, Bahrain, Kuwait and Qatar are pressing ahead with single currencies and the Gulf Monetary Union. The Saudi Arabia riyal is forecast to remain pegged to the dollar, although there is a possibility that the level at which the peg is set could be altered as part of preparations for the monetary union. The single currency would probably initially be pegged to the dollar, but a currency basket may be introduced in the medium term.

Bahrain intended to enter the currency union since it was announced and formed a plan to do this with Kuwait, Qatar and Saudi Arabia. Bahrain said that the project was expected

to take place as a single currency by 2013, but nothing has happened yet. However, the member states have pursued convergence on inflation and sought a consensus on the functions of the planned central bank. In the meantime, the Central Bank of Bahrain is expected to maintain the dinar, pegged to the dollar at a rate of BD0.376: US$1 and that has been in place for over two decades.

The Qatar riyal is pegged to the dollar at the rate of QR3.64: US$1 and the authorities are committed to maintaining the current exchange rate regime. One reason for this is that gas and oil exports are denominated in the US $s, which offers stability for the country's economy and reassures investors as well. Revaluation is unlikely to happen unless the dollar weakens substantially. Qatar is still committed to the single currency, unlike Oman and UAE that have withdrawn from the monetary union project.

Oman has fixed its exchange rate to the dollar at OR0.3845: US$1 since 1986. Oman's external accounts and foreign asset levels are still sufficiently robust to enable the Central Bank of Oman (CBO) to defend the peg. Oman decided not to join the GCC currency union, which means that it is less likely to adjust its peg in response to any revaluations of the currencies of the other gulf countries.

According to the Central Bank of United Arab Emirates, it announced in 2010 that the UAE dirham is pegged to the dollar at (Dh 3.673: US$1) and expected to remain fixed to this rate in the coming years. Especially after the recovery of the dollar since mid-2008, it has become even less likely that the peg will be broken or the currency will be revalued from a rate that has stood since independence in 1971. This pegging has provided the UAE with stability for decades and has helped the country to ride out problems. As such, the authority seems keen not to change the system. Although the UAE dropped the GCC monetary union project this had no immediate implications for the exchange rate over the forecast period.

By June 8 1981 the GCC leaders had the well-known "Unified Economic agreement" to coordinate their financial, monetary and banking policies and endeavour to establish a joint currency. The Gulf Cooperation Council (GCC) countries were founded in 1981 through Article 22 of the Council's Unified Economic Agreement of June 1982, which stipulates that:

> "The member states shall seek to coordinate their financial monetary and banking policies and enhance cooperation between monetary agencies and central banks including an endeavour to establish a common currency in order to further their desired economic integration".

Over the past two decades most of the states pegged their currencies to the US dollar, which gave them exchange rate stability. In 2003 the states all decided to peg their currency to the dollar officially to fix the bilateral exchange rates, which was a transitory stage prior to the currency union. Even though until that year, Kuwait was pegged to a trade-weighted basket of currencies dependent on its major trading partners.

Prior to having a common currency, a degree of Economic Integration is required. A key component associated with such integration is the extent to which individual country markets are efficient. This relates to the extent to which individual country markets demonstrate informational efficiency, the extent to which there is arbitrage across the different country markets and the market for foreign exchange is efficient. One requirement for such efficiency is a common regulatory framework and arbitrage. The regulatory framework has to be developed at the level of the union and some form of trade arrangement needs to be put in place along with agreements with respect to free trade across borders.

The GCC countries have many similarities in history, culture and economic characteristics. They are highly dependent on the export of oil and trying to diversify their economies. They believe in free enterprise and that is why capital movements to and from these countries are unrestricted and there are no taxes or subsidies on the purchase or sale of foreign exchange. The GCC countries have taken a number of steps to integrate their financial and economic systems. A common tariff has been adopted, cross border trade disputes resolved, land ownership for nationals building homes and for business purposes liberalised, foreign direct investment and intraregional capital flows promoted and investment codes and stock exchange regulations harmonised. Additionally, electricity grids have been interlinked and common gas grids developed. Unified bank supervision procedures have been adopted to integrate GCC countries' financial systems and banks have been allowed to open branches in different jurisdictions, ATM machines have been interlinked and measures initiated to interlink stock markets to allow cross listing and trading. In a further effort to successfully diversify, GCC countries have adopted similar

exchange regimes pegged to the dollar, established a customs union with a common external tariff rate of 5% as well as a common customs law and many other steps to quicken the pace of economic and financial integration for the union to take place.

The largest single sector in almost all the GCC states, with 80% of export earnings and government revenue is hydrocarbons (oil and gas). Four out of the six Gulf States are members of the Organization of the Petroleum Exporting Countries (OPEC). OPEC is an oil cartel with a mission to coordinate the policies of the oil-producing countries to secure a steady income for the members and to secure the supply of oil to consumers. The founding members are Iran, Iraq, Kuwait, Saudi Arabia, and Venezuela. OPEC was established in the 1960s by Venezuela and Iran and Iraq, Kuwait and Saudi Arabia joined later. Other members that subsequently joined included Algeria, Angola, Ecuador, Gabon, Indonesia, Libya, Qatar, Nigeria and the UAE.[3] OPEC has a strong influence on international oil prices and prices have fluctuated upward and downward tremendously since it started. For example, prices increased for last months of 1973 due to the oil embargo, when OPEC members refused to ship oil to western countries after they supported Israel in the Yom Kippur War in which Israel fought against Egypt and Syria. On January 7 1975 OPEC increased prices by 10% and adopted output rationing to maintain prices.

As a result of the GCC's high dependence on oil and because of the continued decline in oil fields across the world in general and in the Gulf in particular, the GCC needed to prepare for the post-oil age when reserves will run out. The GCC has to diversify to reduce risks, create jobs and prepare future generations for the post-oil age. This has been in the public domain since a report by the Economist Intelligence Unit (2010), sponsored by the Qatar Financial Centre Authority. They came to the conclusion that the structure of the GCC economies is likely to undergo some change over the next decade with expanding financial services, aviation, tourism, trade and logistics, mining and mineral-based industries in addition to energy-intensive manufacturing. The GCC is also expecting strong growth in infrastructure and service sectors like education, healthcare, transport, power, water, consumer goods, sport and leisure and media and film with a growing

[3] http://opec.org

population of GCC nationals and residents. The GCC countries have also begun to develop other export-oriented sectors, including agriculture, which largely relies on desalinated water and requires extensive subsidies; agro-processing (such as sweets and sugar refining), which has already seen some success; renewable energy (particularly solar power), which could also eventually be exported, although this is likely to be a longer-term initiative; and medium- to high-tech manufacturing such as biotechnology and pharmaceuticals, which will require significant new investments in Research and Development (R&D). While Abu Dhabi has signed a nuclear power deal with South Korea to build four nuclear power plants in the UAE; a US$20 billion contract.[4]

GCC member states have already achieved a high degree of monetary convergence but not yet fiscal convergence. This is a big challenge that requires a lot of harmonisation of fiscal levers for the six states. Given that the GCC shares one common factor; they have economies depending on oil and gas production, they have common economic structures, dynamics and trade patterns, which reduces the likelihood of asymmetry in their response to external shocks. However, as oil and gas are scarce resources, they will be exhausted in the not too distant future. This implies a need to diversify the economies as soon as possible and the common currency with a common market would be an important and influential factor forcing economic diversity.

There are many challenges facing the GCC before they can take the important step of a union in the Gulf currencies, to make sure of monetary, fiscal and market integration. To get such integration, there should be efficient markets not only among the six states, but internally within each state. That is a great challenge for each member of the GCC. Every year the GCC members meet to discuss and make sure that integration is going in the right direction and to try to remove any obstacles. What kind of interrelatedness is there in the exchange rate with the financial and money markets? There is an issue here of interest rate policy and inter-relatedness of the Gulf's financial markets as well. Moreover, informational efficiency is observed via arbitrage across the different economies. This can be tested by looking at the capacity of prices across different borders to mirror each other. Such analysis might be applied at product level or via a set of products or a basket of products. The former can be considered in relation to products within a country or across countries according to the data collected.

[4] http://www.thenational.ae/news/uae-news/

The optimal currency area (OCA), theory Mundell (1961) assesses a currency union for a region. For an economic region to be an OCA, it should have mobile flows of labor and capital, similar economic structures, synchronized business cycles, and a willingness to coordinate monetary, fiscal and other economic policies (Rutledge, 2004). Analysis of the GCC economic variables has shown that they don't have OCA yet. In this thesis the degree to which these preconditions are met is to be investigated. Although the states union will have many benefits for the region and economy, it also has some drawbacks like losing flexibility and the ability to use national monetary policy against any downturns or inflationary pressure in future, because they will all have a single monetary policy and interest rate and that should be appropriate for all of them. Also there are political costs like loss of national sovereignty and collective pressure on individual states for greater fiscal accountability and economic transparency. Taylor (2002) introduced the idea of the macroeconomic policy trilemma. The policymakers have to select between three objectives: a fixed exchange rate, capital mobility and the nature of monetary control.

To have a common currency for the Gulf, the trilemma provides some underlining notion of the types of factors which impact exchange rate behaviour relative to monetary policy. Taylor (2002) suggested some of the primary considerations that need to be resolved prior to thinking about having a common currency. If certain conditions are not satisfied, then thinking of having a common currency is not applicable.

This emphasises that a key problem with the Euro zone was the rate at which a country enters the union, but over time the economic and financial strengths of the economies in the union will also have a key influence. Although fixed exchange rate systems can add some complexity in terms of policy, it might benefit the Gulf region in the future to strengthen the economy, encourage regional and international diversification especially with the conflicts facing the region.

The nature of monetary policy would be different under a fixed rate as it means policymakers lose a degree of freedom. There is some debate, but in a currency union, individual countries have limited control of their own monetary policy. That is demonstrated in Greece; it is the ECB, which decides on the interest rate and the amount of money that is in the system. The ECB has had a policy that has been grounded in the

experience of the German economy with inflation after World War I. This has made monetary and interest rate policy very conservative. It is the central monetary authority that sets interest rates as a primary means of control of the currency. Things are then fixed across the Euro countries, but floating against the world. It is not as restricted as being in a fixed exchange rate regime as the world was before 1971, but countries are tied to the average behaviour of the whole of the zone that they are in. If the countries are different in one zone, it is sensible not to engage in one of these fixed systems.

It may be the case that the issues that were a problem for Greece are not the same for the Gulf. There is more cultural uniformity across the Gulf than exists between Greece and Germany. Further, there is little evidence that PPP held for a number of economies in the Euro zone prior to the creation of the common currency as evidenced for Ireland, Italy, Portugal and Spain by Beirne (2010). There seemed an excessive keenness on behalf of Germany and France to ensure that all countries in the EU entered the currency union. As has been mentioned in Beirne (2010) this seems more of a political than economic decision. It may have been viewed in the EU commission or in Germany that Greece was so insignificant that whatever happened economically such a small country could not bring the whole zone down. Something the Gulf states should learn from the Euro crisis is that prior to any union countries' prices across the zone should respond at least in the long run to the same underlying drivers. If this is not the case across these countries prices, then perhaps a currency union would not be a good idea.

Exploring a fixed exchange rate and currency union, as mentioned before, addresses the question of market efficiency. The Gulf States have to make sure that they have a market that is efficient in distribution and production before creating a monetary union and a common currency. In the three main chapters of the current thesis different aspects that should help answer the question of whether the Gulf is ready for a currency and monetary union will be examined. A check will be made to see if the necessary building blocks are there before going into a union. A currency union requires the free movement of capital. This implies the freeing up of financial markets and as a result the capacity to freely trade financial assets across country borders. This would imply that financial markets are efficient and that there is perfect or long-run arbitrage across markets in a zone that intends to form a currency union. Hence, observing efficiency in a cross-market context is another pre-condition for currency union.

Once the union is configured then there will be a single monetary authority (Buiter, 2008) and this means that markets at all levels need to be well functioning and efficient. As has been observed in the context of the EU, the failure to arbitrage goods across a single market may lead to market failure in one part of the union or a state of economic failure linked to dwindling productivity. If a country is not able to set monetary policy and inflate itself out of trouble or deflate the currency and alter the competitiveness of the single economy, then the only solution is economic contraction, and this may cause political crisis and economic failure.

CHAPTER 3: CROSS ARBITRAGE, THE LAW OF ONE PRICE AND SPECIFICATION IN DEVELOPED FREE FLOATING ECONOMIES AS COMPARED TO THE GULF STATES.

3.1 Introduction

There are three main approaches to assess the efficiency of the market that arise and relate to parity conditions: (i) uncovered interest rate parity, (ii) covered interest rate parity and (iii) purchasing power parity (PPP). One way of testing market efficiency empirically is through PPP or in the long-run by testing whether the real exchange rate is stationary. Usually, this arises as a result of arbitrage, which implies a law of one price holds, which is the approach adopted in this chapter.

The literature is well explained in three important papers (Taylor 1995; Taylor 2002; Taylor and Taylor 2004). A significant literature exists on PPP and subject to the three articles mentioned above this will be summarized next.

PPP is a pillar of international macroeconomics. PPP states that it is expected that the nominal exchange rate between two currencies should be equal to the terms of trade (ratio of two price series). In simple terms, the purchasing power of money should be the same across countries when measured in the same currency. There is another way of expressing the theory by using the real exchange rate which is the nominal exchange rate multiplied by the ratio of two countries prices. As defined by Taylor (2009). " It implies a real exchange rate in which the value of a unit of foreign currency in the foreign economy equates to the purchasing power of a unit of domestic currency in the domestic economy". The early literature in economics suggested this should hold instantaneously while now it is accepted that this is a long-run concept.

It is well known that the exchange rate should when free to move follow a random walk implying the series is non-stationary, and then there will be a long-run relation when the combination of the exchange rate and relative prices are said to co-integrate (Engle and Granger, 1987). That implies a linear relation between these two series is stationary and that any deviation from parity will be considered as an arbitrage opportunity. Equivalently the real exchange rate is a stationary or mean reverting. If that arbitrage is exploited, then

that will force the exchange rate towards PPP. PPP suggests that these variables move in proportion to one another, at least in the long run.

The economics of the exchange rate and long-run PPP have been one of the most difficult and challenging areas of research for decades. PPP developed after World War I to explain how the correct level of the nominal exchange rate in all the major industrialized countries could be found after the large increase in inflation that arose as a result of the war. The doctrine has a long history in economics but is often attributed to Cassel (1922). This idea is well expressed as follows:

"Under the skin of any international economist lies a deep-seated belief in some variant of the PPP theory of the exchange rate". Dornbusch and Krugman (1976)

Therefore:

$$E_{12} = \frac{P_1}{P_2} \qquad (3.1)$$

Where E_{12}, is one unit of the foreign currency valued in terms of the home currency (for example the US dollar in terms of pounds), P_1 is the home price and P_2 is the foreign price.

Using the right hand side of (3.1), any product or product index is a measure of the terms of trade. Another way of viewing this is that (3.1) defines a long-run expectation of the exchange rate, so this may not always apply. Much of the evidence suggests that the exchange rate can be some way away from the terms of trade (Lothian and Taylor 1996).

In logarithmic form, the PPP hypothesis implies that:

$$e_{12} = P_1 - P_2 \qquad (3.2)$$

Where e_{12} is the natural logarithm of E_{12} or the nominal exchange rate (the foreign price of domestic currency) p_1 is the natural logarithm of P_1 (the domestic price level) and p_2 is natural logarithm of P_2 (the foreign price level).

Testing the PPP hypothesis can be undertaken in a number of ways, but one approach is to consider whether the real exchange rate is stationary or mean reverting. In logarithmic form this becomes a parity equation:

$$e_{12}^{r} = e_{12} - p_1 + p_2 \qquad (3.3)$$

The deviation of this nature from PPP is usually examined through the real exchange rate and when applied in logarithmic form is described by (3.3) and this may be seen in terms of deviations from PPP. When PPP holds, then the equation defines an arbitrage condition, which when it holds exactly, implies:

$$e_{12} - p_1 + p_2 = 0 \qquad (3.4)$$

If this is seen as a target to which the real exchange rate is supposed to move, then:

$$y^{*} = e_{12} - p_1 + p_2 \qquad (3.5)$$

If PPP were to hold at all times then (3.5) would be zero for any sample observation *t* while in practice, deviations from the exchange rate from the terms of trade are expressed by the real exchange rate across the sample:

$$y_t = e_{12t} - p_{1t} + p_{2t} \neq 0 \qquad (3.6)$$

If the long-run behaviour of the variables that make up the real exchange rate is considered, then their expectation may be captured by a long-run average, so that:

$$y^{*} = E(e_{12}) - E(p_1) + E(p_2) \qquad (3.7)$$

Or

$$y^{*} = \bar{e}_{12} - \bar{p}_1 + \bar{p}_2 \approx 0 \qquad (3.8)$$

Therefore, in reality we observe a discrepancy between this long-run average or correlation –see (Lothian and Taylor 1996) or expected value of the real exchange rate as a long-run error or correction term:

$$y_t - y^{*} = \eta_t \qquad (3.9)$$

The requirement for PPP to hold over this long-run is that η_t is well defined or, as is explained in Burke and Hunter (2005), has controlled variation. One way of defining this is to say the series is difference stationary I(0) or integrated of order zero while the linear combination:

$$y_t - y^{*} = \eta_t \sim I(0) \qquad (3.10)$$

In practice it is possible to replace y^{*} by its long-run average or mean value and this form of analysis has been considered by Lothian and Taylor (1996) and this should be close to zero so our any analysis might concentrate on the stationarity of the computed real exchange rate. Hence, we can replace this procedure of averaging by a test of stationarity that can be viewed as implying that, for any finite sample, the discrepancy between the exchange rate and the terms of trade is tends to zero. This is a less strict way of saying PPP holds in the long-run.

From the discussion in Simpson (2002) the nature of PPP goes back to ancient times, but most empirical studies take as their point of departure a model that comes from Cassel (1922):

$$y_t = a + b(p_t - p_t^{*}) + \varepsilon_t \qquad (3.11)$$

In simple terms the null hypothesis of PPP is equivalent to a=0 and b=1. Usually there is strong rejection of the null for most of the studies prior to 1980 because tests did not take account of non-stationarity of exchange rates and price levels and the possibility of ε_t being I(1) while static equations don't separate short run deviations from long run

deviations from PPP. Empirical studies using the so called 'next generation' tests of PPP have often assumed stationarity and checked when the residual is I(0). Others studies such as Edison (1987) chose to examine the validity of PPP in terms of the long-run speed of adjustment that is best seen by analysing the coefficient in the following type of error correction equation:

$$\Delta y_t = a + \gamma(y_t - p_{t-1} - p^*_{t-1}) + \kappa(\Delta p_{t-1} - \Delta p^*_{t-1}) + \varepsilon_t \quad (3.12)$$

γ computes the rate of convergence towards PPP. Results usually suggest half-lives of deviations from PPP between 3 and 7 years.

Taylor (1988) considered when e_t is the logarithm of the nominal exchange rate at time t and ρ_t is the ratio of the domestic to the foreign price level, then the logarithm of the real exchange rate would be e^r_t, which is:

$$e^r_t = e_t - \rho_t \quad (3.13)$$

Then for PPP to hold in the long run, $e_t = \rho_t$ and $e^r_t = 0$. So e^r_t must be a zero mean stationary process. If the real exchange rate is found to follow a random walk, then e_t and ρ_t will drift apart and in the limit in the long run and will never settle down. Taylor (1988) was potentially less stringent and more general as it considered cointegration between the exchange rate and the terms of trade. When compared to similar papers they have tested for a unit root in an autoregressive model rather than simply for a random walk residual without further restriction.

The exchange rate may be seen as a random walk and driven by other sources of transactions like capital assets. If what is happening is driven by financial markets, it could be balanced by other series that may capture further risk such as interest rate parity not the focus of attention here. However, the case here is broader than interest rate parity; it could be any type of financial transaction, so this would be reflected in the exchange rate but not the prices that impact whether PPP does not hold or that the real exchange rate is nonstationary.

Conventional financial market efficiency suggests that the exchange rate follows a random walk and this is a much debated subject when the exchange rate is considered.[5] The news or surprises that affect the financial market or real economy or both could impact the exchange rate. If such shocks are surprises means that the best prediction of tomorrow's exchange rate value is today's value as at the same time one is never sure of tomorrow's value. The pure random walk model is a surprise model. If the exchange rate is a random walk and that implies all past information is embedded in last period prices. In other words, the best predictor of future values of the exchange rate is the current spot rate under the assumption of a random walk. In reality this will almost never be true due to the timing of the surprises that hit the market place. If the exchange rate follows a random walk and price or inflation follows an autoregressive process, then it seems possible that PPP may never hold.

The more market phenomena affect exchange rates, the more shocks dominate and the more these surprises shock the system, the more likely the real exchange rate would follow a random walk and the less likely that economic information will reflect exchange rates rather than shocks that hit the market. By having other factors affecting exchange rates compared to other markets like stock markets, the more likely it might be that they purely follow a random walk. However, the exchange rate is different from other financial variables such as stock prices, because the exchange rate is impacted by more fundamental factors like interest rate movements, beliefs about government policy and other components of risk

According to the Random walk (RW) hypothesis, it is impossible to predict what the exchange rate will be tomorrow because the best guess of tomorrow's exchange rate is its price today. Otherwise, if that is not the case, then you may observe a very small amount of predictability, which means supplementing the RW with a very small autoregressive coefficient on any lagged difference in the exchange rate. A coefficient from the last period of the order 0.19, is not zero or may still be significant in statistical terms, but may not greatly enhance predictability compared to the value likely from the RW. The best guess of a stock change related to the stock next period assuming a small degree of autocorrelation would have a very small effect, as the largest component of any prediction

[5] According to (Frenkel, 1981a) and then in further studies in 1980s it was not possible to reject the random walk hypothesis (Michael Adler & BrLehann, 1983).

of the stock today is what it was yesterday to which is embedded the new information or the surprise.

The consensus on PPP has changed and shifted since the early 1970s. More specifically after international currencies stopped being fixed to the US $. Prior to the float, PPP was considered as a support of a stable real exchange rate (Friedman et al., 1963; Gaillot, 1970). In the mid and late 1970s, because of the high variability of the real exchange rates, it was seen that there was a collapse of PPP by Frenkel (1981) and further studies in the 1980's could not reject the hypothesis that the exchange rate followed a random walk (Adler et al., 1983). Following those studies there was a decrease in confidence that PPP held (Dornbusch, 1988). Overall, if the real exchange rate has a unit root or follows a RW, then this would affect the PPP concept and usefulness of the theory.

This is where a distinction is made between observation using retail or consumer prices as compared with the micro studies of PPP that relate to products that are easy to compare as can be seen with what is called the "Big Mac" index as published in *The Economist Magazine*. Here this looks at prices that are readily comparable across the world as it is a homogenous product where the quality and source of ingredients of the hamburger are controlled by a single retailer and production process. This can indicate whether the currency of any country is over or under valued, but many more factors make prices differ internationally such as inputs even related to the same product may cause quality differences. These inputs could be the service or wages of labour where the valuation of certain activities not as open to competition may differ from country to country; for further discussion (see Beirne (2008)). PPP or the Law of One Price (LOOP) considers homogenous products and so it would be a concern were it to fail in the context of regions of a single country where the exchange rate is not free to move. Forni (2004) looked at the market for milk in Italy and found that for this homogenous product in a single market, that arbitrage may fail and LOP may fail even in the long-run.

Lothian et al.. (1996) considered similar long-run price proportions over long time periods, but in terms of PPP by observing the extent of the correlation between the home price and the foreign price converted through the exchange rate. The idea behind PPP is related to arbitrage and the LOOP. However, to compare prices of products in one country to prices in another country, the baskets used to construct the Consumer Price Index (CPI) should be the same for the two compared countries by weight and type. While as

mentioned above PPP is easiest to consider when based on traded goods, and CPI is a mixture of traded and non-traded goods and services. So it may be preferable to use the producer price indices (PPI) rather than CPI to analyse PPP. However, it is difficult to find two CPIs or PPI, which have exactly the same components and weights. In this chapter, to better compare the results CPI will be used for developed countries and the Gulf as PPI is not readily available for the Gulf States.

Exchange rates keep changing and the main reason is, as prices change internationally day by day and from the theory the exchange rates must also change to keep the prices measured in a common currency equal across countries. At the aggregate exchange rates will reflect adjustments to offset differing inflation rates between countries as well. PPP considers the behaviour of product prices and is seen as being driven by longer run factors or their expectation. Exchange rates may be influenced on a daily basis by either goods or financial assets, but while assets change daily with their supply and demand physical goods prices tend to move more slowly (Dornbusch, 1976). Suggesting this argument should more likely relate to the long-run.

Results of testing PPP have varied over time and the focus of research had shifted to the robustness and accountability of the theory. Some more recent empirical studies failed to reject PPP while others have not. Taylor and Taylor (2004) found that PPP never holds in the short run in both absolute and relative terms[6], but does hold in the long run for both. However, the exact one-to-one relationship between the exchange rate and relative prices does not always hold as in the short run the exchange rate is affected by many factors such as capital movements and expectations while it takes time for trade to even out deviations from long-run PPP. Also, it is often thought that PPP should not hold even if prices stay the same as there are costs such as freight charges and tariffs to include in relation to international trade and arbitrage (Taylor, 1988).

Taylor and Taylor (2004) suggested that PPP may be more likely observed in relation to certain types of markets as compared with others. The suggestion is that PPP may be more

[6] Absolute PPP assumes that the exchange rate is equal to the ratio of the two relevant national price levels, while relative PPP assumes that the changes in the exchange rate is equal to the changes in relative national prices. For that reason, it is easier to believe that relative PPP rather than absolute PPP is likely to hold, because the latter tests the percentage change rather than the absolute value in exchange rate over the same period of time.

often seen when the markets are better integrated and this is what expected for the Arab Gulf countries. This would be more likely with European Economies as compared with OECD countries in general. However, as can be seen in the study by Beirne et al., (2007) that considered PPP just prior to the configuration of the common currency on average, for 11 developed economies, PPP is satisfied either via panel or single equation methods once the models are corrected. Some of the Euro zone economies did not meet the Maastricht Criteria for the formation of a common currency and it is found here that the two nations that fail to satisfy PPP, Portugal and Spain have suffered a great deal in the recent crisis. This may suggest why these economies have not been robust to the type of crisis that has hit the Euro zone in the recent past. On the grounds of PPP, it would seem that Ireland, Italy and the UK were much better positioned in terms of a broad basket of goods for entry into a common currency.

Froot et al., (1995); Lothian and Taylor (1996) amongst others, attempted to improve the power of the tests for PPP by using a larger sample size by using monthly and daily. While, this would increase the information about the short-run adjustment especially in terms of the exchange rate, in terms of the span of the data it made little difference to the long-run. In general, long-run information is more likely to increase by using more - extensive sample rather than increasing the frequency of the data (Shiller and Perron 1985).

As has been explained above PPP has always been viewed as a theory of the determination of the exchange rate both for the short-run and long-run equilibrium (Officer, 1976; Frenkel 1976 and Dornbusch 1987a). Rogoff (1976) said in his book “While few empirically literate economists take PPP seriously as a short run proposition, most instinctively believe in some variant of Purchasing Power Parity as an anchor for long run real exchange rates”. One main reason behind the impossibility of PPP holding on the short-run is the concept of overshooting (Taylor and Taylor, 2004). Quoting Dornbusch, and Krugman (1976), “PPP is retained as a long run equilibrium while allowing for significant short run deviations due to sticky prices”. Other researchers, like (Froot et al., 1995) and (Lothian and Taylor , 1996), have said that the low power due to using a short span of data may not yield enough information in detecting the mean reversion of the real exchange rate. Another view for PPP not holding in the short-run is that, during the short run, nominal exchange rates move and change substantially while prices do not. This can be observed when the real and nominal exchange rate volatilities correspond one-to-one

in the short run, which according to Flood, et al (1995) violates the law of one price and PPP.

From the theory view, markets are efficient when prices reflect all available information for all participants. Researchers consider observing the random walk phenomena as evidence of market efficiency because if it exists then market returns are not predictable. In a weak sense efficiency is met when financial time series follows a random walk. The simple idea is sufficient when the time frame is short, but a more appropriate definition that is consistent with financial asset pricing derives from asset prices being log-normal and this corresponds with more complex time series processes (Hull, 2006).

It was Poole (1967) that performed one of the earliest studies in efficiency and tested if exchange rate changes are random. While, Cumby and Obstfeld (1981) even suggested that the random walk model was inconsistent with the UIP condition. Whereas the early research of Mussa (1984) found for data collected over the floating exchange rate period that the majority of nominal exchange rate time series are extremely hard to distinguish from random walks. The random walk may be the prime driver, but as can be seen for aggregate consumption although 1(1), it is not often seen to be a pure random walk and so the difference in the series is generally seen as predictable. If it purely follows a random walk with drift then the model related to the difference series would be a constant value plus error and this is usually a small element for financial data especially using short frequency data. As a result of the random walk component the time series is still not easy to predict. If there is any explanation, then the change would be explained by past values. When UK consumption data are considered, then at the annual frequency the dynamic may extend three periods and this information can be used to explain today's value and that is the autoregression. Whereas Hall (1978) found that some US aggregate consumption series might be explained by a RW with the exception of some impact by stock prices in their first difference.

Taylor (1995) has reviewed much of the empirical research related to the behaviour of the exchange rate and concluded that it was hard to distinguish whether the exchange rate is was non-stationary or simply follows a random walk. While much of the early empirical work applied regression to test whether uncovered interest rate parity held; the evidence was rarely in support of this proposition especially when predictive performance was compared to a random walk. While, there seemed to be some strong evidence of the risk

premium speculative efficiency hypothesis (Hansen and Hodrick, 1980). Further confounding factors in terms of testing efficiency and rejecting the efficient markets hypothesis was explained by of risk aversion and departures from rational expectations (Hansen and Hodrick, 1983).

Taylor (2009) has provided a substantial review of long-run purchasing power parity and real exchange rates. One such finding by Yoon (2009) was that real exchange rates are more likely to be stationary during fixed nominal exchange rate regimes than floating regimes. While, Akdi, et al (2009) analysed the periodogram for data on the G7 countries and found that the null of a unit root for a large number of countries was rejected. Ruhul Salim & Kamrul Hassan (2009) examined PPP and its relation to relative population growth using data from 30 countries finding a stable long-run relationship between PPP the exchange rate and relative population growth.

Many papers considered PPP as not being mean reverting, rather than following a random walk, especially those related to industrialized major economies such as Lai (1993) and MacDonald (1993) that have been favourable towards the long-run PPP hypothesis over the floating period. While panel data studies such as Abuaf and Jorion (1990) found evidence again in favour of long-run PPP when their tests resulted in rejecting the null hypothesis of joint non-mean reversion. Flood and Taylor (1996) analysed 21 industrialized countries relative to the dollar over floating period and found strong support for mean reversion. Studies that adopted long time series, such as Lothian and Taylor (1996) found for two centuries of data on the dollar-sterling and franc-sterling exchange rates strong evidence of mean reversion for the real exchange rate. Lothian and Devereux (2011) studied data from 1590-2009 for the Netherlands and the United Kingdom accepted that arbitrage occurred across the exchange rates and price level data to support PPP. They compared the prices in a common currency for 400 years of data to test for PPP. While in the case of Middle East for the case of Jordan it was found that PPP held in the long run (Bolatoglu et al., 2009). In particular that the real exchange rate was stationary during low volatility periods when compared to high volatility periods.

Smith and Hunter (1985) analysed the specification of time series models used to explain the exchange rate under cross arbitrage restrictions. It was discovered that the only models that were coherent between dollar and cross rates satisfied strong parity conditions as are observed with PPP and UIP, but these need to be adopted in the short-run unless the

dynamic models have precisely the same structure. Hunter and Simpson (1995) found PPP in a small system adapted to consider the key parity conditions and found based on the Johansen (1995) procedure that in log form, the UK effective exchange rate and relative prices cointegrated. Although the effective exchange rate may be viewed as a cross rate it was suggested due to valid model specification that the cross rate effects must be small after the weights related to the effective rate are applied.

Hunter and Simpson (2004) considered the impact of non-stationarity on the specification of coherent models of the real exchange rate, but found that the treatment of the problem in Smith and Hunter (1985) is more complex as it relies on the combined exchange rate and price behaviour. It is natural in terms of economic theory to view this as a bivariate problem as the exchange rate being driven by a long-run expectation as given by the relative prices, but this is more complicated when the data are non-stationary. With all series being non-stationary it is usual in terms of cointegration to consider the joint behaviour in terms of any of three variables (log exchange rate and two prices) or two variables, which are log exchange rate and terms of trade. When each series has the same order of integration then we are looking at cointegration between three variables and this might be better addressed by systems approach, but the cross arbitrage restrictions will still apply. However, prices are often seen to be I(2). So here or more generally it might be anticipated that the terms of trade is I(1). Hence, cointegration will operate between two I(1) variables; the log of the exchange rate and the log of terms of trade. As the coefficient on the terms of trade is often seen to be 1 and computed as the real exchange rate then this proposition in terms of the dollar rates can be tested by a Dickey-Fuller test on the real exchange rate.

A further issue arises as a result of the Balassa-Samuelson effect, and that is when growth in productivity of the tradable sector causes a rise in wages for that sector and the non-tradable sector, which leads to increases in prices for both sectors and the real exchange rate. Chong et al., (2012) used panel techniques to investigate PPP and the Harrod-Balassa-Samuelson hypothesis (HBS). Josheski et al., (2011) tested the Balassa-Samuelson effect for German and UK data, while others considered a trend in the real exchange rate to be due to different behaviours in relative prices of traded versus non-traded goods. This became an issue especially as the hypothesis of cointegration was rejected more frequently than the null of unit root. While Culver and Papell (1999) tested

cointegration indirectly through the stationarity of the real exchange rate using the panel test of Im et al., (2003).

Lothian and Devereux (2011) found promising evidence for PPP in the case of 400 years of price and exchange rate data for Great Britain and the Netherlands. While Lothian and Taylor have also pioneered the use of long spans of data in excess of 100 years and as is stated in a Lothian and Taylor (1996) using a long span of data improves the power of tests for long run PPP. Following a different approach Taylor (2009) examined the validity of PPP by estimating the long memory parameter and finding that the difference operator is less than one.[7] The later is not feasible in the case for the Gulf States as there is not enough data available with only yearly data for 30 years, on the other hand

In this chapter, we will apply several tests of PPP through Unit root tests and cointegration for the developed countries that are not in the Euro zone and determine whether they can be in a currency union through analysis of the prices and exchange rate variables. Then analysis of the exchange rate dynamics will take place to test if there is any chance of predictability. However, for an effectively functioning exchange rate, the more usual idea of informational efficiency of financial markets is also relevant. It will be followed with tests on the relation between the exchange rate and prices, first on the original dollar data and then on cross rates. If PPP holds when the absolute value of the coefficients on price is one for the dollar equations and it should hold from the cross-arbitrage restriction on the cross rates. Finally, there will be test on Gulf countries data for PPP through panel test. As the Gulf rates are fixed relative to the dollar only the price relations are used to test PPP in a similar way to Lothian & Devereux (2011).

3.2 Testing for PPP: The Case of Developed Market Data

3.2.1 Data

Initially statistical data was gathered for six Arabic Gulf states, including United Arab Emirates. The research started considering all frequencies, daily, monthly, quarterly and annual data, but it was not easy to obtain prices for the all states and there was always

[7] See the discussion in (Burke and Hunter, 2005, Chapter 2) of the fractional difference operator that for the non-stationary case lies in the interval [.5, 1] and in relation to the fractional cointegration in Chapter 6.

missing observations and gaps in each data set.[8] Furthermore, the Gulf exchange rates were fixed to the $ for most of the years and countries. Fortunately, there was 30 years of annual data collected and used to determine whether a common trend drives prices across the gulf in the long-run. That is why it was decided to add a section at the end of this chapter to provide a flavour of PPP for the Gulf using these prices and given the size of the data it forms a further empirical investigation at the end of this paper.

Of course, the main driver for the first empirical chapter is to find PPP holds across the Gulf States a primary condition for a common currency. However, as the data was limited to 30 annual price observations it was not possible to test PPP and build a model directly for the relations among the Gulf States especially that the exchange rates for the gulf states are linked to the dollar. For that reason, the focus of the first empirical investigation has been refocused on PPP that will be still tested indirectly through the dollar exchange rates as most of the Gulf States currencies are linked to the dollar to which a further empirical investigation considers arbitrage across the prices. [9]

The developed country exchange rates used in this analysis were the UK pound sterling, the New Zealand dollar and the Australian dollar all denominated in US dollars. It would have nice to have analysed the Euro zone, but the data are now historical as the EU project has been running since 2000. These are currencies with a history not unrelated to the Gulf; being at some time in a sterling zone. Canada was not included as there is a land boundary with the US and the behaviour would seem too tightly linked to the dollar. To explain the problem of cross arbitrage it seemed helpful to have a relatively compact number of currencies – similar in number to those in the Gulf Region. While other economies and regions have been prone to significant crises: South America, Eastern Europe and Africa. Also, they are not all as highly developed or to form part of an exchange rate union.

[8] For example, monthly data were available for only a few states, and even where they were available, only for few years: a maximum of three years for the UAE and a maximum of five years for two out of the other six countries.

[9] If a meaningful PPP relation is observed across developed countries exchange rates and prices through the dollar, then assuming the cross rate restrictions are valid, then PPP would hold for the Gulf States as the dollar exchange rate adjustment is effective. The nature of efficiency is also at the heart of the working of currency unions so if we cannot observe price adjustment operating in the long-run for developed economies, then it is less likely to be observed in economies where the history of their markets has been shorter. While should it be shown that arbitrage operates across prices in the Gulf, then this is indicative of the LOOP holding.

In the last century there have been many examples where countries shared common currencies or were pegged to key exchange rates such as the European Currency Unit ECU/EURO, Swiss Franc and US dollar. It is then quite natural to analyse exchange rates that might relate to these zones or linkages instead of the dollar. Whether this is appropriate will be explored next. The UK, Australia and New Zealand, among other countries, formed part of a stable currency zone related to the pound sterling. This zone broke down in the 1960s when the burden of controlling a common currency zone was unsustainable as in the then fixed exchange rate system there seemed no way to pool the risk. So this led to the UK being susceptible to runs on the £ and flows of hot currency temporarily relived by currency devaluations and periods of fiscal restraint. The other countries had become independent and they operated their own monetary and fiscal policies under traditional trade links and tariffs that were not affected in the same manner as the UK. They did not form a supportive economic system (Buiter, 2008). Here the discussion is of PPP and whether this holds as a condition for determining whether a common currency zone makes sense. It will be seen that there are problems in analysing cross rates as a means of doing this. This will lead to the more restrictive approach of testing arbitrage in terms of the behaviour of relative prices across the Gulf Stated with the conversion rates mainly fixed with respect to the dollar.

The data collected for the developed countries are from 1978Q1 to 2009Q4 and this forms a sample of 128 quarterly observations. CPI may be best used here although Australia and New Zealand are primary producers and exchange rates will be affected for instance by oil prices than the other countries in the analysis. But because we will use CPI for the Gulf countries as well, for consistency CPI was used here as well.

3.2.2 Methodology

A number of studies consider an analysis of the real exchange rate.[10] For example, Beirne (2010) examined PPP dynamics using linear error correction models. When he applied univariate basis tests to 12 EU real exchange rates he found them stationary after imposing symmetry and proportionality. The method used by Beirne (2010) combined univariate and panel tests to test for the unit root. Then the Johansen cointegration approach was applied to examine whether PPP would hold in the long run pre- and post-

[10] Note this has been defined in a number of ways by the IMF in terms of their statistical publications (International Financial Statistics) and for an alternative definition see Papel and Theodoridis, (2001).

crisis and after financial shocks. He also examined a less restrictive model with no proportionality and no symmetry. He said that, as developed economies have highly integrated goods and capital markets, it was expected to find PPP, but if not found then this might imply the exclusion of important factors that influence the behaviour of real exchange rates. Beirne (2010) used a joint test of PPP and UIP and found it to hold for countries like Denmark and the UK, which suggested that they were suitable for EMU.

Taylor (1988) has considered PPP over a considerable period of time adopting a wide range of methods. Here given the interest in the relation between the exchange rate and the long-run expectation a highly popular paper examining PPP using regression based cointegrating techniques is used. The method in Taylor (1988) is also appropriate for the following reasons:

1. It should be noticed that, when the strict version of PPP holds in a long-run sense, the real exchange rate under the more conventional definition is stationary.
2. PPP in the sense of Paya and Peel (2004) may not be exact and this is tested in the context of a cointegrating regression approach, as the coefficient on the log relative price may not be unity (so a coefficient of .7 may arise and that may still yield cointegration, but not stationary real exchange rates).
3. This makes it possible to analyse the impact of cross arbitrage on the problem.

There are also advantages to analysing the dynamic regression equation as compared with the method that applies the test to a Dickey-Fuller-type model (Dickey and Fuller, 1979) [11]:

1. In the pure error correction case there are advantages in terms of the performance of the test statistic applied to the error correction term so the test is normal in the limit, but for relatively large samples (Jeroen et al., 1992) and (Ericsson et al., 2002).

[11] The ADF model can also be augmented, but this is not the way in which many of the packages apply this test. See (Burke & Hunter, 2005, Chapter 3) for an explanation of how this may be implemented. This is also the argument underlying the paper by (Hansen, B. E. 1992) and a consideration in the test performance that arise from the tables in (Kremers, Ericsson and Dolado, 1992).

2. The Dickey-Fuller form of the problem imposes both relative and absolute PPP onto the problem as the test is forcing a short- and long-run restriction on the data that might suggest in part why PPP has often been rejected.

Here it makes sense to consider the approach of Taylor (1988) to use first tests based on the work of Fuller (1976) ; Dickey and Fuller (1979) ; Dickey and Fuller (1981) to test for a unit root and cointegration. Taylor (1988) is applied adopting the method of Granger (1983) ; Engle and Granger (1987) to test for cointegration. First, testing the hypothesis that the logarithms of nominal exchange rates and price ratio are I(1) series. If the null hypothesis is not rejected for the logarithms of nominal exchange rates and price ratio, then test for cointegration. The cointegration test is applied by checking if the residuals from the cointegrating regressions are I(0) or if the hypothesis that the cointegrating regression residuals are I(1) cannot be accepted.

An alternative way would be to fix the parameters on prices to unity by testing these series for a unit root to determine whether they are stationary or not[12]. In Taylor (1988), cointegrating regressions were related to long-run models of the log exchange rate relative to two log prices or the log terms of trade.[13] The nature of integration and the properties of the unit root series for the terms of trade and the exchange rate are looked at next.

3.3.2.A Unit Root or ADF test

In considering the question of PPP in the confines of cointegration, the series should be of the same order of integration I(1). This is dealt with here in the analysis, but it is useful to reflect what this means. First it can be seen in relation to a combined price variable and that is why it is popular to test whether the real exchange rate is stationary.

The nature of integration of the series is important for a number of reasons. The requirements for cointegration via PPP or that the adjusted price series follow a common trend is important for arbitrage across products. In PPP, the nominal exchange rate is proportional to a ratio of foreign and domestic price levels. While real exchange rates

[12] The cointegration test follows from an ADF test on the regressions residual (i.e., by redefining the regression residual as a new error term here residauus and applying the conventional stationarity tests to such variables.

[13] For any PPP relation there are a triple of variables (exchange rate, home price and foreign price) it is possible to formulate the equation in a regression of the exchange rate on the two prices, but there are also two reverse regressions of the home price on the other variables and the foreign price on the other variables (notice endogeneity is not an issue as long as all the variables are I(1)).

consist of a nominal rate that is added to the inflation rate that is calculated here through terms of trade. If the purchasing power parity condition holds, one would expect the real exchange rate to be stationary I(0) and mean reverting. While the presence of a unit root in the deviations between these series would indicate the existence of permanent shocks, which do not disappear in the long run.

Nominal exchange rate and prices usually have a common trend or stochastic trend to be cointegrated and each one should be I(1). Nonsense results happen and are caused usually if some or all variables in the model are nonstationary. In the long run regression model, there is usually serial correlation, which implies the model is not well defined as a conventional regression, but in a long-run sense this serial correlation only implies a nonsense result when there is a unit root. The key is that any analysis should always account for this possibility. If the model is not spurious then the variables in the model are cointegrated. If variables are cointegrated then a long-term relationship exists among them and the regression estimates would then be valid in the long-run.

Here this is considered in terms of the testing of stationarity and cointegration. Here, the analysis is applied to quarterly data for this empirical section. The best-known and most flexible approach to testing stationarity probably relates to the model that forms the basis of the Dickey-Fuller test (Dickey and Fuller, 1979):

For AR(1) model at lag i, when:

$$Y_t = \beta_\varphi Y_{t-1} + \varepsilon_t \qquad (3.14)$$

The following hypothesis tested is for a unit root and when β_φ is less than 1, Y_t will be stationary and if β_φ is equal or bigger than 1, then Y_t will be non-stationary. However, we should transform model (3.14) because in hypothesis testing, it is usual to test a null of zero and also this makes it possible to consider any length of lag order and still apply the same test. To achieve this, we should subtract Y_{t-1} from both sides of (3.14) and in the case where i=1:

$$\Delta Y = \gamma Y_{t-i} + \varepsilon_t \qquad (3.15)$$

$H_0 : \gamma = 0 (y_t \ non-stationary)$
$H_1 : \gamma < 0 (y_t \ stationary)$
$\gamma = \beta\varphi - 1$

Equations (3.14) and (3.15) are without intercept or trend, but when they are required they can be included in the model.[14] Typically, exchange rate data would have a non-zero intercept, but no trend,[15] whereas, prices on their own would have drift. A valid testing procedure can benefit from scrutinizing plots of the data. It is anticipated that the exchange rate will in the long-run reflect movements in the terms of trade - that is PPP.

In the case of the exchange rate, or in terms of their logarithms, it is expected that the DF model is appropriate for the test, but for price indices and the terms of trade series the DF models need to be corrected for further autocorrelation and in that case the DF test-statistics would be wrong. The solution for this problem is to extend the DF model or compute the augmented or ADF model by adding lags of the dependent variable ΔY and to keep adding them until the autocorrelation problem disappears. The correct number of lags can also be found by Schwarz information criterion (SIC) or Akaike information criterion (AIC).

The ADF test is used to check when a more sophisticated time series model has a unit root and the DF test is nested within this. Most economic and financial data is positively correlated over time; normally exact unit coefficients are not found as there is some bias in the AR(1) type estimations (Davidson and MacKinnon, 2004), it is usual that most series exhibit positive serial correlation to find a negative test statistic and the more negative it is, the more likely the rejection of the unit root hypothesis. The DF test is used when the series is of the AR(1) type and this is of interest as it links to the RW hypothesis, but the ADF test model is for higher order autoregressions. So for the ADF(2) case or under the null the dependent variable follows the AR(2) model:

$$\Delta Y_t = \beta_* Y_{t-1} + \beta_1 \Delta Y_{t-1} + \beta_2 \Delta Y_{t-2} + \varepsilon_t \qquad (3.16)$$

[14] It is usual to include the intercept in the case where the test is for stationarity of a single variable (see Burke & Hunter, 2005, Chapter 2) as compared with testing for arbitrage when the hypothesis is testing for cointegration under some restrictions.
[15] An exception to this is when the Balassa-Samuleson effect is observed as a result of different economies having different forms of technical development.

To further consider whether the variables are stationary or not two methods can be used. Firstly, scrutinizing a graph of the data and next formally using the Dickey-Fuller test. The graph gives an indication of stationarity, but it is not always accurate. However, prior to testing it may be possible to observe any trends in series or other types of autoregressive pattern and by comparison see how the data behaves after they are differenced. Of course, when a variable is non-stationary and this is not as a result of a deterministic trend, then the behaviour is likely to be autoregressive and when this is not taken account of in the model (DF versus ADF) there is a good chance that the model suffers from serial correlation. After checking whether the variables are stationary or not, it makes sense to check for serial correlation in these models or for other forms of misspecification such as autoregressive conditional heteroscedasticity (ARCH).

In this study, the single equation test procedure is used mainly to confirm whether a series is non-stationary and requires differencing Segot and Lucey (2008) analysed the stock market in relation to market efficiency and the random walk. However, these tests also provide a way to analyse whether a combination of series is stationary and this is a test of cointegration. This will be carried forward to find a long-term relationship among the variables.

After allowing for lags, the regressions used in the empirical section use about 110 observations and the critical values reported in (Fuller, 1976), and (Engle and Granger, 1987) are appropriate. For the analysis of dollar currencies and price behaviour in the Gulf to be coherent, consumer price indices are used to capture the terms of trade and investigate arbitrage. Subject to the findings of the information criteria this is the type of model that is anticipated might be used so the terms of trade are analysed to see whether their integration order will allow for the possibility of PPP. In the case when the orders of integration are different, then we may not observe PPP as they may not cointegrate (Taylor, 1988).

Before performing the ADF tests for stationarity, the dynamics related to the price series need to be understood. The plot in Figure 3.1 was obtained for Nominal Exchange Rates for UKUS log and differenced data (see Appendix A for all other countries Nominal Exchange Rates, Cross Rates, Terms of Trade, Prices and real Exchange Rates):

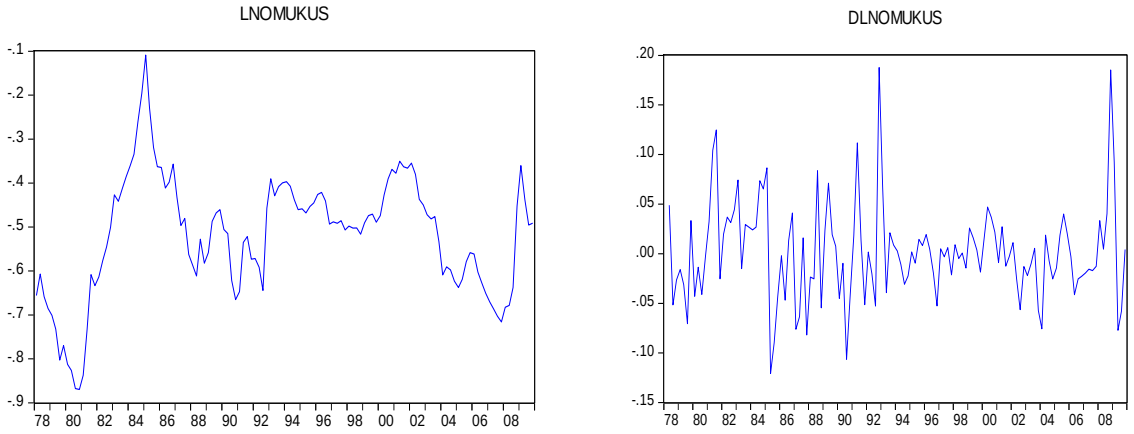


Figure 3.1: Nominal Exchange Rates for UKUS log and differenced data

From visual inspection of the graphs it would appear that the nominal exchange rate is non-stationary for the US dollar denominated exchange rates. Plots of the other variables (the terms of trade and prices) after logging them indicates that all the

Table 1 Tests for a unit root hypothesis of the nominal exchange rates [a] **16**

Variable	predictability Coefficient UKUS	predictability Coefficient AUUS	predictability Coefficient NZUS
D(LNOM(-1))	0.330644(0.0004)	0.362061(0.0001)	0.410726(0.0000)
D(LNOM(-2))	-0.105315	-0.179826	-0.043618
D(LNOM(-3))	0.086235	0.117888	0.058175
D(LNOM(-4))	0.034866	-0.175256	-0.154572
LNOM ADF(i) test statistic i 1 4 White (1)	 -3.093184* -2.940387* -2.4457538	 -2.359047 -2.073049 -2.679472	 -2.854821 -2.582268 -3.067766*
D(LNOM) ADF(i) test statistic i (SIC) 0 1 3	 -8.331827** -7.634434** -5.303382**	 -7.910937** -7.30534** -5.759909**	 -7.136383** -6.249573** -5.674051**

[a] The null hypothesis is that the series in question is I(1). The large sample critical value at 5% level is -2.89, with rejection region $\{t_\gamma<-2.89\}$. Please note, ADF(4) and in the differenced data ADF(3) correspond to an underlying AR(5) model in prices. Where **/* relates to significance at 1%//5% level.

[16] Here are presented ADF tests selected by SIC and with 1 and 4 lags using the conventional t-statistic where the denominator is based on classical standard errors derived using the variance covariance matrix $s^2(X'X)^{-1}$.

variables are non-stationary I(1) and stationary when differenced, while real exchange rates appear stationary/I(0) (see further plots in appendix A).

A more formal way of investigating the variables is by running ADF test. Table 1 is summarising the results of ADF in the nominal exchange rates.

For the ADF test and here for comparison the same lags are used as in Table 2. However, even with quarterly data, the primary focus is on the models that have shorter lags, as this is consistent with the RW hypothesis based. The test results using the differenced data are presented in Table 1 suggesting that these series are as expected I(0) when differenced. By comparison, at the 5% level, it is not possible to reject the null that the exchange rate is not stationary for any of the dollar rate series analysed in Table 1 using conventional standard errors, except for the UK sterling rate. While only in the case of the New Zealand dollar was it found that the test is significant when the test is derived using robust standard errors. As anticipated with financial data the errors do not appear normal and independent and identically distributed, but in this case there appears to be no heteroscedasticity. It would appear that preference is given to the test results using the adjusted standard errors except in the case of New Zealand where based on the results on the classical standard errors it is suggested that exchange rates in all cases have a single unit root.

Further testing of market efficiency is applied following the incapacity to reject the unit root hypothesis. Here in a similar manner to the testing for a unit root in the terms of trade, it is found that the exchange rate is I(1) and the difference is I(0). As the Gulf rates have been fixed relative to the dollar any test of efficiency is here applied to the dollar rates. In a similar manner to Guidi and Gupta (2013), the ADF test provides an effective way of deciding whether a financial variable follows a random walk. Here this is applied to the case of the exchange rate and in Chapter 5 for stock prices. Market efficiency is viewed simply in terms of the information content of the lagged price and thus whether the exchange rate follows a random walk relates to the acceptance of the null of non-stationarity. Previously the random walk model was examined as an example of a non-stationary time series and parity conditions for testing PPP were discussed. If the nominal exchange rate follows a RW, the series are forced by autoregressive behaviour related to the unit root, but for an efficient market the change in the exchange rate should not have an autoregressive pattern so the level series is consistent with a random walk when it is not predictable.

Looking at the dynamics of the exchange rate, there may appear to be some predictability. One reason for this is that the data looked at are quarterly for comparison with prices. It may be that there is some inefficiency, but this autoregressive behaviour can have other explanation such as cointegration and PPP or ARCH behaviour that may also be corrected for. Testing for stationarity for the prices or terms of trade will be used to compare with the dynamics specified above on the exchange rate, but when the real exchange rate is analysed it makes sense to consider these dynamics be based on the price series.

The results in Table 1 with the first differenced data suggest that the financial markets are informationally efficient, assuming that the exchange rate returns have no significant correlation or the error for the DF models is uncorrelated. There is some evidence of an AR(4) model in the differenced data and that is the model that arises from accepting the null of the ADF(4) test that the series are difference stationary. Finding autoregressive behaviour in the differences suggests that the market is not efficient. The overall conclusion for the results in Table 1 would seems to suggest that the exchange rate is I(1), and it exhibits a unit root, but the further autoregression suggests that the model does not support the RW hypothesis. We have to difference the series, because differencing means that we are forcing the unit root onto the dependent variable structure, but the further autoregressive behaviour is not linked to the RW hypothesis. However, the current value of the exchange rate is most strongly influenced by the previous value of the series as arises due to the random walk and any predictability that may arise due to serial correlation in the error or autoregression in the exchange rate returns does not makes the exchange rate any more predictable. The first lagged difference is significant in each case so weak form efficiency cannot be accepted. Here the ADF test for a unit root the time series behaviour of a single series was tested, but this does not relate to long-run behaviour until more than two series are considered as occurs with the real exchange rate. Predictable exchange rates does not mean that markets are inefficient as nominal and real interest rates differential may exist and this makes them predictable.

Table 2. Tests for a unit root in the terms of trade [a]

Level	LTOTUKUS (lag)	LTOTAUUS(lag)	LTOTNZUS (lag)
SIC	2.931192 (5)*	-2.198617 (1)	-2.979439 (2)*
1	-3.478261*	"	-3.315139
4	-2.461256	-2.393170*	-2.825567
First Difference ADF			
SIC 0	-8.331827**	-7.910937**	-7.136383**
1	-8.089449**	-3.212169**	-3.957338**
3	-3.648748**	-3.180759**	-2.925020*

[a] The null hypothesis is that the series in question is I (1). Approximate critical value at 5% level is -2.89, with rejection region $\{t_\gamma<-2.89\}$. DF and ADF stand for Dickey-Fuller Statistic and Augmented-Dicky Fuller Statistic respectively. Please note, ADF(4) and in the differenced data ADF(3) correspond to an underlying AR(5) model in prices.

Initially the SIC is used to determine lag length but following the discussion in Hunter and Menla (2014), it was thought best to extend the lags to allow for the primary impact of serial correlation in the error. It is also relevant that the data were quarterly, so 4 lags capture the annual frequency for the inflation series. Models that assume annual inflation effects are dealt with in the Table 2 results and the plots above in terms of US prices and they all appear to be I(1) or non-stationary. On the other hand, they appear I(0) or stationary when the first difference is taken. This is unlike the similarly specified Dickey-Fuller test for levels these series appear stationary based on the test evaluated at the conventional 5% level using a sample of 119 time series observations.

From both Table 1 and 2, the variables have to be integrated of the same order to be cointegrated (Engle and Granger, 1987). As was found in previous section, terms of trade and exchange rates were both I(1) or integrated of the same order as required for cointegration.

3.3.2.B Testing Cointegration

Cointegration is an econometric tool for the empirical analysis of nonstationary data and it is used mainly to detect a long-run relationship. This is also because long-run

relationships affect current behaviour, so in terms of the exchange rate current long-term interest rates are determined by expected short-term rates and this long-run reaction can help further explain the short-run.

Before the 1980s, empirical research in macroeconomics in building and testing models was often based on the assumption that series are stationary. However, Granger and Newbold (1974) emphasised that as conventional macroeconomic models contained non-stationary stochastic variables the findings from much empirical econometrics might be spurious. The exception to this was the error correction approach that had developed at the LSE. The conventional error correction method did not distinguish between stationary and non-stationary series, but as the error correction model (Davidson et al., 1978) was defined with the dependent variable and many of the regressors in first difference form and so generally stationary.

Sir Clive Granger developed the notion of cointegration as a solution to the problem of spurious regression by adopting the error correction framework, but then explaining why the error correction framework had to depend on an error correction term that was required to be stationary. He discovered that macroeconomic models defined in terms of nonstationary stochastic variables could be reorganised so all the variable were stationary and this implied the error correction term was stationary and as a result cointegration implied a linear combination of non-stationary series needed to be stationary, which has meant such relations were meaningful. Cointegration changed the way of formulating empirical work today.[17] This method made the results more meaningful statistically and economically.

One of the earliest papers on cointegration was by Campbell (1987), who tested the hypothesis that consumption is determined by permanent income. While, Johansen and Juselius (1988); Johansen and Juselius (1990) ; Johansen and Juselius (1992) developed a systems approach to the estimation of long-run behaviour. Of particular interest here is the work on money demand (Johansen, 1990) and PPP (Johansen and Juselius , 1992).

[17] The approach of (Box, G. and Jenkins, G. 1970) in time series provided pre-analysis, but not a test procedure to transform univariate time series equations to stationarity and at the LSE models were developed that combined differenced and levels data to model economic time series (Davidson, James E H, et al 1978).

Cointegration is handled in a number of different ways, foremost is the method of Johansen (1995). Otherwise as discussed above from the cointegrating regression and/or the error correction model (see Patterson 2000 ; Ericsson and MacKinnon, 2002). The Johansen method considers the error (Davidson and MacKinnon 2004) model in terms of the VAR, while the other methods often look at single equations.

The error correction models are seen in an ADF form (the Dickey-Fuller Model with the test for stationarity applied to the cointegration regression error) or a dynamic regression form. The former can (with the exception of the intercept) be seen as being exactly the same as testing the real exchange for stationarity when the coefficient on the log-relative price is unity (Patterson , 2000). Cointegration is considered in the latter case by testing the significance of the error correction term.

Under cointegration, the coefficients on the cointegrating regression can be seen to be super consistent (Burke and Hunter, 2005). However, this also applies to the coefficients computed directly from the error correction model or the cointegrating regression. This implies that any finding of cointegration should be coherent across methods and models. In simple language once we have found cointegration by one method, then it is likely to exist when another approach is applied. One method may be better than another for statistical or theoretical reason, but all the methods are tending to the same conclusion when cointegration is present. That means with a large enough sample, each method is essentially saying the same thing. Assuming the same problem is being considered and the stationarity test applied to real exchange rate data implies that the exact PPP restriction holds. However, it is possible to find cointegration amongst log exchange rates and prices when we do not find stationary real exchange rates, because PPP is not exact.

For this purpose, Hendry (1995) has distinguished between error correction when the coefficient is unity and what he has called equilibrium correction when the coefficient is not unity (see for example, Burke and Hunter, 2005).

"Non-stationarity is a common property to many macroeconomic and financial time series which was not well understood as it took some three decades to build models (Engle and Granger, 2003). This property gives the variable no clear tendency to return to a constant value or a linear trend.

A further key property of economic time series is volatility, where the variance - especially of prices - varies over time. Up until the 1980s, it was often assumed that the variance was constant over time, however, this was not true and the variance may vary considerably over time especially for financial data. Forecasting and modelling volatility is crucial for financial markets. Engle (1982) developed the concept of ARCH in the early 1980s to explain and test for this[18]. When dealing with economic and financial data, non-stationarity and volatility need to be dealt with.

Taylor (1988) adopted the approach in Engle and Granger (1987) to explain the linear relation between exchange rates and terms of trade to explain PPP. Here of cointegration is a property of "a pair of variables that a necessary but not sufficient condition is that those variables should be integrated of the same order". He suggested that, unless the real exchange rate in his case is I (0), or stationary, explanatory variables tend to drift apart without bound. However, when those variables are cointegrated, they correct each other and this would produce a stable long run linear relationship (Engle and Granger, 1987; Granger, 1983) explained how a linear relationship between non-stationary data might be stationary. While the method of Engle and Granger (1987) was adapted to estimate the long-run parameters, and how this would relate to dynamic models that related to the error correction model.

If the static regression gives a form that relates to PPP, then we have stationary real exchange rates and some tests for spuriousness/cointegration must be significant so the static exchange rate equation holds. There are a range of ways to test for cointegration, but prior to the application of ADF tests to regression residuals to test stationarity. Sargan and Bhargava (1983) adapted the Durbin Watson (DW) statistic to test for a unit root in the regression residual. This was the first test of cointegration with a DW of zero relating to a unit root in the error being associated with spurious correlations and an appropriately sized DW value being related to cointegration. That is a preliminary means to interrogate the potential long-run model when the dependent variable for these equations is essentially a random walk. The DW test does not have the best properties, but it is usually a good indicator of serial correlation and provides an estimate of the serial correlation coefficient. However, the test depends on the number of variables and as this number grows it becomes inflated. It is also essentially a test of first order serial correlation. This

[18] Robert Engle together with Sir Clive Granger received the 2003 Bank of Sweden Prize in Economic Sciences in Memory of Alfred Nobel for methods for economic time series.

suggests the method of Engle and Granger (1987) that applies the ADF test procedure to the regression residual implying that the model is not limited to first order serially correlated errors.

When the unit root hypothesis cannot be accepted, then the parameters of the associated regression can be linked to long-run averages and this related to cointegration. This compares with Lothian and Taylor (1996) who took different period averages to consider results that converged in the long-run when applied to two centuries of data. In a similar way the long run correlation between long run averages can be viewed as cointegrating.

"While few economists would nowadays seriously argue that PPP holds continuously, many would view it as a long run equilibrium condition. This implies that the nominal exchange rate and relative prices should be co-integrated or, equivalently, that the real exchange rate should be stationary." (Taylor, 2009)

Table 3 tests presents tests for cointegration by determining whether the residuals from the cointegrating regression are I(0).

Table 3. Tests for cointegration and Cointegrating regression results [a]

	Constant	Coefficient	R^2	DW	ADF(1)
UKUS	-0.497883	0.199123 (0.546609)	0.009706	0.142647	-3.403743 [0.0482]
AUUS	0.345199	1.274862 (0.140448)	0.411158	0.121766	-2.161984 [0.4466]
NZUS	0.516753	0.631696 (0.101016)	0.250505	0.108606	-2.751768 [0.1892]

[a] Dependent variable is the nominal exchange rate. R^2 is the coefficient of determination, DW is the Durbin-Watson statistic. Approximate critical value for the Dickey-Fuller statistic (DF) at the 5% level is -3.37, with rejection region {DF\DF<-3.37}; approximate critical values for the DW statistic at the 5% level is 0.386, with rejection region {DW\DW<0.386}; in every case the null hypothesis is that the residuals are I(1) (Engle and Granger,1987). Robust standard errors are reported as the classical one's are misleading in this context (Granger and Newbold,1974), [p-value].

The null hypothesis is that the residuals are I(1) and that the series cointegrate when the test is significant and null hypothesis is cannot be accepted. In the case of the Australian dollar, from visual inspection of the regression coefficients it would seem unlikely that the proposition that PPP holds would be accepted in the strict sense. It seems less likely for the cases of the pound and the New Zealand dollar, where the coefficients are even

smaller. However, before any further analysis of PPP the ADF test statistics in Table 3 should be examined.

It is concluded that the null hypothesis fails to be rejected for the cases of Australia and New Zealand and there is no cointegration , while it is not possible to reject the alternative hypothesis at the 5% level for the UK/$ exchange rate. It could be expected that, were this to hold, it should do for the UK, as the pound sterling rate became a highly traded currency in the late 1980s following the removal of exchange controls, while New Zealand is positioned away from world markets and to a lesser extent the same might be said for Australia. There may also be other factors that are required to observe a long-run relation linked to PPP. In general, we looked at the possibility of cointegration between real exchange rates of the UK, US, New Zealand and Australia and we found that these countries cant form a monetary union and one reason is that they are structurally very different.

Here, this analysis did not find convincing evidence of PPP in the case of two developed countries. For the UK, although the series cointegrate, the small size of coefficient does not seem to be consistent with conventional or extended PPP. When the Newey-West Standard errors are used to evaluate the coefficients in this case, then statistically the coefficient is much closer to zero than one. Although there is some evidence for PPP holding for developed economies, there is still considerable debate as to whether this finding is reliable. For example, Beirne, et al (2007) considered PPP for the Euro zone economies amongst others prior to the common currency. The results were corrected for non-standard behaviour in the error and after correction the real exchange rate was found to be stationary for all the currencies analysed except Portugal and Spain. A conclusion of this work might be that, on average PPP holds, but it may also be concluded that these two economies were not well prepared to enter a common currency zone. This would be supported by the difficulties these economies have had in adapting to the financial markets crisis of 2008; the same may also be said of Greece.

If the finding of PPP is not reliable for developed countries, then how might it be observed for less well-developed economies? For the Gulf States similar data are not available to test directly for PPP as the currencies have for most of the floating exchange rate period been tied to the US dollar. Hence, it is the finding of PPP in terms of the dollar that is the primary evidence based on the exchange rate that it may hold for the Gulf economies.

Later a test on prices will be undertaken for the Gulf States using panel methods to determine whether their price series when converted through fixed rates are related. Before that, the coming empirical section will look at PPP through Cross Rates applied to the same developed countries data.

3.3.2.C Cross Rates

Other researchers, such as Coakley and Fuertes, (2000) examined PPP by changing what they called the base currency and accounting – or not – for cross sectional dependence. Most of the earlier papers on the base currency affect for PPP used panel methods to investigate the impact of ignoring cross-sectional dependence and heterogeneity in the country specific serial correlation. In general, the base currency effect or the numeraire currency effect literature found different outcome according to the methods uses, further properties of the date, currency used, and assumptions. Some papers relaxed some if not all of the assumptions and varied in null and alternative hypothesis in intercepts, speed of adjustment, heterogeneity, and the degree of cross sectional dependence.

One of the pioneer papers on the base currency effect was by O'Connell (1998). He argued the numeraire effect using two cases with restricted homogenous serial correlation scenarios. O'Connell (1998) ignored the cross-sectional dependence in one case and for the other case accounted for it using feasible generalized least squares (FGLS), because FGLS controlled for size and power. He found no PPP if cross-sectional dependence was accounted for, while PPP holds if the cross-sectional dependence was ignored.

Papell (1997) allowed for heterogeneous serial dependence, which is in contrast to O'Connell. Papell (1997) used FLGS with the German mark, dollar and European real exchange rates (RER). The results supported PPP for European, but not non-European currencies; Papell found that the choice of numeraire currency does indeed matter for PPP. He found that distance between countries and volatility of the exchange rate or the base currency used are the two most important determinants of PPP. He used 21 different base currencies and found that the null was rejected when the mark was used and was not rejected when the United States dollar or the Japanese Yen was used as numeraire. This means that he found PPP when the German mark rather than the dollar was used as numeraire.

Pedroni (1997) studied weak PPP for a panel procedure again after correcting for cross-sectional dependence, but he added dummies to the test again for heterogeneous serial correlation. His procedure differed from those of Papell (1997) and O'Connell (1998) in that he compared and used two separate procedures for controlling cross sectional dependence. One procedure was by demeaning or time dummies with cross-sectional dependence and the other was with a combination of a GLS correction and time dummies, again with cross-sectional dependence. He found that accounting for cross-sectional dependence strengthens the evidence for PPP and that the GLS estimator had no effect on the results whether applied or not.

Higgins and Zakrajsek (1999) used panel unit root tests to contradict O'Connell (1998) and in doing the testing accounted for contemporaneous cross-sectional dependence. They found very strong evidence supporting PPP for the OECD on a group of European economies and a large sample. Kalyoncu (2009) studied Turkey and the country's main trading partners, the US, Germany, UK, Japan, France and the Netherlands. He used different unit root tests and different base countries and found that PPP was sensitive to the choice of the base country and could be influenced by the type of test used. While Keung (2009) found that conventional tests of stationarity[19] reject the null hypothesis of a unit root for all four OECD countries used in the panel while taking into consideration cross sectional dependence.

Coakley et al., (2000) used three tests with varying degrees of cross-sectional dependence and heterogeneous serial correlation. The IPS test, seemingly unrelated regression (SUR) estimated by FGLS and the Johansen Likelihood Ratio test (Johansen, 1995). They found evidence for a base currency effect when cross-sectional dependence is ignored and that the result is invariant across the mark and the dollar when this is accounted for. This provided evidence against the base currency effect and generally, their results supported the stationarity of real exchange rates.

Hunter and Smith (1982) analysed interest parity conditions in terms of the US $ and the cross rates. They found that the interest rate parity condition did not hold on the data while an appropriate analysis of the cross rates showed from the cross arbitrage conditions that the cross rates analysis cannot be independent of the results on the $ data. This

[19] The idea of the unit root and stationarity testing is considered with the methodology.

econometric issue is explained more succinctly in Smith and Hunter (1985). They observe as a property of the algebra that either all exchange rate models are coherent and PPP or UIP holds for all rates or that coherent dynamic models include all the variables in the system. The analysis by Smith and Hunter considered a world where data were viewed as being stationary, but it is now understood that price series and interest rates do not usually exhibit this property.

In practice, most transactions are done via the intermediary of the dollar rates and many analyses based on cross rates[20] have not considered this. Meaning such analyses are either misspecified or have not paid full attention to this. Were one to collect the bid ask prices from dealers it may be possible to avoid this problem. However, dealers engaged in financial market transactions confirm their trades by round-tripping any calculations using the dollar rates. The dollar is traded on one side of a transaction in most of the cases. Since banks quote foreign exchange rates with respect to the dollar, the numeraire of the system is the dollar.

Taylor (2002) also suggested that selection of another base currency may improve the capacity to observe PPP. So these results might be better observed in terms of the Euro or in relation to a basket of currencies. Again such roles are impacted by cross arbitrage (Hunter and Smith 1982) as any study based on dollar rates will impose an arbitrage condition. The cross-rate results are not independent of the results that follow from an analysis based on the dollar.

Smith and Hunter (1985) show the only way by which cross rate and dollar rate specifications give the same conclusions is when the dollar and cross rate equations are consistent with very simple parity conditions such as models of the exchange rate based on PPP or UIP. The difficulty with this is that these models do not pay attention to non-stationarity and are usually not well specified. Well-specified models are either not coherent or are complex. The logical conclusion of a coherent model where the unit coefficient restriction for PPP does not hold is that all the prices appear in all the models. This proposition is tested below in terms of a triangular system. In the case of regressions on variables assumed to be stationary, (Hunter and Smith, 1982) observed that the exchange rate model coefficients related to UIP had the wrong sign. While more general

[20] The third exchange rate implied by any two exchange rates involving three currencies

dynamic exchange rate equations based on the cross rates produce coefficients that can be derived from the dollar rate equations. This suggests that any analysis based on cross rates is suspect.

While when PPP holds for the original dollar equations, then the algebra in Smith and Hunter (1985) implies that it should also hold for the cross rate equations. Whereas some early studies of stationarity of the real exchange rate found that, when PPP did not hold for the dollar rates, it did when the tests were applied to the cross rates data. The impact of these restrictions may also need to be considered when data based on the effective exchange rate is considered (Johansen and Juselius, 1992, and Hunter and Simpson, 1995).

To emphasise the problem in this section initially we consider the relation between the exchange rate and prices, first on the original dollar data and then on cross rates. Usually PPP holds when the absolute value of the coefficients on price is one for the dollar equations and then it should hold from the cross-arbitrage restriction on the cross rates. It is still of interest to investigate the models related to the table of regression results as they provide in a long-run context the same problem of cross arbitrage investigated without considering stationarity by (Smith and Hunter, 1985). In addition, they show the potential problems for studying cross rates in the context of Gulf currencies when they are all pegged to the US dollar. This will be investigated further, but there is cointegration at the 5% level in only one case. Table 4 might be seen to provide regression results for a number of potential cointegrating relations for dollar and cross exchange rates under a restricted model.

In the following Table, potentially cointegrating regressions are estimated for the primary dollar rates and then a triangle of cross rates.

The equations relate the exchange rates to the relevant prices for those rates. The tests of cointegration in Table 4 might be compared with the critical value of -3.37 (Patterson, 2000) and the figures for the empirical distributions given in (Davidson and MacKinnon; 2004).

Table 4 Restricted models coherent under exact PPP [a]

	Lnom auus	Lnom ukus	Lnom nzus	Lnom auuk	Lnomnzuk
C	0.180309	0.401345	0.730786	-0.346585	0.495142
LPAU	1.19 {0.394879}[21]			0.60 {0.398015}	
LPUS	-1.15 {0.537128}	-1.17 {1.042949}	-0.74 {0.318167}		
LPUK		0.97 {0.896229}		-0.33 {0.415001}	-0.25 {0.118583}
LPNZ			0.68 {0.223069}		0.37 {0.118583}
DW	0.12	0.15	0.11	0.20	0.19
R-squared	0.41	0.04	0.25	0.43	0.28
ADF	-2.287	-3.420724	-3.174842	-2.220403	-2.547467

[a] Dependent variable is the nominal exchange rate. R^2 is the coefficient of determination, DW is the Durbin-Watson statistic. Approximate critical value for the Dickey-Fuller statistic (DF) at the 5% level is -3.37, with rejection region {DF\DF<-3.37}; approximate critical value for the DW statistic at the 5% level is 0.386, with rejection region {DW\DW<0.386}; in every case the null hypothesis is that the residuals are I(1) (Engle and Granger,1987). Estimated coefficient standard errors are not reported since they may be misleading in this context (Granger and Newbold,1974).

The coefficients for prices in each case have opposite signs (overseas coefficient in the table always being –ve). Hence, some form of PPP may be expected. Especially, for the case of Australia and the UK these coefficients do not seem to be different from one in terms of size and this gives us some form of absolute PPP (Taylor, 1988). While for New Zealand the coefficients seem some way from unity and that would suggest a failure of absolute PPP and lead to a broader form of this idea discussed in (Peel et al, 2004), but the DW statistic suggests that these results may not be reliable.

It has to be noted that conventional inference is not feasible in this context so it is not straightforward to determine whether PPP holds for the case of the UK or Australia. When the DW=2, then the serial correlation coefficient would be zero and the standard errors might be acceptable assuming the model is otherwise well formulated so there is no heteroscedasticity or other forms of serial correlation. However, at first sight a DW statistic that is small, less than R^2 (Granger and Newbold, 1974) is indicative of a poor econometric model – suggesting at worst that the relations are nonsense. Alternatively, this test has another interpretation for this type of regression and can be used as an indicator of cointegration, then the coefficients for lnomauus and lnomukus are close to

[21] Re-estimated standard errors due to Newey-West, see Davidson and MacKinnon (2004).

what we would like for PPP, +1 for the home currency, -1 for the foreign currency (here US). While, testing for cointegration via one of the methods available will be the same as testing for PPP.

Based on the DW test alone it follows that models might only have an interpretation in the long-run, they cannot be used for short-run interpretation or analysis (Davidson et al., 1978). The low values of the Durbin Watson (DW) Statistic provide an indication that cointegration doesn't exist as the residuals are highly serially correlated. It is important to notice that, even were the DW statistic equal to two, the model may suffer from heteroscedasticity and higher order serial correlation. For example, for the case of AUUS the estimate of the first order serial correlation coefficient derived from the DW statistic is .93[22] and this appears very close to 1. The critical value for the test of spuriousness or nonsense regression with one variable and 100 observations is .386 so DW=.122<.386 so the results based on this test alone suggests no cointegration. Here there is an indication of a failure of the result in the long-run. Similar findings arise for the UK/US $ model with the DW=.1506 again we have a large serial correlation coefficient about .925 so the model is incorrect in the short-run – not a good short-run predictor of nominal exchange rate behaviour.

This is not surprising as the earlier tables say the nominal exchange rate is close to a random walk, while stationarity tests and a huge literature on the exchange rate suggests it follows a random walk. However, it is preferable if relations exist in the long-run to find PPP or some form of PPP such as GPP as in (Bernstein, 2000). If the static regression results are consistent with PPP, then the related real exchange rates are stationary. This implies that the tests for spuriousness/cointegration must be significant so the static exchange rate equation holds.

According to the test for stationarity of the residuals from the usual critical value it is only possible to observe cointegration in the case of one of these series that relates to the US dollar and the UK pound. Hence, the relations do not make sense or the relations between exchange rates and prices alone might be seen to be spurious in all the other cases presented in Table 4.

[22] An estimate of the first order serial correlation coefficient as DW=2(1-ϕ)=.122 or .122=2(1-.93) and ϕ=.93.

As Hunter and Smith (1982) suggested, the results for a coherent specification would all need to have the same coefficient, usually seen to be unity.[23] If this is not the case, then a more general specification is advised. A simple version of this, for coherence, would include the cross-rate terms also in the dollar equations (i.e., for the pound/dollar exchange rate then that would include LPAU with LPUK).[24]

To consider this problem in the case of the Australian dollar the results imply:

$$\begin{aligned}\bar{e}_{AU\$} &= \beta_1 \bar{p}_{AU} + \beta_2 \bar{p}_{\$} \\ &= 1.19\bar{p}_{AU} - 1.15\bar{p}_{\$}\end{aligned}$$

$$E_{AU\$} = A\bar{P}_{AU}^{1.19}\bar{P}_{\$}^{-1.15}$$

$A = e^{\beta_0}$ if there is no intercept, then $\beta_0 = 0$ and

$$E_{AU\$} = \frac{\bar{P}_{AU}^{1.19}}{\bar{P}_{\$}^{1.15}} \approx \frac{\bar{P}_{AU}^{1.19}}{\bar{P}_{\$}^{1.19}} \text{ and this is close to pure PPP } \frac{\bar{P}_{AU}}{\bar{P}_{\$}}.$$

This is indicative of some form of PPP, but the DW statistic suggests that these results may not be reliable.[25]

While for the cross rate for Australia we obtain:

[23] The coefficients seem to differ, but the findings on the DW statistics almost admit any possible coefficient, this includes the absence of a model or PPP. For pure PPP the coefficient has to be one, though there are arguments for more general forms (Peel, 2004) and at the extreme this would be GPPP. Most of the research has been looking for a unit coefficient in single equation tests, VARs and Systems models (Taylor M.P. 1988, Lothian, J. R & Taylor, M.P. 1996 and Beirne, J. et al. 2007). It is of interest given recent experience in the Euro zone that in the latter case PPP was not found for Spain and Portugal.

[24] When a specific triangle associated with a particular market is appropriate, for example UAE relative to other Gulf currencies, then this is relatively straightforward, but with developed economies this is either handled with all the prices of interest to the analysis and for coherence the $ and cross rate equations are then the same or we have to consider the possibility that the specification relates to the currencies that may dominate global financial transactions (see Hunter & Smith, 1982).

[25] The DW statistic clearly shows that we have strong error autocorrelation so any conventional testing is affected by this. Further, the test is indicative assuming all variables follow a random walk of this being a nonsense regression (implying no inference and no model). Unless we can develop a superior statistical basis to this analysis there is no point in engaging in further inference. This might suggest the use of different methods (fully modified approach of Phillips or the Johansen approach), different estimates of the standard errors (this seems less appropriate when we think the models are nonsense (Granger & Newbold, 1974, and Yule, 1926). Otherwise, a more general specification may be required.

$$\bar{e}_{AUUK} = \beta_1 \bar{p}_{AU} + \beta_2 \bar{p}_{UK}$$
$$= .6\bar{p}_{AU} - .3\bar{p}_{UK}$$

and reversing the logs or taking exponentials:

$$E_{AUUK} = \frac{\bar{P}_{AU}^{.6}}{\bar{P}_{UK}^{.3}} \neq \frac{\bar{P}_{AU}}{\bar{P}_{UK}}.$$

This does not seem to indicate PPP as the two coefficients seem relatively different in size and certainly not one.

The following are ADF tests on the residuals for cointegration related to three different orientations[26] of the problem. The three different relations give rise to the same conclusion that we do not have cointegration (assuming p=4 lags and g=3 variables). The regression error in the first case comes from the equation of the exchange rate on the two log prices:

$$e_{auust} = \beta_0 + \beta_1 p_{aut} + \beta_2 p_{ust} + v_{auust} \qquad (3.17)$$

Table 5 Unrestricted coherent model without imposition of PPP ($ and cross rates)

	Lnom auus	Lnom ukus	Lnom nzus	Lnom auuk	Lnom nzuk
C	-0.293537	-0.717232	1.229699	0.423694	1.946930
LPAU	-1.499633	-1.413994	-1.581036	-0.085638	-0.167042
LPUS	-0.536600	0.476339	-1.458029	-1.012939	-1.934368
LPUK	0.934007	-0.029438	1.715370	0.963445	1.744807
LPNZ	1.238383	1.007789	1.160370	0.230594	0.152581
DW	0.148981	0.161855	0.123775	0.219420	0.216171

The definition of cointegration means that the above equation relates a regression in I(1) variables that potentially becomes I(0) in combination. There are now three possible ways by which this may occur. Therefore, alternative results may follow from looking at

[26] The term orientation derives from Burke, S. P. & Hunter, J (2005) and relates to the different way in which the problem might be viewed. Cointegration without further restriction or knowledge of the exogeneity characteristics of the data as otherwise it is multi-causal. However, different orientations of the cointegrating regression may give rise to different test results for cointegration. For example the original problem in (Engle, R. F. & Granger, C. W. J. 1987) was derived on the basis that income was weakly exogenous.

regressions between different sets of variables (terms of trade relative to the exchange rate).

Assuming that the only variables that enter the equations are the price series in the long-run and that there is a single cointegrating relationship, then the analysis relates to a restricted form of the conditions on cross rate equations presented in (Smith and Hunter, 1985), except that this is now placed in a cointegrating regression (Engle and Granger , 1987). It is of interest to notice that the same algebra that arises in the case of the empirical models estimated for UIP by (Hunter and Smith, 1982) also operates here as a property of conventional regression. The algebra applies irrespective of whether the models are spurious (Granger and Newbold, 1974).

Here there are slightly higher values for the DW test, but conventional tests of significance are not correct as the standard errors are only valid in the extreme case where the error is uncorrelated over time[27]. If the coefficients can only be interpreted algebraically, then similar results are found to those in (Hunter and Smith, 1982) as this is an example of triangular arbitrage that implies an exact relationship between the dollar rate coefficients and those for the cross rates[28].

Table 6 Robust Cross Rates Standard Errors [a] **[29]**

	LNOM AUUS	LNOM UKUS	LNOM NZUS	LNOM AUUK	LNOM NZUK
C	-0.293537	-0.717232	1.229699	0.423694	1.946930
LPAU	-1.499633	-1.413994	-1.581036	-0.085638	-0.167042
LPUS	-0.536600	0.476339	-1.458029	-1.012939	-1.934368
LPUK	0.934007	-0.029438	1.715370	0.963445	1.744807
LPNZ	1.238383	1.007789	1.160370	0.230594	0.152581
DW	0.148981	0.161855	0.123775	0.219420	0.216171

The analysis above relates to the long-run and it may be better to look at the dynamic equations to explain what is happening to the models, but for the dynamic models applied

[27] Burke, S.P. and Hunter, J. (2007) derive data that relates to this type of example.
[28] For example the cross rate equation for the Australian $ and the £ (lnomauuk), it can be seen that the coefficients are exactly related.
[29] These are robust Newey-West standard errors and covariances computed as in the Eviews using the Bartlett kernel and a fixed bandwidth.

in Smith and Hunter (1985) these models would be even less likely to be coherent. In Table 6 the problem is seen again in terms of the corrected standard errors to view the coherent dollar and cross rate equations.

In Table 6 it is clear from the size of the standard errors that the coefficients of these coherent cointegrating regressions are not significant; even the robust standard errors are inflated and more support is given to the conclusion that the results for that form of the cointegrating type of regression appear spurious.

In conclusion, evidence for cointegration based on prices with both dollar and cross rate data was very weak. A general finding of cointegration and PPP leads to an explanation of the world system of exchange that is coherent. Otherwise it might be hoped that for heavily traded currencies and efficient markets these equations would be coherent and PPP might be found. The cross-rate experiment indicates that these coefficients are not likely to produce coherent models where PPP holds exactly. In this case, we can't use cross rates to study PPP for the Gulf States through other currencies than the dollar. As the cross rates did not hold for developed countries, it would appear less likely to hold for the Gulf States.

When this does not occur then the idea of GPP might be considered. However, it is shown that, while more general equations lead to results that are coherent, calculation of the cross-rate results follows directly from those for the dollar. Were the Gulf exchange rates not tied to the dollar, then a similar analysis could have been undertaken to study those results or in terms of the comparison of the prices translated from the dollar (Lothian and Devereux, 2011). Therefore, any analysis has to be carried out purely in relation to the prices.

3.3 Testing for PPP: The case of the Gulf States

The study by Lothian and Devereux (2011) makes particular sense when PPP defines a useful summary of the behaviour of the exchange rate; that the series are cointegrated or PPP holds in the long-run. The useful summary argument works when the combined price series is well behaved and this would call into question the panel method as it often assumes that the series has a strong degree of homogeneity or heterogeneity that can be captured by random and fixed effects. Of course, the t bar test of (Im et al, 2003) is less

prone to this type of problem as it averages across the Dickey-Fuller tests (Dickey and Fuller, 1979).

There is a problem when the useful summary argument breaks down and it is better to analyse individual series as was found in (Beirne et al., 2007). Furthermore, to look at the behaviour of the price and the exchange rate series separately. That is to see the problem in terms of the common trends in the prices rather than in terms of PPP as a result of stationarity of what may be seen as a single series. In that sense, the price has to be appropriate (the basket of prices must be the same and be tradable) and this might be a criticism of Lothian and Devereux (2011).

Lothian and Devereux (2011) made an argument as to why prices behave in a certain way. So even if we adjust through the exchange rate, that will not make overseas prices I(0), they will still be I(1). Once we get the two prices adjusted for the exchange rate, then they should behave in the same sort of way. Lothian and Devereux (2011) compared the prices in a common currency or translated the data they collected in a common currency. They used 400 years of data to test for a common trend and this find as a result of this PPP. In the current thesis correction of prices through adjustment in the Gulf exchange rates could not be tested. That the law of one price holds has a similar implication when it is related to PPP, but it is better related to price correction, than correction via the exchange rate. For Lothian and Devereux (2011) that would relate the long-run behaviour of the Dutch price in pounds to British prices. In the current study arbitrage relative to the exchange rates was not explored for the data on the Gulf as there is little ability for it to occur through the exchange rate. It was explained previously how the Gulf currencies were linked to the dollar and how with the sample we have on prices they are fixed for almost all of the sample. For the current study there is access to 30 reliable annual observations on prices. Lothian and Devereux (2011) considered this to be an explanation as to why PPP might hold, while the current study considers the behaviour of all prices to consider the common stochastic trend that should apply to all prices across the Gulf economies.

The approach follows from Lothian and Devereux (2011) and although these authors had available to them a very long span of data and found in terms of the relation across two price series alone that PPP holds. The authors adopted the ADF test in their paper while here it is considered appropriate to apply multivariate cointegration techniques

(individual and panel) to assess the nature of the relationship between the Gulf States prices to see if they are cointegrated.

In terms of distributional and allocative efficiency, the PPP condition implies that the home consumer is obtaining a good deal in terms of the value of their products. If PPP does not hold, then there is some problem in the way goods are traded. This may be simply statistical (Lothian and Devereux, 2011) in terms of basket to be used or in terms of the goods selected being tradable.

When the paper by Lothian and Devereux (2011) was presented at Brunel, Professor Richard Baillie commented that even based on the length of sample in Lothian and Devereux (2011) that as a result of trading in financial assets, behaviour in terms of the exchange rate could not be solely accounted for by PPP and thus there may be further factors that determine the exchange rate. While Taylor (1988) suggested issues of transaction and transportation costs may have an impact on any find on PPP and that the findings on the previous section may explain the empirical findings for Australia and New Zealand.

There may also be an issue of the time frame; (Lothian and Devereux, 2011) examined PPP using a very long span of data. It was annual data of four centuries (from 1590 to 2009) of consumer prices and Guilder-Sterling exchange rate for the Netherlands and the United Kingdom (the Dutch Republic and England). Across such a long historical period there have been major changes and events, giving rise to a considerable number of real shocks. There were major political changes over these four centuries, like wars and economic changes. Even so, the authors still found that PPP held as a long-run equilibrium condition.

This paper is different in terms of the data used and the nature of the variables used, but this is still related to PPP in the sense that the LOOP applies for prices across nationally boundaries. Lothian and Devereux (2011) collected 400 years of data related to what has evolved as a similar basket of goods that has evolved slowly over time. While the fast changing nature of the Gulf economies suggests that such comparison may not be so straightforward. Data from several sources was sourced from the GCC, Arab Monetary

Fund and other Gulf source web sites, but it was only possible to find 30 years of reliable information for the current study[30].

The law of one price can be considered by comparison of price data across all the Gulf States. It is then relatively straightforward to apply stationarity tests to see whether PPP holds from either pound - or dollar-valued price proportions and here the analysis is extended to a panel.

For much of the earlier analysis of PPP (Taylor, 1988) real exchange rates were viewed as not being well behaved and not predictable from an analysis of historical data as compared with the theory. Whereas now, in 2014, the view has changed of PPP that it does hold, but often in terms of the long run as expressed using cointegration methods and long-run average correlations. Of course, there has been much debate over PPP theory as a result of the empirical findings. It has been typical in the literature to focus on the exchange rate in looking at this problem or in terms of finding long-run PPP in logarithmic form in terms of e=p1 - p2. However, Lothian and Devereux (2011) explain the problem slightly differently in terms of the relation between two prices:

$$P_1 = P_2 \times E_{1,2} \qquad (3.18)$$

Hence, finding PPP implies that the home prices in terms of the home currency behave in the same way as foreign prices in terms of the home currency. When the series are I(1) this means that the two prices should follow the same stochastic trend. Based on the earlier discussion of cross rates (Smith and Hunter, 1985) it may be best to convert this into a common currency (say the dollar). Therefore:

$$E_{1,2} = E_{1,\$} / \mathrm{E}_{2,\$}$$

Therefore

$$P_1 = P_2 \times E_{1,2} = P_2 \times E_{1,\$} / \mathrm{E}_{2,\$}$$

This implies

$$P_1 / E_{1,\$} = P_2 / \mathrm{E}_{2,\$}$$

$$P_1 \times E_{\$,1} = P_2 \times E_{\$,2}$$

[30] Data collected by Economist Intelligence Unit for all Gulf States. They produce monthly and quarterly data, but some were not comparable and others were not complete. There were missing months and quarters in many of the years.

This would suggest that, when looking at a common currency, it is best to analyse everything in terms of the dollar prices.

Taking the series in terms of logarithms:

$$p_1 + e_{\$,1} = p_2 + e_{\$,2}$$

Here the country prices are evaluated in terms of the dollar as compared with Lothian and Devereux (2011) who used the pound as the US dollar was not a reserve currency in the earlier period, but this may make it less likely to find PPP holds.

The second problem of studying PPP was the effect of real variables on the real exchange rate. Lothian and Devereux (2011) found that real factors had some effect on real exchange rates and PPP. In general, following the approach in Taylor and Lothian (1996), by analysing longer averages moving from yearly averages to to 20-year averages improves the correlation and decreases the standard deviation. The finding by Lothian and Devereux (2011) was of surprisingly coherent evidence for PPP.

3.3.1 Data

For the further current study on prices, an analysis was carried out on six countries of the Gulf on yearly prices from 1980 to 2012 for the United Arab Emirates (UAE), Qatar (Q), Oman (O), Kuwait (K), Bahrain (B) and Saudi Arabia (KSA), using CPIs or a consumer price index. CPI is the only price index available for the Gulf countries and it is not possible to use others like relative prices as they are not available at all. Although PPI or a producer price index is often applied it was not available for any of the Gulf countries, CPI was used instead with the variables denoted: CPIUAE, CPIQ, CPIO, CPIK, CPIB, CPIKSA. Five out of the six Gulf countries' currencies have been fixed to the dollar for quite some time. Most of them started fixing their currencies to the dollar in the 1980s except Kuwait, which was fixed to a basket of currencies rather than the dollar. Here an analysis of PPP requires exchange rates that vary, but as the rates for the Gulf have mainly been pegged to the US dollar for the period used here, the analysis operates through the prices so the analysis is similar to that adopted to explain whether markets are well defined at the product level as is considered in papers such as Forni (2004).

It may seem natural to investigate the cross-rate relationship between the currencies in the Gulf and that may be possible with trade data directly from the markets, but any analysis has to be indirect for the following reasons:

a. As can be seen from the discussion of the Gulf currencies, their behaviour is primarily driven by the dollar as most of them are pegged to the dollar. If there is any movement, then it is really in terms of that currency and the impact of the Gulf States is secondary (i.e. via oil prices and reserve movements). To decide whether the dollar is efficient relies on the comparison with other dollar denoted currencies.

b. Another problem with any analysis of what may be seen as cross rates between the Gulf currencies is a further problem; without any meaningful data from the exchanges this cannot be analysed as it will have to be seen through the dollar rates as was explained in the study undertaken above on developed countries data.

c. This leads to the final analysis of pricing and efficiency that follows from the behaviour of prices across the Gulf countries. Here it made sense to study the consumer price indices due to the fixed nature of the exchange rates relative to the dollar. An alternative approach using so-called big Mac prices or data on cities has been considered to get closer to the micro reactions of how prices adjust and when considered in these terms leads to the observation of faster rates of adjustment and the finding of PPP. However, these series relate to highly homogenous products where the key components are traded goods and the process controlled by a single producer. As compared with the price behaviour related to basket of commodities observed in a retail or consumer price index.

3.3.2 Methodology

In the current study there had only been 30 observations when compared with (Beirne et al., 2007), who adopt the panel approach related to the null of stationarity as a requirement for the test due to Hadri (2000) to perform well is that the time series exceeds 50 observations. While, Froot, et al., (1990) suggest a long span of data is needed to reject a unit root.[31]

[31] This also depends on the information content in the data and the capacity of such data to discriminate that may reflect any notion of super consistency that applies to the long-run parameter matrix (Davidson & Mackinnon, 2004).

Next, the cross-sectional dependence factor for the panel will be discussed and individual stationarity tests will be examined, and then long run behaviour and arbitrage, then the panel related to prices. Finally, cointegration will be analysed and long-run behaviour examined. The exchange rates will be discussed but through the prices and in terms of trade.

The logged prices were plotted for all Gulf States that would here seem to follow a similar pattern suggesting one or more common trends.

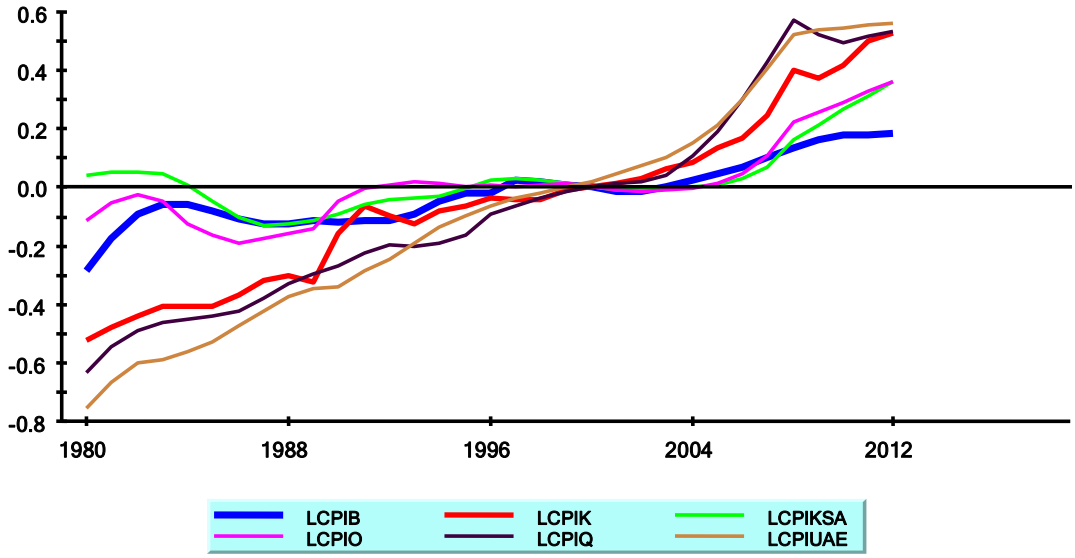


Figure 3.2 Logged price indices for all the Gulf States

When the panel method was applied, it is compared to the single series where the critical values are simulated in Microfit 5.0 (Pesaran and Pesaran, 2010). Further tests were performed to deal with extreme observations, compare the analyses and check robustness. Unit root tests were applied on both levels and differences using the panel ADF test of (Im et al., 2003) for all prices.

Table 7 shows the IPS test for a group of logged series (n=6). First the log level and these are as would be expected from figure 3.2 non-stationary (greater than 0.1) and on first difference, stationary (less than 0.1). The lag order is selected by automatic t-values and SIC, for the level, the IPS is applied with individual intercept. Then tests of stationarity were applied using Microfit 5.0 (Pesaran and Pesaran, 2010) with critical values

simulated via the programme for the sample and model selected. The results are summarized in Tables 7 and 8.

Table 7 ADF with IPS test type for the Gulf States Prices [a]

LCPI	Level (t) (t-stat)	Level (sic)	Differences (t) (t-stat)	Differences (sic)
KSA	-0.8309 (1) [0.7961][32]	-0.8309 (1) [0.7961]	-2.8754* [0.5045]	-2.8754* [0.5045]
UAE	-0.2121(1) [0.9268]	-0.2121(1) [0.9268]	-3.2721** [0.0279]	-2.9246** [0.0539]
O	-0.0742 (1) [0.9438]	-0.0742 (1) [0.9438]	-1.5319 [0.0598]	-1.5319 [0.0598]
Q	-0.0446 (1) [0.9470]	-0.0446(1) [0.9470]	-3.3304** [0.0220]	-3.3304** [0.0220]
B	0.2982 (4) [0.9739]	-0.2384 (1) [0.9231]	-3.5210** [0.0148]	-4.221** [0.0024]
KW	0.9486 (2) [0.9948]	0.4069 (0) [0.9802]	-5.2088** [0.0002]	-5.2476** [0.0002]
t-bar	0.0142	-0.1655	-3.2899**	-3.35515**

[a] Critical values panel t-stat -2.11500 (.05) -1.98500 (.1) Im et al (2003), while the single series are considered significant according to conventional critical asymptotic critical values at ** (1%) and * (5%) level (Dickey and Fuller, 1979)

We fail to reject the null that the levels are all I(1) and the differences are stationary in the panel case and except for one case stationary at the 10% level for the individual series.

Table 8 ADF Test (with Simulated Critical Values) By Microfit (Pesaran and Pesaran, 2010)

LCPI	t-stat	CV
KSA	2.5253	-2.9605
UAE	-.026283	-2.9605
O	1.5732	-2.9605
Q	.32447	-2.9605
B	-.18409	-2.9605
KW	.47031	-2.9605

[32] [prop]

The next step was to consider error correction behaviour using the log of the Saudi Arabia price and deducting that from all other prices. In a similar the panel is derived by stacking the five new correction terms and apply the IPS test. In econometric terms this is normalizing the results on the log price in the country column relative to the log Saudi price. In economic terms this is the numeraire price. It makes sense to decide on one of these and then pooling the data is more robust to the selection of the numeraire affecting the results of the stationarity tests. As is the case with PPP in International Finance and price arbitrage for single products (Forni, 2004) this is in practice a test of cointegration.

We picked KSA as the dominant player in the region, because it leads OPEC and it is a main commodity for the Gulf States. Looking at a consumer price index, oil also an important component. The Gulf is seen as orientated towards Saudi Arabia, or prices may be seen as relative to Saudi Arabia. Ideally you would be trying to find a country whose price equation or long-run price relation did not depend on the other countries. This is not easy with the time series available but it seems likely that the others will pay more attention to Saudi Arabia than each other and all have a land border with that country.

Table 9 ADF&IPS Test type for (the differential between KSA&Other Gulf Countries Prices) [a]

	t-stat	sic
ECUAE	-2.0995(2)* [0.2462][33]	-2.0995(2)* [0.2462]
ECO	-2.0327(1)* [0.2721]	-2.2449(3)** [0.1958]
ECQ	-1.7984(2) 0.3741]	-1.7984(2) [0.3741]
ECB	-1.6760(1) [0.4331]	-1.6760(1) [0.4331]
ECK	-2.9618(2)** [0.0502]	-2.9618(2)** [0.0502]
t-bar	-2.1137*	-2.1561**

[a] Critical values panel t-stat -2.11500 (.05) -1.98500 (.1) Im et al (2003), while the single series are considered significant according to conventional critical asymptotic critical values at ** (1%) and * (5%) level (Dickey and Fuller, 1979)

We could change the orientation by using other countries rather than Saudi Arabia like UAE or Bahrain for example. We analyze indices as exchange rates are fixed at the

[33] [prop]

beginning and then changed from home CPIs to dollars for each country CPI, because there are small variations in some countries prices across the years and also because some countries like Kuwait were pegged to a broader basket of currencies than the dollar for the early part of the sample. Table 9 considers the IPS test results.

Therefore, based on the t-bar form of the IPS test relative to the critical value in table 7 the stacked error correction term is stationary at the 10% and 5% level when the panel is looked at relative to the t-values and the SIC is used to select the lag length with the critical value for this test as -2.115 though the value is close to the critical value in the case of the selection of the lag length using to the t-values.

Table 10 ADF&Error Correction (with Simulated Critical Values) By Microfit (Pesaran and Pesaran, 2010)

	t-stat	CV
ECUAE	-3.4434**	-2.9605
ECO	-1.9570	-2.9605
ECQ	-2.3613	-2.9605
ECB	-2.5184	-2.9605
ECK	-2.5196	-2.9605

The individual error correction terms were investigated and when the critical values are simulated in Microfit 5.0 (Pesaran and Pesaran, 2010) as can be seen in table 10, then only the UAE seems to define a market with KSA. A further consideration of the data suggests that there may be at least two different groupings amongst the countries so the information in the figure below might be used to combine countries with similar trends and repeat the tests. Though, this would relate to three countries and 30 observations per country.

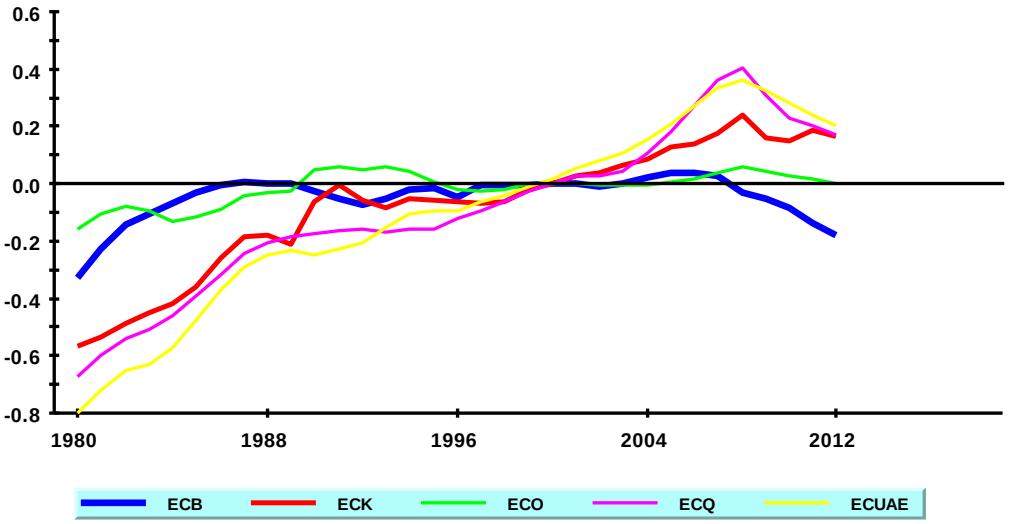


Figure 3.3 Error correction combinations for all Gulf economies.

The first group that behave in a similar way appears to be the UAE, Qatar and Kuwait and the second group is Bahrain, Oman and Saudi Arabia.

3.4 Conclusion

The main target for this chapter was to check if PPP would hold for the Gulf States. One of the building blocks for the Gulf currency union was considered. For comparison it was decided to apply PPP to some developed OECD countries and the reasons were: difficulties faced finding enough observations for the Gulf; second, the exchange rate variable is fixed and pegged to the dollar for all GCC countries; third because the analysis of the exchange rate relates to the $, analysing PPP on developed economies may be the only way to handle this issue as this may be seen as analysing the Gulf indirectly through the freely moving dollar rates.

After the tests were conducted for Australia, New Zealand and the UK, PPP was only found for UK, but the coefficients were not convincing. The aim was next to study the Gulf currencies' efficiency, but this is not possible by analysing cross rates as with fixed currencies and the translation to different currencies. The exchange rates are not adjusting and in algebraic terms as was shown for the $ rates any result for the Gulf rates would depend directly on the behaviour of the rates against the $. This works when the underlying models are the same and require the same coefficients.

At the end the Gulf prices were analysed and based on the IPS test, it was found that all the error correction terms could be seen as stationary when compared in turn with the prices for KSA. However, unlike Beirne et al (2007), the panel results were not supported by the univariate analysis. Only one series was found stationary on that basis and that was the one for the UAE relative to KSA. However, the prices are only for 30 years of annual prices and the exchange rates are fixed so any suggestion that there is arbitrage across the commodities of the Gulf States may be surprising. Given the concerns of Beirne (2009) over the performance of stationarity tests in a panel driven by a key series, then any analysis has to be seen as tentative certainly at the 5% level.

CHAPTER 4: THE NATURE FOR THE MARKET FOR FUNDS IN THE UAE

4.1 Introduction

The main objective for this chapter is to find out how efficient the money market is in the UAE as a building block for a currency union. The money markets work effectively when there is interest rate pass through across the different yields related to Government Debt and this relates to the term structure of interest rates. This chapter is so unique, because as far as we are aware, no one has used this data before and data is obtained from very reliable source and data is very confidential for the UAE.[34]

Market efficiency for UAE money markets were checked using the first set of data of interbank interest rates through a range of approaches from testing stationarity of the interest rates differential for the five available terms of interest rates. That is one week, one month, three months, six months and one year. Then the cointegration was tested more directly using the error correction models (ECM) and autoregressive distributed lag (ARDL) Models and the approach of non-linear autoregressive distributed lag model (NARDL).

A successful time series model considers both long run equilibrium and short run dynamics. While Cointegrating regression deals only with long run property, for that reason ECM was developed. ECM became popular after Engle and Granger although it goes back to Sargan (1964). While Greenwood-Nimmo et al., (2013) used a new method of an NARDL model developed previously by Shin and Greenwood-Nimmo (2014) to analyse the term structure of interest rates. Here a straight forward adaptation of this method has been applied and related to alternative approaches to cointegration linked to the ADF model, the ECM, the ARDL and NARDL models. This section will conclude

[34] The target was to get data for the entire Gulf and complete a study of all the money markets and for all of the Gulf States, but unfortunately, it was not easy to get the data for any of the other states, because of a lack of statistical data infrastructure for the Gulf. It would have been extraordinary to find interest rates for all the other Gulf countries because this kind of data has not to my knowledge been published. The data are confidential.

with the results of the analysis using these different methods. All these methods will be explained in details in section 4 below.

The literature on the term structure continuous to expand. There have been few studies and little empirical literature on interest rate pass-through (IRPT) and the article by Matthew Greenwood-Nimmo et al., (2013) addressing this important issue in terms of non-linear adjustment. The current study's contribution is to analyse the United Arab Emirates' money market to see whether it is efficient through the analysis of IRPT using interbank interest rates.

The methods applied relate to single equation dynamic and ARDL models. With interest rates we are dealing with parity conditions and this form a sequence, then the system methodology can be exploited to test further aspects of the problem. Interest rate parity relates to money market efficiency and this relates to the effective implementation of interest rate policy. One might anticipate in the context of a single market that the condition underlying the yield curve will be satisfied and in a global context that UIP is satisfied. The requirement is for arbitrage to hold in the context of the financial market or that interest rates are related to each other, especially in the long run. As was mentioned above, UIP has not been well observed in the linear context as can be observed from the early findings of (Hunter and Smith, 1982 ; Baillie et al., 1983). Further, an analysis of interest rates is not always straightforward, especially when such data are not easy to obtain. To this end it would appear better to consider the yield curve as there is more evidence in support of this proposition. In addition, observing arbitrage across government is indicative of an effectively functioning monetary system capable of instituting an appropriate monetary policy. Hence, observing the yield curve implies arbitrage across financial assets and this is a pre-condition for a single monetary system's integration into a common currency.

Even were the economy to be relatively efficient and productive. To absorb the impact of any crisis failure in financial markets may hamstring a single economy. With the crisis in the Euro zone, the failure of the banking system was a primary problem for Ireland. The crisis was associated with other forms of failure, especially in terms of the purchase of assets, where the assets were not correctly priced for risk and a certain amount of illegality could be observed. The finding of any inefficiency within markets, especially in the context of interest rates, would be suggest the potential for market failure. Yield curve

inversion, or excessively high short-rates, was a precursor of the crisis that hit the UK in 2007 with the failure of Northern Rock. This bank failed as a result of a poor business model sensitive to an active inter-bank market (Hunter and Menla, 2014). However, this was purely a precursor of more fundamental problems that impacted the global financial system following the failure of Lehman Brothers. As a result, banks stopped lending to each other and short rates rose; this led to the inversion of the yield curve with short-rates leading long-rates. A history of bond inversion or a failure to find a stable yield curve in normal times would indicate the potential for the type of systemic failure that might lead to the breakdown of an exchange union. Bank failure or a failure of liquidity can be related to corporate failure and the feed through from the monetary sector into the financial markets and the real economy.

While Anderson and Granger (1992) considered the term structure of interest rates, Cochrane (1994) ; Ludvigson and Lettau (2001) investigated the predictability of stock prices. All of the above articles looked at the behaviour of the financial markets.

This chapter will give an indication of how efficient the Gulf money markets are, at least for the UAE, which will show whether its financial markets are ready for integration or not. Specifically, that the single Gulf currency project has a priority among all other projects in the Gulf States and has always been a main issue of discussion in the Gulf. In every meeting of the Gulf States for at least the last 20 years or more, there were discussions about this project. However, for the UAE this sophisticated project has gone in and out of favour especially after the recent Euro zone financial crises for Spain and Greece.

The final results of the current study may be an important source of information on whether or not the UAE will go into the currency union and the study will indicate how efficient UAE money markets are. There are three sets of unique data for UAE interest rates: interest rates of interbank deposits, interest rates on deposits and interest rates on loans and advances. The data cover the period from 1996 to 2007 on a monthly basis and it was not possible to find similar data in other data bases such as the IMF International Financial Statistics (IFS) or Bloomberg, especially for a country, developing economic data and developing infrastructure like the UAE. The overall objective was to measure the efficiency of the money and financial markets of the UAE.

4.1.1 The Term Structure of Interest Rates

The term structure of interest rates is the relationship between the interest rate and the term of maturity. The term structure of interest rates has always attracted researchers theoretically and empirically. Yield curves are constructed either on the basis of simple interest rates or a continuously compounded interest rate. The yield curve represents graphically the term structure of interest rates, which is the relationship between the term to maturity and its yield (Patterson, 2000). One of the leading theories of the term structure is the combination of the expectations model and the rational expectations hypothesis. Because of investments it is very important to find the relationship between the short and long period rates or the spread (the difference between two bonds with different maturities) or the difference between the long period and short period interest rates (Patterson, 2000). Monetary policy assumes that pass through is complete from policy controlled interest rates to longer-term rates and yields.

On the other hand, Campbell et al., (1993) defined the yield curve as "a curve that shows the yield to maturity prevailing at a given point in time for bonds that differ only by maturity". The yield curve is normally upward-sloping with a positive spread, but it could have unusual patterns as well, for example inverted if it is downward-sloping with negative spread, or hump-shaped or trough-shaped with mixed signs of spread.

Campbell and Shiller (1989) explored yield curves and interest started developing as to the efficiency of money markets and interest rate transmission mechanisms. Similar issues arose in relation to the term structure of interest rates and pass through across financial markets. Campbell and Shiller (1987) used a VAR to test a model of long-term interest rate and short-run interest rate for stocks and bonds on US data. In this paper, they tested when combining variables in a model that is stationary when the model follows a linear stochastic process in first differences rather than in levels. Then they used the VAR to compare the unrestricted forecast with a restricted one and looked at the standard deviations and correlation of the two forecasts to find their movements. They found that both models were rejected statistically, because of their deviations from the present value model, but found stronger evidence for bonds as the spread between long

and short interest rate moves closely with the present value of the expected short rate changes, as compared to deviations for the spread between stock prices and dividends.

Campbell (1995) summarized the literature on the yield curve and the mixed evidence on the term structure and the expectations hypothesis. He used the interest rates for US bonds of short and long maturities (Yield Curve or Term Structure of interest rates) to prove the expectations hypothesis. The expectations hypothesis assumes that yield spreads reflect only the rational expectation of movements in short rates and it is then unusual for the expected yields on long bonds to deviate from this. In that case, regressions in long and short rates onto the yield spread will give a coefficient of one. So high yield spread would occur due to high returns on long bonds or increases in interest rates or a mixture of the two. The pure expectations hypothesis of the term structure expects interest rates to move to equalize returns on short-term and long-term investment strategies. On the other hand, the expectations hypothesis is a weaker theory, because to hold the difference between the expected returns on short and long-term investments should be constant rather than zero.

Campbell tested whether excess long bond returns are zero on average, and whether excess long bond returns vary predictably through time. Such results contradicting the expectations hypothesis of the term structure that yield spreads don't forecast short-run changes in long yields. Though Campbell also found some support for the expectations hypothesis at short and very long maturities that yield spreads do forecast long-run changes in short yields. This is now linked to what has more recently been called pass through in terms of exchange rates and interest rates. If there is pass through then price movement at the short end are passed across rates into financial assets with longer maturities. Testing for and observing pass through in interest rates will indicate that yields are related and that will give rise to the yield curve.

In an efficient market, investors should be indifferent to buying an n period bond (n is an asset assumed to have a long maturity) at time t and buying a sequence of shorter period bonds. Otherwise investors should not yield the expectation of a profit and if they do, it will be arbitraged away by an efficient market (Patterson, 2000). Shin et al., (2012) developed a cointegrating NARDL model and Greenwood-Nimmo et al., (2013) published a paper about the term structure of interest rates and the yield curve to further

study the non-linear ARDL model. The paper discusses different interest rate theories, including the yield curve and pass through. In this chapter, the method in Greenwood-Nimmo et al., (2013) will be followed to test for a non-linear ARDL specification.

4.1.2 The Pass-Through Concept and Money Market Efficiency

Greenwood Nimmo et al., (2012) reviewed the literature on pass through and the interest rate transmission mechanism. While the following quote is of interest here:

> "Learning about term structure is fascinating and becomes important specially when people start choosing or selecting between investing in a bond fund or money market fund or at time of saving for a retirement. It is important as well for economic policymakers and private individuals. Term structure became so important in 1994 in U.S when an increase in the short-term interest rates caused unusual sharp increase in long bond yields. Then the U.S Treasury began shortening the maturity of the government debt to lower the federal interest costs". (Campbell, 1995, p. 6)

Because of the need to understand the impact of monetary policy, decisions on rate changes and their effect on the economy, there have been various kinds of empirical literature and theories on the linkage between policy-administered short-term interest rates, and the longer-term money market and retail bank interest rates. In general, the Federal Reserve tightening of monetary policy started under the leadership of Paul Volcker in October 1979 and was a turning point in United States monetary history. Gregoriou et al., (2009) suggested that an econometric analysis of the monetary system is unlikely to be well defined prior to 1980 as inflation series that impact interest rates via the Fisher Effect give rise to series that are highly persistent and may well not be stationary. In the 1970s and across the OECD, inflation had been high following the first oil crisis in 1973. Across this time inflation rose from around 1% to 10% in the US and to higher levels in the UK, but after the Volcker reforms, inflation fell to around 4% in the US by 1984. Since then, inflation has generally been controlled and reduced and kept between 1% and 2% for the US. Under the leadership of Alan Greenspan, it has been characterized as being "effective price stability" because of his policy to fight inflation.

Volcker's actions at that time had an enormous impact on monetary policy and since then the Federal Reserve has mainly relied on monetary policy driven via the setting of interest

rates. In 2003, the linkage between the markets and Fed became very important. The Fed wished to react to deflation by shifting the yield curve down by steering expected future interest rates down and signalling to the public to be patient of raising interest rates gradually. It is important to create a clear understanding of Interest Rate Pass-through (IRPT) and thus try to resolve the disagreements in the literature that arise in part as a result of a lack in the finance field of an empirical literature on IRPT and as a result of disagreements over the validity of the theoretical models based on the rational expectations hypothesis (REH) of the term structure that have performed poorly under empirical scrutiny (Campbell, 1995). This problem within the theory and the shortfall in empirical support of the term structure model has led to the need for further research on IRPT. Campbell and Shiller (1987) said that the expectation hypothesis of the term structure relates to finding a cointegrating vector of the form [1,-1] linking short and long interest rates. The expectation hypothesis holds if IRPT is complete from short- to long-term rates and symmetric in the long run.

In particular, long-run interest rates appear to react differently to policy decisions. For example, sometimes the US Federal Reserve can surprise markets by actions on rates that are not announced in advance. Sometimes the time frame is so short that the Fed needs to act quickly so that markets have little time to adapt. Greenwood Nimmo et al., (2013) provided an example of the decoupling of long-term interest rates and yields from policy controlled interest rates in the early years of the 21st century called a 'conundrum' by Federal Reserve chairman Greenspan. Commentators have accused the Fed of deviating from the Taylor rule, between 2003 and 2005 as the principle reason for the housing boom and the financial crisis that hit the world financial system in August 2007 and led in September 2008 to the chaos in financial markets that followed the failure of Lehman Brothers (Milne, 2009) due to the decoupling or failure of banks in Europe and the US to reflect rate cuts in their portfolio of retail and commercial interest rates in recent years.

A major contributor to the crisis was the failure of the market for credit default swaps in the US and the contagion to the UK in 2007. This later related to the failure of Northern Rock in the UK, which could not sustain its mortgage business as a result of the failure of the credit default swap market that was supporting the inter bank loan system. As a result, by the end of August 2007 banks were reticent to loan to each other and this made Northern Rock very vulnerable to a bank run. The Bank of England and their Governor, Mervyn King did not appear to recognize that this was a failure of liquidity. The Bank of

England and the UK Government were no longer in control of the base rate as this had been set independently of Government via the Monetary Policy Committee in the UK since 1997. It was believed that the only mechanism that was available given European rules on competition was via printing money, but this had been an anathema to governments across the world since the end of the 1970s. The failure of Northern Rock was resolved in much political turmoil by nationalization. Mervyn King had berated the Labour Government as he viewed this to be a microeconomic issue linked to setting an appropriate incentive to banks to perform well. It is possible that Northern Rock should have been allowed to fail. The governor did not mention the losses to lenders who may have lost substantial sums while further nationalization was seen to set a perverse incentive, though board members of these banks were sacked and the shareholders lost their money. The subsequent failure of the US Treasury in 2008 to act in a similar way with Lehman Brothers was far more fundamental. Lehman Brothers was a market leader in the CDS market and when it failed chaos ensued as other banks were unable to unwind their positions while a significant counterparty to this risk was the US Insurance Giant AIG, which also failed (Milne, 2009). AIG was saved by the US Government, but not before the damage to the world financial system had occurred.

Bondt (2005) stated that central banks steer money market interest rates which affect long-term interest rates and retail bank rates and that those retail bank's decisions on yields paid on their assets and liabilities affect the behaviour of investors and borrowers and real economy activity via the wealth impact of a loss of value in asset markets. The existing empirical literature analysed IRPT from short-term rates to longer-term rates and bond yields in two ways. First, through retail bank IRPT by which banks adjust their deposit and lending rates, whenever short-term market rates or policy controlled rates change or second, via the dynamic nature of the term structure of interest rates at various maturities.

Again, disagreements in the existing literature arose between the empirical results and policy implications. For example, Borio and Fritz (1995) found evidence of a more rapid response of long-term interest rates to rate hikes than to rate cuts and this implies that there may be some asymmetry in the system. Gual (1999) found exactly the opposite result, while Sellon (2000) found the opposite in relation to US mortgage rates.

The asymmetric response might call into question the use of conventional models that assume long-run reactions are the same irrespective of the direction. This implies models that might have asymmetric corrections in the long run or non-linear ARDL (NARDL) models. A basis of this might be the nature of the monetary policy rules that are being applied.

4.2 Data

The data set is weekly for 12 years with 5 frequencies up to a year. The data are for interbank interest rates for the United Arab Emirates of various forms. In the current study there are five sets of data for interest rates: 1 week, 1 month, 3 months, 6 months and 1 year over the period 1996-2007.

4.3 Methodology

4.3.1 Augmented Dickey-Fuller (ADF) Test

The interest rate is a rate of return so would not ordinarily be logged unless taking the log of an underlying relationship that for ease of estimation was in logarithmic or semi logarithmic form. According to Granger (1981), assuming that both $x_t \sim I(1)$ and $y_t \sim I(1)$, then generally $y_t - \beta x_t \sim I(1)$ as well but if $\varepsilon_t \sim$ I(0), then $y_t - \beta x_t \sim I(0)$ and in this case both variables x_t and y_t are cointegrated because the linear combination $y_t - \beta x_t$ has the same properties as an I(0) variable. An econometric model can't be well specified without knowing the order of integration of the variables. Granger and Newbold (1974) generated independent random walks as nonstationary series and regressed these series on each other with the assumption of a zero coefficient and observed the value of t-statistic of the coefficient. They found that the null hypothesis of zero coefficient was rejected more frequently and got strong positive autocorrelation in the residuals. This means that the relationships in this case would be spurious, and to resolve this problem the economic relationship must be specified on first differences rather than levels or removing a linear time trend from the variables by using detrended variables.

Checking if the variables are I(1), see Appendix B for graphs, there is the suggestion that the series have been generated by nonstationary processes and are stochastic, and as was

expected, interest rates fluctuate and none of them has a clear tendency to return to a constant value or linear trend. They generally look nonstationary stochastic variables that appear to be following pure random walks. It can also be noted that their volatility varies over time and graphs clearly illustrate how high volatility periods alternate with periods of relative calm, which is a further property of nonstationary variables.

In case of further autocorrelation, lags of the dependent variable ΔY_t are included until there is no error autocorrelation as can be observed in relation to the previous studies in the previous chapter.

After computing the ADF test on each of the five variables, using Schwarz Info Criterion for the lag length selection, it was found that all the variables were as expected I(1). The first column of Table 11 shows the t-statistic for the optimal lag length to be added in the ADF test based on the SIC. For example, for the one-week interest rates the lag length was 4 and the maxlag was 12. In table 11 it is observed that in all cases the test is not significant so it is not possible to reject the null the of unit root and that for all five variables are I(1). While the next column for comparison looks at a single lag and the same conclusion is found that all the interest rates are I(1). In general the differentials are stationary and there appear to be no GARCH effects.

Table 11 ADF Test for the 5 sets of Interest rates [a]

Variable(Lag)	t-Stat sic	t-Stat 1 Lag
1Week i.r (4)	-2.215254 [0.2020][35]	-1.220043 [0.6646]
1Month i.r (5)	-1.992150 [0.2900]	-0.960561 [0.7658]
3Monthsi.r (4)	-2.137285 [0.2306]	-1.220190 [0.6646]
6Monthsi.r (2)	-1.277768 [0.6387]	-1.060270 [0.7300]
1Yeari.r (1|)	-0.338463 [0.9148]	*

[a] ADF Test Critical value at 1% is -3.437483, at 5% is -2.864578.

[35] [prob]

With all series being I(1), then with a sequence of interest rates it is possible to test for cointegration and pass through using slightly different methods to those previously mentioned above.

4.3.2 Univariate Tests for Non-Stationarity and Cointegration

Here the ADF test was applied to check whether the interest rate differential is stationary and as a result the money market may be considered to be efficient or the term structure relation holds in the long-run.

It is common practice to apply Dickey-Fuller tests (Dickey and Fuller, 1979) to each interest rate in turn to determine whether they are stationary as was done above and then consider a differential in the interest rate to determine that there is money market efficiency or a primary result related to the term structure of interest rates. Let the following variable, determine that differential:

$$y_t = r_{it} - r_{jt} \qquad (4.1)$$

Where r_i is a short interest rate and r_j a longer rate and y denotes the interest rate differential related to the yield curve. When the two interest rates follow random walks, then they are by definition I(1) series and from (4.1), the market is efficient or the price differential is stationary, then $r_1 - r_2$ must be I(0). It is important to note that the Dickey-Fuller test is sensitive to initial conditions, dynamics in both the conditional variance (ARCH) and the mean equation (serial correlation), and non-normality. While some of the more recent literature related to these cases has suggested that there might be some form of non-linear adjustment (Peel and Taylor, 2000).

The ADF lag order was selected either using the SIC or t-value. Other ways of determining lags include considering the correlogram under the null of non-stationarity to determine the maximum lag order of each model of the interest rate (Burke and Hunter, 2005, Chapter 2). This corresponds with the view presented in Said and Dickey (1984) that long order AR models improve size as compared with the introduction of redundant lagged terms that may lead to a loss of power (Haldrup and Jansson, 2006). The test performance is affected by not accounting for serial correlation, as the standard errors are

not correct, while the inclusion of too many lags may affect test performance. To improve the power of the univariate tests one might follow a General to Specific approach (Taylor, 2002) and discard intermediate lags that are insignificant at some intermediate level of significance based on conventional inference. As there is no trend in the original data and the asymptotic distribution of the Dickey-Fuller test is not sensitive to the inclusion of differenced series, the test was applied to the type of variable defined in (4.1) above.

Table 12 provides the triangle of test results related to the SIC selection criterion and these relate to highly parsimonious explanations of the interest differential. This has to be traded against the misspecification that happens with serial correlation and possible bias in the standard errors. In the case where $y_{3t} = (r_1 - r_3)_t$ where r_1 is the one month rate and r_3 is for the three month rate. Table 12 is relative to each interest rate differential:

Table 12 ADF of lagged interest rate differentials based on SIC (Lower triangle of the matrix) [a]

Rate	Weekly (W)	One Month (1M)	Three Month (3M)	Six Month (6M)	Yearly (1Y)
1M	-3.433703 (1)[36]	1			
3M	-3.326388 (0)	-3.376268 (2)	1		
6M	-3.104201 (0)	-4.751723 (0)	-5.185601 (0)	1	
1Y	-3.242228 (1)	-3.074004 (0)	-3.833085 (1)	-2.930290 (0)	1

[a] The null hypothesis implies that the series is I(1). Approximate critical value at the 5% level is -2.89. Please note the ADF(2) form of the model, compares to an underlying AR(3) model in the interest rate differential.

Based on the previous discussion, a student-t selection criterion is used based on the 10% [.100] level to select the lag order to eliminate serial correlation in the data, but at the expense of the test not being efficient. The results below apply to this approach.

[36] **(lag order)**

Table 13 ADF of lagged interest rate differentials based on students t criterion (Lower triangle of the matrix) [a] [37]

Rate	Weekly (W)	One Month (1M)	Three Month (3M)	Six Month (6M)	Yearly (1Y)
1M	-3.730692 (12)	1			
3M	-4.036178 (9)	-2.938810 (12)	1		
6M	-3.165442 (7)	-3.332518 (12)	-5.185601 (0)	1	
1Y	-3.473766 (7)	-3.625498 (12)	-3.264857 (11)	-2.528860 (8)	1

[a] The same rubric from the table above applies here.

Comparing the unit root tests in Table 12 and 13 the results in the tables are unable to reject the alternative hypothesis that the differentials are stationary except for one result in Table 13. That is the comparison between the six-month interest rate and the 1-year rate as in this case it is not possible to accept the null. Further investigation of the lags in the model for Table 13 that is not coherent with the other results suggests that these extra terms are not significant. If in this case a more strict selection based on a p-value of .05 is applied then the resulting model is the same as the one selected by the SIC. Looking at the specific model for the interest differential between the six month and one year rate, then it would appear the series is stationary:

$$\Delta\hat{y}_{(\text{m6-y})\text{t}} = -0.018149 - 0.136883\text{y}_{(\text{m6-y})\text{t-1}}$$
$$(-2.930290)$$
$$DW = 1.8909$$

The above model would appear to be relatively well formulated and the DW test is suggestive of there being little serial correlation. Further investigation may be considered via a Box-Pierce or LM test for this model to determine whether there are further types of misspecification. To remove the potential for chance findings, it is suggested to focus on the first column of results for any further analysis.

This implies there is a model for each interest rate tested for stationarity in turn, suggesting these results should be representative of the idea that the series are cointegrated. If we consider Smith and Hunter (1985) for triangular arbitrage, when a regression is analysed and the restriction is common across the sample, then the finding

[37] **(lag order)**

of cointegration on N-1 price comparisons (Burke and Hunter, 2012) should leads to the same finding on the remaining lower triangle of results assuming the interest rate parity models are coherent.

If :

$y_{(m6\text{-}y1)t} = r_{m6t} - r_{y1t} \sim I(0)$

and

$y_{(m3\text{-}y1)t} = r_{m3t} - r_{y1t} \sim I(0)$

then:

$y_{(m3\text{-}y1)t} - x_{(m6\text{-}y1)t} = r_{m3t} - r_{m6t} \sim I(0).$

As a result of this the findings for the remaining equations in the triangle can be deduced. Here the dynamic equations for the models related to the first column of results in Table 13 above are investigated. It is suggested by Burke and Hunter (2012) that the simplifying assumption that follows from the ADF model specification may be benefitial especially when the sample is relatively or there is common behaviour across variables such as prices and interest rates. Similar arguments were made by Forni (2004) in terms of product price and Devereux and Lothian (2011) in terms of the historical analysis of the exchange rate.

Next the specification of the ADF models is considered.

Table 14 ADF & Box-Pierce (Q) test statistics based on students-t criterion

Up to lag 25	Correlogram of residuals Q-Stat	Correlogram of squared residuals Q-Stat
1W to 1M	8.977 [0.999][38]	5.37 [1.00]
1W to 3M	17.626 [0.858]	33.057 [0.130]
1W to 6M	19.770 [0.759]	52.505 [0.001]
1W to 1Y	15.276 [0.935]	24.542 [0.488]

If the residuals related to the model for the first ADF test in column one in Table 14 are examined, for 1Wto1M, little evidence of serial correlation is found as the Box-Pierce test for 25 lags is Q(25)=8.9771 with a p-value of .999 so it is not possible to reject the null hypothesis that the errors are correlated. Similar results apply to the LM test of Breusch

[38] [prop]

and Godfrey for serial correlation (see Davidson and MacKinnon, 2004) as the p-value based on the Chi squared test is 0.66, which means that it is not possible to reject the null at the 5% significance level for a test of serial correlation on the residuals up to order 25. Given the data relate to financial markets, the issue of Auto-regressive Conditional Heteroscedasticity (ARCH) arises. Here the squared autocorrelations can be considered, where the Box-Pierce test for 25 lags is 5.3797 and the p.value=1.000 so it is not possible to reject the null hypothesis of no squared error autocorrelation at the 5% level while the largest individual coefficient related to ARCH is.161.

For the second term in the first column (1week relative to 3 month) there is little evidence of serial correlation as the Box-Pierce test for 25 lags is Q(25)= 17.626 with a p. value of 0.858. The LM test statistic with an F value of 0.6857 is also not significant at the 5% level so it is not possible to reject the null of no serial correlation in the residuals up to order 25. When the squared autocorrelations are considered the Box-Pierce test for 25 lags is Q(25)= 33.057 with a p.value of .130 that implies they are not jointly significant at either the 5 or the 10% level. It seems possible to ignore all the individual tests except for the Box-Pierce test at lag 2, because Q(2)=10.538 is significant for lags up to 2 at both the 5 and 1% level as the p.value= .005. At lag 15 the p.value=.008 that would suggest lags significant up to 15 according to the Box Pierce statistic. However, when the Box-Pierce tests a are considered incrementally, then the key lag is 15 as the Box-Pierce are independently normally distributed so an approximate test for a single coefficient can be applied by looking at the differential of between Q(15)=31.463 and Q(14)=15.169 which has a value of 16.29 and comparing this with an approximate Chi-squared one tabulated value this exceeds both the 5 and 1% critical values up to 6.6349.

All of the above would suggest that the model be best estimated with a method that takes account of variance structure such as an ARCH(15) with restriction or a GARCH(1,1) might be used. Beirne et al. (2007) estimated these extended ADF models to test stationarity of the real exchange rate, but the models had much simpler lag structures. Overall, either some correction is made for heteroscedasticity or a more complicated model is applied or this is viewed as an anomaly.

Moving to the next interest differential in the first column (1 week related to 6 month), it looks as if the portmanteau test is not significant as the p.value=0.759 for the serial correlation test. While the equivalent LM test was also not significant with a similar

p.value = 0.75. However, the test related to ARCH is significant at both the 5% and 1% level as the Box-Pierce test is 52.505 with a p.value=0.001.

Looking at the last interest rate differential which is 1W to 1Y, the Box-Pierce test for 25 lags is Q(25)= 15.27,and p-value of 0.935, the portmanteau test again is not significant from the p-value and from observation of the correlogram no individual test catches the eye. While for the squared residuals both Q(1)=5.41 is significant at the 5% level, and Q(12)=19.60. It would appear that in addition to the first lag the term at lag 12 is also significant at the 5% level when the increment in the Box-Pierce test is considered to be comparable with a Chi-square one distribution is 9.25 as it is not possible to reject the alternative and that this term is significant at the 5% and 1% level.

Based on re-estimating the ADF model using the GARCH(1,1) procedure, there was no longer autocorrelation at lag 1 and the degree of squared correlation at lag 12 also fell. Now the differential in the Box-Pierce test statistic at lag 12 is 5.59 and that is significant at 5% but insignificant at 2.5% and 1%. It may be possible to avoid over rejection of the null to apply this test at a level less than 5% level.

As there are many different volatility models that might be used to correct the ADF model and the results can become sensitive to this choice it seems better to address the issue directly and develop a more robust and consistent method to amend the tests in the presence of ARCH. Beirne et al (2007) use a simpler procedure to further support their findings and account for the observations not being White Noise. That is to correct the standard errors either using the procedure due to White or the Newey-West Heteroscedasticity and autocorrelation Bartlett corrected standard errors (HAC) of Bollerslev and Wooldridge (1992). The corrected ADF test is provided in Table 15.

Table 15 Interest rate differentials based on t-stat (using HAC corrected standard errors) [a]

	1W t-stat
1M	-4.36673*
3M	-4.00378*
6M	-4.10017*
1Y	-4.05576*

[a] * denotes that this is significant at the 5% level as can be seen when the asymptotic critical value due to Dickey and Fuller is considered.

After correcting the standard errors using the HAC procedure option, the conventional critical value presented below Table 15 is applied and it is found for all cases that the interest rate differential is stationary (see Beirne et al., 2007) for discussion of this issue.

4.3.3 ARDL/Error Correction Model

Cointegrating regressions only considers the long-run property of the model and never deals with the short-run dynamics. Long-run relationships measure any relation between the levels of the variables while the short-run dynamics measure the dynamic adjustments between the first differences of the variables. However, we could say that a good time series model should consider short-run dynamics and long-run equilibrium. The ECM became popular across the globe following Engle and Granger (1987). However, estimation of a pure ECM with a unit coefficient on the long-run goes back in econometrics to Sargan (1964). The model below places that ECM form in a similar format to the ADF models estimated previously to provide the ADF test statistics (see Burke and Hunter, 2005):

$$\Delta(r_{\mathrm{jt}}\text{-}\mathrm{r}_{it}) = \alpha_j (r_{\mathrm{jt}}\text{-}\mathrm{r}_{it})_{jt-l} + \sum_{l=1}^{\mathrm{p\text{-}1}} \pi_{jl} \Delta(r_{\mathrm{jt}}\text{-}\mathrm{r}_{it}) + \varphi_{j0} \Delta r_{it} + \sum_{l=1}^{\mathrm{p\text{-}1}} \varphi_{jl} \Delta r_{it-l} + \varepsilon_{\mathrm{ECMjt}} \qquad (4.2)$$

Compared to the ADF, the ECM explains the behaviour of $\Delta(r_{\mathrm{jt}}\text{-}\mathrm{r}_{it})$ by the lags in $(r_{\mathrm{jt}}\text{-}\mathrm{r}_{it})_{jt-l}$ and Δr_{it}. The extra variables pick up the extent by which the short-run behaviour is the same as the long-run and when that is the case the ADF model and the ECM cannot be seen to be different. The ECM still focuses on the long-run and the test is still valid for this reason, even when the interest rates are endogenous. This is discussed in Davidson and MacKinnon (2004) in terms of super consistency. These results will be contrasted with those of the ARDL models presented in Table 16.

A natural way to solve the specification issues associated with serial correlation and to some extent also the problem of omitted variables that may cause serial correlation and to some extent heteroscedasticity is to include lags of the dependent variable in the equation. This strategy leads to an autoregressive distributed lag (ARDL) model. An early example of this model was fitted to Dutch construction data by Merkies and Steyn (1994) and Steyn (1996). The ARDL model can also be seen in terms of both short- and long-run behaviour. If the short-run is important, then the model requires estimation by

Instrumental Variables (IV), the first example of this being the wage equation estimated by Sargan (1964).

In a similar way to the estimation of the model underlying the ADF t-statistics, the ARDL model with sufficient data can be estimated by Ordinary Least Squares (OLS). The model used in the ADF test is a restricted version of equation (4.2) above, while the ARDL model is a version of this by which the same idea of cointegration/stationarity may be tested using price proportions in percentages here r_i-r_j. All of these methods relate to single equations and might also be seen as particular types of ARDL models. The most straightforward way to extend the ADF model (4.2) in a dynamic way is to augment it by additional lags in one of the interest rate differences (Δr_{it-l}):

$$\Delta(r_{jt}\text{-}r_{it}) = \alpha_j (r_{jt}\text{-}r_{it})_{it-l} + \sum_{l=1}^{p-1} \pi_{jl} \Delta(r_{jt}\text{-}r_{it}) + \sum_{l=1}^{p-1} \varphi_{jl} \Delta r_{it-l} + \varepsilon_{ARDLjt} \qquad (4.3)$$

In terms of testing for cointegration via the significance of the error correction term there is no issue with endogeneity as super consistency should apply to these results (Davidson and MacKinnon, 2004). Otherwise we should look at an ARDL formulation or a single equation from a bivariate VAR model, which has the same ADF type structure except the current interest rate on the right hand side is removed so the lag indicator goes from 1 not 0.

The following results relate to both the ECM and a version of the ARDL model comparable to the ADF test model. First the conventional test on the error correction terms appears as a t-test. The ECM is considered and then the model augmentation associated with (4.3) above will be explored with the specifications all seen as augmented Dickey-Fuller models.

Table 16 Extended ADF test statistics using t-ratios [a]

Lag (p)	ECM-t-value	ARDL-t-value	Critical values 5%
1W to 1M	-2.261110	-3.3851*	-2.885249
1W to 3M	-2.57	-2.8852*	-2.884665
1W to 6M	-2.6177	-2.2935	-2.884291
1W to 1Y	-3.2979*	-2.257	-2.884291

[a] * significant at the 5% level.

Looking at Table 16, it can be noted that all t-statistics are insignificant for the ECM except 1 week related to 1 year, which is significant at 5%. On the other hand, results are much different for the ARDL model, where the t-values indicate that the tests were significant only at 1 week related to 1 month and 3 month, but not significant at 6 months and on a yearly basis. Stationarity tests do not accept the null with shorter interest rates for the ARDL model and the longest rate comparison for the ECM.

Table 17 ADF &Box-Pierce (Q) test stat using t-ratios

Lag 25	Correlogram of residuals ECM/ARDL Q-stat	Correlogram of squared residuals ECM/ARDL Q-stat
1Wto1M	6.0204/12.607 [1.000] /[0.981][39]	11.780/5.1832 [0.988]/[1.000][40]
1Wto3M	24.536/22.092 [0.489]/[0.630]	41.105/31.816 [0.0220/[0.1630]
1Wto6M	23.274/19.414 [0.562]/[0.777]	32.025/50.278 [.157] / [.002]
1Wto1Y	25.265/14.755 [0.448]/[0.947]	39.718/33.546 [0.031]/[0.118]

Table 17 considers the models looked at in terms of their residual diagnostics from the correlogram and Q statistics for the residual and their square. The test results and their associated p-values in square brackets are presented for both the ECM and the ARDL models.

This test is significant to reject the null if enough terms in the correlogram are significantly greater than zero. When the Q-statistic is bigger than the tabulated value at the lag, then comparison can be made accordingly; if the p value is less than 1% or 0.01. Looking at Table 17, all Q-statistics are not significant to reject the null of no serial correlation in the residuals for both ECM and ARDL models.

The same test is applied to the correlogram of squared residuals. When there are significant lags, this indicates that there is ARCH behaviour. Table 17 provides mixed results for both ECM and ARDL model. Looking at the ECM results, the null was rejected for the interest rate differential for 1W to 3M and 1W to 1Y and accepted for the rest. On the other hand, for the ARDL model the null was rejected and significant ARCH

[39][prop]
[40] [prop]

behaviour found for only one differential, which was 1W to 6M and the null accepted for all the others.

Table 18 ECM tests of Cointegration based on Robust Standard Errors [a]

Lag25	ECM	ARDL t-stat	CV 5%
1Wto3M	-3.93*		-2.884665
1Wto6M		-2.42	-2.884291
1Wto1Y	-4.39*		-2.884291

[a] *Is the corrected test statistic compared with the asymptotic critical values at 5% level

The findings in Table 17 above should be taken account of in the calculation of the tests on the error correction term to determine whether there is cointegration. Here it has been decided to use the corrected standard errors. Robust standard errors are derived using the approach of Newey and West as specified by Bollerslev and Wooldridge (1992).

In Table 18, robust standard errors were applied to the t-tests on the interest rate differential when ARCH was observed in Table 17. Doing this should correct the standard errors for heteroscedasticity found in the ECM and ARDL model. However, for the ARDL model the interest rate differential (1W to 6M) is not significant and the corrected test statistic is smaller. Further investigation of these linear models did not provide clear evidence when the specifications were correct of cointegration. This led to looking at alternative non-linear models of which there are many used in finance including further corrections for volatility.

However, recent findings on non-linear correction in interest rate pass through and the yield curve can be found in Greenwood-Nimmo et al., (2013), and Claudia and Johann (2010), which also relate to developed monetary systems such as the USA and Germany. As the linear models seem surprisingly successful, given the above research, it was felt the one outlying interest rate might benefit from further analysis with this method to see whether a limited type of efficiency might be determined.

4.3.4 Nonlinear Autoregressive Distributed Lag (NARDL) models

Greenwood-Nimmo et al. (2014) suggested that the foundations of the NARDL model might even go back to Keynes (1936). They gave this interpretation based on Keynes writing in relation to interest rate movements that “The substitution of a downward for an upward tendency takes place suddenly and violently”. Keynes (1936) had a different idea

of the long- and the short-run as periods of adjustment related to economic processes. However, that the correction is non-linear would seem to be clear and then whether the NARDL model works well is an empirical issue. This might explain why others like Meese and Rogoff (1983) found that it was difficult to forecast real exchange rates. Of particular interest here is the further article by Greenwood-Nimmo et al., (2013) that looked at money market efficiency in terms of interest rate pass through. The term pass has drawn a lot of attention in terms of exchange rates. For example, Beirne et al (2009) found that pass through is higher in countries where there is fixed exchange rate regime.

As far as the models used here are concerned, the main reasons for non-linearity relate to asymmetric cointegration and asymmetry in the short-run responses plus combinations of long-run corrections and short-run behaviour (Shin et al. 2011). In the first instance, the non-linear behaviour relates to the error correction. An easy way to view this is to separate the error correction into +ve and –ve parts. The ADF type structure can be extended to make a special case of a non-linear ARDL model in a similar way to the ECM model above:

$$\Delta u_t = \rho^+ u^+_{t-1} + \rho^- u^-_{t-1} + \sum_{j=1}^{p-1} \varphi_j \Delta u_{t-j} + \varepsilon_t \quad (4.4)$$
$$where\ u^+_t = r_t^s - r_t^l > 0\ u^-_t = r_t^s - r_t^l \leq 0$$
$$\Delta u_t = \Delta r_t^s - \Delta r_t^l$$

With the exception of the error correction term the standard ADF model is used with the linear yield curve assumption captured by interest rate proportions or a non-linear (NADF) model. To see this, an indicator function is used to represent a dummy variable and then we might estimate the following equation by least squares regression:

$$\Delta u_t = \rho^+ u^+_{t-1} + \rho^- u^-_{t-1} + \sum_{j=1}^{p-1} \varphi_j \Delta u_{t-j} + \varepsilon_t \quad (4.5)$$
$$\text{where } u^+_t = I^+ u_t (i.e. > 0)\ u^-_t = I^- u_t (\leq 0),$$
$$I^- = 1 - I^+ \text{ and } \Delta u_t = \Delta r_t^s - \Delta r_t^l.$$

The next step is to handle the short-run behaviour in the same way as Greenwood-Nimmo et al. (2013). Based on the findings for the linear ARDL model and ECM it would seem to be sufficient here to emphasise the long run behaviour. A range of conclusions is possible; cointegration with +ve or –ve reactions or with different reactions in the short

and the long-run or not at all. As shown by Shin et al (2011), the extension of the ARDL(p, q) case is straightforward, yielding the following asymmetric error correction model:

$$\Delta r_t^s = \rho r_{t-1}^s + \theta^+ r_{t-1}^{+l} + \theta^- r_{t-1}^{-l} + \sum_{j=1}^{p-1} \varphi_j \Delta r_{t-j}^s + \sum_{j=0}^{q-1} (\pi_j^+ \Delta r_t^{l+} + \pi_j^- \Delta r_t^{l-}) + \varepsilon_t \quad (4.6)$$

This is a dynamic equation and it is related to a cointegrating regression based on the following model:

$$r_t^s = \theta^+ r_t^{+l} + \theta^- r_t^{-l} + u_t. \quad (4.7)$$

Where the terms are individually:

$$r_t^{+l} = \sum_{j=1}^{t} \Delta r_j^{+l} = \sum_{j=1}^{t} \max(\Delta r_j, 0),$$

and

$$r_t^{-l} = \sum_{j=1}^{t} \Delta r_j^{-l} = \sum_{j=1}^{t} \min(\Delta r_j, 0) \quad (4.8)$$

An alternative process might be to analyse the cointegrating regression:

$$r_t^s = \theta^+ r_t^{+l} + \theta^- r_t^{-l} + u_t \quad (4.9)$$

Testing cointegration based on this model should be the same as considering the ADF test statistics from the model below:

$$\Delta(r_{jt} - r_{it}) = \theta^+ (r_{jt} - r_{it})_{t-1}^{+l} + \theta^- (r_{jt} - r_{it})_{t-1}^{-l} + \sum_{j=1}^{p-1} \varphi_j \Delta(r_{jt} - r_{it})_{t-j} + \sum_{l=1}^{p-1} \varphi_{jl} \Delta r_{it-l} + \varepsilon_t \quad (4.10)$$

The approach by Greenwood-Nimmo et al., (2013) has the advantage of making estimation of the short- and long-run asymmetries easy. As mentioned by Greenwood-Nimmo et al. (2013, p.7) "he was unaware of any existing empirical studies that have deployed a rigorous economic framework to explore these effects" and that the existing literature failed so far to establish the nature of the asymmetries characterizing the transmission from the short-term interest rate to longer-term lending rates and bond yields. In addition existing studies have so far given contradictory conclusions.

Greenwood-Nimmo et al., (2013) contributed to the empirical literature by using the NARDL model advanced by Shin et al. (2012) to the analysis of IRPT. NARDL is related to the more straightforward ARDL model framework developed by Pesaran et al. (2001). The existing literature only modelled asymmetries in the short run dynamics or error correction model, but the study addressed and nested long- and short-run asymmetries.

Greenwood-Nimmo et al. (2013) constructed five hypotheses in an article that dealt with the decoupling of monetary policy from long-term interest rates that is considered to have occurred in the US and Germany during the Great Moderation period. This study was motivated to assess the different patterns of IRPT for the US and Germany to separate the inflationary period prior to the Volcker disinflation from the Great Moderation period.

Greenwood-Nimmo et al. (2013) broke the model formulation down into five related hypotheses that explained how the NARDL model affects pass through. Here the focus was on the first hypothesis, which implies that interest rate cuts will be passed through to longer-term rates more forcefully than rate hikes in the long-run. This is denoted as 'negative long-run asymmetry', because the hypothesized long-run response to a negative rate change dominates that of an equivalent positive change. The interest in the long-run follows from the fact that the linear models seemed to be relatively well formulated here as well as accepting that the corrections for all except one case were stationary.

However, the other hypotheses suggested by Greenwood-Nimmo et al. (2013) were still related to NARDL but not relevant to this chapter. They tested if interest rate hikes will pass through to longer-term rates more rapidly than rate cuts in the short-run (i.e. 'positive short-run asymmetry').

In their empirical study Greenwood-Nimmo et al. (2013) found that rate cuts are passed through more completely than rate hikes in the long-run. They concluded that when pass through is complex as a result of the non-linearity, short-term interest rates should be used to manage aggregate demand in the economy. In Table 19 results are presented for the NARDL model given as a more general form of ADF equation specialised to cover the first hypothesis of Greenwood-Nimmo et al. (2013).

Table 19 Nonlinear ARDL model for 1W to 6M differential [a]

	1Wto6M NEG(-1) t-stat	1Wto6M PLUS(-1) t-stat	Critical value 5% level
Unrestricted Model	-2.3303	-3.9842	-2.883073/-3.0051
Restricted omitted lags	-2.6089	-4.1726	-2.88307/-3.0256
Restricted HAC	-4.1143	-5.5253	-2.883073/-3.0256

[a] *MacKinnon (1996) one-sided p-values (two tests so might look at the t-test in sequence (one of the tables in the SYG (2012)) or do the F-test comparing model above with the PSS (2001) critical values and this is a joint test).

Greenwood-Nimmo et al. (2013) used single tests and combined tests. As mentioned earlier, the non-linear behaviour relates to the error correction term. The method used in the current study, as occurs in Greenwood-Nimmo et al. (2013), for the first case replaces the usual error correction term by the positive and negative components as described above. Here, the testing is applied by forming the model as a special case of the ADF test model and conditioning this on separate negative and positive components. Greenwood-Nimmo et al. (2013) tested the error correction terms separately and then applied the joint F-test on the two error correction terms using the critical values from Pesaran et al. (2001).

The model below is first estimated on the interest rate differential by OLS regression:

$$\Delta(r_{\mathrm{jt}}\text{-}\mathrm{r}_{it})=\theta^{+}(r_{\mathrm{jt}}\text{-}\mathrm{r}_{it})_{t-1}^{+l}+\theta^{-}(r_{\mathrm{jt}}\text{-}\mathrm{r}_{it})_{t-1}^{-l}+\sum_{j=1}^{7}\varphi_{j}\Delta(r_{\mathrm{jt}}\text{-}\mathrm{r}_{it})_{t-j}+\sum_{l=1}^{7}\varphi_{jl}\Delta r_{it-l}+\varepsilon_{t} \qquad (4.11)$$

Critical values for the single test are derived from the simulated augmented ADF test devised in Pesaran and Pesaran (2010). Table 19 shows that the t-statistic for the unrestricted model is significant for the positive error correction but not for the negative error correction based both on conventional ADF critical values and those corrected for the impact of the stationary components of our NARDL model. This also seems to make sense when compared with the simulations in Patterson (2000) and the discussion in Davidson and Mackinnon (2004).

The model is further restricted by using a single downward test to eliminate variables that are less significant and may affect the performance of the test (Hendry, 2014). The second row in Table 19 shows the t-statistic for a slightly more restricted model, but although the t-values increase slightly the same conclusions apply. It was mentioned previously that there may be a problem with ARCH and so similar robust standard errors were used to those applied in the previous section. Following Beirne et al., (2007) when these standard errors are applied the test applied at both the 5% level using simulated critical values is significant for both the positive and negative terms. Shin et al. (2012) applied two approaches with their simulated critical values on the single components and a combined F test based on Pesaran et al. (2001). When these terms are excluded the F(2,108) value of 9.5994 exceeds the critical value of 4.85. This provides further support

for the idea that the NARDL model takes a non-linear form and includes both positive and negative correction terms.

Although the fit of the model may be seen as not being strong (R^2=.2754) this relates to financial data. The Durbin Watson statistic at 2.04 is very close to 2 and implies little sign of first order serial correlation, which is not surprising given the inclusion of up to 7 lagged terms in the dynamics of the further augmented DF model. When the error correction terms are looked, at the positive response is almost instantaneous given a coefficient of -.90984, while the response to a negative differential is much slower at -0.22143. When the long-rate exceeds the short rate, then the error correction term is negative and this response, based on the size of the coefficient is more persistent. This would seem to be what might be expected from the market place where the longer rates lag short rates when they fall. While the positive corrections imply that when short rates exceed long-rates the market correction is very fast. The order of the correction is termed coherent.

4.4 Conclusion

The current study looks at the correction in terms of the yield curve and this suggests, based on the performance of the error correction/ARDL models that the interest rates correct in the long-run. When the whole spread of rates behave this way the markets would appear to be efficient in a long-run sense. This means arbitrage is occurring and the short-run behaviour passes through to the long-rates. Given that the models are well specified in terms of the dynamics the findings related to the linear models seem to make sense. This may relate to the size of the market and it may not be possible to show that this happens across the Gulf. However, it is encouraging that there may be one model that might be adopted that shows how the money markets can behave efficiently across all Gulf States.

The one exception is the results that relate to the one-week to six-month interest rate horizon. Here the error correction term does not yield a stationary response, meaning that the linear correction does not occur. Greenwood-Nimmo et al. (2013) explained this slightly differently in terms of pass through and found more significant problems linked to what may be seen as developed markets. They suggest the NARDL model as pass through occurs differently between the positive and negative response. They also argued

that the short-run and long-run may be different. Here the focus is on the long-run and as the NARDL version of the ADF model seems relatively well formulated, which would seem to show that this long-run analysis can explain a degree of inefficiency in one part of the market. The correction occurs, but it is much slower when the long-rate exceeds the short-rate. In the next Chapter the financial markets and their linkages across the Gulf will be explored further.

CHAPTER 5: EFFICIENT FINANCIAL MARKETS, DEPENDENCE AND INTERDEPENDENCE

5.1 Introduction

The aim of this chapter is to find if the stock markets for the Gulf States are efficient, and whether the same market fundamentals and sentiment are relevant. In part this idea will be follow initially from testing whether the series follow a random walk. While in the multivariate context a further test may be applied to demonstrate whether the same trend is a key driver for all the markets across a prospective common financial market for the Gulf and here this proposition is testable. The current study was undertaken for the period 2003 to 2012.

Investors seek profit and returns especially in equity markets. They study markets to find anomalies and arbitrage opportunities to profit from. The more stock markets are inefficient, the more the stocks are mispriced and the greater the possibility to make such profits. If markets are not efficient, assets may be misspriced, because their prices do not represent all of the available information so assets are not appropriately priced.

A well-established way by which market efficiency is evaluated follows from the random walk hypothesis or RWH. As mentioned before, the aim of this thesis is to test the preconditions for the Gulf States to be ready for a currency union. Hence, integration of their financial markets in general and stock markets in particular is one of the key components for any currency union which depends on their market's efficiency, especially informational efficiency. Before considering financial market integration and further discussing currency union, investors should be secure that markets are relatively efficient across the Gulf States so that they allocate their capital across the six states with minimal risk.

Market efficiency in a specific market implies that all information is reflected in the price and this is the conventional notion that a market is efficient so that arbitrage is effective in removing anomalies quickly. However, for a common currency to be effective, then in addition to the separate markets being efficient, the market should not be segmented and this is a sign that it is competitive. This is considered in relation to gasoline prices across the United States of America by Burke and Hunter (2012) and Kurita (2008). There is a

literature that has called this locational efficiency. One can view this in different ways: for financial markets to be regionally competitive, then arbitrage must operate across the different markets. This implies that markets are not segmented and that a financial agent in a local market should not be able to profit differently from the same transaction say in Dubai as compared with Oman.

Financial market efficiency has been of particular interest in the last decade for the Gulf States. The studies considered thus far have produced mixed results on efficiency. The studies so far have used different data sources, methodologies, tests, restrictions, and data frequencies, but they have all focused on the efficiency of the Gulf markets or the Middle East stock markets. However, the literature on testing the RWH hypothesis and market efficiency is vast using different data and countries. It is intended that this chapter will contribute, because although there are some papers on the Gulf countries or GCC related to stock markets and market efficiency, this analysis is performed on recent data. Second, the methodology applied is different from that previously performed on data for this region.

There are many methods for testing efficiency, initial investigations of the RWH try to show that the market was efficient by showing that stock market returns were random and this might be done by considering the Box Pierce or Ljung Box statistic to investigate whether the autocorrelations were insignificant. Other methods designed to determine whether financial market data are mean reverting included runs tests (see BenJellon and Squalli, 2008). Here it is suggested that any understanding of efficiency is more reliable as a result of developing a time series model to explain stock returns. This gives the modeller the capacity to control better the model for any unusual behaviour in the data. The RWH can be nested within a more general time series model. If this is limited to stationary autoregressive (AR) models, then the specification can be tested for lag dynamics and for a fixed sample such as Moving Average (MA) or ARMA models (Burke and Hunter, 2005).

From the simple RWH on the stock price it is also possible to test whether continuously compounded stock prices are unpredictable when the log stock price is non-stationary and this can be tested using a Dickey-Fuller (DF) or Augmented Dickey-Fuller (ADF) test by extending an AR model to include the lagged stock price in log form. The ADF test can be extended to control for volatility, which is not readily done in the case of Box Pierce

test. As was mentioned in Chapter 3, the RWH implies that the underlying time series model is consistent with the model underlying the DF test and that one anticipates that the null of non-stationarity is to be accepted in this case. Lag selection is undertaken by a number of methods commonly-used in software such as Eviews. The process that selects the last significant lag based on a t-value is similar to determining the lag order of a time series model using the partial autocorrelation function (PACF). Computing an ADF(j) test is equivalent under the null to identifying a stationary AR model of order j. It is suggested in Chapter 2 by Burke and Hunter (2005) to run a sequence of DF models augmented by lags than by detecting such specifications from the ACF or PACF. Then prior to undertaking the ADF/DF test, a potential maximum lag length can be determined by a sequence of t or Chi-squared tests that adjust the lags based on their statistical significance.

An early attempt to investigate the GCC stock markets for efficiency was by Gandhi et al. (1980). The authors used simple regressions to study weak form efficiency (Fama, 1970) for the Kuwait stock market over the period 1975-1978 by testing the autocorrelations on a monthly basis with the finding from these tests that the RWH could not be accepted. Different results were found by Butler and Malaikah (1992) for the Kuwait stock market using similar tests but for the period, 1985 to 1988. It was found that, out of 36 stocks, the RWH was accepted for only 60% of them. In the same paper, the RWH was rejected for the 25 Saudi Arabian stocks considered with data for the period 1986 to 1989. While, Smith (2007) tested the RWH for five countries across the Middle East region and that included Kuwait and Oman. He rejected the RWH using a Mean Variance Ratio (MVR) test on weekly prices from 1996 to 2003.

Other researchers have tried to apply different restrictions to test for efficiency. Abraham et al., (2002) tested efficiency after removing the effects of infrequent trading for Bahrain, Kuwait and Saudi Arabia and found different results when these adjustments were not made. The tests rejected the RWH without adjusting for thin trading and accepted this for the adjusted data for Bahrain and Saudi Arabia, but not Kuwait. One may anticipate that observing thin trading suggests that these markets are not efficient.

Abraham and Seyyed (2006) examined the cointegrating relationship between three markets Bahrain, Saudi Arabia and the US using daily indices from 1998 to 2003, but they found no long run equilibrium relationship across these markets. While Al-Kazali et

al., (2007) applied their tests with and without corrections for thin trades and found interesting results. The tests for Kuwait, Saudi Arabia, Bahrain and Oman for the period 1994 to 2003 rejected the RWH without correcting for the thin trading, but accepted when thin trading was corrected. If a researcher finds efficiency after taking account of thin trading, then for markets that are prone to thin trading, it would be a concern to form a currency union. Asiri (2008) studied market efficiency for the Bahrain stock market using 40 stocks from 1990 to 2000 on daily basis. They then used Autoregressice Integrated Moving Average (ARIMA) models, Dickey-Fuller tests and autocorrelation tests and found they all confirmed the efficiency of this market.

Al–Abdulqader et al., (2007) looked at the Saudi Arabia stock market for the period 1990 to 2000 based on 45 companies using two methods to test efficiency a method applying the Kalman filter and a moving average strategy. They found that the results supporting EMH were much stronger than many of the previous studies. Moustafa (2004) looked only at the United Arab Emirates stock market using daily data for 43 stocks from 2001 to 2003. Somewhat surprisingly the research found that 40 out of 43 stocks follow a random walk. The UAE market is quite a new developing market and has infrequent and thin trading, but still was found efficient. Again similar tests were done but this time for two UAE equity markets, Abu Dhabi and Dubai, by Squalli (2006) who assumed homoscedasticity for the period 2000 and 2005 using daily index data. The RWH was rejected for all sectors in both markets except for two sectors and those are for the banking and the insurance sector in Abu Dhabi. Hazem and Min (2008) examined UAE market efficiency and the RWH for the period 2003 to 2008 using daily data with ADF and Philips-Perron tests. They found that the UAE stock market Index has a unit root and follows a random walk.

Results sometimes changed according to the tests adopted. For example, BenJellon and Squalli (2008) used the MVR and runs tests on some GCC countries and these results changed accordingly. Therefore, the MVR test of the RWH was rejected for Abu Dhabi and Dubai. On the other hand, the RWH was rejected for Abu Dhabi, Qatar and Saudi Arabia, but not for Dubai with the runs test. Another researcher, Al-Ajmi (2008), tried to find out if the tests for RWH are sensitive to the selected test type. He applied his tests to the Saudi Arabia securities market and found that the results were sensitive to the test used, both the MVR and a single ratio test.

Chen, (2006) tested all GCC countries plus UK and US stock markets to find if there is any correlation and link between these markets using ADF tests, the Johansen methodology and Granger causality test. They found that there is a low correlation between the GCC and other foreign markets. They also found that the Saudi Arabian market dominates GCC stock market activities. Finally they divided the data into two periods using weekly prices 2000-2002 and 2002-2004, and watched the change in the cointegrating vectors for the two periods for the GCC countries. They found in what in terms of the span of data is a very small sample that they could observe no long-run relationship in the first period, but some long-run relationships for the second period. If this analysis was projected forward, then it may indicate support for the preparation of a future currency union should these markets become more homogenous.

Abdmoulah (2010) tested 11 Arab Stock Markets including the Gulf countries for efficiency. The test was applied to data from the1990s and it used the Generalized Autoregressive conditional heteroscedasticity in mean (GARCH-M) model along with a number of tests and they were not able to observe weak-form market efficiency. Al Khazali (2011) considered the stock markets for the GCC and looked at the effect of infrequent trading on tests of efficiency. These tests were applied for the period 1995 to 2007 on weekly data and the study found that the RWH was not rejected after removing the effect of infrequent trading. Al-Ajmi and Kim (2012) tested all the GCC countries financial markets for the period 1999 to 2010 and found most of these markets were efficient. They tested the impact of thin trading corrections using a wild bootstrap, Chow-Denning and joint sign test. They found that the Gulf stock markets are inefficient by the rejection of RWH for all GCC stock markets on daily and weekly frequencies even when thin trading is corrected.

Bachelier (1900) wrote the first clearly articulated explanation as to why stock prices follow a random walk. That the stock price follows a random walk is a simplification that may appear reasonable when daily or weekly time series data are considered across relatively short time periods. However, this is more appropriate in terms of the log of stock prices. So today's stock prices are a continuous compound of their past values or the log of today's stock price depends on the log stock price yesterday. Usually any predictability in the stock return can be seen from autocorrelation in the stock return series. If stock returns are a simply independently and identically distributed (iid), then it may be expected that the variance of stock prices may change over time, and stock prices

may follow a random walk when the log return is constant. Hull (2006) discussed stock price properties and said that stock prices may follow a generalized Wiener process when they accept two properties: a constant expected drift rate and a constant variance rate. However, this fails to capture the change in return even though in the Weiner case this return is independent of the stock price. In other words, investors are uncertain of the return regardless of the stock price levels. It is then suggested to replace the above property and the most widely used model for stock price behaviour is:

$$\frac{ds}{s} = \mu dt + \sigma dz \qquad (5.1)$$

Where $\frac{ds}{s}$ is the rate of change in the stock price, and μ is the expected rate of return per unit of time, while μdt is the expected value of this return, σ is the volatility of the stock price and so σdz explains the stochastic behaviour of the stock over a small time interval. In discrete time this implies the return has constant drift and volatility and continuously compounded returns can be measured by the change in the log of the share price (Hull, 2006).

Some discussion was made of market efficiency in relation to the exchange rate in Chapter 3. Here the analysis and determination of efficiency are focused on the stock price indices of the Gulf States. It is well known in the finance literature that spot market efficiency is related to the random walk hypothesis (Fama, 1970) or more appropriately that stock returns are not predictable. To be more precise, Fama (1970) suggested that there may be some predictability over time, but that such predictability will in an efficient market be removed by the elimination of the arbitrage opportunities this presents. Much of the research has been undertaken on developed markets and depending on the data and period analysed there have been some evidence of predictability based on conventional inference assuming returns are normal iid. However, the correlations are often numerically small and likely to change over time. Kian-Ping Lim et al., (2013) studied three US stock markets to see if they were predictable and found some significant autocorrelations in the return series.

Here similar data are to be analysed for the Gulf States, because the Gulf countries are looking at financial integration. In 2010, ASEAN ministers gathered to plan a future economic and financial integration by 2015 and prior to this a currency union. They are

now in the process of pre-integration, but are taking this integration process slowly and with caution to avoid what happened in the Euro zone. Prior to integration it is important to make sure that their financial and product markets are fully integrated before integrating the currency.

For this reason, recently Guidi and Gupta (2013) explored this. They were interested in finding out whether the EMH and RWH hold for data on Asian economies. In their study they found mixed results. They rejected EMH for Indonesia, Malaysia, the Philippines and Vietnam, but found it for other markets like Singapore and Thailand. They also analysed this individually and collectively, finding collectively the studied markets don't follow a common stochastic trend, which means that investors can diversify through investing in different markets as one market is not predictable in terms of information through another market. A similar approach is adopted here for the Gulf States, because it is believed that the markets are similar in terms of their development and they present a fairer comparison of performance than well-developed markets such as the New York and London stock exchanges. If these Asian stock markets are efficient individually and collectively, then a similar performance might be expected of the Gulf States.

The goal of this chapter is first to find out if the Gulf stock markets are ready for integration and second to make a contribution to the Gulf region literature on emerging markets.

5.2 Data

The index selected for the empirical work should be one that is consistent across all the Gulf countries. There will be stock market prices for six countries in the Gulf, which are Saudi Arabia, United Arab Emirates, Qatar, Bahrain, Oman and Kuwait. Data used for the current study were daily prices for stock market indices in dollars obtained from Arab Monetary Fund (AMF) for the period 2005-2012. There was a longer span of data for some of the Gulf stock markets but to maintain coherency prior to 2005 some countries had no stock market. The AMF is located in the United Arab Emirates and is responsible for the collection of Middle East statistics and it publishes periodical reports on a regular basis. In this chapter Wednesday to Wednesday prices will be used, so that the day of the week effects especially those related to the end of the week are removed and the most stable data are observed for weekly returns. The Gulf markets start on Sunday and closes on Thursday, so using Thursday would give a weekend effect which is not reliable, and

Sunday is an unusual day for markets to be open as this is not the case for developed economics such as Japan, the UK and the US.

5.3 Methodology

A number of articles consider the time series properties of the data (see Guidi and Gupta, 2013). In the current study the Dickey-Fuller test was primarily used as it defines a model within which the random walk and uncorrelated nature of returns can be appropriately tested. Guidi and Gupta (2013) used different kinds of tests: ADF, VR tests, Wright test, runs test, Johansen and Juselius cointegration test and MVR and cointegration test. In this chapter, the ADF plus other tests will be used to investigate if the data has unit root and follows a random walk.

5.3.1 The Augmented Dickey Model

If the unit root in a time series is present, it suggests a random walk or the RWH. To apply the Augmented Dickey–Fuller (ADF) unit root test (Dickey and Fuller, 1979), the below equation is estimated:

$$\Delta y_t = \pi_0 + \omega y_{t-1} + \sum_{i=1}^{p-1} \varpi_i \Delta y_{t-i} + \varepsilon_t \qquad (5.2)$$

y_t is a series that follows an AR(p) process, ω and ϖ, are parameters to be estimated with ε_t assumed to be white noise. In the case where *p=1*, none rejection of the null hypothesis of the DF test implies the presence of a unit root, and if the hypothesis is not rejected, it means that the series follows a random walk. The null and alternative hypotheses can be written as:

$$H_0 : \omega = 0 \left(\textit{the random walk for the stock market level} \right)$$
$$H_1 : \omega < 0$$

In terms of testing this hypothesis the ADF and DF cases are the same in large samples except the first includes extra variables (here the lags). In finance the latter case relates to market efficiency when the null of non-stationarity is accepted and

$$\Delta y_t = \varepsilon_t \qquad (5.3)$$

The lagged level term can be excluded when the null is not rejected. However, accepting the null for the case with higher order difference terms still means the series is non-stationary, but the difference series then follows an autoregressive form. This is the random walk plus further dynamics and so EMH cannot be accepted when p-1>0.

The following Table 20 presents these results. The t-values relate in the first two columns to the stationarity that is compared in large sample with -2.89.[41] The tests in the first column are for the ADF model selected by the programme and for the second column the DF test. The final column presents the significant lagged terms to test for further predictability and test the EMH.

Table 20 ADF tests for Stock Prices (2005-2012)

	ADF t-stat	DF t-stat	Autoregressive structure in the ADF model AR Coefficient/ t-stat
SASP	-1.751761	-1.429895	
ADSP	-2.139900	-1.073826	D(LADSP(-10)) 0.085612/1.724087
DSP	-2.233238	-2.107171	D(LDSP(-3)) 0.103875/ 2.033070 D(LDSP(-4)) -0.106810/ -2.088401
BSP	-1.946794	-1.219125	D(LBSP(-1)) 0.108543/2.154231 D(LBSP(-7)) -0.094866/-1.896071
KSP	-1.644783	-1.039098	D(LKSP(-3)) 0.124030/ 2.438987 D(LKSP(-14)) 0.101283/ 2.005364
OSP	-2.855855	-1.435324	D(LOSP(-15)) 0.123147/ 2.452914
QSP	-2.778625	-3.099118	D(LQSP(-1))-0.268004/ - 5.438873 D(LQSP(-4)) 0.098192/ 2.009037

It is easy to see that all the series are non-stationary in levels at the 5% level. When these models are looked at in terms of further dynamics, then there is some sign of inefficiency with the exception of the SASP stock market index. To further confirm that the indices are I(1) is to also check whether the differenced series are stationary; see the Table below for the first difference that here measures the return in the ADF test case. The t-value relate to the stationarity test and when compared with a tabulated critical value of -2.89, then it is easy to confirm that for all the differenced series it was not

[41] See the tables reported in Dickey and Fuller (1979) or in relation to conventional Dickey-Fuller inference look at p.values reported in the unit root testing module in Eviews.

Table 21 ADF test for the return series (2005-2012)

	t- stat
SASP D(LSASP(-1))	-18.91300
ADSP D(LADSP(-1))	-5.615309
DSP D(LDSP(-1))	-10.39919
BSP D(LBSP(-1))	-7.206055
KSP D(LKSP(-1))	-4.747473
OSP D(LOSP(-1))	-3.553276
QSP D(LQSP(-1))	-8.121403

Possible to reject the stationary alternative so all the series were I(0). The result confirms that the stock price series are I(1) and return series are I(0).

Assuming all the stock indices have a unit root, it is important to decide whether there are extra dynamics and this comes from investigating for further the autoregressive dynamics. The correlation in the error is eliminated by lags and the error in the data is then assumed to be normal and homoscedastic. However, for finance data that is not the case. One way to deal with these issues especially in terms of heteroscedasticity is to adopt robust standard errors. When this is done the tests of the lagged variables appear less significant, especially at the 1% level and in many cases even at 5%. This leaves at the 5% level the Qatar market index having the largest and most significant lags especially the first and fourth. At the 1% level based on the robust standard errors there appears to be no significant lagged correlation and so at this level the market appears to be efficient. Given that the ADF test provides a mechanism to extend the explanation of the series by extending the dynamics. While handling the problem to pay attention to these alternative forms of abnormality, robust standard errors may be more effective to pay attention to non-normality, heteroscedasticity and ARCH all features of financial market data. However, what is critical is for the more fundamental definition of efficiency is that any predictability is stable over time otherwise there may not be the room to make money in the market place as mentioned by Fama.

After it was found that the log index series for Abu Dhabi was I(1), the dynamics were considered and for efficiency a model without lagged variables is required so this must

be tested to check for short-run predictability. There may be a very small amount of short-run predictability at the 10%, but this implies very small coefficients. It may be that this reflects the capacity of large traders to make money out of small anomalies in the market or it could be as a result of some misspecification due to ARCH or non-normality. This may look as if it may exhibit efficiency this may be in doubt when today's stock price could be predicted from past prices while the past lag maybe unusual and/or the coefficient small.

For Abu Dhabi it appears that a logarithmic RW (LRW) holds and there is no need for further dynamics, and the market is efficient. If all dynamics could be removed then the market is efficient. If a shock hit the SA market, by the time dealers find out, that would already hit other markets, which will not improve capacity to forecast the stock markets from the SA market. In the long run it should be able to forecast the SA market to be able to know what is happening in other markets. If dynamics affect the short run, it means that they are not following a pure random walk and if not then something else is happening. If something else is happening then there is inefficiency. For AD it appears to follow a LRW and does not need further dynamics and the market is efficient. After all, if we take as many lags as required from this stationarity test, the procedure in the program suggests 10 lags, then the series is still I(1). If we accept that and remove the lag term, nothing else is important. After removing short run dynamics, it was still concluded that it is I(1). If the model is misformulated without the extra lags, the series is still I(1). If the model is well formulated without lags, it is still I(1). If variables are removed, then there may not be further dynamics.

The series with extra lags is I(1) so the variable explained by itself captures the non-stationarity. The lags are removed to check what happens to the series and it was found that they were not important except for lag 10 which is small and only significant at the 10% level. In this case it was concluded that the series is I(1) and has no short run predictability and no dynamics.

In a similar way to Abu Dhabi, the Dubai results mean that the series are I(1) and this is the LRW with the dependent variable a stock market return. Selection based on t values suggests 17 lags and the ADF test using this model is consistent with the non-stationary null. This is a first step to testing market efficiency. Finding the series I(1), the model can be re-estimated without the lag in the stock price (the coefficient is zero). So the model

can be re-estimated on this basis and then a further test applied to the dynamics. In the Abu Dhabi case they were only significant at the 10% level, with a very small coefficient (.08). So there are good reasons to exclude the lags and then the market seems to be efficient. Fama's definition suggests that the final test is whether it is possible to profit from this and that is beyond the scope of the current investigation.

For the Dubai market after removing the dynamics, the series are still nonstationary. When short run predictability is investigated by removing the lag variable that captures any stationarity it was found that no important dynamics remain and all these terms are insignificant. So no important dynamics means that there is no short-run predictability and it follows a LRW and the market is efficient.

In the long run it should be possible to forecast the Saudi Arabia market to be able to know what is happening in other markets. If dynamics affect the short run, it means that they follow some form of random walk and if not, then something else is happening. If something else is happening then there is inefficiency. It was not surprising to find that the Saudi Arabian market is I(1) in all cases. The behaviour is still non-stationary even when lags are included or removed. The market index is I(1), a LRW seems very efficient as there were no significant dynamics or predictability. After investigating Bahrain, the market looked efficient and the series was I(1) with and without further dynamics.

Kuwait looked quite similar to AD and Dubai and the series was found to be I(1) for both ADF and DF models. In the latter case the dynamics were removed. But then there may be a very small amount of short-run predictability at the10% with a very small coefficient at lag 17. It can be concluded that the market looks efficient and not predictable. The Qatar index was found to be I(1) with the ADF test, but not when the DF test is applied. Checking with the dynamics and when variables were removed, it was found that there is some predictability at lag 4 at the 10% level, but with a very small coefficient. So in general the market is not predictable in the short-run and would appear efficient.

For Oman the situation was different, as although the series was found I(1) with ADF and DF tests applied, there was some predictability at lag15 which looked somewhat more important with a coefficient of 0.123 significant at the 10% level. To better control for heteroscedasticity the tests are undertaken again using robust standard errors. That is with

White and more general HAC corrected standard errors. The corrected results are considered next in Table 22.

Table 22 White and HAC t-stat (2005-2012)

	ADF t- stat White	ADF t-stat HAC	DF t- stat White	DF t-stat HAC
ADSP	-1.39206	-1.45959	-1.073826	-1.136985
DSP	-0.99448	-0.99202	-0.980235	-0.933609
BSP	-1.43399	-1.38333	-0.893945	-0.802952
KSP	-1.55567	-1.56026	-0.877274	-0.877274
OSP	-2.20669	-2.30857	-1.066442	-1.155620
QSP	-2.59805	-2.34318	-1.509742	-1.537399

The t-values related to the robust stationarity test can be compared with the conventional critical value of -2.89. It is easy to see that all the series are non-stationary and so need to be differenced whether the DF or the ADF column is used. Table 22 shows that for all the variables the non-stationary null cannot be rejected both when HAC and White standard errors are applied.

After looking at Tables 20, 21 and 22, the individual countries' stock prices appear to be I(1) or follow a random walk individually or that the stock returns for one country is not predictable from past returns. This means that new announcements for the firm stock are incorporated in the stock immediately. In this case, any changes in stock prices do not affect investors trading or investment decisions as this information is not a fundamental change and is already incorporated in the stock price (Elton et al., 2010). On the other hand, if new announcements or news are not incorporated in the stock price today then prices don't follow random walk (RW). It may take some time for investors to know about these announcements and their effects and the stock volatile during this period. This could reveal deviations from efficiency and create profitable opportunities for some investors over other investors because the information may not be embedded evenly in the stock price.

If a country stock index follows a LRW, the EMH holds or the market is weak form efficient and in this case investors cannot find mispriced assets to benefit from. If they do not follow

LRW, they are not efficient or not weak form efficient, then investors can identify mispriced assets and make a profit. After every stock index for the Gulf States was investigated, some shocks and extreme jumps in the stock prices for most of the states were found. The research was further looked at to find whether the dates where these extreme jumps occurred were the same for all the markets and this means this is linked to an event in the Gulf that impacted all their prices during this period. The event was at the end of 2009 and the beginning of 2010 after normal shocks or jumps were taken into account of by the use of dummies related to the shock or jump. So according to this event the sample was divided into two sub samples, the first sample from before the steep jumps in stock prices at the end of 2009 and the beginning of 2010 and the second sample after these events.

One of the common events was a jump in stock prices, reported by CNN in 2010 and started with positive stock prices movements and with the markets closing on January 4 at 15-month highs and all leading shares having jumped in performance. This event was noticed in the Gulf countries and all of the Gulf countries prices started moving up as did other international stock markets. This event was happening according to the Economist Intelligence Unit periodic reports at the end of 2009.

Another common event noticed was a decline in stock prices before the end of 2009. The Economist Intelligence Unit announced that, after the global financial crisis that hit the world, the UAE economy and all Gulf countries in general had issues with restoring confidence to investors. Especially after Dubai had a blow to its reputation when it requested Dubai World Creditors to accept a "standstill" on debt-service payments.

According to the National Bank of Kuwait, there was a subsequent fall in Dubai and Abu Dhabi stock markets that wiped off US$23bn in market capitalisation in the two weeks after the standstill. This created concerns and uncertainty for some time during 2009 and the beginning of 2010 about UAE banks. Many local banks were downgraded by the global credit ratings agencies because ratings affected the asset quality, financial performance and capitalisation of UAE banks as banks had to absorb large losses. Abu Dhabi came to rescue Dubai with US$10bn on December 14th, which was three weeks after the standstill. The Dubai leadership was criticized by the international media for their debt crisis handling in December and lack of professionalism as not enough information was given on which companies were included in the restructuring of Dubai World (DW). According to the

World Bank's Doing Business 2010 report, the UAE did not provide adequate protection for creditors.

Other Gulf countries saw a direct impact by DW's request for a standstill. Bahrain announced facing risks resulting from the DW effect. There was a rise in credit default swap rates on debt. It followed defaults in Saudi Arabia, Kuwait and Bahrain banks. Bahrain Stock Exchange shares were hit in late November by DW. Kuwait Central Bank announced that two Kuwait banks had limited exposure of US$120m to DW. So like other Gulf countries and elsewhere in the region, DW raised fears of further crises.

In the current study many different kinds of tests were conducted to check if stocks are efficient and markets are efficient, including DF and ADF tests, and tests of dynamics. If it was found that some lags are important, then the specific dynamics can be included in the Microfit ADF test (Pesaran and Pesaran, 2010) and these critical values can be simulated to take account of this in the test distribution. Here many of the factors can be explained in the current study to pay attention to ARCH, non-normality and serial correlation, and these were then corrected. It is hoped these tests and factors make the results and analysis more robust.

It has been demonstrated that there was quite a large adjustment required to the development of the Gulf markets, the downward movement suggesting significant initial overvaluation in the Kuwait market and the Saudi Arabia markets and subsequent revaluation that occurred by the end of January 2010. Thus it may be anticipated that there will be a need to check for longer dynamics in the mean and the variance for data on share prices for the Gulf.

We can take some account of these extreme observations when the standard errors are computed by making sure that each variance term has an individual effect. The failure of normality test is partially an indication of volatility. A heteroscedasticity correction is a simple way of capturing these effects in the standard error being calculated. It means that the calculated standard error is sensitive to some difference in the variance in every observation. That difference could be because such observations arise from a different distribution or related to this ARCH behaviour. So ARCH and non-normality are put together as a more general form of misspecification and the standard error correction takes some account of that.

Testing efficiency here is by the unit root test. Fewer anomalies and smaller shocks are expected after 6th January 2010 or in the second period. To feel that any analysis of a system is reliable such as in the VAR adopted in the Johansen methodology, it would be preferable for behaviour to be more stable.

The study is also affected by extreme events. It is very unlikely that normal residuals would be found for our problem or the model but the series is related to financial data here. The number and size of extreme observations would appear unusual for the case of some Gulf countries (in particular Dubai). If this is typical of financial market behaviour, then this might suggest a common currency is not good idea. If this is particular to Dubai or any other country then they might not be ready for such inclusion.

Table 23 ADF for Stock Prices before the events (2005-2009) [a]

	DSP	ADSP	SASP	OSP	KSP	QSP	BSP
ADF T-stat CV	 -.43845 -2.8536	 -.59761 -2.8536	 -.13601 -2.8536	 -.69343 -2.8536	 -.73487 -2.8536	 -1.3981 -2.8536	 .34790 -2.8536
ADF with Dummies T-stat CV	 -1.3627 -3.0458	All below 15% jumps	 -1.5480 -2.9038	 -1.1166 -2.8733	 -1.0311 -2.7848	All below 15% jumps	All Below 15% jumps
t-OLS/ t-W	-.43845/ -.41732	-.59761/ -.56569	-.13601/ -.12434	-.69343/ -.64439	-.73487/ -.63178	-1.3981/ -1.6163	.34790/ .34975
Mean of dependent variable (return)	-.0084665	-.0025514	-.0034301	-.0013140	-.0020360	-.5808E-3	-.5808E-3
ARCH(5)	15.9008	23.3456	27.2172	24.0631	26.0257	20.1349	10.3106
BP(5) of the residuals	9.7472 [.083]	2.6996 [.746]	3.0995 [.685]	6.6499 [.248]	11.5455 [.042]	15.3990 [.009]	8.1750 [.147]
JB(2)	122.0849	114.1507	87.3733	288.0138	73.7887	29.8972	27.4583

[+] Critical values simulated in Microfit 5.0 including Dummy variables

For example, the case of Greece in the Euro zone where there as evidence that the Athens Stock Exchange was not especially efficient (see Karfakis and Moschos, 1989).

In the case of the Gulf it is hoped that behaviour will be different after the events of Jan/2010. The adjusted results are presented in Table 23 in a similar manner to Beirne et al. (2007). Table 23 relates to those before the event and Table 24 to tests after the event. What is surprising with the problems outlined above is that the series in the first sub-period look close to the following LRWs. Whatever correction or adjustment is applied,

the series are I(0) when first differenced. Taking the case of the Dubai stock index price it is quite clearly volatile up to and including five lags of weekly data and non-normal given the very large test statistic and almost zero p. value (CHSQ(2)= 122.0849[.000]), which may affect the usual ADF test statistics. From the results in row 3 of Table 23, the DF test statistic is derived here using White standard errors as a result of the ARCH and non-normality results. By a similar argument to Phillips and Peron (1988), corrected standard errors were used to determine the tests for stationarity. Firstly, White's (1982) standard errors were applied to the conventional Dickey-Fuller t-test and this yielded a standardised estimate of the residual variance that has no impact on the behaviour of the mean equation. White standard errors are used to correct the error variance for the undue influence of large observations reflected in the Jarque-Bera statistics (see Davidson and MacKinnon, 2004) reported in Table 23 and 24. Using the 5% critical values simulated in Microfit 5 (-3.0458) including dummy variables that capture the largest shocks (Pesaran and Pesaran, 2009) when compared with the test statistic (-.41732) it is clear that the null cannot be rejected and the series are non-stationary. The overall conclusion for Dubai, surprisingly, is efficient; and LSDP follows a random walk and returns are stationary. Looking at Oman as the non-normality is the most extreme and has amongst the largest ARCH test implying volatility but again this is usual with financial data and the adjusted results still suggests non-stationarity.

The mean or return is going down, which means credibility is decreasing. There is almost no serial correlation, which increases efficiency here. This makes these markets non-predictable or have limited predictability.

A test interest from Table 24 is the one for the Saudi stock market which based on conventional inference is significant at the 5% level as the ADF t-value of (-3.5171) being less than the one sided critical value (-2.8171). Were this correct, then the Saudi

Arabia index series are stationary so the unit root is rejected for this case as the null is rejected against the one side alternative that the stock price does not have a unit root. Meaning there is an autoregressive model that can explain stock prices or the return is predictable by last periods log stock index value. This is not the case for any of the other indices. In the previous period there seemed to be large shocks that were captured by dummy variables. Here this seemed less important so the analysis focuses on the correction to the standard errors. It should be noted that the errors for the Saudi Index

equation are highly non-normal and this relates to quite a high degree of ARCH behaviour in the error process. However, almost all of the measures of volatility are lower for the later sample.

This is further supported by the tests of serial correlation and combined with the test for non-linearity indicates that these markets, except for Saudi Arabia, are efficient but became more efficient after White. There is a small amount of serial correlation and volatility, which is to be anticipated for any financial data. It is good to add here that, after what happened in the early years with an overvalued market and loss of investors' confidence on these markets, all governments started enrolling and the regulatory environment was developed further within this regime.

The conclusion is that they are all non-stationary in terms of the simulated critical values that take account of country specific shock dummies. In general, apart from the non-normality and volatility found with financial data, the models are well formulated for example little sign of significant serial correlation (Box Pierce test/LM test). Partial account is taken of the non-independent nature by the use of White standard error that rescale the variance for errors of the periodic differences.

If one were to accept conventional inference, then the models do not suffer from serial correlation, heteroscedasticity and non-linearity. However, in all but two cases the errors are non-normal and in two cases there is significant ARCH behaviour.

Table 24 ADF after the event (2010-2012)

	DSP	ADSP	SASP	OSP	KSP	QSP	BSP
ADF T-stat CV	 -2.62 -2.8172	 -2.19 -2.8172	 -3.51 -2.8172	 -1.26 -2.8172	 -1.60 -2.8172	 -2.01 -2.8172	 -1.25 -2.8172
t-OLS/ t-W	-2.62/ -2.67	-2.19/ -2.34	-3.51/ -2.40	-1.26/ -1.29	-1.60/ -1.56	-2.01/ -1.52	1.25/ -1.13
Mean of dependent variable (return)	-.001	-.40E-3	.81E-3	-.002	-.68E-4	.88E-4	-.30E-3
ARCH(5)	12.59 [.027]	23.18 [.000]	26.66 [.000]	8.28 [.141]	3.33 [.648]	11.76 [.038]	19.69 [.001]
BP(5) of the residuals that follow from the regressions	6.66 [.247]	5.34 [.376]	3.27 [.657]	8.16 [.148]	6.83 [.233]	5.19 [.393]	6.09 [.297]
JB(2)	3.59 [.166]	277.72 [.000]	951.78 [.000]	37.99 [.000]	48.70 [.000]	164.92 [.000]	83.65 [.000]

5.3.2 Analysis of the VAR using Cointegration and Exogeneity

Here the second sample is analysed as a result of the problems discussed in the previous section. The series though having highly non-normal errors seem at the level of the single country share price to be relatively well behaved. As the data relate to financial information the random walk with drift is expected to be appropriate so the cointegration analysis is undertaken on a VAR(1) model with unrestricted intercept. The sample is T=155 observations and the dynamics are expected to be short from the univariate Dickey Fuller models found in the last section. The data are expected to be volatile, but the cointegration method is still viewed appropriate in this case.

Given the non-normality as a check on robustness cointegration is tested on models with and without dummy variables for the largest extreme observations. The test is the cointegrating rank test explained in Johansen (1995). It is explained in Chapter 4 of Burke and Hunter (2005) that the trace test is optimal. The test is for cointegrating rank (r) and operates from the no cointegration test to further cointegration. So for n markets we have $0<r<n$ when the series are all I(1) in their levels. If $r=0$, then there is no cointegration and when $r=n$ the series are all stationary.

In Table 25 the Eigenvalues are presented in descending order and these are applied in Table 26 to construct the Johansen test.

Table 25 List of Eigenvalues in descending order with No Dummies

.27957	.18002	.12412	.062944	.056989	.034997	.0093126

Table 26 Cointegration LR test based on Trace of the Stochastic Matrix with No Dummies

Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r = 0	r>= 1	128.2762	124.6200	119.6800
r<= 1	r>= 2	77.4497	95.8700	91.4000
r<= 2	r>= 3	46.6855	70.4900	66.2300
r<= 3	r>= 4	26.1438	48.8800	45.7000
r<= 4	r>= 5	16.0669	31.5400	28.7800
r<= 5	r>= 6	6.9720	17.8600	15.7500
r<= 6	r = 7	1.4502	8.0700	6.5000

The test is a likelihood ratio test, but with non-stationary data this is not chi-squared, but has a Johansen distribution. We test the table ordered from the null of cointegration stopping when the test is not significant. Here the test is significant at the 5% level and this means it is not possible to reject the alternative so r=1 and there is a single cointegrating vector. In the next row in table 26 the next Eigenvalue is not significant so the null cannot be rejected at the 5% level and the test procedure stops at this point.

Table 27 List of Eigenvalues in descending order with Dummies

.29449	.18452	.10602	.070844	.056469	.031837	.0027062

Table 28 Cointegration LR test based on Trace of the Stochastic Matrix with Dummies

Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r = 0	r>= 1	128.8930	124.6200	119.6800
r<= 1	r>= 2	74.8227	95.8700	91.4000
r<= 2	r>= 3	43.2053	70.4900	66.2300
r<= 3	r>= 4	25.8339	48.8800	45.7000
r<= 4	r>= 5	14.4447	31.5400	28.7800
r<= 5	r>= 6	5.4351	17.8600	15.7500
r<= 6	r = 7	.42003	8.0700	6.5000

The test is a likelihood ratio test, but with non-stationary data this is not chi-squared, but has a Johansen distribution. We test the table ordered from the null of cointegration stopping when the test is not significant. Here the test is significant at the 5% level and this means it is not possible to reject the alternative so r=1 and there is a single cointegrating vector. In the next row in table 26 the next Eigenvalue is not significant so the null cannot be rejected at the 5% level and the test procedure stops at this point.

Table 27 List of Eigenvalues in descending order with Dummies

.29449	.18452	.10602	.070844	.056469	.031837	.0027062

Table 28 Cointegration LR test based on Trace of the Stochastic Matrix with Dummies

Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r = 0	r>= 1	128.8930	124.6200	119.6800
r<= 1	r>= 2	74.8227	95.8700	91.4000
r<= 2	r>= 3	43.2053	70.4900	66.2300
r<= 3	r>= 4	25.8339	48.8800	45.7000
r<= 4	r>= 5	14.4447	31.5400	28.7800
r<= 5	r>= 6	5.4351	17.8600	15.7500
r<= 6	r = 7	.42003	8.0700	6.5000

In Table 28 the trace test calculated with dummy variables to account for large movements in the share price are presented. In both cases the analysis shows that the null

of no cointegration cannot be accepted as the test value exceeds the critical value at the 5% level. The test is ordered optimally (Johansen, 1995) and so the next hypothesis is considered, that there is a single cointegrating vector (r=1) and this hypothesis cannot be rejected. This would seem appropriate given the size of the largest Eigenvalue (.29). At this point the test procedure stops. Linked to the Eigenvalue there is a single Eigen- vector and following a slight re-ordering of the system, the problem is normalised relative to the Bahrain market:

$$\beta = [-1 \quad .64 \quad .06 \quad -.54 \quad .84 \quad .71 \quad -.87].$$

Next we apply the test of long-run exclusion on all the elements in the above vector to make sure that the orientation of the problem is valid. For a single vector this is the

Table 29 Long Run Exclusion and Further Restrictions on Cointegrating Vectors

Null hypothesis	test value	[p.value]
$\beta_B = 0$	24.65	[.000]
$\beta_A = 0$	.7962	[.372]
$\beta_D = 0$	.2272	[.634]
$\beta_K = 0$	4.45	[.035]
$\beta_O = 0$	10.67	[.001]
$\beta_Q = 0$	9.47	[.002]
$\beta_S = 0$	8.86	[.003]
$\beta_A = 0$ and $\beta_D = 0$	1.50	[.472]
$\beta_A = 0$; $\beta_D = 0; \beta_B + \beta_O = 0$	2.39	[.495]
$\beta_A = 0$; $\beta_D = 0; \beta_B + \beta_O = 0; \beta_Q + \beta_S = 0$	2.45	[.654]
$\beta_D = 0; \beta_B + \beta_O = 0; \beta_Q + \beta_S = 0; \beta_A + \beta_K = 0$	1.49	[.828]

1=Bahrain(LBSP),2=AbuDhabi(LADSP),3=Dubai(LDSP),4=kuwait(LKSP),5=Oman(LOSP),6=Qatar(LQSP), 7=Saudi Arabia(LSASP)

same as testing whether a variable is long-run excluded (LE) from the system. For this purpose we impose the restriction related to whether an element can be excluded

(Juselius, 1995) for each variable in turn. These results are presented in Table 29 along with parity restrictions that may apply to the coefficients in the vector. These tests are further likelihood ratio tests distributed Chi-squared with 1 degree of freedom in the case of LE and j for the cases where further restrictions are applied. In the first case this is equivalent to a large sample t-test.

In Table 29, we find that we cannot exclude Bahrain or Kuwait, Oman, Qatar and Saudi Arabia from the long run, but based on the p.value for the individual test we can exclude Dubai and Abu Dhabi as the null hypothesis that means the variable is not significant cannot be rejected. Based on these results and the signs and size of the coefficients Dubai is excluded from the vector and combinations of the other variables are restricted to parities a pair at a time. All these restrictions can be accepted based on p.values that far exceed 0.05 (5%). Include the final test in the table that imposes j=4 restrictions.

Then after imposing the restrictions on the cointegrating vector as for the last row in table7, the restricted eigen vector is:

$$\beta = [-1 \quad .76 \quad 0 \quad -.76 \quad 1.0 \quad .91 \quad -.91].$$

It should be noted that this only involves the estimation of two free parameters for the two further parity conditions. An interpretation is that the share price parity between Bahrain and Oman depends on some proportion of the parity between Qatar/Saudi Arabia and Abu Dhabi and Kuwait. Though in the latter case the restriction can be imposed Abu Dhabi can on a single variable basis be excluded.

The short-run equations including dummy variables and error correction terms are considered next in Table 30. Here the test on the error correction term, given that the cointegrating vector is stationary can be seen as equivalent to the test in Johansen (1992) of weak exogeneity (WE) when r=1. More generally this is a chi-squared test of r restrictions (Johansen, 1992).

Only long run exogeneity and not short run is tested because everything is interrelated. If there is a common behaviour, then that is what is the arbitrage but it is not necessary to get a unit coefficient for the stock prices. If a unit coefficient is found, it might be quite interesting but, if not, then it does not mean that nothing important is happening. We expect a relationship but it does not have to be one, rather it depends on the nature of the

basket, talking about oil prices in two countries might be one, but if it is a basket of assets it might not be one. If it is long run weakly exogenous, then it means that the cointegration related to that variable is not appropriate. There is not any cointegration related to that variable if it is long run weakly exogenous. That variable could be part of a system but the cointegration is not related directly to that variable equation. In the VAR model, all the variables are treated as endogenous variables. That is what the VAR does. When it comes to the long run, there is more general notion of endogeneity and exogeneity, which allows the estimation of a single equation. So a single equation could be estimated if a variable in the right side is weakly exogenous.

Hunter and Wu (2014) stated that stock market effects impact different economies and because the US effect is very powerful, the shocks that hit the UK will be influenced by the US. Hence, financial markets are interdependent without there being cointegration. Exchange rates are impacted by PPP in long run and this suggests that they should not be endogenous. Exchange rate is impacted by interest rates and the terms of trade is driven by exchange rates. Hunter and Simpson (1996) find that the UK interest rate is not exogenous, but US interest rates are and they drive everything else. Hunter and Simpson (1996), based on tests of exogeneity in relation long-run PPP and Uncovered Interest Parity, suggested the exogeneity assumption in this paper that the US impacts UK but not the reverse. In a sense US interest rates follow a random walk, but the UK does not as that is driven by inflation (the Fisher Effect). Interest rates may follow a random walk on their own, but when put into system they do not.

At the moment we should not be worried about identification because the short run parameters are identified in the VAR and in the long run we want to see how much cointegration is there in the system and cointegration helps the identification Burke and Hunter (2005). Talking about Saudi Arabia and other Gulf countries, it is expected that Saudi Arabia drives the market place and a cointegration relationship is imagined here. What we imagine to find is that stock markets are interrelated and weakly exogenous. For a country such as Saudi Arabia, that the index being weakly exogenous for the long-run coefficients, means that it would affect all the other Gulf countries. In the short run they are all interrelated and endogenous. If the Saudi Arabia index is weakly exogenous then dealers in the other Gulf countries are all looking at what is happening in Saudi Arabia. Saudi Arabia might be a long run driver, but it could be another country. That would be another contribution of this paper to find which variables would be weakly exogenous.

In this chapter the law of one price was applied to stock price indices or arbitrage and finding cointegration and looking for weakly exogeneity. This will tell about the nature of Gulf and how these markets are interrelated. First the cointegration and rank were found. If the rank is n-1 then all Gulf prices are interrelated with each other with them all pricing relative to each other. We can also test parallel pricing (1-1) for each of the prices and pick one of them to treat as dependant variable or weakly exogenous variable. If there are less than n-1 cointegrating vectors, then it might be more complicated. If the Saudi Arabia index is weakly exogenous, then the Saudi Arabia index is not affected by the other Gulf states indices, but the other states are affected by that of Saudi Arabia. This is very likely because the Saudi Arabian is a bigger market and highly liquid which will feed into other markets or other markets liquidity has a big influence in the SA market. At the end they might be all interrelated. Also, the SA index may dominate as other Gulf countries have a border with SA, but not with the others. They are all linked to SA while not with each other and that is why SA is found to be dominant.

Table 30 The final results ECM Models

	ECM for variable LBSP	ECM for variable LADSP	ECM for variable LDSP	ECM for variable LKSP	ECM for variable LOSP	ECM for variable LQSP	ECM for variable LSASP
Inpt	-5.2208 [.000]	.11227 [.911]	1.7671 [.079]	-1.9236 [.056]	-.85707 [.393]	3.0774 [.003]	-1.0450[.298]
Ecm(-1)	-5.3691 [.000]	-.067821 [.946]	1.9056 [.059]	-2.2207 [.028]	-.61928 [.537]	3.0266 [.003]	-1.3803[.170]
D_{S1}	-3.7630 [.000]	-7.2041 [.000]	-2.7320 [.007]	-4.8934 [.000]	-3.8490 [.000]	-3.6048 [.000]	-8.1755[.000]
D_{Q1}	-.67223 [.503]	1.4562 [.148]	.90823 [.365]	.56873 [.570]	-.38877 [.698]	2.2907 [.023]	.61451[.540]
D_{O1}	-.28120 [.779]	-.52200 [.602]	-.90000 [.370]	-2.2726 [.025]	1.5839 [.115]	-.63556 [.526]	.055726[.956]
D_{A2}	1.1980 [.233]	1.1163 [.266]	.50479 [.614]	-.85175 [.396]	1.0278 [.306]	.91309 [.363]	.83633[.404]
D_{S2}	-.16134 [.872]	5.4582 [.000]	3.1774 [.002]	.67757 [.499]	.10584 [.916]	3.0738 [.003]	6.9662[.000]
D_{Q2}	-1.6211 [.107]	-2.9123 [.004]	-.0036555 [.997]	-1.9115 [.058]	-1.1097 [.269]	-5.7055 [.000]	-1.0558[.293]
D_{B2}	5.6225 [.000]	.25785 [.797]	-.28314 [.777]	.65113 [.516]	.99760 [.320]	.77482 [.440]	-.48760[.627]
D_{Q4}	.0077094 [.994]	1.8749 [.063]	.010888 [.991]	1.0558 [.293]	.64673 [.519]	5.9516 [.000]	.75434[.452]
D_{Q5}	-.13544 [.892]	-3.5838 [.000]	-2.1834 [.031]	-1.2003 [.232]	-3.1948 [.002]	-5.8169 [.000]	-2.4505[.015]
D_{S3}	-1.7788 [.077]	-5.2034 [.000]	-2.6144 [.010]	-2.8713 [.005]	-4.1800 [.000]	-3.6824 [.000]	-4.4448[.000]
D_{A3}	.69300 [.489]	-4.6164 [.000]	-.12470 [.901]	-.13274 [.895]	1.2341 [.219]	.17597 [.861]	.12255[.903]
R-Squared	.36807	.52853	.18893	.26821	.26559	.51901	.51502
Serial Correlation	.23878 [.626]	.074973 [.785]	.0063365 [.937]	1.9425 [.166]	1.5155 [.220]	1.1522 [.285]	.33237[.565]
Functional Form	1.2445 [.267]	.27702 [.599]	.73400 [.393]	2.0722 [.152]	.60728 [.437]	.092224 [.762]	052123[.820]
Normality	21.7805 [.000]	38.3412 [.000]	8.9823 [.011]	28.0764 [.000]	18.3712 [.000]	13.2098 [.001]	10.7548[.005]
Heteroscedasticity	.16358 [.686]	1.2524 [.265]	1.2457 [.266]	.49452 [.483]	1.0725 [.302]	1.4105 [.237]	.88916[.347]

Here this is a t-test on the error correction term. So based on the p.values test on each equation tat the loading ($\alpha i = 0$) for i=1,...7. The null hypothesis cannot be accepted in the case of Bahrain, Kuwait and Qatar. That means that in all the other cases on a single

equation basis it is possible to exclude the error correction term. So these variables are WE for the cointegrating vector (β), and Saudi Arabia and Oman can be seen as driving the system in the long-run and this means that these markets are not affected by the others they are essentially random walks or they define the stochastic trends driving the regional markets. Dubai is both WE and LE, which implies, from Burke and Hunter (2005), that this is strictly exogenous to the system. Although it follows a stochastic trend this does not affect the other prices either. Abu Dhabi is also WE, but may be long-run excluded. However, in terms of the price proportions and their coefficient it does appear to have an effect on the long-run.

The size of the loading (tested under the null $\alpha_i = 0$) is more significant for Bahrain among all countries, but less significant for Qatar and Kuwait and not significant at all the other countries. When we look at the 11 dummies, they have different influence and level of significance. Most significant dummies for all countries would be dummies related for Saudi Arabia. We would notice that any dummy related to Saudi Arabia is quite common to affect all countries in most of the cases. Looking at the specifications, there is little evidence of serial correlation, but significant non-normality, § which in all cases seems similar,

Cointegration is often for stock markets linked to contagion and thus the dummies are often seen as an alternative way of explaining the long-run effect amongst stock indices. If these models are re-estimated and the critical values computed using 10000 simulations of the underlying VAR(1) model including dummies then the critical values from these simulations are very different.

Table 31 Cointegration LR test based on Trace with simulated critical values including Dummies

Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r = 0	r>= 1	134.3056	136.8503	130.8398
r<= 1	r>= 2	66.6023	104.1377	98.8621
r<= 2	r>= 3	43.1311	76.5541	71.8677
r<= 3	r>= 4	20.1994	53.0892	49.2164
r<= 4	r>= 5	8.3115	33.9158	30.4306
r<= 5	r>= 6	2.5881	19.1079	16.6326
r<= 6	r = 7	1.0150	8.4104	6.6808

Based on these simulated results, the null cannot be rejected at the 5% level that there are no cointegrating vectors (r=0). However, there is some suggestion that, although the

maximum eigen value test lacks power, that with small samples it may perform better. Unfortunately it also does not have an optimal ordering, but for simply comparing the case of r=0 and r=1 (max test (r=0) = 67.7033>50.8336) and it would appear from this test that r=1 (max test (r=1) = 23.4712 < 43.8136). .

5.4 Conclusion

It would seem that the different markets are all relatively efficient on the basis of finding they follow random walks or the stock market return not being predictable. Only in one case is this not possible to accept with usual inference and that is for Saudi Arabia. However, this is not true when the test is applied with robust standard errors. There is evidence that some of the markets were mispriced prior to a major correction in January 2010. The tests of stationarity were applied before and after this date, and it was found that the idea that the market is efficient can be accepted for both periods. However, due to the correction and the suggestion that all Gulf stock markets were overvalued in the earlier period any further analysis is undertaken for the latter period.

The analysis both with and without dummies suggests a single cointegrating vector implying that the dummy correction does not affect the findings on cointegration. However, the trace and the max test are slightly contradictory when correction is made to the test statistic using simulated estimates of the critical values. If the single cointegrating vector is accepted, then the Bahrain market seems to be directed by interaction with all but the Dubai market. In the case of Abu Dhabi this may be left out though a more appealing hypothesis is that this interacts with the Kuwait market. While the Saudi market relates to Qatar. Once the coefficient for the Oman index is accounted for the differential between Bahrain and Oman is affected by similar proportions between the other four countries. Based on this and the tests of exogeneity it makes sense in further research to consider how the tests might be affected by the subsystem driven by the exogenous market indices.

CHAPTER 6: CONCLUSION

This thesis confirms all previous studies conducted for the Gulf currency union that they are not ready for integration. These findings suggest that the financial markets and money markets, where tested, do appear efficient in an informational sense, but the financial and product markets do not define a market that might be seen as broad. The first empirical chapter started to consider PPP and this was meant to relate to the Gulf States, but unfortunately it was not possible to investigate the law of one price from the side of the Gulf currencies as they are fixed to the dollar and have been for at least the last three decades. Therefore, any observation of exchange rate behaviour for these currencies is really related to the dollar. As these currencies are fixed to the dollar, then any findings on efficiency or study of PPP for dollar currencies is an analysis of the Gulf currencies, but indirectly through the dollar.

Therefore, when the dollar is found not efficient for the currencies related to developed countries and there is no finding of PPP even in the long-run by cointegration between the exchange rate and the terms of trade, then it would seem unlikely to observe this for the Gulf countries. First as when it does not hold for the dollar there appears even less of a mechanism for arbitrage to eliminate mispricing in and across the Gulf countries. To observe this, an analysis was carried forward on some developed countries, but these currencies needed not to be fixed and there needed to be a reasonable span of data where the currencies were floating.

After the analysis for three developed countries the pound sterling, the New Zealand dollar, and the Australian dollar all denominated in US dollars the currencies were all found to be close to random walks for log data. However, there was insufficient to find enough PPP in the long-run for two of the three developed countries New Zealand and Australia and although we found cointegration between the terms of trade and the exchange rate for the UK, the coefficient was small and did not seem consistent with the law of one price.

At one point it is hoped that it will be able to find enough data for the Gulf States for exchange rates, prices and interest rates or prices, to be able to investigate in a more direct way the idea of currency union. Of course, that would not remove the need for markets to be efficient or that the building blocks hold for a valid union. However, as Hunter and

Menla (2014) find the macroeconomic analysis may be adjusted to correct for some of these issues via an extended model of money and adjustments to correct for some failure of PPP. However, this is not currently possible for the Gulf.

One avenue to analyse the law of one price in terms of PPP in the long-run might be seen from the use of cross rates. To investigate this further and see the problems that this leads to the testing of PPP through the developed economy currencies is dealt with in terms of rates related to the pound sterling and the Australian dollar. Smith and Hunter (1985) observed that for stationary data cross arbitrage needs all exchange rate equations to be coherent and that means the same coefficient holds for all equations or that the models must include all the same variables. The exact finding of PPP or UIP would lead to coherent models as then the same unit coefficients should hold for each country model of the exchange rate. The other case is more unusual as it means that for a dynamic model the dynamics are either all the same or any group of equations requires all the same variables. The cross rate analysis proved how the cointegrating regressions of the exchange rates were not coherent as the coefficients were not the same. When the cointegrating regressions were applied in a coherent way by the algebra of the problem that the cross rates are constructed from the coefficients on the dollar rate models. This invalidates any study that relies on cross rates unless an analysis based on the dollar rates is found to be coherent.

Given that the rates are fixed the only analysis of the law of one price could be applied to the price indices for the Gulf States. Unfortunately, the only data found to be reliable was annual and this meant that there were only a small number of time series observations. The only method that seemed to make sense was a panel study of the prices. The idea follows from the article of Devereux and Lothian (2011) as they suggested a coherent way of analysing the law of one price for exchange rates for the UK relative Holland for 400 years of data by considering the stationarity of what might be seen as a real exchange rate. In this case the finding of stationarity implies that the exchange rate and the terms of trade match each other over this time period. For Devereux and Lothian (2011), the price indices may change over the sample, but all that is required is that the different prices behave in the same way across the sample.

In the case of the Gulf States the behaviour of the exchange rate is not important so what is needed is for the prices to follow a common trend and that is linked to there being a

broad market (Forni, 2004). The finding that the price proportions are not stationary across the panel indicates that the market is not broad. Forni (2004) suggested that market breadth could be looked at using stationarity tests of relative prices using a number of tests of stationarity. This type of analysis was undertaken for gasoline prices for the USA by Hunter and Tabaghdehi (2013) who compared various univariate and panel stationarity tests. By a similar argument to Smith and Hunter (1985) for non-stationary data the panel approach provides a coherent analysis. The conclusion of the panel study suggests that the Gulf market is divided as compared with defining a "Common Market" so the further fixing of links using a single gulf currency may not work as arbitrage does not seem to lead to price adjustment when all currencies are linked to the dollar. The following chapters will give more support to our conclusion in regards to the likely success of a gulf currency union. Although in general there are signs that these countries have efficient markets and we found that product and asset prices were I(1), the prices did not cointegrate or follow a common trend from the evidence of the panel.

In the second empirical chapter, we carried out a very unique study for the United Arab Emirates (UAE) interest rates and so investigated the efficiency of the monetary system. In this chapter, we hoped to use all other gulf countries interest rates but it was not easy to find the same data for the other countries. These kinds of data are not usually published or found for the gulf and in this case came from a confidential source. It was encouraging in carrying out this study for UAE that the results were promising for the pass-through in interest rates for one of the monetary economies in the Gulf; even more useful to me as this is my country. We investigated the link between interest rates using the ADF test and then related that form to the ECM, ARDL and finally NARDL to find that the five sets of interest data interrelate or the yield curve and interest rates pass through holds in the long-run. We found IRPT for UAE using all the mentioned tests, except for the 1 week rate relative to six months. Then using the NARDL model for we found a form of IRPT after correcting the standard errors using robust standard errors (HAC). These results showed the relative efficiency of the UAE money markets, which is of particular interest when the study by Greenwood-Nimmo et al. (2013) of developed countries generally seems to work for the NARDL as compared with the ARDL model.

The final empirical chapter is for the Gulf States financial markets. We analysed seven countries stock prices. Testing is applied to the stock indices on their own and they all appear to be relatively efficient. Then using the VAR to test the breadth of the market we

found only one cointegrating vector, when N-1 would be anticipated were the markets strongly interrelated (Burke and Hunter 2012). This chapter supports our findings in chapter three based on the behaviour of CPI's for the Gulf countries where we found no common trend among these countries prices. Again the evidence suggests that these countries stock markets are not really interrelated. As was said before the stock markets do seem to be relatively efficient when compared with other studies of developed and less developed markets. From the tests of weak exogeneity for the parameters of interest we found that the Oman, Saudi Arabia and Kuwait indices are WE, while Qatar and Bahrain are not. The Dubai index is also weakly exogenous, but this is not important in driving the cointegrating relation as it is also LE. The finding of cointegration is in some debate when comparison is made between model that include dummies and the case where they are excluded. It appears that the dummies do not affect the finding on cointegration except when the Johansen trace test is simulated, then the cointegration is no longer accepted. However, with correction the finding of a single cointegrating vector using the max test cannot be rejected. It is the latter result that we have decided to go with. However, it may be that this analysis would be more appropriate were the weak exogeneity further looked at the analysis limited to the variables seen to be endogenous. This may also reduce the required number of dummies (Pesaran et al., 2001).

In this chapter and the other chapters, we found that, although Gulf countries markets are efficient, they do are not appear yet ready for a currency union. Unfortunately, the analysis of the exchange rate in terms of PPP is limited by the currencies already being fixed via the dollar. If this is an indication of the problems of fixing the currencies, then this does not suggest that is a good idea. When the euro zone is analysed (Beirne, 2010), then there is an indication from those results that Ireland, Portugal and Spain may have had problems in terms of a common currency. The same may also apply to Greece. Although individual markets may be relatively efficient especially the stock markets, there seems little evidence that these markets interact in an appropriate way. If there is not a common market for products or financial assets then how might there be a common currency. The EU started off by forming a common market and then moved to the common currency, though some countries such as the UK having already been burnt by the EMS in 1992 decided not to join and other countries may have been better able to recover from the financial meltdown of 2008 had they been able to stimulate their economies via a reduction in the value of their currency.

BIBLIOGRAPHY

Abuaf , N. and Jorion , P. (1990), Purchasing Power Parity in the Long Run, The Journal of Finance, 45(1), 157-174.

Abu-Qarn, A. S. and Abu-Bader, S. (2008), On the optimality of a GCC monetary union: structural VAR, common trends, and common cycles evidence, World Economy, 31(5), 612-630.

Adler, M. and Dumas , B. (1983), International Portfolio Choice and Corporation Finance: A Synthesis, Journal of Finance, 38(3), 925-84.

Adler, M. and Lehmann, B. (1983), Deviations from Purchasing Power Parity in the Long Run, Journal of Finance, 38(4), 1471-87.

Akdi, Y. , Ozdemir, Z.A. and Olgun , H. (2009), Testing the PPP hypothesis for G-7 countries, Applied Economics Letters, 16(1), 99-101.

Al–Abdulqader, K.A. Hannah, G. and D.M (2007), A Test of the Weak–form of the Efficient Markets Hypothesis for the Saudi Stock Market, Journal of Emerging Market Finance, 6 .

Al-Ajmi, J. (2008), Audit and reporting delays: Evidence from an emerging market Advances in Accounting, incorporating Advances in International Accounting, 24(2)

Al-Ajmi, J. and Kim, J. H. (2012), Are Gulf stock markets efficient? Evidence from new multiple variance ratio tests , Applied Economics, 44(14)

Al-Khazali , O. , Ding , D.K. and Pyun , C.S (2007), A New Variance Ratio Test of Random Walk in Emerging Markets: A Revisit, The Financial Review, 42(2), 303-317.

Al-Khazali, O. (2011), Does infrequent trading make a difference on stock market efficiency? Evidence from the Gulf cooperation council (GCC) countries, Studies in Economics and Finance 28(2), 96-110

Al-Mansouri, A.K. L. and Dziobek, C. (2006), Providing official statistics for the common market and monetary union in the Gulf cooperation council countries, A Case for "Gulfstat", IMF working paper: International Monetary Fund, 6-38. 31.

Anderson , H. and Granger , C. (1992), A Cointegration Analysis of Treasury Bill Yields, The Review of Economics and Statistics, 74(1), 116-26.

Asiri, B. (2008) , Testing weak-form efficiency in the Bahrain stock market, International Journal of Emerging Markets, 3(1), 38-53.

Bachelier, L. (1900), Théorie de la Spéculation [Theory of Speculation]. Thèse de doctorat ès sciences mathématiques. Université de la Sorbonne, France.

Bahram, P. and Pesaran, M. H. (2009), Time series econometrics: using Microfit 5.0 : A user's manual.

Baillie, R. , Lippens, R.E. and McMahon, P.C. (1983), Testing Rational Expectations and Efficiency in the Foreign Exchange Market, Econometrica, 51(3), 553-63.

Beirne, J. (2008), Real Exchange Rate Dynamics and Monetary Integration in Crisis-Affected Regions, Journal of International and global Economic Studies, 1(2), 1-25.

Beirne, J. (2010), International Exchange Rate Dynamics and Purchasing Power Parity, Ph.D. thesis, Brunel University. Google Scholar

Beirne, J., Hunter, J. and M. Simpson, M., (2007), Is the Real Exchange Rate Stationary? The Application of Similar Tests for a Unit Root in the Univariate and Panel Cases, Qualitative and Quantitative Analysis in the Social Sciences, 1(2), 55-70.

Benjelloun, H. and Squalli , J. (2008), Do general indexes mask sectoral efficiencies?: A multiple variance ratio assessment of Middle Eastern equity markets, International Journal of Managerial Finance, 4(2)

Benjelloun, H. and Squalli, J. (2006), Do general indexes mask sectoral efficiencies? A multiple variance ratio assessment of Middle Eastern equity markets, International Journal of Managerial Finance 4 (2), 136-151

Bernstein , D.J. (2000), Generalized purchasing power parity and the case of the European Union as a successful currency area, Atlantic Economic Journal, 28(4), 385–395.

Bijsterbosch , M. and Beirne , J. (2009), Exchange Rate Pass-through in Central and Eastern European Member States, No 1120, Working Paper Series from European Central Bank.

Bley , J. and Chen , K.H. (2006), Gulf Cooperation Council (GCC) stock markets: The dawn of a new era, Global Finance Journal . 17(1), 75-91.

Bolatoglu , N. and Telatar , F. (2009), Stochastic behavior of the real exchange rate for Jordan: a re-examination, Applied Economics Letters 16(1), 81-85.

Bollerslev, T., and Wooldridge, J. (1992), Quasi-Maximum Likelihood Estimation and Inference in Dynamic Models with Time-Varying Covariances. Econometric Reviews 11, 143–172.

Bondt , G. (2005), Interest Rate Pass-Through: Empirical Results for the Euro Area, German Economic Review, 6(1), 37-78.

Bonser-Neal, C. , Roley , V.V. and Sellon, G.H. (2000), The effect of monetary policy actions on exchange rates under interest-rate targeting, Journal of International Money and Finance, 19(5), 601-631.

Borio, C. and Fritz , W. (1995), The response of short-term bank lending rates to policy rates: a cross-country perspective, No 27, BIS Working Papers from Bank for International Settlements.

Box, G. and Jenkins, G. (1970), Time Series Analysis: Forecasting and Control, Holden-Day, San Francisco.

Buiter, W. H. (2008), Economic, political, and institutional prerequisites for monetary union among the members of the Gulf Cooperation Council, Preparing for GCC Currency Union: Institutional Framework. 20-21.

Burke, S. P. and Hunter, J. (2005), Modelling non-stationary economic time series: A multivariate approach. Palgrave Texts in Econometric: Basingstoke.

Burke, S. P. and Hunter, J. (2012), Arbitrage, market definition and monitoring a time series approach, Brunel University Working Paper, 12(20).

Butler, K.C. and Malaikah, S. J. (1992), Efficiency and inefficiency in thinly traded stock markets: Kuwait and Saudi Arabia, Journal of Banking & Finance, 16(1), 197-210.

Campbell , J. and Shiller , R. (1987), Cointegration and Tests of Present Value Models. Journal of Political Economy, 95(5), 1062-88.

Campbell , J. and Shiller , R.J. (1989), Yield Spreads and Interest Rate Movements: A Bird's Eye View, NBER Working Paper No.3153.

Campbell , J. and Shiller , R.J. (1991), Yield Spreads and Interest Rate Movements: A Bird's Eye View, Review of Economic Studies, Oxford University Press, 58(3), 495-514.

Campbell , J. and Shiller, R.J. (1986), The Dividend-Price Ratio and Expectations of Future Dividends and Discount Factors, NBER Working Paper No. 2100.

Campbell, J. (1987), Cointegration and Tests of Present Value Models, Journal of Political Economy, 95(5), 1062-88.

Campbell, J. (1995), Some Lessons from the Yield Curve. Journal of Economic Perspectives, 9 (3), 129-152.

Campbell, T.S. , Kracaw, W.A. (1993), Financial Risk Management: Fixed Income and Foreign Exchange, HarperCollins College Publishers, Business & Economics - 350 pages

Cassel, G. (1922), Money and Foreign Exchange After 1914, New York: MacMillan.

Cheung, Y.W. and Lai, K.S. (1993), Long-run purchasing power parity during the recent float, Journal of International Economics, 34(1–2), 181-192.

Chi , K.M. (2009), A more powerful panel unit root test with an application to PPP, Applied Economics Letters, 16(1), 75-80.

Chong, Y. , Jorda, O. M. and Taylor, A. M. (2012), The Harrod-Balassa-Samuelson hypothesis: real exchange rates and their long-run equilibrium, International Economic Review. 53(2), 609-634.

Coakley, J. and Fuertes, A. (2000), Is There a Base Currency Effect in Long-Run PPP?, International Journal of Finance and Economics, John Wiley & Sons, Ltd., 5(4), 253-263.

Cochrane , J. (1994), Permanent and Transitory Components of GNP and Stock Prices, The Quarterly Journal of Economics, 109(1), 241-265.

Culver, S. and Papell, D. (1999), Long-Run Purchasing Power Parity with Short-Run Data: Evidence with a Null Hypothesis of Stationarity, Journal of International Money and Finance.

Cumby, R.E. and Obstfeld, M. (1981), A Note on Exchange-Rate Expectations and Nominal Interest Differentials: A Test of the Fisher Hypothesis, The journal of Finance, 36(3), 697-703.

Davidson, J.E.H, Hendry, D.F., Srba, F and Yeo, S. (1978), Econometric Modelling of the Aggregate Time-Series Relationship between Consumers' Expenditure and Income in the United Kingdom, Economic Journal, 88, 661-92.

Davidson, R. and MacKinnon, J.G. (2004), Econometric Theory and Methods, published by Oxford University Press (New York).

Devinder, K. and Woodward, R.S. (1980), Thin capital markets: a case study of the Kuwaiti stock market, Applied Economics 12(3), 341-49 .

Dickey , D.A. and Fuller , W.A. (1979), Distribution of the Estimators for Autoregressive Time Series With a Unit Root, Journal of the American Statistical Association ,74(366), , 427-431.

Dickey , D.A. and Fuller , W.A. (1981), Likelihood Ratio Statistics for Autoregressive Time Series with a Unit Root, Econometrica, , 49(4), 1057-72.

Dornbusch, R. (1987a), Purchasing Power Parity, in The new Palgrave dictionary of economics, Eds.: John Eatwell, Murray Milgate and Peter Newman. London: MacMillan; New York: Stockton Press.

Dornbusch, R. (1988), Real exchange rates and macroeconomics: a selective survey, National Bureau of Economic Research Working Paper No. 2775.

Dornbusch, R. and Krugman, P. (1976), Flexible Exchange Rates in the Short Run, Brookings Papers on Economic Activity. 1(3), 537- 75.

Edison, H.J. (1987), Purchasing Power Parity in the Long Run: A Test of the Dollar/Pound Exchange Rate, 1890–1978, Journal of Money, Credit and Banking. 19(3), 376–87.

Elton, E. J. and Gruber , M.J. (2010), Marginal Stockholder Tax Rates and the Clientele Effect, Investments and Portfolio Performance, 3-9.

Engle R. F. (1982), Autoregressive conditional heteroskedasticity with estimates of the variance of U.K. inflation, Econometrica. 50, 987-1008.

Engle, R. F. and Granger C. W. J. (2003), Time-series econometrics: cointegration and autoregressive conditional heteroskedasticity, Nobel Prize Committee in its series Nobel Prize in Economics documents with number 2003-1.

Engle, R.F. and Granger, C.W.J. (1987), Co-Integration and Error Correction: Representation, Estimation, and Testing , Econometrica , 55(2), 251-276.

Ericsson, N.R., and MacKinnon, J.G. (2002), Distributions of Error Correction Tests for Cointegration, Econometrics Journal, 5, 285-318.

Eurofi (2000), Banking and Financial Europe after Euro: Discussions of the Eurofi 2000 Association, Revue d'Économie Financière, 62(2), 13-38.

Fama , E. (1970), Efficient Capital Markets: A Review of Theory and Empirical Work, Journal of Finance, 25(2), 383-417.

Flood, R.P. and Rose, A.K. (1995), Fixing exchange rates:A virtual Quest for Fundamentals, Journal of Monetary Economics . 36(1) , 3-37.

Forni, M. (2004), Using stationarity tests in antitrust market definition, American Law and Economics Review, 6, 441-464.

Frenkel, J.A. (1976), A Monetary Approach to the Exchange Rate: Doctrinal Aspects and Empirical Evidence, Scand. J. Econ, 78(2), 200-24.

Frenkel, J.A. (1981), The Collapse of Purchasing Power Parity During the 1970s, European Economic Review. 16(1), 145-65.

Frenkel, J.A. (1981a), Flexible Exchange Rates, Prices, and the Role of "News": Lessons from the 1970s, Journal of Political Economy, 89(4), 665-705.

Frenkel , J.A. and Froot , K.A. (1990), Chartists, Fundamentalists, and Trading in the Foreign Exchange Market, The American Economic Review. 80(2), 181-185.

Friedman, M. and Schwartz, A. J . (1963), A monetary history of the United States: 1867-1960, Princeton, NJ: Princeton U. Press for the National Bureau of Economic Research.

Froot , K. and Rogoff , K. (1995), Chapter 32 in Handbook of International Economics, 3, 1647-1688 .

Fuller, W. A. (1976), Introduction to Statistical Time Series, New York, Wiley.

Gaillot, H..J. (1970), Purchasing Power Parity as an Explanation of Long-Term Changes in Exchange Rates, J. Money Credit Banking, 2(3), 348-57.

Garratt, A. , Lee , K. , Pesaran, M.H. , and Shin , Y. (2012), Global and National Macroeconometric Modelling A Long-Run Structural Approach.

Gawon, Y. (2009), Are real exchange rates more likely to be stationary during the fixed nominal exchange rate regimes?, Applied Economics Letters , 16(6),17-22 .

George, A.T. , Nuri, E.S. and Behrouz, G. (2003), The GCC Monetary Union: Some Considerations for the Exchange Rate Regime, IMF Working Paper 03/66, 1-25.

Graham, S. (2007), Random walks in Middle Eastern stock markets, Applied Financial Economics , 17(7), 587-596.

Granger, C. (1981), Some properties of time series data and their use in econometric model specification, Journal of Econometrics, 16(1), 121-130

Granger, C. and Newbold, P. (1974), Spurious regressions in econometrics, Journal of Eonometrics , 2(2), 111-120.

Granger, C. (1983), Co-Integrated Variables and Error Correcting Models, Unpublished UCSD Discussion Paper 83-13.

Greenwood-Nimmo, M. and Till Treck, Y. (2013), The decoupling of monetary policy from long-term rates in the U.S. and Germany during the Great Moderation, Working paper.

Gregoriou, A. , Kontonikas, A. , MacDonald, R. and Montagnoli, A. (2009), Monetary Policy Shocks and Stock Returns: Evidence from the British Market, Financial Markets and Portfolio Management, 23(4), 401-410.

Gregoriou, A. and Kontonikas, A. (2009), Modeling the behaviour of inflation deviations from the target, Economic Modelling, Elsevier, 26(1), 90-95.

Gual , J. (1999), Deregulation, Integration, and Market Structure in European Banking, Journal of the Japanese and International Economies, , 13(4), 372-396.

Guidi, F. and Gupta, R. (2013), Market efficiency in the ASEAN region: evidence from multivariate and Applied Financial Economics, 23(4)

Gupta, R. and Guidi, F. (2013), Market efficiency in the ASEAN region: evidence from multivariate and cointegration tests, Applied Financial Economics. 23(4), 265-274.

Haldrup, N and Jansson, M. (2006), Improving size and power in unit root testing, Palgrave Handbook of Econometrics, Econometric Theory,1, 252-277

Hall, A.D. , Anderson, H.M and Granger, C.W J, (1992), A Cointegration Analysis of Treasury Bill Yields, The Review of Economics and Statistics, MIT Press, 74(1), 116-126.

Hall, R.E. (1978), Stochastic Implications of the Life Cycle-Permanent Income Hypothesis: Theory and Evidence, Journal of Political Economy. 86 (6), 971–987.

Hansen , L. and Hodrick , R. (1980), Forward Exchange Rates as Optimal Predictors of Future Spot Rates: An Econometric Analysis, Journal of Political Economy, 88(5), 829-53.

Hansen, B. E. (1992), Tests for Parameter Instability in Regressions With I(1) Processes, Journal of Business and Economic Statistics, 10, 321–336.

Hansen, L. and R. Hodrick (1983), Risk averse speculation in the forward exchange market : An econometric analysis of linear models, J.A.Frenkel (ed), exchange rates and International Macroeconomics (Chicago IL; Chicago University Press).

Hendry, D. and Doornik, J.A. (2014), Statistical Model Selection with 'Big Data', Economics Series Working Papers 735, University of Oxford, Department of Economics.

Hendry, D. (1995), Dynamic Econometrics, Oxford: Oxford University Press.

Higgins. M. and Zakrajsek, E. (1999), Purchasing Power Parity: Three Stakes in the Heart of the Unit Root Null, Mimeo, Federal Reserve Bank of New York.

Hull, J.C. (2006), Options, Futures and Other Derivatives, 6th edition, Prentice Hall.

Hunter, J and M Simpson (1996), Exogeneity and identification in a model of the UK effective exchange rate, Econometrics Society European Meeting in Istanbul

Hunter, J and Tabaghdehi, S.A. (2013), Cointegration and US Regional gasoline prices: Testing market efficiency from the stationarity of price proportions, Economics and Finance Working Paper, Brunel University, 13-03

Hunter, J. and Menla, A.F (2014), Money demand instability and real exchange rate persistence in the monetary model of USD–JPY exchange rate, Economic Modelling, 40 (c), 42-51

Hunter, J. and Burke, J. (2007), Common Trends, Cointegration and Competitive Price Behaviour, ESRC Econometrics Study Group Annual Conference, University of Bristol

Hunter, J. and R.P., Smith (1982), Problems with Exchange Rate Arbitrage in Economic Specification, Paper presented at the NBER Summer School.

Hunter, J. and Simpson, M. (2004), The specification of cross exchange rate equations used to test purchasing power parity, Brunel University Discussion Paper, 04–22.

Hunter, J. and Wu, F. (2014), Multifactor consumption based asset pricing models using the US stock market as a reference: Evidence from a panel of developed economies, Economic Modelling, 36, 557–565

Im, K.S., Pesaran M.H. and Shin, Y. (2003), Testing for unit roots in heterogeneous panels, Journal of Econometrics 115, 53–74.

Johansen, S. (1992), Cointegration in partial systems and the efficiency of single-equation analysis, Journal of Econometrics, 52(3)

Johansen, S. (1995), Identifying restrictions of linear equations with applications to simultaneous equations and cointegration, Journal of Econometrics. 69(1), 111-132

Johansen, S. (1995), Likelihood-based inference in cointegrated vector autoregressive model, Oxford University Press.

Johansen, S. and Juselius, K. (1988), Hypothesis Testing for Cointegration Vectors with an Application to the Demand for Money in Denmark and Finland, Working Paper No. 88-05, University of Copenhagen.

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.

Johansen, S. and K. Juselius (1992), Testing structural hypotheses in a multivariate cointegration analysis of the PPP and the UIP for UK, Journal of Econometrics, 53(1-3), 211-244 .

Josheski, D. , Koteski , C. and Lazarov, D. (2011), Empirical Testing of Balassa-Samuelson Hypothesis with German and UK Data, Electronic Journal.

Juselius, K. (1995), Do purchasing power parity and uncovered interest rate parity hold in the long run?, Journal of Econometrics An example of likelihood inference in a multivariate time-series model, 69(1)

Kalyoncu , H. (2009), New evidence of the validity of purchasing power parity from Turkey, Applied Economics Letters , 16(1), 63-67.

Karfakis, C. and Moschos, D. (1989), Testing for long run purchasing power parity: a time series analysis for the Greek drachmas. Economic Letters, 30(3). 245–248.

Keynes, J.M. (1936), Fluctuations in Net Investment in the United States, the Economic Journal, 46(183), 540-547

Kremers , J.J.M , Ericsson , N. and Dolado , J. (1992), The Power of Cointegration Tests, Oxford Bulletin of Economics and Statistics, 54(3), 325-48.

Kurita, T. (2008), Common Stochastic Trends and Long-Run Price Leadership in the US Gasoline Market , CAES working paper.

Kwapil , C. and Scharler , J. (2010), Interest rate pass-through, monetary policy rules and macroeconomic stability, Journal of International Money and Finance, 29(2).

Lagoarde-Segota, T. , Brian M. and Luceya, B. M. (2008), Efficiency in emerging markets—evidence from the MENA region, Journal of International Financial Markets, Institutions and Money. 18(1), 94–105.

Larsson, R., Lyhagen, J. and Lothgren, M. (2001), Likelihood-based cointegration tests in heterogeneous panels, Econometric Journal, 4, 109-42.

Lim , K.P. , Luo, W. and Kim, J.H. (2013), Are U.S. stock index returns predictable? Evidence from automatic autocorrelation-based tests, Applied Economics, Taylor and Francis, 45(8), 953-962.

Lothian , J. R and Taylor , M. P. (1996), Real Exchange Rate Behavior: The Recent Float From the Perspective of the Past Two Centuries, Journal of Political Economy. 104(3), 488-509.

Lothian, J. R. and Taylor, M.P. (2008), Real Exchange Rates Over the Past Two Centuries: How Important is the Harrod-Balassa-Samuelson Effect?, 118(532), 1742-1763

Lothian, J. R. and Devereux , J. (2011), Exchange rates and prices in the Netherlands and Britain over the past four centuries, Papers. 135, Bank of Greece.

Ludvigson, S,. and Lettau, M. (2001), Consumption, aggregate wealth and expected stock returns, Staff Reports from Federal Reserve Bank of New York. No 77.

MacDonald, R. (1993), Long-Run Purchasing Power Parity: Is it for Real?, The Review of Economics and Statistics, 75(4), 690-695.

Marashdeh , H. and Shrestha , M.B. (2008), Efficiency in Emerging Markets - Evidence from the Emirates Securities Market, European Journal of Economics, Finance and Administrative Sciences, (12)

Meese, R. and Rogoff , K. (1983), Empirical Exchange Rate Models of the Seventies: Do They Fit Out of Sample?, Journal of International Economics 14, 3-24.

Merkies, A. H. and Steyn, I.J. , (1994), Modelling changing lag patterns in Dutch construction, Journal of Economic Dynamics and Control, Elsevier,18(2), 499-509.

Milne , A. (2009), Alistair Milne on Robert J. Shiller, The Subprime Solution: How Today's Global Financial Crisis Happened and What to Do About It, World Economics, World Economics, 10(2), 173-176

Moustafa , M.A. (2004), Testing the Weak-Form Efficiency of the United Arab Emirates Stock Market, International Journal of Business, 9(3)

Mundell, R.A. (1961), A Theory of Optimum Currency Areas, The American Economic Review, 51(4), 657-665.

Mussa , M. (1984), The Theory of Exchange Rate Determination: A chapter in Exchange Rate Theory and Practice, National Bureau of Economic Research, Inc. 13-78.

Narayan , P.S. and Prasad, A. (2009), Evidence on PPP from a cointegration test with multiple structural breaks, Applied Economics Letters, 16(1), 5-8.

O'Connell, P. G. J. (1998), The overvaluation of purchasing power parity, Journal of International Economics. 44, 1-19.

Officer, L. H. (1976), The Purchasing Power Parity Theory of Exchange Rates: A Review Article, Int. Monet, Fund Staff Papers, 23(1), 1-60.

Papell, D. and Theodoridis, H. (2001), The choice of numeraire currency in panel tests of purchasing power parity, Journal of Money, Credit and Banking. 33(3), 790-803.

Papell, D. H. (1997), Searching for stationarity: purchasing power parity under the current float, Journal of International Economics (43), 313-332.

Patterson, K. (2000), An introduction to applied econometrics: a time series approach, Palgrave Macmillan.

Paya , I. and Peel , D.A. (2004), Nonlinear Purchasing Power Parity under the Gold Standard, Southern Economic Journal. 71(2) , 302-313 .

Pedroni P. (1997), Cross Sectional Dependence in Cointegration. Tests of Purchasing Power Parity in Panels, Mimeo, Indiana University.

Peel , D. , Peel, M. and Venetis , I. (2004), Further empirical analysis of the time series properties of financial ratios based on a panel data approach, Applied Financial Economics, Taylor and Francis Journals, vol. 14(3), 155-163.

Pesaran, M.H., Shin ,Y. and Smith , R.J. (2001), Bounds Testing Approaches to the Analysis of Level Relationships., Journal of Applied Econometrics 16(3), 289–326.

Pesran, B. and Pesaran M. H. (2010), Time series econometrics using Microfit 5.0: A user's manual

Phillips, P.C.B. and Perron, P. (1988), Testing for a Unit Root in Time Series Regression, Biometrika, 75(2), 335-346

Poole, W. (1967), Speculative Prices as Random Walks- An Analysis of Ten Time Series of Flexible Exchange Rates, Southern Economic Journal 33, 468-478.

Rogoff, K. (1996), The Purchasing Power Parity Puzzle, Journal of Economic Literature. 34(2), 647-68.

Rutledge, E. (1994), Establishing a successful GCC currency union: preparations and future policy choices, Gulf Research Center, 33 pages.

Said, S.E. and Said, D.A. (1984), Testing for Unit Roots in Autoregressive-Moving Average Models of Unknown Order, Biometrika , 171, (3) , 599-607

Salim, R. and Hassan, K. (2009), Does the relative population growth affect purchasing power parity?, Applied Economics Letters, Taylor and Francis Journals, 16(1), 103-107.

Sargan .J and Bhargava , A. (1983), Testing Residuals from Least Squares Regression for Being Generated by the Gaussian Random Walk, Econometrica, 51(1), 153-74.

Sargan, J. (1964), Wages and Prices in the United Kingdom: A Study in Econometric Methodology, 16, 25–54. in Econometric Analysis for National Economic Planning, ed. by P. E. Hart, G. Mills, and J. N. Whittaker. London: Butterworths

Sarno, L. and Taylor, M.P. (1998), Real Exchange Rates under the Recent Float: Unequivocal Evidence of Mean Reversion, Economics Letters, 60, 131-37.

Seyyed , A. and Fazal, J. (2006), Information transmission between the Gulf equity markets of Saudi Arabia and Bahrain, 20(3), 276-285

Seyyed, A. , Fazal J. and Alsakran , S. (2002), Testing the Random Walk Behaviour and Efficiency of the Gulf Stock Markets, 37(3), 317-480

Shiller, R.J. and Perron, P. (1985), Testing the Random Walk Hypothesis: Power Versus Frequency of Observation, Economics Letters. 18(4), 381-86.

Shin, Y., YU, B. and Greenwood-Nimmo, M. J. (2014), Modelling asymmetric cointegration and dynamic multipliers in a nonlinear ARDL framework, In William C. H. & Sickles, R. C. (Eds), Festschrift in Honor of Peter Schmidt: Econometric Methods and Applications.

Simpson, M. (2002), Studies of Identification and Exogeneity Testing of Exchange Rate Models, PhD manuscript, Brunel University.

Smith, R.P., and Hunter, J., (1985), Cross Arbitrage and Specification in Exchange Rate Models, Economics Letters 18, 375-376.

Squalli, Jay (2007), Electricity consumption and economic growth: Bounds and causality analyses of Energy Economics, Volume 29, Issue 6

Steyn, I. J. (1996). State Space Models in Econometrics: A Field Guide. Phd, Thesis, University of Amsterdam

Sturm, M. and Siegfried., N. (2005), Regional monetary integration in the member states of the Gulf Cooperation Council, European Central Bank, Occasional paper series. 31.

Taylor, A. M. (2002), A century of purchasing power parity, The Review of Economics and Statistics. 84(1), 139-150.

Taylor, A. M. and Taylor, M. P. (2004), The purchasing power parity debate, Journal of Economic Perspectives. 18, 135–158.

Taylor, M. P. (1988), An empirical examination of long-run purchasing power parity using cointegration techniques, Applied Economics. 20, 1369-1381.

Taylor, M. P. (1995), The economics of exchange rates, Journal of Economic Literature. 33(1). 13-47.

Taylor, M. P. (2009), Long-run purchasing power parity and real exchange rates: Introduction and overview, Applied Economics Letter. 16, 1-4.

Taylor, M.P. & Peel, D.A., (2000), Nonlinear adjustment, long-run equilibrium and exchange rate fundamentals, Journal of International Money and Finance, Elsevier, 19(1), 33-53

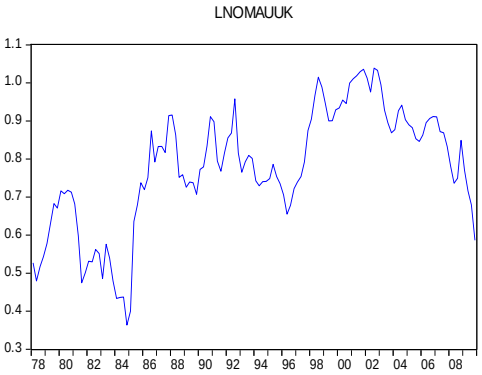
Vaknin , S. (1995), Deja V-Euro, the History of Previous Currency Unions, , phd.

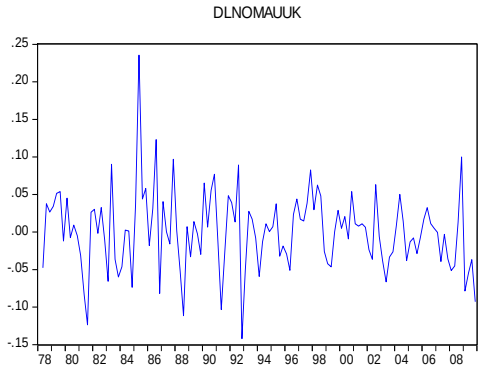
Walid, A. (2010), Testing the evolving efficiency of Arab stock markets , International Review of Financial Analysis, 19(1)

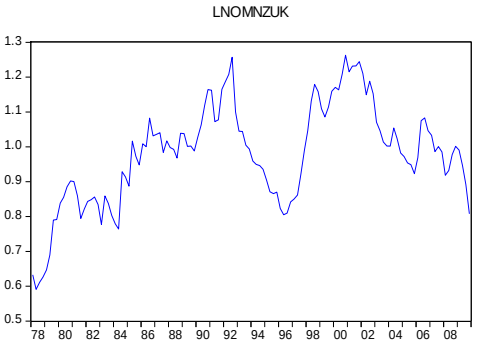
White, H. (1982), Maximum Likelihood Estimation of Misspecified Models, Econometrica, 50(1), 1-25

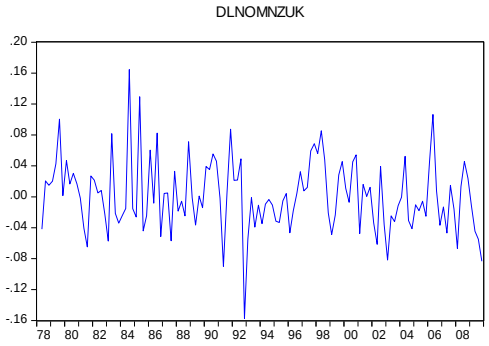
Yule, G. U. (1926), Why Do We Sometimes Get Nonsense Correlations Between Time Series? A Study in Sampling and the Nature of Time Series, Journal of the Royal Statistical Social Sciences, (89), 1-64.

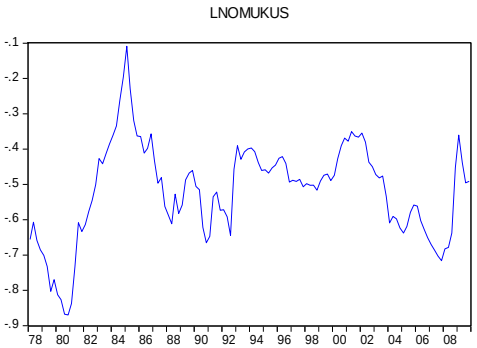
APPENDIX A: Log & Differenced of Nominal Exchange Rates, Cross Rates, Terms of Trade and Prices

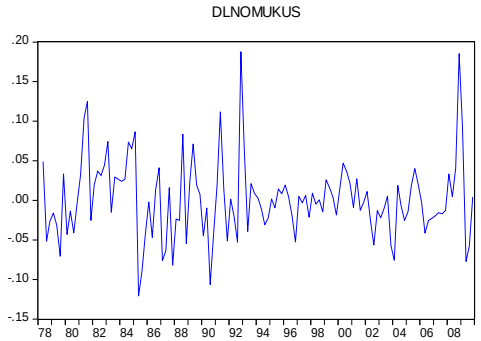


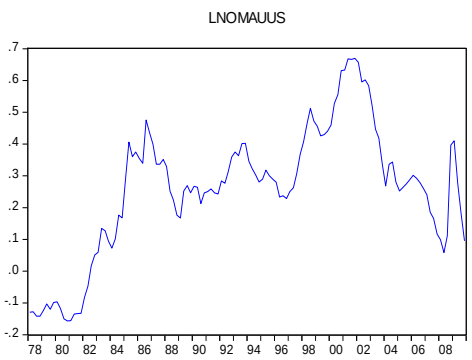


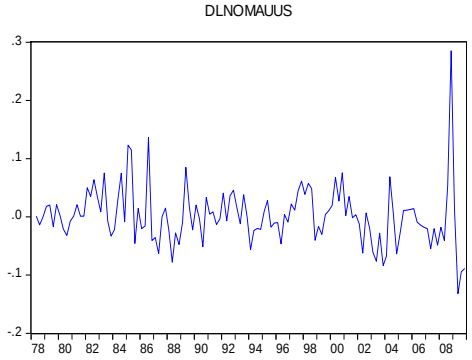




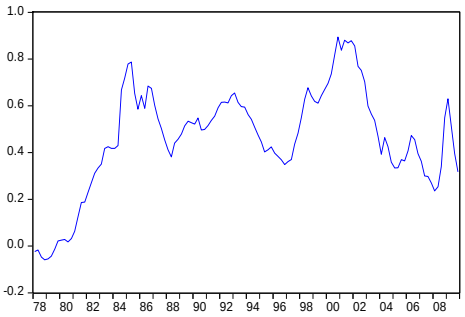




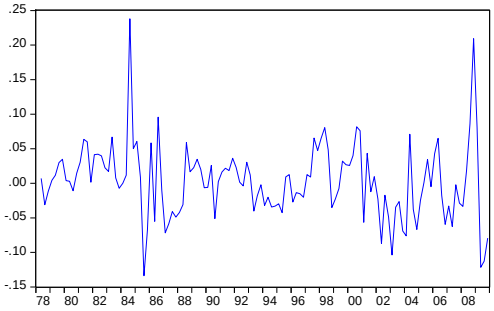




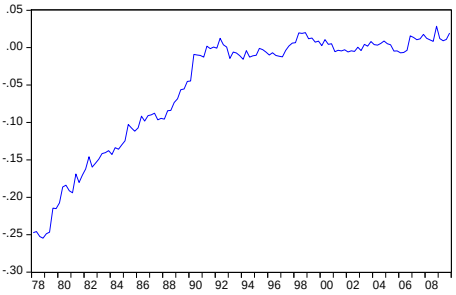
LNOMNZUS



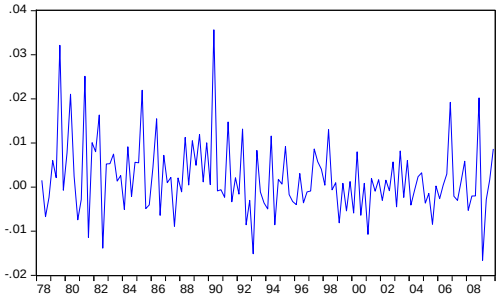
DLNOMNZUS



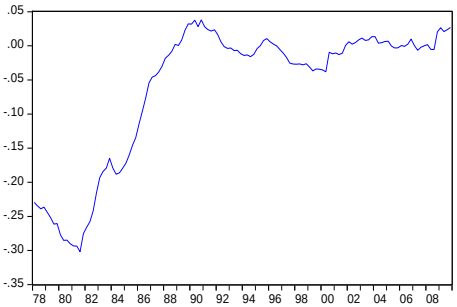
LTOTUKUS



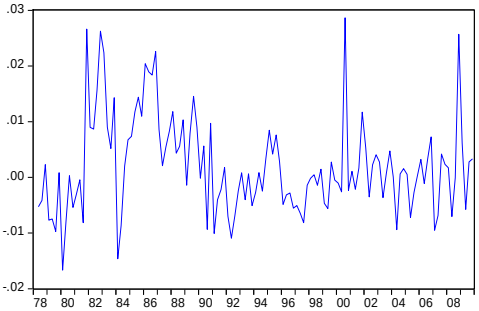
DLTOTUKUS



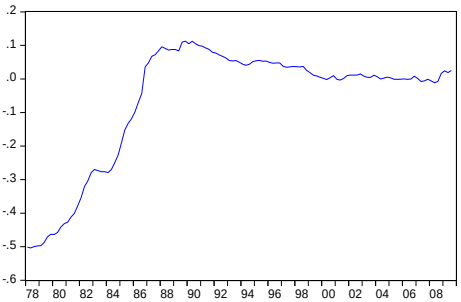
LTOTAUUS



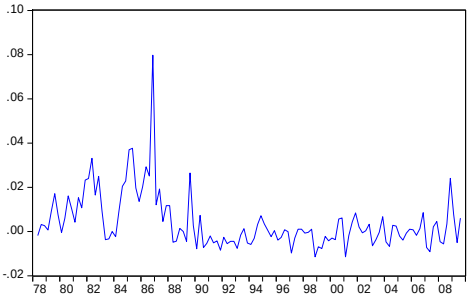
DLTOTAUUS



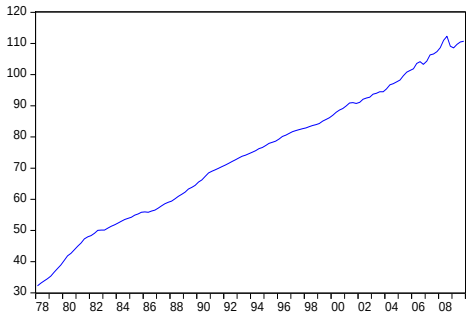
LTOTNZUS



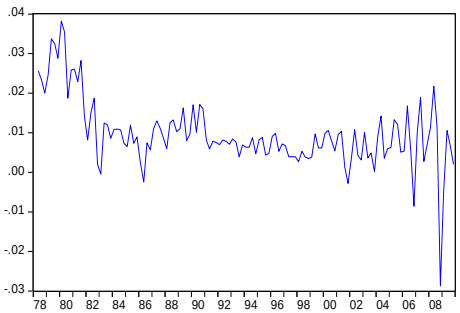
DLTOTNZUS



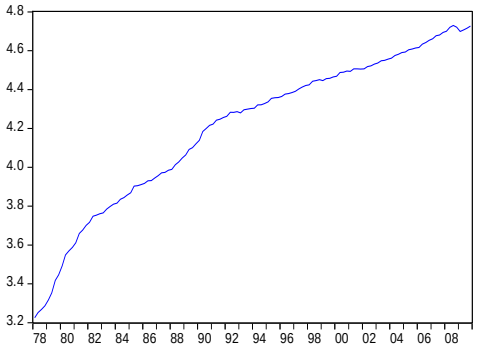
PUS



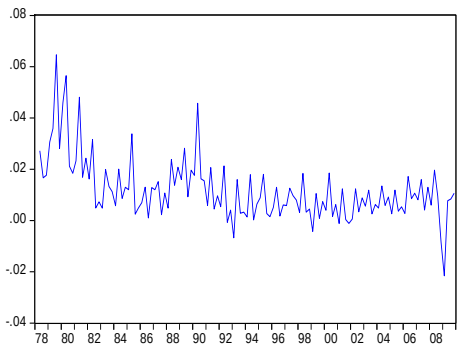
DLPUS



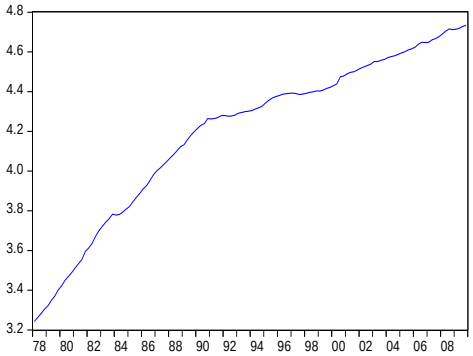
LPUK



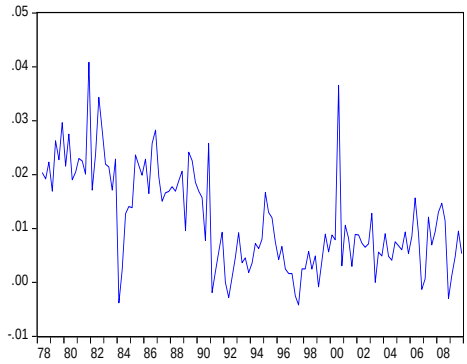
DLPUK



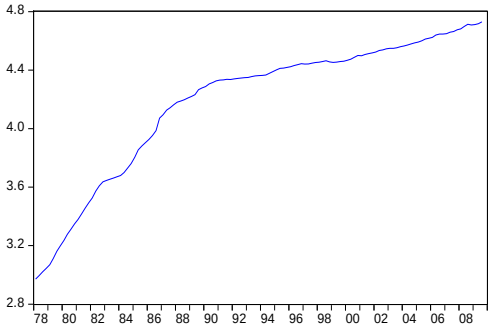
LPAU



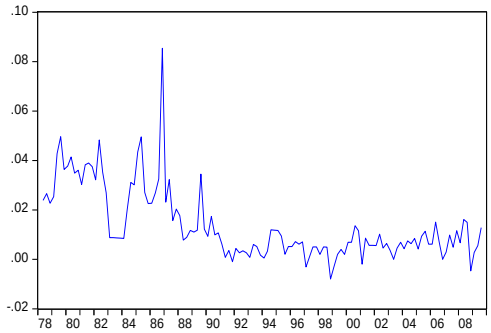
DLPAU



LPNZ

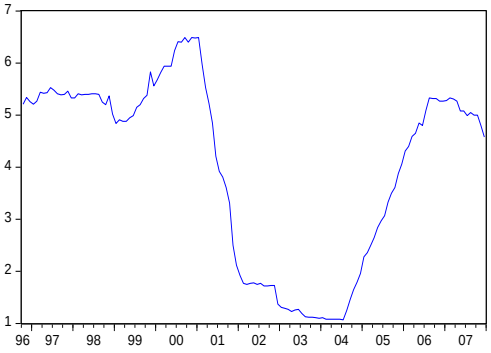


DLPNZ



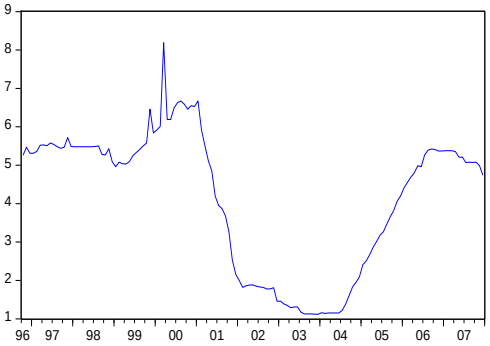
APPENDIX B: Log & Differenced Interest Rates

1week i.r

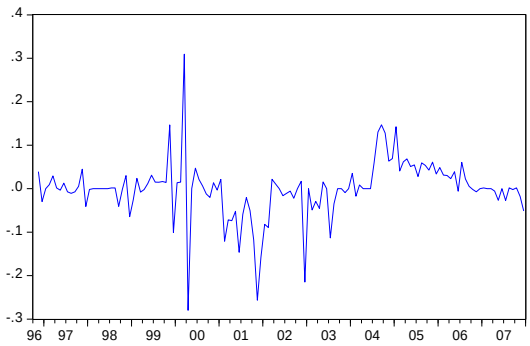


DLONEWEEKIR

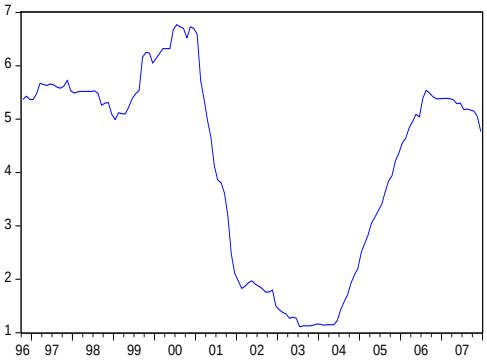
1month i.r



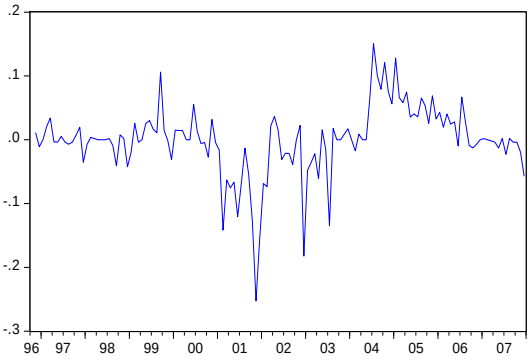
DLONEMONTHIR



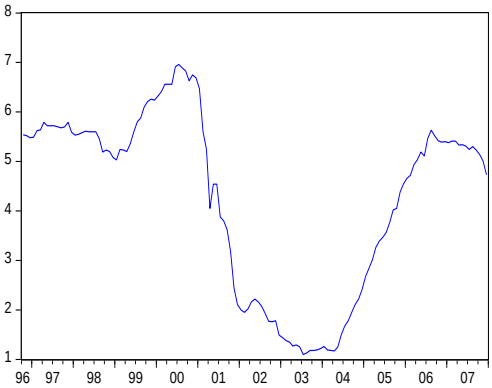
THREEMONTHSIR



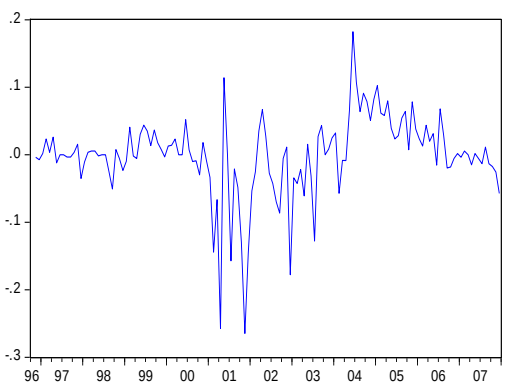
DLTHREEMONTHSIR

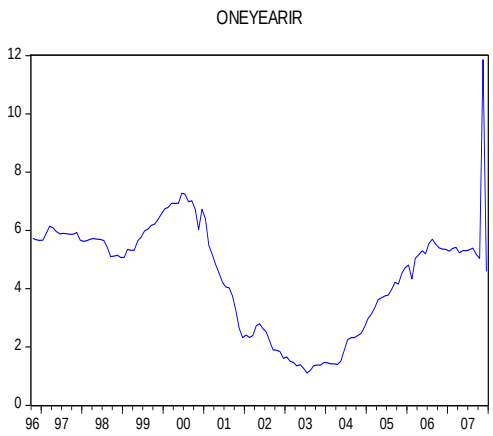


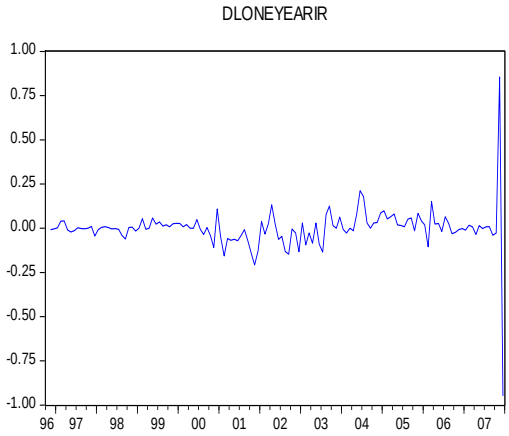
SIXMONTHSIR



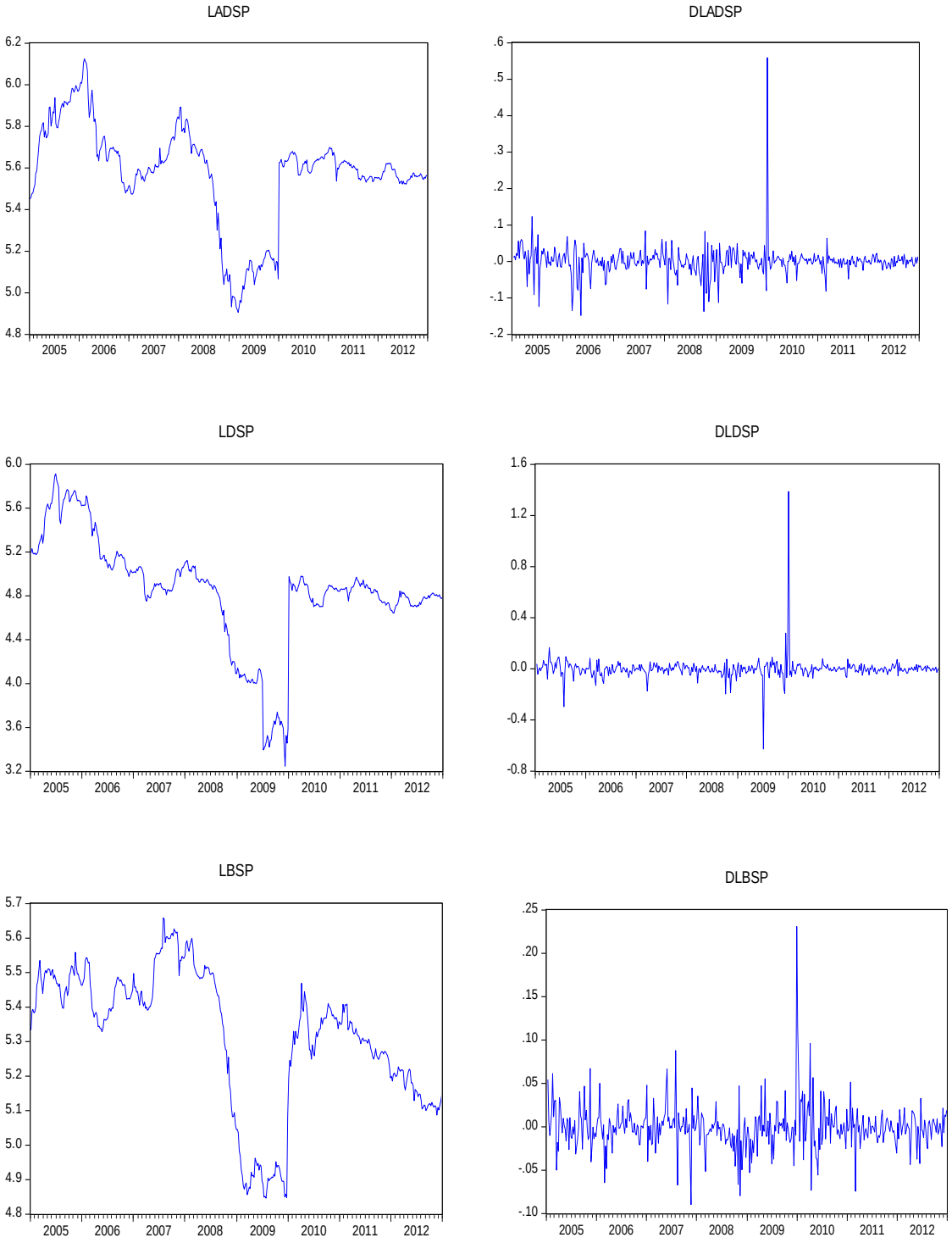
DLSIXMONTHSIR



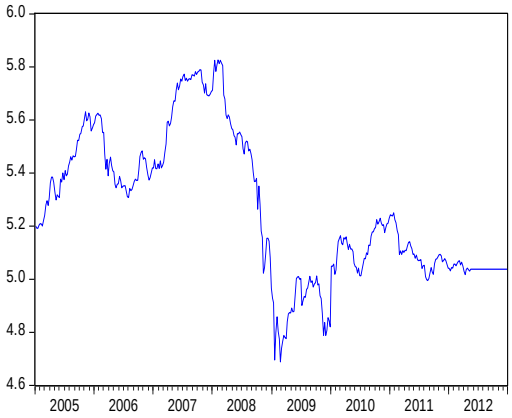

ONEYEARIR
12
10
8
6
4
2
0
96 97 98 99 00 01 02 03 04 05 06 07


DLONEYEARIR
1.00
0.75
0.50
0.25
0.00
-0.25
-0.50
-0.75
-1.00
96 97 98 99 00 01 02 03 04 05 06 07

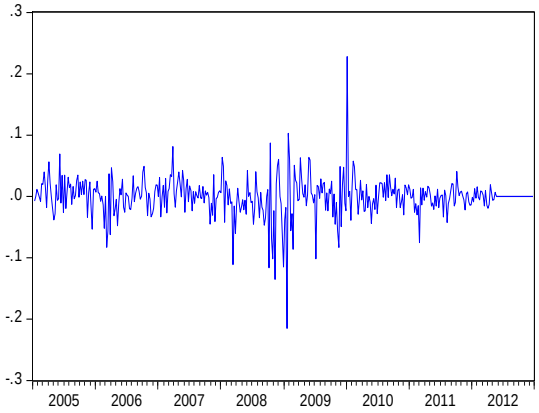
APPENDIX C: Log & Differenced Stock Prices



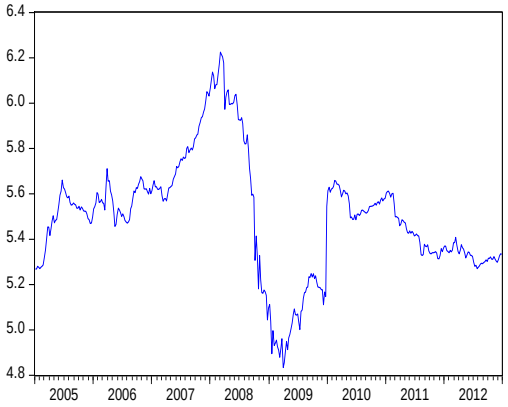
LKSP



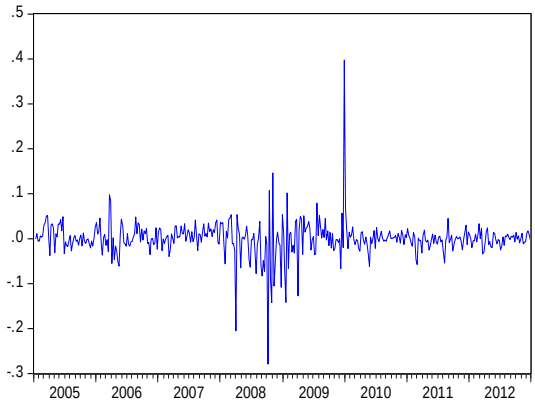
DLKSP



LOSP

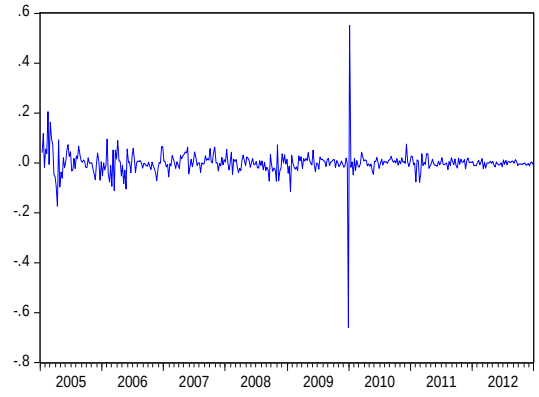


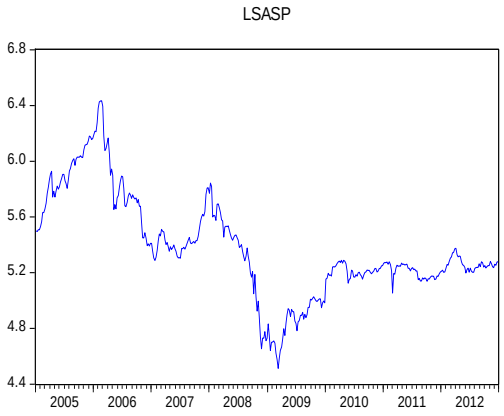
DLOSP

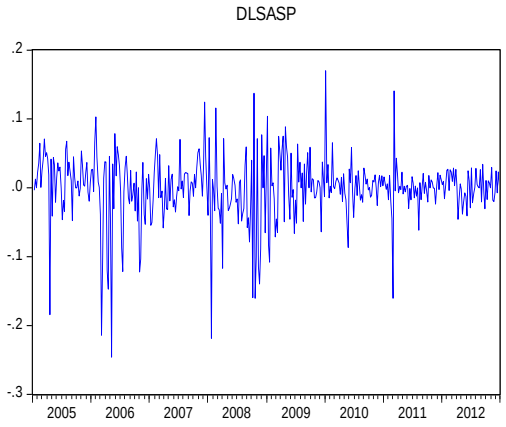


LQSP

DLQSP




LSASP
6.8
6.4
6.0
5.6
5.2
4.8
4.4
2005
2006
2007
2008
2009
2010
2011
2012


DLSASP
.2
.1
.0
-.1
-.2
-.3
2005
2006
2007
2008
2009
2010
2011
2012