Real Exchange Rate in Commodity Exporting Countries

M Mahdi Lotfi Heravi

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Adam Smith Business School

University of Glasgow

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Abstract

The aim of this thesis is three-fold. First, in contrast to developed exporting countries such as Australia, New Zealand and Canada, Middle East oil exporting countries are years behind achieving the prerequisites for floating exchange rate and Inflation Targeting monetary regime. On the other hand, their performance under fixed exchange rate (to the US dollar) has brought them some painful experience such as the Dutch Disease and high inflation. For a sample of five of these countries – Qatar, Oman, Kuwait, Saudi Arabia and the UAE – we conduct a set of counterfactual experiments. We empirically simulate government consumption expenditure, under a hypothetical peg to a nominal anchor (oil price in either the radical or moderate version) or to a basket (containing the US Dollar, Yen and the Euro) and compare this simulation with whatever exchange rate regime each country actually followed. We find that lower volatility of real oil price in local currency causes lower volatility in government expenditure and fiscal balance as a share of GDP. Hence, we face a less volatile economy.

Second, we determine the equilibrium exchange rate (using BEER) of these five oil exporting countries in the Persian Gulf which depend heavily on exports of oil, natural gas and oil products. We employ a new data set for the real effective exchange rate of these countries which is updated annually and covers the period from 1980 to 2011. Given the limited length of the sample (32 years) and low power of individual country by country tests for unit root and cointegration, estimating separate equations for each country (time series) does not provide us with precise results; therefore, to increase the efficiency of the estimators, we employ panel analysis. We apply the pooled mean-group (PMG) of Pesaran et al. (1999) and four more panel estimators for a robustness check. All estimators strongly support the positive effect of real oil price on the real effective exchange rate (i.e. higher real oil price leads to appreciation of the real effective exchange rate) which is consistent with theoretical predictions and with previous studies for commodity (oil) exporting countries. The productivity deferential elasticity is 0.10 which is consistent with the results of the related literature such as the studies of MacDonald and Ricci (2004) for South Africa, and of Lee et al. (2008) for 48 countries over 1980-2004. The BEERs of Qatar, Kuwait and (to some extent) the UAE follow their real effective exchange rates. From 2000, with the increase in oil price, the BEERs appreciate while the real exchange rate of Oman and Saudi Arabia decline; therefore, the Saudi Arabian and Omani currencies get undervalued.

Third, employing a new data set of Canadian commodity price indices, we revisit the Canada Bank Equation and introduce a new version with more fundamentals. We present a similar equation for Australia as one of the other developed commodity exporting countries. Using cointegration and the first differences analysis between real exchange rate and fundamentals, we investigate the SVECM and SVAR frameworks to decompose the variance of real exchange rate of Canada and Australia. In the SVECM analysis, the productivity differential and commodity price are the main contributor to the variance

of the real exchange rates of Australia and Canada. For the SVAR analysis, we confirm that, as in the literature, demand shock is the dominant force in explaining the variance of real exchange rates of both countries. This result does not change even by adding the commodity price shock to the SVAR framework.

Contents

List of Tables

List of Figures

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Declaration

I declare that, except where explicit reference is made to the contribution of others, that this dissertation is the result of my own work and has not been submitted for any other degree at the University of Glasgow or any other institution. M Mahdi Lotfi Heravi

Part I

Thesis Introduction

Oil is still the most important source of energy for our world and is a political commodity. Most of the developed or developing countries, whether oil importer or exporter, are concerned about its availability and price. On the demand side, increasing oil consumption in India, China, and some other emerging economics, pushes the oil price upward. On the supply side, the Middle East has been a major source of oil supply for decades. The timing of the Peak Oil Theory,[1] if not rejected, has been postponed by the US expansion of oil production. Based on the British Petroleum Projection, the US will be energy self-sufficient by 2030 and become the biggest oil producer by 2020, outpacing Saudi Arabia. The US crude oil daily production jumped 14 per cent between 2008 and 2011, from 5 million to 6 million barrels.[2] On the other hand, in the Middle East, Iraq aims to increase its daily oil export to 7 million barrels by 2018, and Saudi Arabia keeps pumping oil into the market at a constant level of 7 to 9 million barrels per day. In 2012, the Iranian oil export declined due to sanctions but it has been substituted by Iraq, the UAE and Saudi Arabia. Meanwhile an agreement at the Iranian nuclear talks may mean the removal of sanctions and the possibility of more Iranian oil coming into the market after summer 2015. With this positive projection on the supply side of the oil market, the Middle East will still be a major oil exporter, with its economy linked tightly to the oil market.

The Middle East is best known as for its position as a strategic energy supplier to the world, and its geopolitical role in the world economy is undeniable. Table 1 reports the estimated oil reserves, daily oil production, daily oil export, population and the GDP of the oil exporting countries in the Middle East. The cost of oil extraction in the Persian Gulf oil exporting countries is among the cheapest in the world. In 2012, they held 57 per cent of the world oil reserves, 44 per cent of the world oil export and 32 per cent of the world oil production.[3]

[1]Peak oil is the point in time when the maximum rate of oil extraction is reached, after which the rate of production is expected to decline.

[2]The World Energy Outlook 2012, International Energy Agency (IEA).

[3]The OPEC Annual Statistical Bulletin 2012.

Table 1- Some Statistics of the Persian Gulf Oil Exporting Countries - 2011

Country	Oil reserves	Daily Oil production	Daily oil export	Population	GDP
Kuwait	104	2.6	1.8	2.7	166
Oman	5.5	0.888	0.738	3.154	90.66
Saudi Arabia	267	9.311	7.2	27	740
Qatar	25.38	0.833	0.588	2	189
UAE	97.8	2.56	2.142	5.4	271
Iran	154	3.5	2.5	79	997

Notes: Oil reveres are in Billion Barrels, daily production and export in Million Barrels, GDP is PPP in Billion Dollars and Population in Millions.

Oil revenue is the backbone of these economics; for example, in Kuwait, oil accounts for nearly half of the GDP, 90 per cent of export revenues, and 95 per cent of government income. Qatar's proved reserves of natural gas are nearly 26 trillion cubic metres, about 14 per cent of the world total gas reserves and the third largest in the world (after Russia and Iran). In Qatar, oil and gas account for more than 50 per cent of GDP; 70 per cent of government revenues and 85 per cent of export revenue. With 267 billion barrels of oil (one-fifth of the world's proven total petroleum reserves) and 7.2 million barrels in daily export, Saudi Arabia is a major oil supplier to the world. Oil accounts for 75 per cent of its government revenue, 90 per cent of export revenue and 45 per cent of GDP. Oman exports around 700 thousand barrels of oil per day. Among all these countries, only the UAE has partially reduced the oil dependency of its economy, but 45 per cent of its total export is still oil related.[4]

On the other hand, these countries – Saudi Arabia, Kuwait, Oman, Qatar and the United Arab Emirates – have some of the fastest growing populations in the world. An Economist Intelligence Unit (EIU) report indicates that by 2020 the total population of these countries will grow by 34 per cent to 53 million with the majority under 25 years of age. In comparison to their energy sector, their manufacturing and service industries are tiny. These economies are heavily subsidized and they have almost no tax revenue; a large proportion of their service industries depends on foreign labour; they have free health and education, and subsidized energy, food and housing. Their governments are faced with very high domestic energy consumption which constrains their oil exports in the long term; therefore, it appears most likely that the current oil price just manages to cover the increased government spending to handle all the current subsidies and to continue the development plans for now. However, with the high population growth rate, any sustained drop of oil price may be devastating. This would cut the public

[4] For the UAE export, we should consider the huge volume of re-export to Iran. In recent decades, the UAE has been Iran's intermediary to the world economy.

spending and subsidies, speed the depletion of cash reserves and may consequently lead to political instability.

In recent decades the Middle East economic and political performance has been a mix of major failures and some successful attempts. Most of the countries in the region have tried to diversify their economies. They are open to imported labour and are rentier states with massive unemployment, high inflation, and non-democratic government. The decline of oil price in the 1980s hurt their economies hard; although, between the 1960s and the 1980s, the massive oil revenue reduced poverty and established some infrastructures. In addition to the economic issues, the Middle East suffers from political turmoil.

In a Middle East where the political atmosphere is poisoned by various conflicts and tensions, religious extremists and lack of trust, peace, democracy and political stability are prerequisites for prosperity. Political and social reforms are out of the scope of this thesis; therefore in two chapters we focus solely on the macroeconomic challenge, its consequences, solutions and especially on the proper monetary policy and on the equilibrium real exchange rate for these oil exporting countries facing swings in oil price.

For these oil exporting countries, almost all of which have their currencies pegged to the US dollar,[5] fluctuations in the world oil price and their exchange rate against the major currencies are an important source of macroeconomic instability. In recent decades, they have faced some episodes when their anchor currency (the currency to which they are pegged) has moved in one direction while the price of their principal export commodities has moved in the opposite direction. Figure 1 shows the example, in the 1990s, of a weak oil price coinciding with a strong anchor currency (the US dollar).

Apart from some developed commodity exporting countries (such as Norway, Australia and Canada), most of the commodity exporting countries have experienced a long history of high inflation which has undermined their central bank credibility. To fight against inflation, in the absence of credible monetary intuitions, some economies import credibility by pegging their currency to an anchor currency such as the US dollar. In a world of diversified trade, this policy helps them to control inflation to some extent but it means that they are hostage to the fluctuation of their anchor currency against the other major currencies and to the volatility of commodity price. As Figure 2 presents, the primary problem for these five countries is the high inflation in the region which coincides with high oil price and depreciation of the US dollar against other major currencies, such as the Euro and Yen, of their main trading partners.

[5] Since 2007, Kuwait has pegged its currency to a basket of Euro and US dollar. The main reason for this decision announced by the Kuwaiti government was the depreciation of the US dollar against the other major currencies, which caused inflationary pressures

In the face of fluctuations in oil price and in the value of the US dollar against other major currencies, these economics have been damaged through two channels. The first channel is imported inflation. The larger part of these countries' imports are from non-US markets such as those of Europe and Japan. With a weak US dollar, their imports are more expensive; under the dollar peg, adjustment can only be expected to take place through the inflation which is experienced by most of these countries. As MacDonald (2010) argues, this process is slow and boosts inflationary expectations which can cause further misalignment[6] in the real exchange rate, hurting competitiveness and long term growth.

The 'Impossible Trinity'[7] explains the second channel. With an open capital market and a currency pegged to the US dollar, these countries cannot follow an independent monetary policy to fight against inflation. The hands of their central bank are tied; therefore, they cannot apply a domestic monetary policy while their nominal interest rate closely follows the interest rate in the USA. Consequently, the high inflation causes a negative real interest rate which increases aggregate demand which in turn expands inflationary pressures. Hence, the peg to the US dollar links their monetary policy to that of the US while their business cycles may not be correlated with the US. Indeed, as oil exporters, their needs and the shocks they face are completely different from those of the US as an oil importer.[8]

In their development process, these economies have gone through major structural changes; therefore, a perfect exchange rate regime (to constantly perform miracles) does not exist. According to Frankel (1999), no single exchange rate regime is right for all countries at all times. The choice of the right exchange rate regime depends on the circumstances of the country in question, at any one time. As most policy makers in the region confirm, in recent decades, pegging to the US dollar has worked for some of the Persian Gulf oil exporting countries but recently most governments in the region have acknowledged the flaw in this regime choice.

The current popular monetary policy regime recommended by many monetary economists and adopted by some countries (such as Australia, Chile, Brazil, the United Kingdom, Sweden, Canada, New Zealand, Norway, Korea, and South Africa) is Inflation Targeting which comes with a floating exchange rate regime. The currency crises of the 1990s and early years of the 21st century have proved the failure of the peg exchange rate regime. In fact, all proposed anchors in monetary economics do the same job: they stabilize prices. As Cashin and McDermott (2001)

[6] An exchange rate is called misaligned if its movements are not linked to the movements of the fundamentals.

[7] Impossible Trinity or Triangle of Impossibility: we cannot simultaneously have fixed exchange rate, free capital flow and independent monetary policy. A country must select two out of the three. It can fix its exchange rate, and have its own monetary policy, but only by maintaining controls on capital flows (as China has done); it can leave capital movement free and adopt an independent monetary policy, but only by letting the exchange rate fluctuate (as the UK or Canada have done); or it can go for free capital flow and fixed exchange rate, but only by a dependent monetary policy (as in Argentina from 1991 to 2002).

[8] By the increase in the US oil production, this may change in the future.

argue, if the Middle East oil exporting countries go for Inflation Targeting, there is the danger that fluctuations in oil price may cause large volatility[9] in exchange rates and that this may lead to volatility in inflation and in non-oil output.

On the other hand, these economies have not satisfied the prerequisites for a functioning flexible exchange rate regime with Inflation Targeting. First, they do not have independent central banks. Second, they do not have developed financial markets. Third, the implementation of the floating exchange rate regime in their thin foreign exchange markets is not applicable efficiently. In the long term, they may be proper candidates for a flexible exchange rate regime with Inflation Targeting, if they satisfy these prerequisites. However, at this stage Inflation Targeting with the CPI as the target is not a proper option.

The CPI is the usual target in the Inflation Targeting framework, but this may not be the best choice especially for developing commodity exporting countries. Most commodity exporting countries suffer from swings in the price of their commodities which cause severe business cycles; these large booms and busts hurt the health of the economy. The developed commodity exporting countries such as Canada, Australia and Norway have already managed this problem. They have diversified their economics, and commodities are only one part of their extensive exports unlike the Middle East oil exporting countries where commodities make up the major part of their economies. Frankel (2011a) points out that several commodity exporters such as Canada, Australia and Chile have suitable monetary and fiscal policies to moderate the adverse effect of the variability of commodity prices. In these countries the procyclicality issue is a historical and not a current phenomenon.

Often in the developing world, particularly in the developing commodity exporting countries, macroeconomic policy is procyclical rather than countercyclical or acyclical. The Persian Gulf oil exporting countries have also faced the procyclicality of fiscal policy. Their fixed exchange rate regime and their openness to the international capital market have constrained their monetary policy; this has left fiscal policy as the main contributor to stabilizing their economies. There are two major reasons for this procyclicality: the swings in commodity price; and the mismanagement of their monetary and fiscal policies. For these countries, as Husain et al. (2008) argue, the link between oil price and fiscal policy is well documented and the fiscal policy is the major channel to transfer volatility from the oil price to the economy. Therefore, government expenditure increases when they face high oil prices and decreases when oil prices go down. As indicated by the literature, the establishment of institutions is the main solution for a procyclical fiscal policy. Chile, as a commodity exporting country, is a good example. It assigned a committee, not influenced by any political party, to predict the copper price

[9] Devereux and Lane (2003), Rose (2000) and Klein and Shambaugh (2010) define volatility of exchange rate as the standard deviation of the monthly percentage change.

and to control government spending. This helped Chile to go through the 2008-2009 recession smoothly.

In the absence of functioning fiscal institutions, a proper exchange rate regime may smooth oil prices in the local currency, and may reduce the volatility of government expenditure. Therefore, in chapter two, by introducing an alternative exchange rate regime, we aim to decrease the volatility of the fiscal policy and consequently enhance welfare and economic growth.

The second chapter of this thesis introduces an index of export prices instead of the CPI. We empirically test a new monetary regime for developing commodity exporting countries. The context is the oil exporting countries in the Persian Gulf which are heavily dependent on their oil windfall revenue and are price taker small economies. The choice of monetary regime should be based on the structural characteristics of these countries; and, in particular, the role of oil as the main part of their GDP, export and government revenue should be recognized.

The questions to be examined in the second chapter are as follows: what is the appropriate exchange rate regime for a developing oil exporting country? Does the choice of anchor make an important difference? Which nominal variable is the best candidate for an anchor in monetary policy? A contribution of this chapter is that, within the Inflation Targeting framework, we consider other possible anchors instead of the CPI. In our proposed target, oil has much more weight in comparison to the fuel in the CPI.

For the Persian Gulf oil exporting countries, this chapter offers a peg to a nominal anchor (oil price, in either the radical or moderate version) which may work. We test the possibility and consequences of using oil price in a basket of major currencies as an anchor for monetary policy in the oil exporting countries. We evaluate and compare the performance of the counterfactual pegs to the actual regime in place. We do a set of counterfactual experiments, determining (for each these oil exporting countries) how the volatility of government expenditure and would have changed if they had pegged their currencies to oil prices; to a basket of oil, US dollar, Yen and Euro; or to a basket of those three currencies as compared to a peg to the US dollar exchange rate regime which they actually follow.

In addition to criticizing the peg exchange rate regime, there has been another growing debate regarding monetary union (currency union) in the region.[10] Although a single currency for these countries would encourage trade and investment, there are doubts as to whether these Persian Gulf oil exporting countries are an "Optimum Currency Area",[11] as they still

[10] Currently, there are five examples of monetary union in the world. Three of them are in Africa, one in the Caribbean and one in Europe.

[11] The Optimum Currency Area is a geographical region where adopting a single currency, in comparison

do not satisfy the prerequisites for a monetary union. Reviewing the EU process of monetary union, it is evident that a high volume of trade within the economic region is an important factor in favour of a monetary union; however these five countries do not have enough intra trade, political convergence and the proper institutions to establish currency union. Even after satisfaction of currency union requirements, for each of these countries, an important question is the proper real exchange rate or equilibrium exchange rate to enter a Euro style monetary policy. The determination of equilibrium real exchange rates involves substantial uncertainties such as: the time frame (short, medium or long-run); the choice and definition of the dependent variable (real exchange rate or real effective exchange rate); the selection of the model, and of the econometric method.

The concept of equilibrium exchange rate has been a key element of the annual IMF recommendations for all countries. On the national level; it is one of the important components of an economic policy which promotes economic growth. A misaligned exchange rate adversely affects the domestic economy thorough an overvaluation or undervaluation. On the other hand, it is also on the global agenda, because it is linked to the global imbalance phenomenon which is an international debate.

In the third chapter, we review the equilibrium exchange rate literature. This is a vast research area which has expanded with the introduction of the Euro and questions about the right value of the Chinese currency. Using the Behavioural Equilibrium Exchange Rate (BEER) approach of Clark and MacDonald (1998), for these five oil exporting countries in the Persian Gulf and applying different time series and panel estimation techniques, this chapter assesses the equilibrium exchange rates and misalignments (between the actual and the equilibrium exchange rates) from 1980 to 2011. Furthermore, we present the fundamentals which drive the real exchange rates of these countries.

Allocating chapters two and three to the real exchange rate of developing commodity exporting countries, in chapter four, we investigate the dynamic of real exchange rates for two developed commodity exporting countries: Canada and Australia. These countries have independent central banks and the proper institutions to implement flexible exchange rate regime and inflation targeting. The research in this chapter can shed light on the nature of real exchange rate in these developed commodity exporting countries. On the other hand, the results in this chapter should help developing commodity exporting countries to see where they will be in the long term and also their challenges in future.

The fourth chapter contributes to two types of literature: that of the long run equilibrium

to several currencies, could benefit the economy. The theory evaluates whether or not a region is ready for monetary union. See Frankel and Rose (1998, 2002) and Rose (2000).

relationship between real exchange rate and fundamental variables; and that of variance decomposition of real exchange rate. Monetary authorities should monitor the real exchange rate fluctuations. In theory, for any change in real exchange rate which is linked to the movements of fundamentals, they need not take action; however, if the real exchange rate movement is driven by non-fundamental factors such as speculative forces, then monetary authorities should dampen the effect of these shocks in order to control the volatility of exchange rate and its adverse effect on domestic economy.

For the long run relationship between real exchange rate and fundamental variables, we confirm the results of the original Canada Bank Equation and introduce a new version with three modifications: first, our quarterly data set covers an extended period, 35 years (1980-2014). Second, in addition to the commodity price indices of energy and non-energy, we add other fundamentals. Third, to our knowledge, this is the first study which employs the new Canada commodity price indices to check the robustness of the Canada Bank Equation. In contrast to the old data set used by Amano and van Norden (1995) which was a fixed weight index of commodity prices, the new one contains a broader set of commodities and production weights which are annually updated; therefore it considers the dynamic of the composition of commodity production in Canada. For comparison purposes we introduce a very similar long run relationship between the real exchange rate of Australia and its fundamentals. For Canada and Australia, we observe different reactions for demand and supply shocks, but the same pattern for a commodity price shock.

This chapter proceeds to SVECM and SVAR analysis. For the variance decomposition of real exchange that is in the SVECM framework, we consider the long run conintegration between real exchange rates and fundamentals. Productivity differential and commodity prices are the two main contributors to explain the variance of real exchange rate of both countries: Australia and Canada. For the SVAR analysis, when we consider the first differences of variables, we confirm the stylized fact in the literature that the main contributor to the variance of real exchange rate is demand shock. For Canada and Australia, adding commodity price index to the analysis does not change the results: demand shock is still the main factor in explaining the variance of the real exchange rates of both countries for the different periods.

In sum, the hope is that this thesis offers a useful contribution to the fields of international finance generally and exchange rate in developing and developed commodity exporting countries specifically. Findings are clear and well defined and open up a number of potential avenues for future research.

Part II

A Monetary Policy for the Persian Gulf Oil Exporting Countries

1 Introduction

The macroeconomic performance of the oil exporting countries and their role in the world economy closely depend on the price of oil in the international market. In the last decades, high oil price has been linked to the large current account imbalances across the world, the significant shifts in the wealth of countries, and the possession of the bulk of the global current account surplus by the Middle East oil exporting countries. Therefore the economics of these countries, and in particular their exchange rate regimes, are interesting subjects. In this chapter, we focus on the exchange rate regime of five oil exporting countries in the Middle East: Qatar, Kuwait, the UAE, Saudi Arabia and Oman.[12]

These counties have common characteristics. All these non-democratic kingdoms are small open economies which follow an exchange rate regime pegged[13] to the US dollar. They do not have sound institutions and independent central banks; they do not have their own developed financial markets and are vulnerable to swings in oil price. However, the peg to the US dollar has given them some benefits. It has reduced uncertainty, costs of trade and financial transactions and encouraged investment. At the same time, in contrast to some successful Asian economies, they have not been able to successfully diversify their economies to cope with the high rate of unemployment. Except for the UAE, in all of these countries, most of their export is still energy commodities.

Although, the currencies of these countries are pegged to the US dollar, most of their trade is with Europe and Japan. Therefore, any movement of the US dollar against the Euro and Yen can directly influence these economies. The fluctuation in oil price and the US dollar fluctuations against the other major currencies are the two main channels to hurt these economies. Although a weak US dollar may promote their non-oil exports and tourism industry, they do not have a mature and developed non-oil sector; therefore, the imported inflation could overtop all the benefits of the peg exchange rate. The primary motivation for this chapter is the high inflation in the region which has coincided with high oil price and depreciation of US dollar against other major currencies.

Frankel (2003a) describes the vulnerability of these countries in the 1980s and 1990s when

[12] The oil exporting countries in this study are: The Gulf Cooperation Council (GCC) countries excluding Bahrain. The GCC was formed in 1981 to create economic, scientific and business cooperation among its oil-exporting Arab members in the Persian Gulf region. The GCC consists of six members: The Kingdom of Bahrain, Kuwait, the Sultanate of Oman, Qatar, the Kingdom of Saudi Arabia, and the United Arab Emirates (UAE).

[13] We use the terms fixed or peg exchange rate regime to refer to any regime in which a monetary authority announces buying and selling its currency in terms of a foreign currency (anchor) at constant rate.

they were exposed to three shocks simultaneously: weak commodity prices; scarce international finance; and a strong dollar.[14] If, during these periods, their currencies had been pegged to their principal export commodity price (rather than to the US dollar) they may have gained export competitiveness at precisely the time when their balance of payments was under pressure. This observation leads to the proposal of this chapter for these Middle East oil exporting countries which are a major supplier of energy to the world economy.

The proposal tested in this chapter is that of a monetary policy for the commodity exporting countries in general and the oil exporting countries in particular which do not have their own sound institutions and independent central bank, and are hurt by swings in the oil price. In long term, these countries should diversify their exports, establish the proper institutions[15], and then they should be able to adopt other policies of developed commodity exporting countries such as the Inflation Targeting with a floating exchange rate regime. In the meantime, the monetary policy proposed in this chapter may smooth their transition. The proposal is an exchange rate regime in the Inflation Targeting framework, but with different price index. Therefore, these countries should depart from their current exchange rate regime (the peg to the US dollar) to a currency basket, constituted by their major trade partners, which could possibly contain the price of oil.

The rest of the chapter is set out as follows. The second section, "Characteristics of Commodity Exporting Countries" elaborates on the characteristics of these countries. We go over concepts such as the 'Natural Resource Curse', procyclicality and the adverse effect of volatility in government spending. The third section, "Different Nominal Anchors for a Monetary Regime" surveys possible nominal anchors for a monetary policy and their advantages and disadvantages. The fourth section, "Classification of Exchange Rate Regimes" discusses frameworks for classification of exchange rate regimes. In the fifth section, we investigate the real effect of different exchange rate regimes. Section six reviews the theories of exchange rate regime choice and, in section seven, we review the proposal, "Peg to Commodity Price" as an alternative anchor for commodity exporting countries. Sections eight and nine describe the Data and the Model. Sections ten and eleven contain Data Analysis and Empirical Strategy. In Sections twelve and thirteen, the Empirical Results and Conclusion are presented.

[14] As Cline (1984) describes, one of the reasons for the international debt crisis of 1982 was the combination of an appreciating dollar with weak world market conditions for the commodities exported by developing countries.

[15] In resource-rich countries, Arezki and Gylfason (2011) show that institutions which can limit the mismanagement of natural resources play a major role in moderating the effect of volatility on economic growth.

2 The Characteristics of Commodity Economies

The developing world, especially the commodity exporting countries, usually has less developed institutions, a non-competitive banking sector, high inflation and lower central bank credibility. Such countries are price takers and face exogenous terms of trade shocks. In contrast, the developed countries face fluctuations in their terms of trade – the relative price of exports in terms of imports – which are both smaller and less likely to be exogenous. Another common problem of the developing commodity exporting countries is the mismanagement of their wealth; they cannot get the best out of their natural resources.[16]

Contrary to the countries rich in natural resources which cannot benefit from this wealth, there are some countries rich in natural resource such as Botswana and Norway which are able to use it successfully. Unlike other developing commodity exporting countries, Botswana (which has mined diamonds for several decades) has not suffered the adverse effects of its wealth. There, tribal traditions and good political leadership encourage broad political participation and promote democracy. As for Norway, before discovering oil it already had developed the proper institutions and mechanisms for accountability. In contrast, the oil exporting countries in the Middle East started their oil extraction much earlier than Norway, at a time when they did not have proper institutions and even in some cases a national government.[17] Since that time, they have been faced with an unstable flow of revenue which has hurt their welfare;[18] they require proper policies based on the characteristics and structure of their economies.

Desirable policies for the Middle East oil exporting countries are: reducing the size of the public sector; prompting non-oil exports; and stabilizing government spending. During a boom, when oil revenue flows to the area, the governments usually ignore these policies. The windfall oil revenue increases government consumption which usually causes higher wages and expands the public sector. These changes are very rigid and not easily reversible. During the 1970s, by the dramatic rise in oil prices, most oil exporters in the region suffered from the Natural Resource Curse.

[16] For more details, see Fraga, Goldafjn and Minella (2003).

[17] In the Middle East, the first oil well to enter into production was in Iran (Persia) in 1908 and 30 years later in Saudi Arabia.

[18] See Fatás and Mihov (2003); Afonso and Furceri (2010) and Loayza et al. (2007) for their investigations into the welfare effect of volatility in government expenditure on growth or consumption.

2.1 The Natural Resource Curse

Perhaps surprisingly, the economic performance of most countries with oil, natural gas, or other natural resources does not always seem very promising. Auty (1993, 2001) is widely accepted as the first economic commentator to coin the phrase "The Natural Resource Curse" to describe this phenomenon.[19] It appears, on average, that countries with large endowments of natural resources perform worse economically than countries with fewer natural resources. Without natural resources, advanced economies such as Japan, South Korea and Taiwan have achieved the highest standards of living while many countries rich in natural resources, such as Nigeria and Angola, still are among the poorest. In general, this negative relationship observed by Auty has been subsequently confirmed, however there does remain some controversy about its existence.

In two extensive studies along similar lines, Sachs and Warner (1995, 2001) show that economic dependence on exporting oil and mineral is correlated with slow economic growth. Confirming the Natural Resource Curse, they argue that their result is not easily explained by other variables.[20] Consequently, the Middle East oil exporting countries as the developing commodity exporters suffer from the Resource Curse which could affect the economy through three channels: the volatility of oil price, the political channel and the 'Dutch Disease'.

First, the volatility of oil price (rather than the price trend of the commodity) hurts an economy.[21] Due to low elasticity of supply and demand with respect to price in oil markets, small fluctuations in demand or supply make oil prices volatile. These fluctuations in oil price can create a dangerous cycle in which governments increase their spending when they face a high price of oil and cut spending when facing a decline in oil price.[22] In the bust phase, the government's hands are tied and many projects are unfinished; the government is forced to cut investment which results in decline in growth. On the other hand, oil revenue makes up the bulk of the GDP and export of these countries; therefore, the volatility in oil price influences the whole economy adversely. In a volatile economic environment, investments are not stable,[23] labour is not efficient and the transaction costs of cyclical shifts of resources may hurt the economy. In the boom phase, the size of the government sector grows, more mega projects are started and employees expect higher wages. On the other hand, in the bust phase, there is a lot of resistance against any modification (especially cutting spending on education, public wage and health). Hence, these changes are rigid and not easily reversible. As Reinhart and

[19] Humphreys et al. (2007) and Collier (2007) are two primary source books on the Natural Resource Curse.

[20] For more information on the Natural Resource Curse see Ross (2001); Kaldor et al (2007); and Subramanian and Sala-i-Martin (2003).

[21] See Blattman et al. (2007) and Poelhekke and van der Ploeg (2007).

[22] See Gavin and Perotti (1997) and Montiel and Serven (2005).

[23] See Caballero (1991), Dixit and Pindyck (1994) for a review of the negative effects of volatility on investment.

Reinhart (2009) and Perry (2009) describe, booms in the form of capital inflows and currency overvaluation are usually followed by busts in the form of capital outflow, severe depreciation, and recession. In another study, Arezki and Ismail (2010) confirm the cycles and show that government spending increases in boom phase, but it is sticky in the bust phase. Unfortunately, the high price of the commodity is not permanent and, when the downward swing comes, the government cannot handle its wage bill, the inefficient employees and the white elephant projects.

The second channel is the political argument. Governments who rely on tax revenue are usually more responsible to the public than those who control the revenue of the exporting commodity. The corruption and mismanagement of the oil revenue should therefore be less if there is a mechanism to hold government accountable. Mahdavy (1970) was the first to suggest that Middle Eastern governments' access to oil revenue makes them independent of taxes from their people. Arezki and Brückner (2010) show that, in autocracies a rise in commodity exporting prices boosts government spending and external debt, but not in democracies. The oil revenue being in the government's hand without any accountability tends to discourage democracy; the state does not need to tax people and has no incentive to promote democracy and encourage the development of a strong private sector. On the other hand, citizens do not have any mechanisms by which to hold authorities responsible. These two channels damage the establishment of political institutions and the accountability process. Ross (2012) argues that the oil revenue is against democratization and even could cause a "Political Curse". In an underdeveloped society without proper institutions with all oil revenue in the control of the government, any change or promotion of political freedom is improbable.[24]

The third channel, the 'Dutch Disease' regards inappropriate fiscal policy. The term was coined in 1977 by *The Economist* magazine to describe the decline of the manufacturing sector in the Netherlands after the discovery of a large natural gas field in 1959. It explains the effect of large inflow of foreign currency on an economy. In most cases, this flow of foreign currency is because of the increase in the revenue of the exporting commodity. However, in a small economy, inflow of foreign assistance and foreign direct investment can do the same. The flow of foreign currency appreciates the real exchange rate. This reduces the competitiveness of the manufacturing sector.[25]

Krugman (1987) explains why this phenomenon is a disease: during and after a rise in commodity price, the Dutch Disease hits the manufacturing sector by moving production

[24] After Mahdavy (1970), Luciani (1987) and Vandewalle (1998) study the political argument of the Natural Resource Curse. In another study, Ross (2001) shows that there is a link between economic dependence on oil and mineral with authoritarian governments. For more on the political effect of natural resources, see Jenson and Wantchekon (2004), and Ross (2006).

[25] Other primary studies on the Dutch Disease are Corden and Neary (1982) and Corden (1984).

resources out of the economy, and it becomes a disease when the manufacturing sector does not rise after the boom. On the other hand, in the industrialization process of a country, the Dutch Disease severely hurts the "learning by doing effect" which is one of the factors in promoting the non-commodity sectors of the economy.

The Dutch Disease is a common phenomenon for the countries with high export price volatility. De Gregorio and Wolf (1994) build the theoretical model for the effect of terms of trade on the real exchange rate. In this model, an improvement in the terms of trade appreciates the domestic currency. The model is based on an economy with two different sectors: one sector produces exportable goods (oil) and the other one non-traded goods. The increase of the commodity price (the terms of trade shock) in the international market – exogenous to the domestic economy – increases the wage in the commodity sector. The wages in the two sectors are equal, thus wages and prices in the non-traded section go up, and the country faces a real exchange rate appreciation. The appreciation in the real exchange rate encourages factors of production to transfer to the non-tradable goods. This expands the non-tradable services, crowding out the manufacturing (de-industrialization) and the non-export commodity traded goods.

There is a vast literature of the effect of commodity price on real exchange rate. For Canada, Amano and Norden (1995) find that the non-energy commodity price has a positive impact on the real exchange rate of Canada while the energy commodity price has a negative one. In another study, Chen and Rogoff (2003) detect a positive stable relationship between the non-energy commodity price and the real exchange rate of Australia and New Zealand. Concentrating on 58 developing countries, Cashin et al. (2004) investigate this relationship and show that (in 19 of these countries) there is a long run relationship between the real exchange rate and real commodity price.

Habib and Kalamova (2007) investigate the effect of real oil price on the real exchange rate for three oil exporters: Russia; Norway; and Saudi Arabia. Their results support a positive long run relationship between real exchange rate and real oil price for Russia but not for the other two countries. Using non-stationary panel techniques robust to cross-sectional dependence and focusing on a large sample of developing countries, Bodart et al. (2012) show that real exchange rate appreciates when commodity price increases. In contrast to other studies, they do not use indices for the commodity prices of each country, but instead the price of the dominant commodity.

These five papers suggest that small developing countries heavily specialized in the export of one commodity are vulnerable to the effects of the Dutch Disease. This is exactly the case with oil exporting countries in the Middle East. In the case of commodity exporters with fixed exchange rate regime such as the Persian Gulf oil exporters, the real currency appreciation is transmitted through inflation. For the other commodity exporters, such as South Africa, Chile, Mexico or Russia, which follow floating exchange rate regime, this appreciation works through change in their nominal exchange rate. Studying the Middle East oil exporting countries, the subsidized price of food and fuel may make it difficult to observe clear empirical evidence for the Dutch Disease. Although the government subsidises these prices heavily, they obtain this subsidy by cutting something else. This high subsidising expenditure put more pressure on fiscal sustainability over the long term. For oil exporting countries with a fixed exchange rate regime, this chapter proposes an alternative exchange rate regime to limit the Resource Curse.

A wide range of policies have been proposed to limit the Resource Curse. Some, such as the privatizing of oil resources in Russia and the oil fund in Venezuela, have failed. There have been some successful ones, such as the Norway oil fund[26] and the countercyclical fiscal policy in Chile. In the Norway case, advanced political institutions have been able to avoid the Dutch Disease and isolate the economy against fluctuations of oil price. Therefore, the sound institutions and rule of law appear to be a prerequisite for implementing effective policies against the Resource Curse. Unfortunately most commodity exporting countries in developing world do not have these requirements.

Birdsall and Subramanian (2004) suggest another remedy for the Resource Curse in an oil exporting country. In the case of Iraq, they propose transferring the oil revenue directly to the people. This was tried in Alaska and the Canadian province of Alberta. In both cases, the interest from the oil fund was distributed and not the revenue itself. Birdsall and Subramanian (2004) justify this recommendation as follows: with the lack of proper institutions and in an unstable political environment such as Iraq, distribution of oil windfall to the public keeps the oil money out of the hands of an undemocratic government; therefore, it is welfare enhancing. The direct distribution of oil revenue has its own problems: it is likely to put more pressure on the demand side of the economy and cause higher inflation; handing the money to the people then taxing them to provide for government expenditure and public investment finance may not be very efficient. Perhaps, as Frankel (2011a) recommends, a mix of the Chilean style fiscal policy and a monetary policy based on the proposal of this chapter may be a proper solution for the Resource Curse.

[26] There are some investing funds (sovereign wealth funds) in GCC countries, such as: the Abu Dhabi Investment Authority (ADIA) which is owned by the Emirate of Abu Dhabi (one of the United Arab Emirates); Foreign Holdings of Saudi Arabia (SAMA); The Kuwait Investment Authority (KIA); and The Qatar Investment Authority (QIA).

2.2 The Macroeconomic Volatility and Procyclicality

In any assessment of macroeconomic volatility, developing countries are among the most volatile economies. Loayza et al. (2007) describe three main reasons for this. First, this volatility may be in the form of terms of trade shock for goods markets or a sudden suspension of capital flow for financial markets. Second, these countries are faced with internal shocks because of policy mistakes and inconsistency in their development plans. Third, the lack of proper shock dampening policies or tools may accelerate the volatility. Here, the financial markets cannot function the way they do in the developed world and usually macroeconomic policies, instead of stabilizing and moderating volatility, increase volatility.

Often in the developing world, particularly in the developing commodity exporting countries, macroeconomic policy is procyclical (which is destabilizing) rather than countercyclical or acyclical. Some part of this procyclicality is because of the swing in the commodity export price of these countries in the international market, but the other part of the problem is their mismanagement of their monetary and fiscal policies.[27] One of the common characteristics of these countries is the procyclicality of capital flow, fiscal policy and monetary policy. The capital market in these countries is imperfect. In theory, in a perfect capital market, countries can borrow from the international financial market and pay it back later. However, in an imperfect capital market, which is the case for all the developing countries, they are not able to smooth consumption and investment by borrowing during temporary downturns.[28]

Gavin and Perotti (1997) show that fiscal policy in the developing world generally is procyclical. Montiel and Serven (2005) calculate the correlation of government spending growth and GDP growth as 0.5 for a typical developing country and zero for a G7 country. In another study, using a sample of 56 countries, Talvi and Végh (2005) show that fiscal policies in the US, Japan, France, Germany, Italy, Canada, and the UK are more acyclical while in those of developing countries are procyclical. The two explanations in the literature for the procyclicality of fiscal policy are the imperfect capital market and political distortions. During bad times, because of an imperfect capital market,[29] spending must be cut. During good times, the governments of these countries are under great pressure to increase spending.

The main reason for the procyclicality of fiscal policy is the political distortions which are an institutional problem. Governments, especially the more populist ones, cannot resist the temptation and the pressure from their people to spend more. Alesina et al (2008) investigate the procyclicality of fiscal policy with a political agency problem. When voters see a boom,

[27] For example see Perry (2009).

[28] For more details see Kaminsky et al. (2005) and Reinhart and Reinhart (2009).

[29] See Gavin and Perotti (1997); Riascos and Vegh (2003).

they ask for more public goods, services and lower taxes. This forces fiscal policy to be more procyclical. According to their empirical results, the procyclicality of fiscal policy is more likely to happen in more corrupt regimes. In a paper entitled "The Voracity Effect" Tornell and Lane (1999) show that fiscal policies in many countries are determined by powerful interest groups. They argue that, first, lack of political institutional infrastructure and the illegal competition of multiple powerful groups cause the voracity effect which leads to lower economic growth. Second, a positive shock to commodity price causes a more-than-proportionate increase in fiscal redistribution.

Medas and Zakharova (2009), and Gavin et al. (1996) show that procyclicality of fiscal policy is more intense in developing commodity exporting countries. Ossowski et al (2008) confirm the major effect of weak institutions for the procyclicality of fiscal policy in the commodity exporters. Many other authors compare fiscal policy in the developing and developed countries and document the procyclicality of fiscal policy in the developing world.[30]

The Persian Gulf oil exporting countries, as developing commodity exporting nations, have also faced the procyclicality of fiscal policy. Their monetary policy has been constrained by the fixed exchange rate regime and open capital market; this leaves fiscal policy to manage the major burden of macroeconomic stabilization. Figure 3, from Frankel et al. (2011c), shows the correlation between government spending and GDP for 94 countries over the period 1960-1999.[31] It shows data for 73 developing countries (white bars) and 21 developed countries (black bars). A negative correlation confirms a countercyclical fiscal policy and a positive correlation a procyclical fiscal policy. As shown in Figure 3, Oman, Qatar and Saudi Arabia are top on the list among all these countries in the procyclicality of their fiscal policy. The fiscal policy in the UAE is less procyclical, and Kuwait is the only country among these five Middle East oil exporting countries with a countercyclical fiscal policy. The decade of the 2000s has observed a major shift in the fiscal policy of some developing countries from procyclicality to countercyclicality.

Figure 4 is the updated version of Figure 3, for 2000 to 2009, from Frankel et al. (2011c). We see more white bars on the left side of the Figure which means a shift from positive correlation (the procyclical fiscal policy) to negative correlation (the countercyclical fiscal policy) in a number of countries. Among these are Saudi Arabia, Oman and the UAE. The establishment

[30] Tornell and Lane (1999), Kaminsky et al. (2005) and Ilzetski and Vegh (2008). Kaminsky et al. (2005) in their study "When It Rains, It Pours: Procyclical Capital Flows and Macroeconomic Policies" based on a sample of 104 countries, document the procyclicality of fiscal policy in developing world and in particular in commodity exporting countries. Ilzetski and Vegh (2008) building a quarterly dataset for 49 countries covering the period 1960-2006 confirm the procyclicality of fiscal policy in developing world, and support the idea of "When It Rains, It Pours".

[31] More precisely, excluding the longer-term trends, it shows the correlation between the cyclical components of spending and GDP. It is other version of evidence presented in Kaminsky et al. (2005).

of sovereign wealth funds in these countries may explain this shift. Kuwait, surprisingly, shifts from countercyclical fiscal policy to procyclicality. Qatar still follows a procyclical fiscal policy during the 2000-2009 period, as it had done during the 1960-1999 period.[32]

As it indicated by the literature, the main remedy for a procyclical fiscal policy is the implementation of the right institution. Frankel et al. (2011d) show that the cyclicality of a fiscal policy is inversely correlated with a country's institutional quality in terms of such parameters as bureaucracy quality, measures of law and order and corruption. Christiano et al. (2011) show in a stochastic model that, with sticky prices, the optimal fiscal policy should be countercyclical. Better institutions cause more countercyclical fiscal policy. Here, Chile is the champion. With the structural budget reforms of 2000 and 2006, a committee of experts, not influenced by political forces, was assigned to forecast copper price and control government spending. This worked very well especially during the 2008-2009 recession.

The link between oil price and fiscal policy in the oil exporting countries is well documented. However, is fiscal policy the only channel to transfer volatility from oil price to economy? Husain et al. (2008) investigate the relationship between fiscal policy and economic cycles in ten major oil exporting countries with the total of 50 per cent of world oil export. Using panel VARs of a three-variable system – oil price, government spending to non-oil GDP, and output – they show that the volatility in oil price is transmitted through fiscal policy to the economy and that it hurts the welfare of the people.

For the impact of a volatile economy on welfare, Fatás and Mihov (2003) and Afonso and Furceri (2010) investigate the welfare effect of the volatility in government expenditure on growth. Fatás and Mihov (2003) estimate that every percentage point increase in the volatility of fiscal policy decreases economic growth by more than 0.8 percentage points. This is a huge negative effect on growth because of the procyclicality of fiscal policy. Afonso and Furceri (2010) examine the effect of fiscal volatility on growth for a set of OECD and EU countries from 1970 to 2004. The total expenditure negatively influences the real growth of the GDP per capita for the OECD and the EU countries. In particular, a percentage point increase in the share of total expenditure decreases output by 0.12 and 0.13 percentage points for the OECD and for the EU countries, respectively. In other studies based on the theories of irreversible investment, Ramey and Ramey (1995), for 92 countries including the OECD countries, and Aghion and Banerjee (2005), using an empirical cross-country method, explain the adverse effect of the

[32] Based on the countercyclicality or procyclicality of fiscal policy in 1960-1999 and 2000-2009, Frankel et al. (2011d) classify countries into four categories: Established graduates: these are countries that have always been countercyclical. Still in school: these are countries that have continued to behave procyclically. Back to school: these are countries that were countercyclical during the 1960-1999 period and turned procyclical during 2000-2009 period. Recent graduates: these are countries that used to be procyclical and became countercyclical during 2000-2009.

volatility of government spending on growth via its negative impact on capital formation and investment. Indeed, in a volatile economic environment, the economic agent (which could be the government, the private sector or a household) cannot decide optimally regarding saving or investment; this negatively affects economic growth.

For the procyclicality of monetary policy in the commodity exporting countries, we describe the issue in a fixed exchange rate regime. In the Middle East oil exporting countries with a fixed exchange rate regime, an increase in oil price causes expansion of money and credit and this is followed by high inflation. This is exactly what happened in the Middle East in the oil boom of 2000-2008. When oil price decreases, money and credit contract, and recession follows, such as occurred in Russia and Mexico in the 1990s. The proper policy against this procyclicality of monetary policy of an economy under a fixed exchange rate is to appreciate currency when there is a boom in commodity price and depreciate it when there is a bust.

As commodity exporters, the oil exporting countries in the Middle East are not immune from all the adverse effects of commodity exporting described above. Although they have high per capita income, their overall economic performance is poor. They have experienced relatively low economic growth rate and a very volatile macroeconomic environment. On the other hand, there is some improvement in education, health, and overall in the standard of living, but these countries still suffer from structural problems in their economies. For now, a self-insurance policy in the form of oil funds may be helpful; however, for the long term, focusing on the political economy, they should promote institutions and a Chilean style of fiscal policy (conservative assumption of oil price) and expand their non-oil exports. That is the long term remedy, but for the short and medium term, this chapter proposes and empirically tests a monetary policy (close to Inflation Targeting but with a different price index) to decrease volatility in the macroeconomics of these countries. In the next section, we review some nominal anchors which have been already tried or proposed.

3 Different Nominal Anchors for a Monetary Regime

A proper nominal anchor, as the essential part of a monetary policy for commodity exporting countries, may moderate the booms and busts caused by a swinging commodity price. The main function of a declared specific nominal target is transparency, with communication of a target which public can monitor. Therefore, a nominal anchor establishes credibility for a monetary policy and limits people's expectations of inflation. Frankel (2011b) argues, in a non-stochastic model, that as long as the anchor is a nominal variable, the system functions properly and there is no difference in performance of different nominal anchors. In contrast, in a stochastic model, different nominal anchors have distinct effects. There are different nominal variables such as: money supply, exchange rate, the CPI and other alternatives. This chapter proposes and tests an alternative nominal anchor which may work for commodity exporting countries. The different variables serving as nominal anchors are explored next.

3.1 Gold

Under a gold standard, the central bank pegs the price of gold in terms of domestic currency. It announces that it will exchange the currency for a certain weight in gold; therefore, central bank must have enough gold reserves. Upon the demand of the people, the central bank must always be ready to exchange gold for the currency of the country. From 1880 to 1914, the price of gold was considered to be the only possible anchor, although it had its drawbacks. An economy with gold as an anchor is hostage to the world gold market. Instead of gold, Keynes (1938) and Graham (1941) proposed a basket of metals and minerals to average out any price fluctuation in a single commodity. As we will see in this study, if the basket contains the exported commodities of a country, this may work. In contrast, it may fail if the basket contains imported commodities.

3.2 Nominal Income Targeting

First proposed by Meade (1978), Nominal Income Targeting targets the future level of economic activity in nominal terms. It was popular with macroeconomists in the 1980s. Because of problems of measurement error and delay in data gathering usually encountered in developing countries, it is difficult to apply to them. Despite these difficulties, McKibbin and Singh (2003) argue that Nominal Income Targeting is a proper anchor for developing countries, since these countries are more vulnerable to supply shocks than developed countries. Using the theoretical framework of Rogoff (1985), Frankel and Chinn (1995) show the superiority of Nominal Income Targeting in facing import price shocks over the Inflation Targeting regime. The Nominal GDP Targeting does not have the problems of Inflation Targeting facing supply shocks as it manages to stabilize demand and dampens any adverse supply shock by dividing it between inflation and GDP. The number and influence of economists who support Nominal Income Targeting is growing. On 21st September 2010, the Federal Open Market Committee of the US Federal reserve also discussed the possibility of a nominal income target.[33]

[33] From the minutes of the Federal Open Market Committee on 21st September 2010.

3.3 Monetarism

Under a monetarist regime, the central bank fixes the growth rate of M1,[34] but fluctuations in the public demand for money affect velocity, which influences the economy. In 1980, the US Federal Reserve adopted the money growth rule; however, in 1982, the rise in demand for money caused the cancellation of this policy due to threat of recession. Estrella and Mishkin (1997) point out that Germany successfully implemented a monetary target; however, the credibility of the central bank in Germany is not comparable with its counterparts in the developing world and many countries in both the developing and developed world did not welcome Monetarism.

At the end of the 1980s, monetary policies based on money supply targets were almost completely out of the fashion. The main criticism was the credibility issue. Atkeson and Kehoe (2001) argue that money targeting is not visible and controllable by the public to monitor the central bank's behaviour in the way Exchange Rate Targeting does. After the failure of monetarism, the peg exchange rate regime, as champion of the monetary regime, was able to defeat hyperinflation in some developing countries such as Israel, Argentina, Chile, Bolivia, and Brazil; this accelerated the adoption of the fixed exchange rate regime.

3.4 Fixed (Peg) Exchange Rate Regime

In a fixed exchange rate regime,[35] the government announces the value of its currency in terms of the anchor currency, and the central bank is committed to buy and sell its currency at the fixed rate. The Persian Gulf oil exporting countries follow a peg exchange rate regime; they do not have the proper institutions and central bank credibility to go for a floating exchange rate regime, which is the regime that the developed commodity exporters such as Australia, Canada and New Zealand follow.

The academic literature of the advantages and disadvantages of various exchange rate regimes (fixed versus floating, as well as various intermediate regimes) is very large. In practice, many factors influence exchange rate regime choice, and the theoretical models cannot accurately simulate the complexity of optimal flexibility of different exchange rate regimes. Under the fixed exchange rate regime, the home currency is linked to an anchor currency, and the fluctuation of the anchor currency can produce volatility in the country's international price

[34] In the US, M1 is defined as the total amount of cash plus the amount of demand deposits, traveller's checks and other checkable deposits.

[35] We use the term exchange rate to refer to nominal exchange rate not the real exchange rate. Few studies propose real exchange rate instead of nominal exchange rate.

competitiveness in other export markets. In most currency crises, such as those of Mexico (1994), Thailand and Korea (1997), Russia (1998), Brazil (1999) and Turkey (2001), the rigidity of exchange rate has been, if not the main factor, at least one of the important factors. Obstfeld and Rogoff (1995) in "The Mirage of fixed exchange rate" attack the fixed exchange rate. They encourage policy authorities to avoid relying for their credibility on an asset price (exchange rate) which is dynamic by the people's expectations.

In the next section, we will detail the advantages and disadvantages of floating and fixed exchange rate regimes. The possible exchange rate regimes are on a flexibility continuum of exchange rate regimes which Frankel (1999) describes in nine categories from the most rigid (the currency union) to the least (the clean float):

1. The Currency Union: two or more countries share the same currency. If a country abandons its own currency and circulates the anchor currency, it is called the Dollarization. It is not only applied to usage of the US dollar, but generally to the use of any foreign currency as the national currency. For example Ecuador, El Salvador and Panama are in a currency union with the US dollar. It is the firmest fixed exchange rate regime.

2. The Currency Board: in contrast to a currency union, the country has its own currency at a fixed rate of exchange. It maintains unlimited convertibility between its currency and the anchor currency. In a currency board, the central bank must have enough foreign currency reserves to response to the people's will to exchange their local currency and to be able to back each unit of the domestic currency. Similar to a currency union, in a currency board, the country does not have its own monetary policy, and authorities are not free to expand domestic credit on their own. A currency board has its own problems; choice of the currency to peg and the rate of pegging to the anchor are not defined clearly. The other problem is the stability of the domestic financial system while there is no domestic lender of last resort.

3. The Rigid Peg: currency is pegged to a single foreign currency. For example; in the Middle East, most of the oil exporting countries are pegged to the US dollar. Similar to a currency board, the main component of a peg exchange rate regime is the existence of a significant amount of foreign reserves.

4. The Adjustable Peg: most countries that declare themselves as peg actually are not following a rigid peg exchange rate regime. It is the exchange rate of the Bretton Wood regime.

5. The Crawling Peg: in countries with high inflation, the peg is reviewed and corrected based on the differences of the inflation in the country and its main partners.

6. The Basket Peg: the exchange rate is fixed in terms of a weighted basket of several foreign countries. For example, from 2007, Kuwait has pegged its currency to a basket of Euro and dollar. Usually, in a basket peg, the officials do not release the weights.

7. The Band: authorities intervene when the exchange rate hits margins on either side of a central parity. For example, from 1979 until 1999, the exchange rate mechanism of the EMS was a band regime. In limit, narrow band functions similarly to a peg and a wide band similarly to a float.

8. The Dirty Float (Managed Float): a dirty float respond to a 1 per cent change in demand of the currency by modifying the supply by k per cent and allowing the rest of the change to be released to the exchange rate. In limit, if k goes to zero, the exchange rate regime approaches an exchange rate peg and if k approaches to 1, it goes to a pure float exchange rate regime.

9. The Clean Float: central banks do not intervene in the market, and the exchange rate is determined by supply and demand in the market. The ideal clean floating exchange rate regime does not exist; however, Australia and Japan follow a regime which is very similar.

In this continuum of exchange rate regimes, most of the Middle East oil exporting countries follow the peg exchange rate regime. In these countries, the business cycles are correlated with oil price in the US dollar.[36] On the other hand, the swing in the dollar is based on the fundamental of the US economy not the Middle East Economy; therefore, locking currency to the US dollar may not be a proper exchange rate regime. In a fixed exchange rate regime, the fluctuations in anchor will create fluctuations in the country's monetary conditions which may not match the characteristics of that country. To avoid this kind of fluctuation, some countries do not peg their currency to an anchor currency, but to a basket of currencies.

The basket peg exchange rate regime minimizes the adverse effect of fluctuations among the major currencies. The weight for each currency could be assigned based on the percentage currency composition of the total trade. Although the basket peg does not have the simplicity and transparency of a single currency peg, it could reduce the volatility of the nominal and real effective exchange rate. Furthermore, as Iqbal (2010) argues, applying a band around a basket peg makes for more flexibility and moderation in the exchange rate regime; therefore, the monetary policy has more space to support the fiscal policy.

Under the Bretton Woods agreement, from 1946 until 1971, the fixed exchange rate regime (peg to the US dollar) worked quite well. Similarly, in Europe from 1979 to 1992, the

[36] See Husain et al. (2008).

European Monetary System (EMS) functioned properly. If such examples of a fixed exchange rate regime worked in the past, whether it works today or not depends on the current influential variables in new international economy. In recent decades, we have observed the appearance of capital flow as a new significant and influential factor in the world economy. In the past, countries controlled capital flow, and sometimes they enjoyed its benefits. In the Asian crisis, the capital control helped China defend its peg exchange rate regime. By removing capital control, countries become much more vulnerable to speculative attacks. At first glance, capital control seems to be the solution but most probably the benefits of the international capital markets and foreign competition in the financial sector dominate the costs.[37]

3.4.1 Advantages of Fixed Exchange Rate

As pointed out by Giavazzi and Giovannini (1989) and Dornbusch (2001), the main advantage of a fixed exchange rate regime is the discipline argument of limiting inflation. Policy makers recognize price stability or limiting inflation as the main goal of monetary policy. To control inflation, countries peg their currency to an anchor currency; typically the US dollar. A peg exchange rate limits the inflation rates for tradable goods, thus keeping inflation under control. Another argument for limiting inflation by a peg exchange rate is the enhancement of credibility through controlling the expectation of the people (the Psychological Effect). Edwards and Meagendzo (2003) argue that the harder the peg, the more credibility is enhanced. A fixed exchange rate regime, if believed by the people, convinces them that they need not fear either high inflation or depreciation.

The discipline argument of a fixed exchange rate regime should be evaluated against the adverse costs of adapting a monetary policy which is not compatible with the local economy. Frankel (2006) states that the optimal monetary policy for an oil exporting country facing a swing in oil price is loosening monetary policy and a real depreciation when oil price declines, and tightening monetary policy and a real appreciation when oil price rises. As Setser (2007b) describes, proper reactions to a supply shock in the importing and exporting oil countries are different. We should recognize the differences between supply and demand shocks. A supply shock is accommodated by loosening monetary policy (currency depreciation) in oil importers and tightening monetary policy (currency appreciation) in oil exporters. In contrast, for a positive demand shock, both oil importers and exporters should go for tighter monetary policy. Sometimes the effects of a supply and a demand shock on oil price are not clearly separable. Therefore, adopting a currency anchor which, in its response to shocks, is not compatible with the local currency may dominate the discipline argument of a peg exchange rate regime.

[37] See Williamson (2000) and Edwards (2002).

Another problem with the discipline argument is that inflation has a significant degree of inertia. Sometimes, without any fundamental reason, after implementing a fixed exchange rate regime, high inflation persists and prices keep rising. Edwards (1998) investigates the persistence of inflation in Chile and Mexico after applying the peg exchange rate regime. In both cases, inflation had not declined much; therefore, the lack of credibility of a peg exchange rate regime or other reasons, such as expectation of the people, may dominate the discipline argument. Although the discipline argument of limiting inflation works for both fixed exchange rate regime and a currency board, we should recognize the differences between them

The currency board as a firm form of a peg exchange rate has more capability in fighting inflation. Argentina 1990-1994, Estonia in 1992, Lithuania in 1994 and Bulgaria in 1997 are examples of successful implementation of the currency board to fight inflation.[38] In addition to all its benefits, the currency board has its own problems. In a currency board, the central bank cannot expand domestic credit; it should completely give up its monetary independence. Under a currency board regime; there is no lender of last resort for the banking system. Chang and Velasco (1998) state that a currency board could limit the probability of balance of payments crises only at the cost of making bank crises more likely; therefore, we could face stable, low inflation while the chance of banking crises increases. In contrast, in a peg exchange rate regime, the monetary authorities can adjust the interest rate and affect domestic credit by some open-market operations. For both a peg exchange rate or a currency board, once inflation is under control, the exit strategy is an important issue. On some occasions, the disadvantages of a peg exchange rate or a currency board soon outperform the advantages; in those cases, we need an exit strategy as well.

The other two advantages of fixed exchange rate are limiting competitive devaluations and promoting trade. Limiting devaluation was one of the main incentives of establishing the Bretton Woods System to create a cooperative outcome for the competitive devaluation (Currency war). Examples include Great Britain on Black Wednesday and Asian tiger economies during the Asian Crises of 1997. Another advantage of a fixed exchange rate regime is facilitating international trade and international investment by reducing transactions costs and exchange rate risk. In an influential research, Rose (2000) shows that fixed exchange rate and, especially, monetary unions increase trade and investment substantially. By applying the gravity model, Rose argues that members of currency union trade with each other three times as much as with similar trading partners. The threefold effect is very great and caused much disagreement and doubt. Initial studies attempting to test the validity of this relationship between exchange rate volatility and trade could not recognize this link, however more recent research has confirmed it.[39]

[38] In Argentina, inflation decreased from 1,000 per cent in 1990 to 5 per cent in 1994.

[39] For example, see MacDonald (2007).

Limiting the time inconsistency problem and promoting capital inflow are the other benefits of a fixed exchange rate regime. Limiting the time inconsistency problem is the case when government's preference changes over time, in such a way that a preference, at one point in time, contradicts another preference at another point in time. A peg exchange rate regime can stop a government concentrating on short run objectives by sacrificing long run outcome; therefore, it helps governments resist any political pressure towards time inconsistent policies. Another possible advantage of a peg exchange rate is increasing capital inflow and consequently promoting growth. This can however cause a lending boom, hurting the banking system and causing financial crises (Mishkin, 1998).[40]

3.4.2 Disadvantages of Fixed Exchange Rate

One prominent criticism of adopting a peg exchange rate regime is the loss of control over monetary policy. The simultaneous combination of a fixed exchange rate regime and open capital markets with an independent monetary policy constitutes the Impossible Trinity. If the exchange rate is pegged and capital is mobile, then the domestic nominal interest rate must equal the foreign nominal interest rate. Lack of effective local monetary policy is harmful, especially when a country is hit by domestic shocks which are not correlated with business cycles in the anchor country. A domestic monetary policy is a plus, but the existence of an independent monetary policy does not guarantee its proper performance. Developing countries usually do not have the developed political and monetary institutions to get the most out of an independent monetary policy; therefore, these countries may be better off adopting the monetary policy of a proper anchor country through the fixed exchange rate regime even with all its negative consequences.

Transmission of shocks from the anchor country to the pegging country is another problem of a peg exchange rate regime. For example, in 1994, the Federal Reserve in the USA increased interest rates. This policy was made based on the USA economy's requirements, but it had very severe consequences for Mexico which had pegged its currency to the US dollar. This rise in interest rates of the USA and consequently interest rates of Mexico hurt the balance sheets of households, banks and non-financial business, and it is one of the reasons for the 1994 financial crisis in Mexico.

Another flaw of a peg exchange rate regime is its vulnerability to speculative attacks. Depreciation under a floating exchange rate regime is likely to be much less and slower than

[40] Kaminsky and Reinhart (1999) show how a lending boom is a predictor of banking crises.

devaluation under a peg exchange rate regime. In a fixed exchange rate regime, it is possible for the government to defend the currency by raising interest rate, but this causes damage to the balance sheets of banks and non-financial institutions. The losses in a failed defence of the currency are more costly in developing countries, and the open capital market intensifies the cost. Three historical examples of the Bretton Woods system in the 1970s, the successful attacks under the European Monetary System in 1992 and 1993 and the emerging market crises of 1994-2000 prove that the fragility of a peg exchange rate is more severe under an open capital market (Obstfeld and Rogoff, 1995).

Another challenge in a fixed exchange rate regime, after choosing the right anchor, is pegging to the right rate. The risk of being locked into a misaligned exchange rate is a disadvantage of a fixed exchange rate regime. The equilibrium exchange rate – an exchange rate based on the fundamentals – is the efficient rate. Any divergence from this rate and insisting on the wrong exchange rate is damaging. This is not the case in a floating exchange rate regime where the exchange rate is not locked. However, even in a floating exchange rate regime, there is a possibility of being far from the equilibrium exchange rate for some time.

In a fixed exchange rate regime, especially if the trade of a country is concentrated with those major currencies, the cross-rate fluctuation (the fluctuations of the anchor currency against other major currencies) is another severe flaw. For example, the Persian Gulf oil exporting countries follow a peg exchange rate to the US dollar and have most of their trade with Europe and Japan. In 1997, the appreciation of the US dollar against the Japanese Yen appreciated the real effective exchange rate of several East Asian countries which were pegged to the US dollar and this accelerated financial crises. In contrast, for a country with most trade concentrated on its anchor, the fluctuation of the anchor currency against other major currencies is not severely damaging.

In addition to all the disadvantages of the peg exchange rate regime (such as loss of an independent monetary policy, transmission of shocks from the anchor country to the pegging country and the speculative attacks) Mishkin (1998) describes a criticism which solely applies to the developing countries: the higher probability of financial fragility and the likelihood of a financial crisis in a peg exchange rate regime. The developing countries do not have much credibility in inflation fighting, and usually their debts are short term and in foreign currencies. Therefore, sudden currency devaluation puts pressure on banks, and firms cannot operate properly because they cannot easily access capital market. In contrast, in most developed countries, the devaluation of a peg has little adverse effect on the balance sheets of firms, banks and households because their debts are mostly in their currencies, and the probability of financial crises is less. As Kaminsky and Reinhart (1999) point out, a peg exchange rate regime may cause excessive capital inflows followed by a lending boom, which is a predictor of banking crises.

3.4.3 Floating Exchange Rate Regime

The primary reason why the exchange rate regime may matter is price stickiness. Friedman in his classic 1953 essay "The Case for Flexible Exchange Rates" introduced the floating exchange rate regime as a tool, in a world with sticky prices, to isolate an economy from real shocks (the Friedman Hypothesis). He argued that the floating exchange rate regime would not be more volatile than pegs. This in fact is not universally agreed upon. Klein and Shambaugh (2010) show that a typical floating exchange rate has more volatility than a peg; however, Friedman (1953) argues that smoothly floating exchange rates create less volatility than the large devaluation which usually happens in peg regimes. Under a flexible exchange rate regime, relative prices can adjust immediately through changes in the nominal exchange rate; however, under a fixed regime the changes are slow, and it takes time until excess demand in the goods and labour market pushes nominal goods prices down. Therefore, flexible exchange rate regimes are likely to have smoother responses and quicker price adjustments to real shocks than fixed exchange rate regimes. Milton Friedman uses an example to describe the concept clearly: every summer, it is easier to move to daylight savings time than to coordinate large numbers of people and move all activities by an hour. Several authors empirically test and confirm the Friedman Hypothesis.

To test the Friedman Hypothesis, Broda (2004) uses a post-Bretton Woods sample (1973-96) of 75 developing countries to check whether the responses of prices to terms of trade shocks, real GDP and real exchange rates differ systematically across exchange rate regimes. Broda (2004) finds that responses are symmetric to shocks of different signs in the pegs and asymmetric in the floats. The paper confirms that responses are significantly different across regimes and supports Friedman's Hypothesis. In this kind of study, using different methods, categorization of an exchange rate regime between floating or peg exchange rate regimes is vague. In one study, a currency is categorized as a peg, but in another, it is characterized as a float; therefore, it is possible to see some contradictions.

To implement a floating exchange rate regime, we need an independent central bank and developed financial markets. In this context, independence is usually defined as the central bank's operational and management independence from the government. Advocates of central bank independence argue that a central bank which follows political pressure may face economic cycles. In this case, to attract people's vote, politicians may expand the economy without considering the long term health of the economy. For the financial market issue, as markets develop, an exchange rate regime with more flexibility becomes more feasible and attractive.[41] Husain et al. (2005) show that the performance of a flexible exchange rate regime dominates a fixed regime only for more financially developed countries, while Aghion et al. (2009) recommend an exchange rate peg regime for countries with low levels of financial development. The floating exchange rate regime as a major regime in the developed world has its advantages.

Allowing a country to pursue an independent monetary policy is the main blessing of a floating exchange rate regime. To some extent, a flexible exchange rate regime can isolate the domestic economy from external shocks. When the economy faces shifts in terms of trade or exogenous shocks, in a fixed exchange rate regime, monetary policy is constrained and cannot actively react. In this case, the transmission of the shock to the real exchange rate takes a long time while the real GPD and employment decline. According to Edwards and Yeyati (2005), terms of trade shocks hurt economic growth more in a peg exchange rate regime, as compared to a floating one. By allowing the currency to float, the country can use monetary expansion and currency depreciation to increase demand and boost output. In a peg exchange rate regime, however, the central bank loses that flexibility and must allow recession to run its course. In a peg exchange rate regime with free capital mobility, this process could be intensified.

Earning seigniorage and existence of a lender of last resort are the other two advantages of a floating currency. Seigniorage is partially lost if the rate of money creation is linked to that of the external currency to which it is pegged. In a currency board or dollarization there is no opportunity for seigniorage. In the Middle East oil exporting countries with high levels of reserves, seigniorage is not an issue. As for the lender of last resort advantage, the central bank is able to act that role for the banking system, and the main prerequisite for the existence of an effective lender of last resort is the credibility of the central bank.

More protection against speculative attacks and minimizing the role of tariffs and quotas are other advantages of a floating exchange rate regime. Reviewing the history of speculative attacks, it is apparent that most of them occur in fixed exchange rate regimes. To manage a speculative attack, countries with a fixed exchange rate regime need high level of reserves. However, the possession of reserves cannot guarantee the stability of a fixed exchange rate regime. During a speculative attack, if the government insists on supporting the fixed exchange rate, they face serious financial crises and quickly lose their reserves.[42] On the other hand, even in a floating exchange rate regime, the central bank must have some reserves to pay for official commercial transactions. The final argument in the favour of flexible exchange rate,

[41] Financial market development is defined by the ratio of private credit to GDP and the recommendation for a proper flexibility of exchange rate regime is a threshold of around 40 per cent.

[42] While Argentina's fixed exchange rate provided short term benefits, it caused the economy's collapse in 2002. Although a peg to the US dollar could manage the high inflation in short term, it was not a long term solution.

as MacDonald (2010) points out, is that if a floating exchange rate regime can equilibrate the balance of payments, then the role of tariffs and quotes is minimized.

3.4.4 The Hollowing of the Middle (The Corner) Hypothesis

During and after the emerging market crises of the late 1990s, there was an acknowledgement of the bipolar view of exchange rate regimes which is called "The Corner" or "Hollowing of the Middle" Hypothesis. Swoboda (1986) suggested the first version of this hypothesis describing an intermediate regime as an inconsistent and not credible exchange rate regime. Eichengreen (1994) and Obstfeld and Rogoff (1995) were first to introduce the bipolar view (the free float and the peg exchange rate) as sustainable regimes. There are mixed empirical results supporting or rejecting this hypothesis. Rogoff et al. (2004) show the durability of intermediate exchange rate regimes and reject the corner hypotheses. In contrast, Fischer (2001) shows the reduction of countries with an intermediate exchange rate regime from 62 per cent in 1991 to 34 per cent in 1999. Fischer and Sahay (2000) confirm the shift from the intermediate exchange rate regime to the corners (the hard peg and the floating) for 1991-1999. In another study, Williamson (2000) accuses the IMF of misusing its authority to push exchange rate regimes to the corners. Since the developed countries either peg (Euro in Europe) or float, IMF (1999) suggests emerging markets and developing countries must do the same and go for the hard peg or the floating, not the intermediate exchange rate regime. In IMF (2003), there is a significant change – replacing the *de jure* measure of regimes with the IMF's *de facto*[43] classification. Focusing on inflation and growth, the IMF recommendation is a peg exchange rate regime for developing countries and a floating one for emerging market countries.

At first glance, it appears that there is a contradiction between the Impossible Trinity and intermediate exchange rate regime. According to the Impossible Trinity, a country cannot simultaneously implement the following three: the fixed exchange rate regime, financial market integration and an independent monetary policy. In a world of almost free capital flow, we are not obliged solely to take one of the two extreme regimes (The Corner Hypotheses), but there is an option of sacrificing a part of exchange rate flexibility for partial monetary independence. We can describe the intermediate exchange rate regime as a medium solution which works by using only a part of all three factors (Frankel, 1999).

[43] The *de facto* exchange rate regime usually is different from *de jure*: countries real behaviour in managing their exchange rate regime (*de facto*) is not consistent with what they claim (*de jure*).

3.5 Inflation Targeting

By the end of the 1990s, the peg exchange rate regime, monetarism and the gold standard had already failed. There was a need for a fresh nominal anchor. Inflation Targeting was pioneered in New Zealand in 1990, and is now also in use by the central banks in Sweden, the United Kingdom, Australia and Canada. It became popular as well in Latin America (Colombia, Chile, Mexico, Peru and Brazil) and in other developing countries (Turkey, Egypt, South Korea, Indonesia, South Africa and Thailand, among others).

The main objective of a monetary policy with a market determined nominal exchange rate is price stability or limiting inflation. With Inflation Targeting, we directly focus on the limiting inflation which is the ultimate goal. In contrast, with other nominal anchors, we use monetary aggregate targets as an intermediate target to satisfy the final objective which is limiting inflation. The Inflation Targeting could be strict or moderated.

The strict version of the Inflation Targeting is defined as a transparent policy which is announced publicly and followed to control inflation within a band of exact percentage. Mishkin (1998) points out that Inflation Targeting, which has a floor in addition to a ceiling, can reduce output volatility. Therefore, negative shocks to aggregate demand are decreased by Inflation Targeting as are positive shocks.[44] On the other hand, a strict focus on inflation may lead to large adverse effects on output; therefore, some recommend flexible or moderate Inflation Targeting. In the short term, such as under Taylor rule, this includes some weight on real GDP growth in the target. For example Larrain and Velasco (2002) describe the experience of countries such as Chile and Brazil with a moderate Inflation Targeting policy which reacted to the output gap and nominal exchange rate besides focusing on the inflation rate. Switching to a moderated version of Inflation Targeting is not limited to developing countries. After the international financial crises that begin in 2007 with the US sub-prime mortgage crises, some suggested adding equity and real estate prices to the Inflation Targeting framework. However, Inflation Targeting, with all its successful performance, has its deficiencies.

The absence of exogenous trade shocks and the existence of perfect capital market in the theoretical models of Inflation Targeting are two assumptions in Inflation Targeting framework which may not be satisfied in the context of developing countries.[45] For the nature of shocks, the developing commodity exporting countries are faced with exogenous not endogenous shocks.

[44] As Mishkin (1998) describes, this benefit of Inflation Targeting has been emphasized by the Canadian monetary authorities.

[45] Frankel (2012a) confirms the vulnerability of theoretical models of Inflation Targeting to terms of trade shocks. First, they are not designed for open economies and second they are established based on the capital perfect market hypothesis.

The export markets for the manufactured goods and services produced by developed countries are much more stable. The terms of trade shocks in the developed world are smaller and less exogenous than in the developing countries. Therefore, Inflation Targeting usually works better in the developed world.[46] It is already documented that the capital market in the developing countries is not perfect, and these countries cannot smooth their consumption path through the international capital markets.[47] For the developed countries, the international capital flow is countercyclical and smooths consumption, but in the developing countries the capital flow is usually procyclical and often exacerbates external shocks.[48] Fraga, Goldfajn and Minella (2003) show that central banks in the developed world are more successful in implementing their promised inflation targets than their counterparts in the developing world.

In theory, a clean floating exchange rate regime is an important component of an Inflation Targeting framework. However, in practice, under an Inflation Targeting policy, central banks still do take care of exchange rates. This is the "Fear of Floating" of Calvo and Reinhart (2002). For example, as Edwards (2006) shows, with the rise of commodity prices in 2003, central banks intervened and limited the currency appreciation. In the opposite case in 2008, because of the fall of commodity prices, they intervened and controlled the currency depreciation.

In addition to a proper exchange rate regime, implementation of an Inflation Targeting regime has such prerequisites as proper institutions, communication strategies, and an independent central bank. Our context is the developing commodity exporting countries where lack of credibility, strong legal system and proper intuitions are major characteristics. Building trust between government and people, and satisfying these requirements are a kind of long term process and are not achievable in short run. Therefore, most it is likely that, being unable to satisfy these prerequisites, most developing commodity exporters would not be able to adopt Inflation Targeting.

Masson et al. (1997) present two requirements for successful Inflation Targeting in developing countries. First, the CPI should be the only anchor. Second, the existence of an independent monetary policy which is not limited by the fiscal policy. Usually, in Inflation Targeting, the CPI is the price index which is monitored; it can be the core (excluded food and fuel price) or the headline CPI. An independent monetary policy in the expansionary and contractionary form could be used to achieve the target. A successful Inflation Targeting monetary policy has some advantages.

[46] See Taylor (2002).

[47] For more details see Kaminsky et al. (2005) and Reinhart and Reinhart (2009).

[48] Kaminsky et al. (2005); Reinhart and Reinhart (2009).

As outlined in Bernanke and Mishkin (1997) and Mishkin (1998), the main advantage of Inflation Targeting is its transparency. It can be easily monitored by the public; therefore, it makes the central bank more responsible for controlling inflation and overcomes the time inconsistency problem. It communicates with the public and the markets about the plans and objectives of monetary policy, and promotes accountability of the central bank for obtaining its announced inflation target. However, with all its benefits, the Inflation Targeting may not always work.

Frankel (2012b) describes the main failure of Inflation Targeting as the lack of response to asset market bubbles. In 2008, central banks in some developed countries found out that they had been focused too much on Inflation Targeting while they did not take care of asset bubbles and their adverse consequences. This is similar to the asset market crash in the US in 1929 and Japan in 1990. To cope with this problem, Greenspan recommends an expansionary monetary policy to manage the crises, but solution has subsequently been proved not to work.[49] In addition to the lack of response to the asset market bubbles, another problem of Inflation Targeting is the inappropriate response to supply shocks and terms of trade shocks.

Inflation Targeting can be vulnerable to supply shocks. If the supply shocks are terms of trade shocks, then the choice of the CPI as the price index on which Inflation Targeting focuses is particularly inappropriate.[50] If the price of imports (food and oil) rises in the international market, the Inflation Targeting is actually procyclical (destabilizing). Food and fuel are a considerable part of the CPI, the appropriate response based on Inflation Targeting Monetary policy is currency appreciation to control inflation around its target. This is a wrong response, precisely the opposite of what we want in accommodating an adverse shift in the terms of trade. For example, the central banks of countries such as South Korea (an importer of food and energy) have experienced this problem because of following an Inflation Targeting policy in the face of increases in the world prices of oil and agricultural commodities. If the price of the export commodity in world market rises, a proper response for such improvement in the terms of trade is the currency appreciation which Inflation Targeting does not provide.

Another problem in implementation of Inflation Targeting in the developing world is the trust and credibility issue. In developing countries with high inflation, the public is not easily convinced of the ability of the government to apply the target, and it takes time and effort to establish trust. Therefore, Inflation Targeting may be implemented in two steps. In the prerequisite period, by joining a currency board, both the people expectations of inflation

[49] It is interesting to know that Greenspan obtained his Ph.D. degree in economics from New York University in 1977. His dissertation includes a discussion of soaring housing prices and their effect on consumer spending; it even predicts a bursting housing bubble.

[50] For example see: Frankel and Chinn (1995) and Frankel et al. (2007).

and inflation itself get under control; and then in the next step, the central bank can focus on hard targets for inflation. During this process, the monetary authorities must communicate with the public and explain their intentions.[51]

In a comprehensive analysis of the alternative monetary policies for the developing countries, we should take into account the breakdown of monetarism in the international financial crises of 1982, the failure of exchange rate targeting of 1994-2001, and the Inflation Targeting problem with supply shocks and the asset market bubble during the 2008-09 crises. This chapter introduces and tests alternative price indices which may work better for the commodity exporting countries. Therefore, our proposed anchor could fit into the Inflation Targeting framework, but with completely different price indices. A contribution of this chapter is to consider the other price indices instead of the CPI as nominal anchor within what could still be called Inflation Targeting.

4 Classification of Exchange Rate Regimes

To evaluate the performance of fixed and floating exchange rate regimes, first we should categorize countries between these two regimes. In practice, it is not an accurate task since the *de facto* exchange rate regime usually is different from the regime *de jure*: the real behaviour of countries in managing their exchange rate regime is not always consistent with what they claim. The other issue is that of dual exchange rates, an official rate and a black (parallel) market one. The behaviour of the black market rate may be considered if most transactions are done in that rate.

Up to the 1990s, using the *de jure* exchange rate regime announced by countries in the IMF Annual Report on Exchange Arrangements and Exchange Restrictions was the only comprehensive categorization of exchange rate-regimes. In 1999, the IMF started to consider the *de facto* classification based on actual exchange rate and reserves fluctuations. Calvo and Reinhart (2002) coin a phrase "Fear of Floating" to refer to the situation of some countries which are *de jure* floating, but in practice which fear to float.[52] Alesina and Wagner (2006) investigate which features of countries make them experience this Fear of Floating and show that these are characteristically countries with good institutions. Officially these countries follow a floating exchange rate regime; however, they peg in order to limit exchange rate fluctuations and not to be labelled unstable, especially in the devaluation phase.

[51] For example, Chile in 1990 followed this policy. Another example is Israel. See Bernanke et al. (1999).

[52] Some countries, such as Japan and Australia, follow an Inflation Targeting framework but follow a clean float exchange rate regime, which is *de facto* floating.

In another study of exchange rate regimes categorization, "A Taxonomy of *De facto* classification", Klein and Shambaugh (2010) review the three influential *de facto* exchange rate classification schemes, which are: Levy-Yeyati and Sturzenegger (2003); Reinhart and Rogoff (2004); and Shambaugh (2004).[53] In each of these three studies, the classification schemes and assignment rules are different. Levy-Yeyati and Sturzenegger (2003) divide the continuum of exchange rate regimes into three categories: the peg; intermediate; and float regimes. This categorization of countries considers the rate of change of the exchange rate and the volatility of the reserves. On the other hand, using the most longitudinally complete data set of 150 countries over more than 40 years, Reinhart and Rogoff (2004) base their categorization on the behaviour of the parallel market-determined and the official exchange rate. In this study, if the official exchange rate is constant but the parallel exchange rate is changing, the country is not categorized as having a fixed exchange rate.[54] Furthermore, Reinhart and Rogoff (2004) show that for the post-World War II period, the officially announced exchange rate is not accurate since most countries at some point either applied capital control or had a dual exchange rate.[55] They carefully distinguish the free floating exchange rate regime from another exchange rate regime which they call "Free Fall". This is an exchange rate regime with very high inflation or a failed peg. As Reinhart and Rogoff (2004) show, 41 per cent of transition economies follow the "Free Fall" exchange rate regime. In any categorization of exchange rate regimes, the free fall must be considered separately from the floating exchange rate regime. The third study, Shambaugh (2004), unlike the other two exchange rate regime classifications, is bivariate (peg or non-peg category). In this categorization the focus is on the official rate; therefore, it is not proper for countries with a parallel exchange rate. Some correlation for these three categorizations of exchange rate regimes is expected.

Klein and Shambaugh (2010) investigate the correlation of these three different exchange rate regimes classifications by the percentage agreement between them. As expected, the correlations are different, but there are overlaps among these categories; however, it is not clear whether this is because of the characteristics and complexion of the classification or real differences in performance across regimes. Therefore, categorization of exchange rate regimes is not an accurate and well defined task. Different assignment rules, the variety of samples and diverse methodologies provide different categorizations of exchange rate regimes, and their contradictions and differences mean it is not possible to label one wrong and another right. Indeed, a unique categorization may not be possible at all.

[53] Other classifications are Moreno (2001) and Dubas et al. (2005). Dubas et al. (2005) use information in effective exchange rate to classify exchange rate regimes. Using three variables as inputs: the volatility of a country effective exchange rate; a bilateral exchange rate; and international reserves, they base their classification by output of a multinomial logit choice problem.

[54] Malaysia is an example for this case. It introduced capital control to defend its peg but the parallel market exchange rate was moving. Based on Reinhart and Rogoff (2004), we cannot consider this case a fixed exchange rate regime.

[55] For example Belgium had a multiple exchange rate until 1990.

5 The Effect of Exchange Rate Regime on the Real Variables

As Iqbal (2010) argues, to evaluate an exchange rate regime we need to prioritize the internal and external objectives. The main internal objectives are stable growth and low inflation. The main external objectives are a sustainable current account, external competitiveness and stability of the exchange rate. For different objective functions (for example, switching the emphasis from growth and competitiveness to inflation control) it is helpful to reconsider the exchange rate regime and its corresponding macroeconomic policies.

The *de facto* classification of Reinhart and Rogoff (2004), Rogoff et al. (2004) can be used to investigate the performance of different exchange rate regimes for developed, emerging and developing countries. This shows that the floating exchange rate regime, in developed countries, causes higher growth rate and less inflation. For the developing countries, their results confirm the peg exchange rate regime as the best regime. This investigation recommends a crawling peg for the emerging countries which are almost integrated in the international capital market but which do not have their own sound institutions as developed countries do. Rogoff et al. (2004) also emphasize the unification of exchange rates for countries with multiple or dual exchange rates. They show the adverse performance of different exchange rate regimes under multiple exchange rates. Many studies have investigated the effect of exchange rate regime on trade volume, inflation and growth.

For the impact of exchange rate regime on trade, as mentioned above, Rose (2000) "One Money, One Market...," influenced the literature by its surprising results (Rose Effect). Rose (2000) argues that countries in a currency union trade three times more with each other than one would expect. He arrives at that surprising result using a Gravity-Equation approach to data for bilateral trade among 186 countries for 1970-1990. Although, many studies – such as Persson (2001), Anderson and van Wincoop (2003), Baldwin (2006) and Nitsch (2002) in his paper "Honey, I Shrunk the Currency Union Effect on Trade" – doubt the large amount of trade boost, other studies – such as Klein and Shambaugh (2010), Glick and Rose (2002), Frankel and Rose (2002) and Rose and Wincoop (2001) – partly confirm the Rose Effect.

For the effect of exchange rate regime on inflation, Ghosh et al. (1997), based on the data of 140 countries from 1960 to 1990, conducted one of the first studies. They find the average inflation in a peg exchange rate regime is less than that of intermediate regimes, and the inflation in an intermediate regime is less than that of a floating one. This result is confirmed by Moreno (2001) and Levy-Yeyati and Sturzenegger (2001) for annual data from

1974 to 1999 of 154 countries, and Husain et al. (2005) from 1970 to 1999 of 158 countries. All these studies are different in their exchange rate classification schemes and regressions, but all confirm the association of the peg exchange rate regime with lower inflation in comparison to a floating exchange rate regime. Most probably, the discipline argument of a peg exchange rate regime on monetary policy and the limiting of expectations of the people are among the main reasons.

For the effect of exchange rate regime on growth, Dubas et al. (2010) find that *de facto* fixed exchange rate regimes have the highest growth rate. Although, the *de facto* exchange rate regimes followed by countries are what matters, Dubas et al. (2010) show the *de jure* exchange rate regime is important as well, especially when countries do not follow what they claim to be following. This study ranks the growth performance of exchange rate regimes from the highest to the lowest for the official exchange rate regime *(de jure)* of counties and their real actions *(de facto)* as follows: i) *de jure* floaters-*de facto* fixers ii) *de jure* fixers-*de facto* fixers, iii) *de jure* floaters-*de facto* floaters, and iv) *de jure* fixers-*de facto* floaters. Several authors focus solely on the effect of the *de facto* classification on growth; however, as we emphasized before, there is no unique *de facto* classification. In one study, a currency may be considered as peg and in another study as floating. Two reasons may explain this: Applying different methodologies may cause different classification outcomes, and the behaviour of countries as regards their currency regime is dynamic; they may switch among all possible exchange rate regimes. In fact, the literature is inconclusive as to the effect of exchange rate classification on growth. Reinhart and Rogoff (2004) recommend limited flexibility. Using annual data from 1974 to 2000 for 183 countries, Levy-Yeyati and Sturzenegger (2003) conclude that the floating regime is the best, and Ghosh et al. (2000) show that basket pegs and intermediate regimes work better for growth.[56]

Many studies confirm the slight impact of the exchange rate regime on long run growth. In growth models, economic growth depends on real variables such as saving rate, the rate of population growth, the initial income and technology. Long run monetary neutrality implies that no nominal variables have any real effect on the economy in the long term. Baxter and Stockman (1989) show that the real exchange rate volatility is different in peg and flexible exchange rate regimes, but their growth performance are not different. Klein and Shambaugh (2010) study the effect of exchange rate regimes on economic growth in a sample of 92 countries over the period 1980 to 1999. Their results confirm that there is little impact of the exchange rate regime on long run growth. Even so, the indirect channel for the effect of exchange rate

[56] Other studies such as Husain et al. (2005) and Moreno (2001) confirm the ambiguity of this literature. Moreno (2001) finds that generally a pegged exchange rate regime is associated with a high rate of economic growth. Husain et al. (2005)) show a floating exchange rate regime is associated with a high economic growth rate only for developed countries.

regime on growth through trade may be valid. Rose (2000) shows that trade is increased by the effect of a peg exchange rate regime and, as Frankel and Romer (1999) argue, increased trade is associated with faster economic growth. Therefore, there is an indirect impact, through trade, from exchange rate regime to growth.

6 Choice of Exchange Rate Regime

Choosing a particular exchange rate regime should be considered in a framework of the domestic and international characteristics of the country in question. There is no a ultimate and exact criterion for the selection of the proper exchange rate regime. In general, it depends on many parameters such as the economic objectives, level of economic and financial development, political system, and characteristics of the economy. Many authors applying theoretical and empirical studies have tried to identify and explain the determinants of the exchange rate choice as a vital decision in any economy. Different countries go for different exchange rate regimes. A commodity exporting country may adopt a floating exchange rate regime to isolate its economy from external shocks; another country may join a currency union to boost trade and import discipline and credibility.

There is no a standard and accepted definition of optimality of an exchange rate regime. Iqbal (2010) and Husain (2006) identify some criteria for the choice of exchange rate regime: degree of involvement with capital markets, trade integration, balance sheet stability, credibility of monetary policy, labour market and wage flexibility, nature of shocks – real or nominal – and their frequency, synchronicity and fiscal policy flexibility. Using these characteristics, there is no precise method to get to a definite recommendation for the right exchange rate regime.

Surprisingly, there are some studies which generalize recommendations for exchange rate regime choice. Hanke and Schuler (1994) support the fixed for all, Williamson (2000) goes for intermediate regimes, and Larrain and Velasco (2002) recommend the clean floating exchange rate regime. Even some international financial institutions such as the IMF and the World Bank are biased toward a particular exchange rate regime. The theoretical and empirical literature on the determinants of the exchange rate regime choice is abundant and extensive. We can categorize this literature into three main groups: the Optimum Currency Area (OCA) theory; determinants based on the nature of shocks; and determinants based on the characteristics of institutions and the political system.

6.1 OAC Theory of Exchange Rate Regime Choice

From the theoretical point of view, the first framework for exchange rate regime selection is the OCA theory, originally formulated by Mundell (1961). The OCA is created to check whether a currency should join a currency union or not; however, it has the capability to consider the desirability of a fixed exchange rate regime against a floating one. It describes the advantages of fixed exchange rates regimes in small and open countries, with a high level of trade with those countries of the currency to which they peg.

MacDonald (2007) reviews the OCA literature and finds it to be mainly based on three papers: Mundell (1961); McKinnon (1963); and Kenen (1963). Mundell (1961) argues that if capital and labour are not mobile, then the country should go for a flexible exchange rate regime. McKinnon (1963) points out that the more open the economy is, the more proper is the fixed exchange rate regime. Kenen (1963) focuses on the level of diversification of an economy as one of the OCA criteria. The more diversified an economy is, the more it is compatible with a fixed exchange rate regime. An OCA theory based on these three criteria could be contradictory. For example, if a country has a closed but diversified economy, based on the second criterion, it should adopt the floating exchange rate regime but according to the third criterion it should go for the fixed exchange rate regime.

Applying the OCA framework, Frankel (2012a) describes the characteristics which could determine the choice of exchange rate regime. These criteria which support a fixed exchange rate, versus a more flexible are: small size and openness, an anchor country with high trade with the home country, symmetry of shocks between home and the anchor country, labour mobility, countercyclical fiscal transfers, and proper level of financial developments. All these criteria are not permanently stable; some of them such as openness and income correlation may be endogenous and change by time.

Evolution in the criteria of some countries may change the result of the OCA. Frankel (1999) describes this: "The OCA criterion might be satisfied *ex post*, even if not *ex ante*" and points to the membership of Sweden in the European Union. Even if Sweden did not satisfy the OCA criteria when it joined the EU, it would have more trade with the EU afterwards and higher income correlation and it would eventually satisfy the OCA criteria.[57] In contrast, there are other studies such as Krugman (1993) which argues that, by becoming a member of a community such as the EU, countries have more trade and have to be more specialist in their production. This reduces their income correlations, moving countries away from OCA

[57] Frankel et al. (1997) use a gravity model and show that membership of the EU increases trade with other members of the EU by 60 per cent or more.

satisfaction. A number of authors test the OCA theory empirically.

Among the first empirical attempts to test the effect of OCA theory on exchange rate regime choice are Heller (1978) and Dreyer (1978). Dreyer (1978) confirms that the larger countries follow a floating exchange rate, but this result for openness does not support the OCA theory. Heller (1978), using five characteristics of a country (such as its size, openness, the degree of international financial integration, inflation, and the foreign trade pattern) shows larger size (GNP), low degree of openness, higher inflation, high degree of international financial integration and less geographic trade concentration all to be associated with a floating exchange rate regime. Álvarez et al. (2011) survey the literature and confirm that the only variable which empirically satisfies the OCA theory in exchange rate choice is the size of the country.[58]

6.2 Shock Theory of Exchange Rate Regime Choice

Departing from the OCA literature, Melvin (1985) argues that the greater the terms of trades shocks (domestic money shocks), the more likely is a flexible exchange rate (fixed exchange rate) to work. The Mundell (1961) and Fleming (1962) model confirms that countries with volatile terms of trade should go for a floating exchange rate regime. Applying a bivariate probit model of exchange rate regime choice based on the OCA theory, Savvides (1990) adds some variables representing shocks and confirms that variables from the OCA theory and the variables representing shocks are effective in exchange rate regime choice. The main problem with those two pure economic analyses (the OCA and shock theory) is that they do not consider the preferences of the policymakers and the authorities who are the ultimate determinants. In practice, in addition to the economic issues, the exchange rate choice has a political dimension. In the same economic situation, but with two different political environments, the exchange rate choice could be different.

6.3 Political Theory of Exchange Rate Regime Choice

In the 1990s, the institution and political theory of exchange rate regime choice entered into the literature. Edwards (1996), as the pioneer of this field, introduced a model based on a pure economic quadratic loss function based on the trade off between inflation and unemployment.

[58] This is confirmed by MacDonald (2007).

The model is extended by adding some political variables such as measures of countries' historical degree of political instability. Applying a probit model, with a binary exchange rate regime index as the dependent variable and using an unbalanced panel data set of 63 countries from 1980-1992, this study empirically shows that the more political instability a country faces, the less is the probability of choosing a peg exchange rate; and the more political transfers between parties, the more probability that a country adopts a flexible exchange rate regime. This result is confirmed by some other authors. Using different measures of political instability on a panel of 125 countries between 1980 and 1994, Méon and Rizzo (2002) confirm the results of Edward (1996). In another study, Leblang (1999) adopts a binary probit model in a sample of 76 developing countries over the period 1973-1994 to check the effect of the democratic environment on exchange rate regime choice. Leblang (1999) finds that democratic governments are more likely adopt a floating exchange rate regime, whereas non-democracies prefer a fixed exchange rate regime.

Another issue is the link between institution and proper exchange rate regime. Alesina and Wagner (2006) point out the possibility of endogeneity of the choice of exchange rate regime with respect to institutions, rather than the other way around. As countries evolve from the developing towards the developed stage, they are more successful in limiting inflation, and the inflation benefit of a peg exchange rate regime fades. During this process, institutions are getting well established and as countries develop economically and institutionally, it is probable that more flexible exchange rate regimes are attractive. (Rogoff et al. 2004)

In contrast to the above three theories, the current literature does not support any special guidelines in determination of the exchange rate choice. Alvarez et al. (2011), using a panel mixed multinomial logit model rather than a cross section approach with data of 21 Latin American countries over the period 1980-2004, empirically check the three types of choice determinants: (i) the OCA theory; (ii) the financial view, which focuses on shocks; and (iii) the political view, which emphasizes the role of institutions, political environment and policy makers' decisions. The results confirm the findings of Juhn and Mauro (2002) which emphasize that there is no general agreement on the parameters influencing exchange rate regime choice by countries. Levy-Yeyati et al. (2010) using a broad set of the most widespread variables in this literature and different methods of classifying exchange rate regimes, reconfirm the results of Alvarez et al. (2011) and Juhn and Mauro (2002). In another study, Alvarez et al. (2007) compare the results of 41 studies of the above three approaches of exchange rate choice. The size of a country is the only variable which is a clear determinant in the choice of a flexible exchange rate regime. Most probably, one of the reasons for the contradictory results in this literature is the different classification of exchange rate regime.[59]

[59] The main three exchange rate regime classifications used in this literature are: the IMF, Reinhart and Rogoff (2004) and Levy-Yeyati and Sturzenegger (2003).

In a survey of exchange rate regime, Rose (2011) argues that similar countries choose completely different exchange rate regimes without any different consequences for their economic performance such as growth and inflation. One example is the case of Singapore and Hong Kong; and another that of Denmark and Sweden. Each pair, with almost the same level of income, institutions, and openness, follow different exchange rate regimes. Rose argues that exchange rate regime choice is a purely academic issue, and emphasizes that it is impossible to determine a clear rule to explain how countries decide about their exchange rate choice; therefore, a certain exchange rate regime, fixed or floating, does not amount to a miracle. Therefore, according to the characteristics of different countries, the optimal exchange rate regime, at different times, is different (Frankel, 1999).[60] Although, as one of the components of a macroeconomic policy, exchange rate regime is important, before the selection of the exchange rate regime, we should take care of the development of sound fiscal, financial and monetary institutions.

7 A Proposed Anchor for Oil Exporting Countries

For the countries which have most of their revenue coming from oil export, some argue that pegging to the US dollar is a proper exchange rate regime. Usually the production level is not volatile, but the oil price in US dollars is. The peg exchange rate could be harmful, if the volatility in government revenues is associated with volatility in the oil price.

As distinct from the developed exporting countries such as Australia, New Zealand and Canada, the Middle East oil exporting countries are years behind in the prerequisites for the floating exchange rate and the Inflation Targeting monetary regime. On the other hand, their performance under the fixed exchange rate has brought them some painful experiences such as the Dutch Disease.[61] Previous work on the proposed exchange rate regime for commodity exporting countries mostly has focused on its benefits to stop debt crises. This is not the case for the oil exporting countries in the Middle East which are creditors.

In 1999, Frankel[62] pioneered a series of studies, some with collaborators: Frankel (2002); Frankel and Saiki (2002) and Frankel (2003a). They introduce a proposal for the developing commodity exporting countries: countries specialized in the export of a particular commodity should peg their currency to the price of that export (PEP). The currency regime proposed in these studies is not for everybody. PEP may work for small economies where a single

[60] The title of Frankel (1999) clearly describes the issue: "No Single currency regime is right for all countries or at all times".
[61] Arezki and Nabli (2012).
[62] Frankel references this proposal to Schliesser (2001).

commodity makes up a large part of exports and their GDP. For such a country, a peg to its export commodity may bring the credibility of a fixed exchange rate regime as a nominal anchor and at same time the flexibility of a floating exchange rate regime. In PEP, a swing in the commodity price in international market does not change the price of the commodity in the local currency; therefore, the government revenue in the local currency is stable. PEP can be seen as a special version of Inflation Targeting as the CPI is the price of a barrel of oil in the local currency. Following the rule that the price of a barrel of oil is constant in the local currency, the central bank every day announces an exchange rate *vis-à-vis* the dollar.

Frankel and Saiki (2002) study the low income debtor countries which are price takers and export silver, copper, aluminium, wheat, coffee and oil.[63] They assume that the local elasticity of supply is equal to one and simulate the path for exports, the trade balance, debt and reserves for the counterfactual peg exchange rate to the US dollar, Euro, Yen and the commodity price. They conclude that the automatic mechanism of a PEP regime could partially save those developing countries facing deterioration in the commodity price of their exports.

Frankel (2003a) concentrates on some oil exporting countries (debtors) such as Nigeria, Venezuela, Ecuador, Cameron, Indonesia, Mexico and Russia.[64] From 1970 to 2000, for each of these countries, Frankel calculates the hypothetical price of commodity in local currency under different pegs and paths for the current account and the debt/ export ratio. This study concludes that not all countries in all periods benefit from a peg to their export commodities. In some countries, PEP was able to cope with the 1990s currency crises when the commodity prices fell. The PEP mechanism automatically depreciates the currency; therefore, it stimulates exports without changing the nominal anchor.

There are two issues with Frankel (2003a). First, in converting the nominal price of the commodity in the local currency to the real in the counterfactual calculations, the analysis is simplified by assuming that inflation in each of the counterfactual pegs is exactly equal to the actual inflation in the country in question. Second, some of these countries are in the Organization of the Petroleum Exporting Countries (OPEC), and they are limited by their quotas. Assuming the local elasticity of supply to be equal to one, and calculating that oil export data in the counterfactual cases are not accurate; this analysis does not apply to the oil exporters which are limited by their OPEC quotas. On the other hand, PEP is a kind of radical proposal and there are some objections to it, but it deserves to be considered as one of

[63] For silver, Peru and Bolivia; for copper, Chile and Mongolia; for Aluminium, Jamaica and Surinam; for wheat, Argentina; and for coffee a set of thirteen: the five Central American countries, three in South America (Brazil, Colombia, and Peru) and five in Africa (Ethiopia, Tanzania, Kenya, Cameroon and Madagascar). If a group of exporters of a commodity all together apply the proposal to peg their currencies to the commodity, the commodity price would be endogenous.

[64] Nowadays because of soaring oil prices, Russia and Venezuela are creditors.

the alternative monetary regimes for the commodity exporting countries.

By linking the currency to a commodity price, we would destabilize the price of other exports in dollars; this is the main objection to PEP. If oil price goes up by 40 per cent, PEP causes the currency to be appreciated by 40 per cent, although the price of one barrel of oil in local currency will be constant, the dollar price of other exports goes up by 40 per cent. This hurts the diversification of exports and damages investments, business plans and markets for other exports. However, the radical version of PEP can be moderated by including a basket of exports or currencies instead of the price of one commodity. For Iraq, Frankel (2003b) proposes a peg to a basket of currencies and oil price. There are other moderate versions of the PEP.

Frankel (2005) introduces a moderate version of PEP which is a peg to a comprehensive index of export prices (PEPI).[65] The definition of the PEPI regime is that it eliminates export price variability. Most probably, a moderate version of PEP or PEPI could limit currency crises which are followed by loss of credibility and shrinking output. Comparing the reactions of PEP and Inflation Targeting to terms of trade shocks could be a way of assessment of these regimes. Frankel (2005) compares the response of PEPI or PEP with Inflation Targeting. Under PEP or PEPI, when the price of exports rises in international market, the currency appreciates. When the export price falls, PEP or PEPI automatically causes depreciation in the currency. This result is desirable and is confirmed by textbook theory.[66] In contrast, Inflation Targeting does not provide this result.

If the price of imports increases, PEP outperforms Inflation Targeting as well. This is the major weakness of Inflation Targeting. In response to adverse terms of trade shocks, appreciation of the currency exacerbates swings in output and destabilizes the economy. For example, in a country under Inflation Targeting policy, positive oil price shocks (as in 1973, 1979 or 2000) require an oil-importing country to tighten monetary policy and to appreciate the currency (to avoid the decline of national output) which is a wrong response. Frankel (2005) confirms this by showing that exchange rates of all major inflation targeting countries (in dollars per national currency) are positively correlated with the dollar price of their import baskets. In contrast, for a rise in import price, PEP and PEPI are neutral since they target the export prices not the import prices.

PEPI can be moderated still further by targeting all domestically produced goods not just the exporting goods. In PPT (Product Price Targeting) oil exporters target a price index with

[65] The target in the PEPI regime contains the goods which the country exports. As Frankel (2011b) points out, this it is different from the proposals of Graham (1941) and Keynes (1938) which suggested a diversified basket of commodities against the gold standard.

[66] Textbook theory says a country's currency should be allowed to appreciate when world markets for its export commodity are strong, and to depreciate when they are weak.

high weight assigned to oil; clearly this weight is much more than the weight of oil (fuel) in the CPI, and excludes imports. As Frankel (2011b) argues, the main point in all the different versions of this proposed monetary policy is the assignment of much weight on the exporting commodities and less or no weight on the imported goods. Inflation Targeting does exactly the opposite. Another candidate could be the GDP deflator, but it also has its problems: lags in collection, measurement errors and only being available quarterly.

To evaluate PEP and PEPI, according to how they would affect the variability of the real prices of tradable goods, Frankel (2011b) compares seven alternative nominal targets, the peg to the dollar, Euro, the SDR[67], CPI; PEP; PEPI and PPT. The context is countries in Latin America and the Caribbean which are price taker commodity exporting countries and suffer from procyclical international finance and volatile terms of trade. PEP beats other regimes in any three criteria of the stability of level of nominal prices, level of real prices and changes in nominal prices; therefore, for commodity exporting countries, PEP or PEPI may work better than other monetary regimes. The findings of simulations in Frankel (2002), Frankel and Saiki (2002), Frankel (2003a,b) and Frankel (2005) are: under PEP, PEPI or the more moderate version of the proposal, the developing commodity exporting countries would be able to avoid some adverse effects of the deterioration in their export revenue because they would concentrate on the export price not the import one. Inflation Targeting does it the other way around. Therefore, for the Persian Gulf oil exporting countries with weak financial institutions and severe terms of trade shocks (swings in the oil market), Inflation Targeting may not be a proper monetary regime.

All Frankel's papers reviewed above are about the comparison of PEP or PEPI with other monetary policies on the country level. Setser (2007a) argues for a global advantage of linking oil exporter's currencies to the oil price. In addition to all the benefits to oil exporting countries, global adjustment will be less difficult as long as the currencies of many large surplus countries are not pegged tightly to the currency of a large deficit country, the USA. In this view, for the Middle East oil exporting countries, importing a monetary policy (pegging to the US dollar) from the US, which is an oil importing country, is a policy mistake.

As we have observed, the peg exchange rate to the dollar in the Persian Gulf oil exporting countries exacerbates procyclical swing in their macroeconomics. By rising oil price, high government revenue leads to high inflation and the Dutch Disease. Switching the anchor from dollar to a basket contains the oil price and may help to smooth government revenue and avoid the Dutch Disease and all its adverse consequences. Most probably, countries such as the UAE which are successful in diversification of their economy and less dependent on oil revenue

[67] As from Dec. 2010, the value of one SDR is equal to the sum of 0.423 Euros, 12.1 Yen, 0.111 pounds, and 0.66 US Dollars. This basket is re-evaluated every five years.

might not be proper candidates for the radical version of PEP. PEP and its moderated versions may be able to limit the macroeconomic volatility of these countries without much political commitment with a cost that is comparable to the current fixed exchange rate regime.

This chapter simulates the nominal and real oil prices of the five Middle East oil exporting countries in local currencies under different counterfactual nominal exchange rate regimes. We evaluate and compare the performance of the actual regime with the counterfactual pegs. The chapter simulates government surpluses and government expenditure under a hypothetical peg to the oil price and compares the results with other conventional pegs, such as a currency basket[68] as well as a peg to the dollar, the current exchange rate regime.

In all Frankel's papers on PEP and PEPI, the aim is targeting the commodity price or price index of the exports in the local currency. Targeting precisely a number, if not impossible, imposes wild fluctuation in exchange rate. One possible margin of moderation is the width of the band; hence PEP or PEPI do not change exchange rate as long as the target in the local currency is within the band. The width of the band can control the degree of moderation. Open market operations to control the export price index inside the band could be done in terms of foreign exchange or domestic securities. Another way of more moderation is to add a weighted average of currencies of major trading partners[69] to PEPI and to apply the band.

In all simulations, the real price (not the nominal one) of the commodity in the local currency is considered. It is the real price of the commodity which makes the incentive for the economic agents to switch between investment opportunities; therefore, we should deflate the nominal price of oil in the local currency by the general price level in the country in question. Depending on the choice of the nominal exchange rate regime, price level and consequently inflation varies. In the case of pegging to the dollar, the inflation in these five oil exporting Middle East countries is not equal to US inflation. There is an inertia element which should be considered. Hence, in an accurate simulation, inflation is endogenous and should be estimated in future research. This analysis should be done by use of the pass through literature. In this chapter, we limit ourselves to consideration of the simple case; for all the counterfactual simulations, we use the actual inflation to get the real oil price in local currency.

[68]For the choice of the currencies in the basket, Meissner and Oomes (2009) suggest going for the currencies that minimize the sum of the bilateral exchange-rate fluctuations, weighted by the trade portion of each country in total trade.

[69]For example Frankel (2003b) proposes one-third dollars, one-third Euros, and one-third oil.

8 Data

We use four datasets; the consumer price indices and the bilateral exchange rates are from the International Financial Statistics (IFS) of the IMF, the oil productions and exports are taken from the US Energy Information Administration (EIA), the Manufactures Unit Value (MUV) from the World Bank data and the oil price, government spending, government deficit or surplus for 1985-2011 all from DataStream.

9 The Model

In most of these five countries, income and sale tax rate are zero,[70] and the major part of government revenue is from oil exports; therefore, with approximation, we assume that the total revenue is equal to the revenue of oil export:

$$\operatorname{Re} v_t = P_t * Q_t \tag{1}$$

Where

$\operatorname{Re} v_t$ is Governments revenue at time t,

Q_t is oil export at time t,

P_t is price of oil at time t.

As we have already reviewed in the literature, in these countries the link between the oil price and the fiscal policy is well documented and the fiscal policy is the major channel to transfer volatility from the oil price to the economy.[71] Another line of enquiry in the literature documents

[70] In four of the five countries, income and sale taxes are zero; in Saudi Arabia, income tax is 2.5 per cent.
[71] Husain et al. (2008).

the negative welfare effect of volatility in government expenditure on growth.[72] Therefore, by introducing an alternative exchange rate regime, we aim to decrease the volatility of the fiscal policy and consequently enhance welfare and economic growth. The fiscal policy in these countries is procyclical; therefore, the government expenditure increases when they face high oil prices and decreases while oil prices go down. In the absence of the proper fiscal institutions and under the influence of multiple powerful groups and the voracity effect, we assume the governments of these countries use the oil price of the current and average preceding three years to set the government spending in each fiscal year. We do not include the net foreign assets in our model, because the data for this variable is not available, and it moves slowly and often is $I(2)$.

$$Exp_t = f(\operatorname{Re} v_t, \operatorname{Re} v_{av}) = \lambda + \delta_1 \operatorname{Re} v_t + \delta_2 \operatorname{Re} v_{av} + u_t \tag{2}$$

Oil revenue is calculated based on the oil price and the amount of oil export.

$$Exp_t = \alpha + \beta_1 P_t + \beta_2 P_{av} + \beta_3 Q_t + \beta_4 Q_{av} \ + u_t \tag{3}$$

where[73]

$\operatorname{Re} v_{av}$ is the average government revenue of preceding years,

Q_{av} is the average oil export of preceding years,

P_{av} is the average price of oil of preceding years.

We do a set of counterfactual experiments, determining for each oil exporting country in the Persian Gulf, how the volatility of government expenditure and would have changed, if they had pegged their currencies to oil prices (the radical forms or the moderate one); to a basket of oil, Dollar, Yen and Euro; or to a basket of those three currencies as compared to a peg to

[72] See Fatás and Mihov (2003), Afonso and Furceri (2010), Ramey and Ramey (1995) and Aghion and Banerjee (2005).

[73] Because of very high correlation of Q_t and Q_{av}, we remove Q_{av} from our model.

the US dollar exchange rate regime which they actually follow. We investigate the relationship between the oil exports, the current price and the average of the preceding three years of oil prices in the local currency with government expenditure. If these two prices could explain government expenditure, we could reduce the volatility in government expenditure by reducing the volatility of oil prices in the local currency.

To manage fiscal policy with less volatility, in the absence of functioning fiscal institutions (the Chilean style), a proper exchange rate regime could smooth oil prices in local currency, and we achieve our goal which is the reduction of the volatility of government expenditure. For these countries, small, open economies, the oil price in the US dollar is exogenous. First, we need to explore the possibility of a relationship between current and the average preceding three years real oil prices in the local currency with government expenditure. Oil revenue is calculated based on the oil price and the amount of oil exports.

Here are the regressions:

$$Exp_t = \alpha + \beta_1 P_t + \beta_2 P_{av} + \beta_3 Q_t + \delta_1 D_1 + \delta_2 D_2 + \delta_3 D_3 + \delta_4 D_4 + \varepsilon_t \tag{4}$$

Where

Exp_t is the government expenditure as a share of output at time t,

Q_t is the log of oil export at time t,

P_t is the log of real oil price in local currency at time t,

P_{av} is the log of the average real oil price of three preceding years in local currency, and D_1 to D_4 are the country fixed effect dummies.

Our hypothesis is that the current and preceding years oil prices can explain the government expenditure as a share of GDP. After a few years of high oil prices, under public pressure government increases its expenditure. On the other hand, a few years of low oil price makes government more cautious and it reduces its spending. Therefore, we expect to see a positive relationship between government expenditure as a share of GDP and past oil prices (a positive and significant β_2 in regression 4).

Although, in real world, oil prices and oil exports are not the only explanatory variables for the government expenditure, the empirical results in regressions 4 confirm their significant effect.

10 Data Analysis

To get a reliable country specific inference, we need a long range of data for government spending of these countries. Unfortunately, these data are not available for long periods; therefore, we pool countries into a panel. Another reason for the panel analysis is that, as Levin and Lin (1992) show, the panel approach substantially increases the power of the unit root test relative to the time series.

There are a variety of different tests with panel data which differ in terms of the assumptions regarding the null hypothesis and the removal of autocorrelation. Levin, Lin and Chu (2002) introduce the LLC test. In this test, the Augmented Dickey-Fuller test (ADF)[74] is done for each individual in the panel. A pooled t-test, asymptotically distributed under the normal distribution, is then produced to test the null hypothesis. Another panel unit root test (IPS) is introduced by Im, Pesaran and Shin (2003) which is an alternative to the LLC test. Instead of assuming a common unit root process such as the LLC test; the IPS tests for individual unit root processes and averages all the individual ADF test statistics. The null hypothesis in the IPS test is that each series contains a unit root. There are two main differences between these two tests. First, the LLC assumes a common unit root for the series, but the IPS considers individual unit root. The second is regarding the alternative hypothesis. In the LLC, the null hypothesis is: each individual series is $I(1)$, versus the alternative hypothesis that is: All the series considered as a panel are stationary. In contrast to the LLC test, the IPS test has an alternative hypothesis stating that at least one of the series is stationary.

Maddala and Wu (1999) introduce the Fisher test which combines the p-values from N independent unit root tests ADF[75] for each series. The Fisher test assumes that all series

[74] Dickey and Fuller (1979).

[75] Or the PP test based on Philips and Peron (1988).

are non-stationary under the null hypothesis against the alternative that at least one series in the panel is stationary. Depending on different values of the N and T components, these test statistics can lead to different results.

The four panel unit root tests for all variables are presented in Tables 2 to 6. The LLC test assumes a common unit root for the series which is a strong statement; therefore, we base our unit root analysis more on the other three tests. Table 2 and 3 report the results of our four panel unit root tests for the log of current and the average of three preceding years of real oil price in local currency. None of the tests reject the existence of a unit root in these variables. These results are consistent with those of other studies which confirm the non-stationarity of oil prices. Table 4 demonstrates the results of the panel unit root tests for the log of oil exports in the Persian Gulf oil exporting countries. It yields very little evidence to reject the null hypothesis of unit root. Table 5 and 6 illustrate the results of the panel unit root tests for government spending as a share of GDP. All four tests, with significance at 5 per cent level, reject the null of unit root. This also accords with the boundedness of these two variables by definition.

Table 2 - Panel Unit Root Tests for P_t

Method	Prob	Prob	Prob
Null: Unit root (Assumes common unit root process	(1)	(2)	(3)
Levin, Lin & Chu t	0.3174	0.0011	0.9760
Null: Unit root (Assumes individual unit root process)			
Im, Pesaran and Shin W-stat	0.8873	0.2835	
ADF - Fisher Chi-square	0.9581	0.2977	0.9997
PP - Fisher Chi-square	0.9856	0.3340	1.0000

Table 3 - Panel Unit Root Tests for P_{av}

Method	Prob	Prob	Prob
Null: Unit root (Assumes common unit root process	(1)	(2)	(3)
Levin, Lin & Chu t	0.0617	0.3402	0.9916
Null: Unit root (Assumes individual unit root process)			
Im, Pesaran and Shin W-stat	0.5196	0.7342	
ADF - Fisher Chi-square	0.2991	0.5318	0.9975
PP - Fisher Chi-square	0.8497	0.9008	1.0000

Table 4 - Panel Unit Root Tests for Q_t

Method	Prob	Prob	Prob
Null: Unit root (Assumes common unit root process	(1)	(2)	(3)
Levin, Lin & Chu t	0.0245	0.0400	0.1808
Null: Unit root (Assumes individual unit root process)			
Im, Pesaran and Shin W-stat	0.0657	0.5402	
ADF - Fisher Chi-square	0.0608	0.3316	0.5656
PP - Fisher Chi-square	0.0691	0.3742	0.5629

Table 5 - Panel Unit Root Tests for Exp_t

Method	P value	P value	P value
Null: Unit root (Assumes common unit root process	(1)	(2)	(3)
Levin, Lin & Chu t	0.0001	0.0000	0.0007
Null: Unit root (Assumes individual unit root process)			
Im, Pesaran and Shin W-stat	0.0218	0.0455	
ADF - Fisher Chi-square	0.0095	0.0232	0.0133
PP - Fisher Chi-square	0.0103	0.0221	0.0006

Notes: Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality. For each test, the P values for the three following cases are reported: (1) Individual intercept (2) Individual intercept and trend (3) None. The lag length is chosen based on the Schwartz criterion.

11 Empirical Strategy

In both regressions 4 and 5, the variables on the right hand side of the equation are $I(1)$ while the dependent variable is $I(0)$, thus resulting in an unbalanced regression.[76] This can potentially cause biased results and unreliable t-statistics and R^2. When all variables in an OLS regression are stationary, the conventional statistical measures such as t-statistics and R^2 are the standard approach. However, if all the variables are non-stationary, such conventional measures no longer have the usual interpretation. A standard cointegration model, however, requires all variables

[76] Banerjee et al. (1993) refer to this type of model as unbalanced regression.

in the regression to be of the same order of integration. In contrast to these two standard cases, here, we face a regression in which the dependent variable is integrated of order zero; $I(0)$, while the explanatory variables are integrated of order one, $I(1)$. The regressors are not stationary; therefore, the conventional statistical procedure is inapplicable. On the other hand, the cointegration statistics are inapplicable, because the variables are not of the same order of integration. However, Pagan and Wickens (1989) state that a minimum criterion for an unbalanced regression is that the error term inherits the stationary property of the dependent variable.

Table 6 presents the unit root tests for the error term of regression 4. We reject the unit root hypothesis for both. Baffes (1997) expands on this and further suggests that if the dependent variable is $I(0)$ and at least two of the independent variables are $I(1)$, the model can still be considered well performing, if the predicted value of the dependent variable is also $I(0)$ and the variance of the observed and predicted dependent variable are equal. Regressions 4 satisfies these conditions; therefore, we pursue with level regression in 4. Finally, in the spurious regression literature, as a rule of thumb, if low values of the Durbin—Watson statistic (DW) accompany with high adjusted R^2, most likely we have a spurious regression. In regression 4, the DW statistic is greater than the adjusted R^2.

Table 6 - Panel Unit Root Tests for the Error Term of Regression 4

Method	P value	P value	P value
Null: Unit root (Assumes common unit root process	(1)	(2)	(3)
Levin, Lin & Chu t	0.003	0.000	0.000
Null: Unit root (Assumes individual unit root process)			
Im, Pesaran and Shin W-stat	0.041	0.071	
ADF - Fisher Chi-square	0.020	0.029	0.000
PP - Fisher Chi-square	0.076	0.026	0.0001

Notes: Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality. For each test, the P values for the three following cases are reported: (1) Individual intercept (2) Individual intercept and trend (3) None. The lag length is chosen based on the Schwartz criterion.

12 Empirical Results

We run regressions 4 for the five Persian Gulf Oil exporting countries using their pooled data of government spending as a percentage of GDP. Table 7 demonstrates that the current and average of three preceding years of real oil price in local currency could explain government spending as a share of GDP. In regression 4, for example, a 10 per cent increase in current real oil price would lead to 1.4 percentage point decrease in government spending as a share of GDP, and a 10 per cent increase in the average of last three years of real oil price in local currency would lead to 0.7 percentage point increase in government spending as a share of GDP. The result for P_{av} is consistent with our hypothesis that last years high oil price convenience government to follow an increasing trend in its spending.

Table 7 - Results of Regression 4 - Gov Spending - The UAE is the Base Country

Exp_t	Coef.	Std. Err.	t	P value
P_t	-14.87	2.02	-7.36	0.000
P_{av}	7.038	2.00	3.51	0.001
Q_t	-11.91	2.84	-4.19	0.000
D_1	15.23	1.83	8.32	0.000
D_2	-.068	2.82	-0.02	0.981
D_3	6.85	3.61	1.90	0.063
D_4	21.39	1.86	11.44	0.000
$Cons$	59.13	5.31	11.12	0.000
R^2	0.85			
Adj R^2	0.83			
Prob > F	0.00			

A possible explanation for the negative effect of current oil price on government spending might be that the rise in oil prices increases GDP; therefore, government spending as a share of GDP may decrease. Another explanation could be that our data for government spending do not cover capital investment. By increasing oil prices, government may increase the capital investment not the government spending of the same year, usually before the start of each fiscal year; they must finalize their planned spending. For the effect of oil export levels which is limited by the OPEC quotas, as shown in Table 7, a 10 per cent increase in oil exports would lead to 1.2 percentage point decrease in government spending as the share of GDP in the same year, which is very similar to the effect of current oil prices. This is what we expect, since both current oil prices and oil export levels directly influence the current oil revenue.

12.1 The Counterfactual Exchange Rate Scenarios

Equation 5 presents the general form of exchange rate regimes; it covers a wide range of exchange rate scenarios, from a radical peg to oil price (PEP) to a basket of Euro, yen and Dollar.

$$Ln(E_t) = \alpha Ln(k/P_t^{'}) + (1-\alpha)\left[(\theta_1 Ln(\$/€)_t + \theta_2 Ln(\$/¥)_t + \theta_3 (Ln(\$/\$)_t\right] \tag{5}$$

Where E_t $(Dollar/Local\ Currency)$ is nominal exchange rate at t,

θ_i is the weights based on the relative trade share of the home country with each of its trade partners where $\theta_1 + \theta_2 + \theta_3 = 1$. In our counterfactual baskets, for simplicity all calculations are done based on equal weights for these three currencies. Possibly applying weights corresponding to the relative trade share of each country with the USA, Europe and Japan could attain better results.

$P_t^{'}$ is nominal oil price in US Dollar at time t,

If $\alpha = 1$, Exchange rate is pegged to oil price. (The PEP)

If $\alpha = 0$, Exchange rate is pegged to a basket of Euro, Yen and Dollar.

Using the Manufactures Unit Value (MUV), the nominal oil price in US dollar, the CPI of each country and its counterfactual nominal exchange rate from equation 5, we calculate the real oil price for each counterfactual exchange rate scenario. Based on the coefficients from regressions 4 and 5, we simulate government expenditure as a share of GDP. Although different counterfactual pegs influence the CPI differently, to simplify the simulation, we use the actual CPI of each country for all its counterfactual pegs.

Table 8 to 12 present the volatility (Standard Deviation/Average) of government spending for the five Persian Gulf oil exporting countries under different exchange rate scenarios. The volatility should be positive; however we calculate Standard Deviation/Average. Three counterfactual exchange rate regimes which are compared to the actual regime are: a radical peg to oil price ($\alpha = 1$); a moderate version of the proposal ($\alpha = 0.5$) with a basket of oil price, Dollar, Euro and Yen; and finally a basket without oil ($\alpha = 0$) containing Dollar, Euro and Yen with equal weights. For government spending volatility, these results are consistent with the growing debates in these countries regarding the need to depart from the current exchange rate regime of the US dollar peg to other regimes. In Saudi Arabia and Qatar, switching from the US dollar peg exchange rate regime to a basket of Dollar, Euro and Yen halves the volatility of government spending. It is the same case for the UAE with 35 per cent decrease in the volatility of government spending. Oman is the only country which faces an increase in its volatility of government spending by shifting from the US dollar peg to a basket of Dollar, Euro and Yen. Oman's more concentrated trade with the USA could be a possible explanation for this. Adding the oil price to the basket of Dollar, Euro and Yen, in all five countries, decrease the volatility of government spending. Except for Kuwait, a radical peg to oil price does not bring them any benefit in reducing the volatility of government spending. On the other hand, a radical peg to the price of oil (PEP) would result in high volatility of the exchange rate as it swings in line with the oil price in the international market. In all these countries, the expanding of non-oil export is a part of their development plans; therefore, PEP could potentially destabilize the price of other goods and services in the local currency and discourage investment and business in the non-oil sectors. However, to remove the volatility of oil price and consequently the volatility of exchange rates in the radical version (PEP) as MacDonald (2010) proposes, we could smooth the oil price by a mechanical filter or by using the equilibrium price.

Table 8 – The Volatility of Fiscal Policy (Qatar)

exchange rate Regime	(St Dev /Average) of Exp_t
Actual	0.24
$\alpha = 0$	0.14
$\alpha = 0.5$	0.09
$\alpha = 1$	0.07

Table 9 – The Volatility of Fiscal Policy (Oman)

exchange rate Regime	(St Dev /Average) of Exp_t
Actual	0.11
$\alpha = 0$	0.14
$\alpha = 0.5$	0.08
$\alpha = 1$	0.09

Table 10 – The Volatility of Fiscal Policy of Fiscal Policy (Kuwait)

exchange rate Regime	(St Dev /Average) of Exp_t
Actual	0.218
$\alpha = 0$	0.217
$\alpha = 0.5$	0.11
$\alpha = 1$	0.05

Table 11 – The Volatility of Fiscal Policy of Fiscal Policy (Saudi Arabia)

exchange rate Regime	(St Dev /Average) of Exp_t
Actual	0.12
$\alpha = 0$	0.05
$\alpha = 0.5$	0.03
$\alpha = 1$	0.04

Table 12 – Volatility of Fiscal Policy of Fiscal Policy (The UAE)

exchange rate Regime	(St Dev /Average) of Exp_t
Actual	0.20
$\alpha = 0$	0.14
$\alpha = 0.5$	0.07
$\alpha = 1$	0.05

Three more points about the result of our panel analysis. First, by adding Iran to the regressions, the results based on regressions 4 and 5 are ruined, perhaps because Iran is different from all other five countries in many aspects: it is not an open economy, and does not have a unique exchange rate. Second, we run regressions 4 and 5 for each individual country, only for Saudi Arabia, we get significant coefficients and the calculated Exp_t and BS_t are similar to results of our panel analysis. Third, for P_{av} by switching from three to two preceding years of average real oil price in the local currency, we do not get significant coefficient for P_{av}. It seems that high oil price in last two years will not convince government to increase current expenditure. Perhaps we need at least three years to see the government's reaction.

13 Conclusion

In last three decades, the US dollar peg has served these countries well by reducing trade and financial transaction costs, encouraging investment and providing a credible nominal anchor for their currencies. This exchange rate regime has been consistent with the main criteria of adopting a peg exchange rate regime such as wage and labour market flexibility. However, it has its limitations, particularity its recent inability to tackle inflation. In the absence of an independent monetary policy, the tools for controlling inflation are limited. This is the case, unless fiscal policy can be tightened significantly which is subject to political impediments. The high volatility in the price of oil coupled with the US monetary policy have had serious implications for these countries in terms of domestic monetary policy and inflation. While these countries are pegged to the US dollar, most of their trade is with Europe and Japan. Any fluctuation of the US dollar against the Euro and Yen could be a destabilizing factor which may hurt their economies. In addition, the weak synchronization of the US and these countries' business cycles increases the cost of maintaining a peg regime to the US dollar. Therefore, these countries need to modify their macroeconomic policy and in particular should adopt a flexible exchange rate regime which could support fiscal and monetary policies in promoting non-oil exports and management of inflation.

The alternative exchange rate regimes range from peg to a basket of currencies, floating exchange rate regime, peg to oil price and a peg to a basket of oil and currencies. In contrast to the developed commodity exporting countries such as Australia, New Zealand and Canada which follow a floating exchange rate regime, the Middle East oil exporting countries are years behind in prerequisites related to Inflation Targeting such as proper institutions, communication strategies, and an independent central bank. The proposed exchange rate regime in this chapter is a medium term solution for commodity exporting countries following the peg exchange rate regime; this could smooth the transition of these economics in diversification of non-commodity exports and development process.

Focusing on the Fiscal Policy volatility, this chapter contributes to the literature of monetary policies in the commodity exporting countries by considering other possible anchors within the Inflation Targeting framework. We simulate the nominal and real oil prices of the Middle East oil exporting countries in local currencies under different counterfactual nominal exchange rate regimes. We do a set of counterfactual experiments. For each oil exporting country in the Persian Gulf, we determine how the volatility of government expenditure would have changed if they had pegged their currency to oil price (the radical forms); a basket of oil, Dollar, Yen and Euro; or a basket of these three currencies without oil as compared to a peg to the US dollar exchange rate regime which they actually follow. In Saudi Arabia, the UAE and Qatar, switching from the US dollar peg exchange rate regime to a basket of Dollar, Euro and Yen significantly decreases the volatility of government spending.

Our results confirm the ongoing debates in the region on the necessity of departure from the current US dollar peg to a more flexible exchange rate regime. Based on the results of our counterfactual experiments in this chapter, we recommend a gradual shift from the current exchange rate regime to a basket of Dollar, Euro and Yen. In our model, we assign equal weights to each of these three currencies, but in future research the weights of the various currencies in the basket could reflect the currency composition of trade. Furthermore, adding the price of oil to the basket of these three currencies decreases even more the volatility of fiscal policy. Meanwhile the volatility of the exchange rate should be monitored. In practice, applying a band around the basket peg would allow the authorities to use monetary policy to support fiscal policy in satisfying internal objectives.

Part III

Equilibrium Exchange Rates in The Persian Gulf Oil Exporting Countries

1 Introduction

The real exchange rate is one of the main factors in the world economy. It has a major influence on the prices faced by consumers and producers throughout the world. It measures the relative prices of domestically produced goods in comparison to international ones, and its volatility and level can influence the world economy. Furthermore, it is one of the important determinants of the balance of payments (competitiveness) which allocates the resources of a country between tradable and non-tradable goods and services. On an individual or company level, the real exchange rate signals the choices between domestic or foreign goods and saving or investing, and its variations may affect many variables, such as: export, import, demand, supply, commodity prices, government finances and employment. There are many questions related to the real exchange rate as an important variable in world economy. This chapter focuses specifically on two of them: first, is there a right or proper real exchange rate? Second, how can we measure it?

The concept of equilibrium exchange rate has been the focus of governments, policy makers, market participants, the IMF and academics since the 1990s.[77] Therefore, often this topic has been on the agenda of international policy summits such as the G20 meetings.[78] In particular, two key issues in the debate on global imbalances are estimation of equilibrium and of any misalignment for both current account and exchange rates.

An exchange rate is called misaligned if its movements are not linked to the movements of the fundamentals.[79] It may impact the competitiveness of an economy, export and private investment,[80] terms of trade, foreign investment, growth rate, and cause global macroeconomic imbalances. One of the important components of an economic policy which promotes economic growth is an exchange rate based on equilibrium not a misaligned exchange rate. A misaligned exchange rate adversely affects the economy thorough overvaluation or undervaluation. The former may cause currency crises and the latter, overheating.

Both overvalued and undervalued currencies adversely impact the economy, but the negative effect of overvaluation can be more serious. Several studies underline that real exchange rate misalignment in the form of overvaluation moves resources away from productive activities,

[77] See Williamson (1994), MacDonald (1995, 2007), Stein (1995, 2002) and Driver and Westaway (2005).

[78] The Group of Twenty (also known as the G-20 or G20) is an international forum for the governments and central bank governors from 20 major economies.

[79] Real exchange rate misalignment is the deviation of the actual real exchange rate from the equilibrium exchange rate. Sallenave (2010) and Aguirre and Calderon (2005) show that average misalignments in emerging economies are higher than in developed countries.

[80] See Caballero and Corbo (1989), Serven and Solimano (1991) and Rodrik (1994).

hurts competitiveness and may slow down economic growth.[81] Furthermore, through current account deficit and increasing external debt, an overvalued currency may cause currency crises and facilitate speculative attacks.[82] In contrast, a real exchange rate undervaluation stimulates investment and exports and improves the current account. However, it also may cause trade and currency war.

Currency war (competitive devaluation) is the phenomenon occurring where countries compete against each other to achieve a relatively low exchange rate for their own currency and consequently boost their exports. It causes international tensions, and has brought the equilibrium exchange rate and currency misalignments to the heart of the economic debates.

To comment on this controversial topic, we need methods for determining real exchange rate misalignments and equilibrium exchange rates. Determination of equilibrium real exchange rates involves substantial uncertainties such as the time frame (short, medium or long run), choice and definition of the dependent variable (real exchange rate or real effective exchange rate), the model selection and the econometrics method. There is a vast literature covering fundamental variables influencing the equilibrium real exchange rate and the mechanisms behind implied misalignment of the actual rate from its equilibrium level.

In the last two decades, the literature on equilibrium exchange rates has mushroomed. Three reasons may explain this wave of studies. First, with the introduction of the Euro, the new EU member countries have to know the right exchange rate in order to join the Euro club. Second, the volatile behaviour of certain currencies (such as the appreciation of Sterling in the late 1990s, the fall of the Euro in 1999, the substantial decline of the US dollar from 2002 to 2008 and the behaviour of the Renminbi against the US dollar) have encouraged a hot debate regarding the sources of exchange rate movements and the right exchange rates. Third, exchange rates are one of the major factors influencing global imbalance manifesting in phenomena such as deficits in the USA and surplus in China.

On the other hand, high fluctuations in oil prices also cause significant shifts in the wealth of nations and can create large current account imbalances. With the rise in oil prices in the decade of the 2000s, the major oil exporting countries have accumulated one of the largest current account surpluses. This highlights the relationship between oil prices and global imbalances and the role of exchange rates.

[81] For the negative relationship between real exchange rate misalignments and economic growth see Ganyaupfu (2013), Bleany and Greenaway (2001), Razin and Collins (1997), and Edwards and Savastano (1999). Some other empirical studies, such as Ghura and Greenes (1993) show the negative link between economic growth and misalignment volatility. In another study, Engel (2011) even proposes that policymakers should target not only inflation and the output gap but also the exchange rate misalignment.

[82] See Kaminsky et al. (1997) and Razin and Collins (1997).

In this chapter, we investigate the following questions: What factors are driving the real exchange rates in the Persian oil exporting countries? Is there any misalignment between their actual and equilibrium real exchange rates at present? To what extent has the evolution of these countries' currencies been consistent with equilibrium real exchange rates; and, over the last decades, to what extent can economic fundamentals explain the path that exchange rates have taken in these countries?

Oil price is becoming more volatile. From 2000 to 2008 oil price jumped (six fold) from $23.5 per barrel in January of 2000 to peak at $146.7 in July 2008 then crashed to $42 at the end of 2008. In 2009, prices began below $40 a barrel, averaging $61.73 per barrel for the year, peaking at $78 in November 2010. In 2011, the price of crude oil started the year on a high note hitting a 2 year high selling point at $95 a barrel. The price continued to trend upward until 2012 (Figure 5).

In this chapter we consider a sample of five oil exporting countries (Qatar, Oman, Kuwait, Saudi Arabia and the UAE) in the Persian Gulf which depend heavily on exports of oil. In addition to other related fundamentals, we investigate in particular the role of oil price as the main source of revenue and its severe exogenous shocks for all of these countries in determination of the equilibrium exchange rate. Based on the Behavioural Equilibrium Exchange Rate (BEER) approach of Clark and MacDonald (1998), this chapter assesses the equilibrium exchange rates and misalignments between the actual and the equilibrium exchange rates from 1980 to 2011.

The rest of the chapter is set out as follows. The second section, "Real Exchange Rate: "Definition and Measurement" elaborates on the multilateral (effective) or bilateral and nominal or real exchange rates, and defines the equilibrium exchange rates. The third section, "Literature Review" surveys different approaches for estimation of equilibrium exchange rate. In the fourth section, we review the literature for the impact of commodity (oil) prices on the real exchange rate and the equilibrium exchange rate in commodity exporting countries with a focus on oil as a strategic commodity. Section five describes the Data. The Empirical Strategy, based on times series and panel methods, is presented in sections six and seven, respectively. In Section eight, the Conclusion is presented.

2 Real Exchange Rate: Definition and Measurement

We may consider different definitions for exchange rate.[83] It could be multilateral (effective), or bilateral and nominal, or real with different price deflators. For any given real exchange rate, there are an infinite number of combinations of nominal exchange rates and relative price levels. In the study of equilibrium exchange rate, most models are based on the real effective rate determined by using different price indices. Although, in the short run, real and nominal exchange rates tend to move very closely together, but most studies are focused on the real rate not the nominal. As Stein and Allen (1997) confirm, economic agents use the real exchange rate in their decisions. Therefore, almost in all analysis of equilibrium exchange rates, the focus is on the real not on the nominal rate. Furthermore, the real exchange rate expresses the terms of trade for domestic and foreign goods and services. It is defined as the nominal exchange rate adjusted by the relative price between domestic and foreign goods and services. Higher price inflation at home relative to other countries, or an appreciation of the nominal exchange rate, strengthens the real exchange rate. This makes the goods and services in the home country less competitive and results in a foreign trade deficit and higher unemployment. The depreciation of real exchange rate causes the opposite. The real exchange rate can be defined in a variety of ways depending on the question at hand. At the simplest level the real exchange rate is given as follows:

$$Q = \frac{E.P^*}{P} \tag{6}$$

where : P, P^*, E and Q are the domestic, foreign price levels, the nominal, and the real exchange rates expressed as units of domestic currencies per unit of foreign currency, respectively. Hence a rise in E and Q implies a depreciation of the nominal and real exchange rate of the local currency, respectively. In the logarithm forms:

$$q = e + p^* - p \tag{7}$$

We distinguish between the price of tradable and non-tradable goods in domestic and foreign countries as follows:

[83] In this study, none of the countries has a black market (parallel) exchange rate.

$$p = \beta.p^{NT} + (1-\beta).p^{T} \tag{9a}$$

$$p^{*} = \beta^{*}.p^{*NT} + (1-\beta^{*}).p^{*T} \tag{9b}$$

where: p^{NT} and p^{*NT} are domestic and foreign non-tradable prices, respectively and p^{T} and p^{*T} are domestic and foreign tradable price, respectively. β and (1-β) are the shares of non-tradable and tradable sectors for the domestic economy, while β^{*} and (1-β^{*}) are the corresponding shares for the foreign economy. Substituting Equations (9a) and (9b) into Equation (8):

$$q = (e + p^{*T} - p^{T}) - \left\{\beta.(p^{NT} - p^{T}) - \beta^{*}.(p^{*NT} - p^{*T})\right\} \tag{9}$$

Equation 10 shows that the real exchange rate is driven by two different components: the real exchange rate of tradable goods and the ratio of the domestic to the foreign relative prices of non-tradable and tradable goods. Therefore, if the Purchasing Power Parity (PPP) in the tradable goods holds, then the real exchange rate of tradable goods (the first term in equation 10) is zero. For an accurate analysis, in transition economies which faces dynamic structures, we should consider the evolutions in β and β^{*} which are the weights assigned to various sectors of the domestic and foreign economies.

Usually countries have multiple trading partners and the real effective exchange rate is a better representative of current account balance rather than focusing on its bilateral balances with individual trading partners. A general expression for the real effective exchange rate of country i (Q_i) is:

$$Q_{it} = \prod_{j=1}^{n} P_{it}\left(\frac{E_{ijt}}{P^{*}_{jt}}\right)^{w_{ij}} \tag{10}$$

where P_i measures the domestic price level in country i; P^{*}_{j} the foreign price level in country j; E_{ij} is the relevant nominal exchange rate (defined as foreign currency per unit of domestic currency between countries i and j); and w_{ij} is the weight of country j in effective exchange rate index of country i.[84] Therefore, an increase in E_{ij} implies that the currency has appreciated, or alternatively that it has become less competitive.[85]The other issue is the definition of price level.

The price level or price deflator is not unique. Marsh and Tokarick (1994) and Chinn (2002) confirm that the price deflators which are used in the calculation of real exchange rate or real effective exchange rate are not necessarily correlated and may move differently. Driver and Westaway (2005) categorize these price deflators to five groups: consumer price index (CPI); the prices of tradable goods; the relative price of export of an economy to its import; relative unit labour costs and the ratio of tradable to non-tradable prices. They propose unit labour cost and the unit value of export indices to measure the cost competitiveness of an economy and the competitiveness of the tradable sector of an economy, respectively. Therefore, by applying different price deflators, we may focus on different measurements of real exchange rates. For example, if a country produces different goods, a shock may change the terms of trade, but not necessarily the CPI. Hence, in this case, the real exchange rate based on the CPI is not very informative. Although the real exchange rates based on the CPI represent the changes in non-tradable and tradable sectors, to focus solely on the tradable sector of the economy, instead of on the CPI, we should apply unit value of the export indices or the producer price index (PPI).

In our five oil exporting counties during the period from 1980 to 2011, the nominal exchange rate (for one US dollar) was at 3.64 in Qatar, 3.67 in the UAE. For Oman, it was 0.34 from 1981 to 1985 then fixed at 0.38 up to 2011. The nominal exchange rate for Saudi Arabia increased from 3.38 in 1981 to 3.75 in 1987 and then fixed at 3.75 up to 2011. Over the 1980-2011 period, for Kuwait, it was in a band of 0.27 and 0.30. Among all these countries, Kuwait is the only country which followed peg to a basket of currencies in some periods. For 25 years from 1977 to 2002, Kuwait was pegged to a currency basket then in 2003 it switched to pegging to the US dollar for 53 months. In May 2007, the Governor of the Central Bank of Kuwait announced an ending of the peg to the dollar, using instead a basket of currencies with 75 per cent of weight for the US dollar to set the price of the Kuwaiti dinar.

Figure 6 shows the real effective exchange rate for the five oil exporting countries over the period 1980-2011. We can divide our five countries to two subgroups and place Kuwait in the middle. It is apparent that the Real Effective Exchange Rate (REER) of Oman follows the

[84] By construction, the sum of w_{ij} will be one. If the real exchange rate is a bilateral exchange rate then $j = 1$.

[85] Usually in the empirical studies, the real effective exchange rate is defined as the nominal effective exchange rate in terms of foreign currency units per unit of the domestic currency. In contrast, in the theoretical models the norm is to define the real effective exchange rate as the nominal effective exchange rate in terms of domestic currency units per unit of foreign exchange.

Saudi Arabian REER, and the REER of Qatar and the UAE move together.

2.1 Equilibrium Exchange Rates

As Driver and Westaway (2005) argue, there is no unique definition for equilibrium exchange rate, and it could be categorized based on the time frame (short, medium or long run). At the equilibrium real exchange rate, there is no reason for the exchange rate to appreciate or depreciate. Furthermore, it is not an observable variable; however, it may be defined as the level of exchange rate which is consistent with the internal and external equilibrium (balance) of an economy. An economy is in internal balance if the level of output is consistent with both full employment and a sustainable rate of inflation.[86] The external balance is in equilibrium if the current account balance is equal to its target level. The existence of a current account deficits increase the foreign debt and associated interest payments. The ratio of debt/ GDP will increase if the growth rate of current account deficit/ foreign debt exceeds the growth rate of real GDP. To be in external balance, the ratio of foreign debt/ GDP should be at a tolerable level.

In summary, based on different theoretical models, different time horizons and different estimation methods, several studies categorize different approaches for estimation of equilibrium exchange rate. On the other hand, there is a distinction between positive and normative methods of determining equilibrium exchange rates. For the former, the equilibrium exchange rate is related to a set of fundamentals while in the latter, we need to add a value dimension to the process of determining equilibrium exchange rate.

3 Literature Review

The literature on the determinants of the equilibrium exchange rates is very broad. There are several comprehensive surveys such as: Wren-Lewis and Driver (1998), MacDonald (2000), Driver and Westaway (2005), Siregar and Rajan (2006), Costa (2005), MacDonald (2007), Williamson (2009), Bussière et al. (2010) and Égert et al. (2006a) for transition economies. The literature starts with the Purchasing Power Parity (PPP), and then based on different theoretical models, the studies such as Dornbusch (1988) focus on the link between real exchange rates and macroeconomic variables. In the 1990s, Froot and Rogoff (1995) and Rogoff (1996)

[86]In some countries, several goods such as food or fuel are subsidised, these price controls could influence equilibrium exchange rate through the change in internal balance.

describe the PPP puzzle. Moving from macro to micro models, Frankel and Rose (1995) go over the micro-structure of the foreign exchange market. Among the methods for determination of equilibrium exchange rate, we review the Fundamental Equilibrium Exchange Rate (FEER), the Behavioural Equilibrium Exchange Rate (BEER) and the Natural Real Exchange Rate (NATREX) which are introduced by Williamson (1983, 1994), Clark and MacDonald (1998) and Stein (1994), respectively.

Overall the literature consists of different methods, ranging from the purely statistical to the purely theoretical, with some methods in between. In contrast to the FEER and NATREX which are normative, the BEER approach, which we will focus on, is rather statistical and does not have normative elements. Meanwhile, in the estimation methods of the BEER approach, there has been a shift from cointegration analysis in pure time series for a specific country to panel methods covering a group of countries. We pursue our literature review with Purchasing Power Parity (PPP).

3.1 Purchasing Power Parity (PPP)

In the First World War, when countries faced different level of inflation, the term "Purchasing Power Parity" was coined by the Swedish economist Gustav Cassel in 1918. The PPP is the usual starting point for investigation of the equilibrium exchange rate. It is built on the existence of arbitrageurs and absence of differences in factors such as transaction costs, transportation costs and taxes. It consists of the choice of a base period in which the economy is assumed to be in equilibrium. Therefore, the dynamic of prices level and nominal exchange rates are matched to keep the real exchange rate constant. The PPP hypothesis is defined in the absolute and relative versions.

The absolute PPP (APPP) does not provide an accurate measure of equilibrium exchange rate, and it is derived by the ratio of price of basket of goods in home and foreign countries in their local currencies.[87] We may drive the condition of absolute PPP as:

$$E_t = \frac{P_t}{P_t^*} \tag{11}$$

[87] In the literature, there is a wide range of baskets of goods and services. From a simple Big Mac Index, which was introduced by *The Economist*, to the Penn World Tables constructed by the UN International Comparison Program (ICP).

Equation 12 may be expressed in logs as:

$$e_t = p_t - p_t^* \tag{12}$$

Another way of presenting the APPP is in terms of the definition of the real exchange rate, Q_t :

$$Q_t = \frac{E_t.P_t^*}{P_t} = 1 \tag{13}$$

so, if the APPP holds, the real exchange rate is equal to one.

The APPP is a long run relationship, and arbitrage is the mechanism which holds it. There are at least three problems with arbitrage. First, in real world trade, there are transaction costs. Second, goods are not identical across countries and third, the weights of goods in the baskets are different in different countries.

As an alternative to the APPP, in the relative form of the PPP, the dynamic of nominal exchange rate follows the inflation differential at home and abroad and keeps the real exchange rate as a stable level (or stationary variable).

The relative PPP is obtained by applying the first differences operator (Δ) to equation 13:

$$\Delta e_t = \Delta p_t - \Delta p_t^* \tag{14}$$

The relative PPP hypothesis closely links to the monetary models and inflation. Depreciation of currency is a logical reaction for a country facing a high rate of inflation.

3.1.1 Empirical Studies of Purchasing Power Parity

Before the introduction of unit root test and cointegration methods, in the 1970s and 1980s, the early empirical studies of PPP used traditional econometrics. These studies confirm the violation of the PPP.[88] In 1982, Jacob Frenkel surveyed the PPP literature and confirmed the collapse of the PPP hypothesis. After the introduction of new econometrics methods in the 1980s and 1990s, there has been much more interest in the empirical test of the PPP. MacDonald (2007) categorizes the PPP empirical literature in the early period (1960s to 1980s) and the recent empirical evidence of the PPP which is enhanced by unit root and cointegration methods.

As MacDonald (2007) describes the early empirical literature for the relative and absolute PPP were based on the following two equations:

$$e_t = \gamma + \alpha_0 p_t + \alpha_1 p_t^* + \varepsilon_t \tag{15}$$

$$\Delta e_t = \theta + \alpha_0 \Delta p_t + \alpha_1 \Delta p_t^* + u_t \tag{16}$$

To satisfy the absolute PPP hypothesis, in Equation 16, α_0 and α_1 should be 1 and -1, respectively. For the relative PPP, in addition to the absolute PPP requirements, θ must be zero. Krugman (1978) applies equation 16 to the 1920s and the 1970s; he could not support the PPP in both periods. In other studies, applying Equations 16 and 17, Frenkel (1980, 1981a) tests both versions of the PPP hypotheses and gets contradictory results for the two different periods. For the 1920s, the results are supportive of PPP while for the 1970s, they are not.[89] Davutyan and Pippenger (1985) criticize Frenkel (1981a, b) for claiming the collapse of the PPP in the 1970s. In their view, the strong coordinated monetary policy in the 1970s (in comparison to the 1920s) is the main reason for rejection of the PPP. In two other studies for the 1970s, Hakkio (1984), for monthly data, and MacDonald (1988), for annual data, document some supportive results of PPP. Later in the 1990s, Lothian and Taylor (1997) find that the real exchange rate does converge towards PPP but only in the very long run (200 years). They show that the mean reversion towards PPP is very slow and the half-life of shocks to the real

[88] See Isard (1977), Kravis and Lipsey (1978) and Giovannini (1988).

[89] Two more studies which reject PPP in the 1970s are: Roll (1980) and Cumby and Obstfeld (1984).

exchange rate is between 3 and 6 years. In another study, Frankel and Rose (1996) find a half-life of 4 years.

Later, as the literature shifts from time series to panel analysis, the introduction of unit root tests and cointegration methods encourage a new wave of empirical studies to test PPP. These tests are done based on equation 16. If e_t, p_t and p_t^* are I (1), and the residual in equation 16 is stationary, then MacDonald (1993) defines this condition as the weak-form PPP. The strong-form PPP exists, if in addition to the weak-form conditions, in equation 16, $\alpha_0 = 1$ and $\alpha_1 = -1$.

The review of the empirical PPP literature for the post-Bretton period confirms that PPP is not a proper method of calculation of equilibrium exchange rate. Several studies such as Rogoff (1996), Sarno and Taylor (2002) and Cheung and Lai (2000) argue that real exchange rates have a tendency to converge towards a stable rate in the long run. Using the method of Johansen (1988, 1995), MacDonald (1993, 1995), MacDonald and Marsh (1994), and Cheung and Lai (1993) support the weak-form of the PPP. Although, in these papers, we observe a kind of support for PPP, the mean reversion in these studies is still very slow. For developed countries, Rogoff (1996) estimates the half-life estimates to be around 3 to 5 years. Rogoff (1996) labels this phenomenon as the "PPP Puzzle" which cannot be explained by sticky prices. It is a puzzle, because if the price stickiness is the real reason behind the slow reversion speed of real exchange rate, the delay should not be more than one year or at maximum two years. In summary, the volatility and the slow mean reversion of real exchange rates together imply the PPP Puzzle. There are several explanations for the empirical rejection of the PPP hypothesis.[90]

First, the PPP does not consider the capital flows and any real determinants of the real exchange rate. For example, the classic Balassa-Samuelson Effect which is based on Balassa (1964) and Samuelson (1964) is the major example which drives the nominal exchange rate away from its PPP level. The Balassa-Samuelson Theorem presupposes that PPP is satisfied for tradable goods, and productivity growth in the tradable goods sector of poorer countries is higher than in more advanced countries. Such stronger productivity increases wages in the tradable sector. If wages are equalized across sectors, this would cause a rise in the prices of non-tradable goods, hence an appreciation of real exchange rate. Therefore, if a country faces an increase in the productivity of the tradable sector (relative to its trading partners), its real exchange rate would tend to appreciate. Consequently, its equilibrium exchange rate, as an endogenous variable, is influenced by changes in fundamentals. Indeed, for a group of industrialized countries, MacDonald and Ricci (2001) demonstrate the importance of this effect in explaining the persistence of the real exchange rates.

[90] For developing countries, Cheung and Lai (2000) estimate the half-life for a given deviation to be around 1 to 2 years. However, Akram (2000, 2002) show that for Norway, as a developed country, it is 1 to 1.5 years.

Second, as Crespo-Cuaresma et al. (2005) argue, even though the Law of One Price (LOOP) holds, in different countries, the existence of different baskets (which cover different composition and weights) may cause the failure of PPP. Third, as Hegwood and Papell (1998) argue, structural breaks may cause the empirical failure of PPP. By considering this structural change, we observe a faster mean reversion for real exchange rate. Fourth, as Taylor (2001) argues, non-linearities in the adjustment mechanism may cause the empirical failure of PPP. Fifth, the frequency of data is important; Taylor (2001) distinguishes the different results if we use different frequency for data (annual rather than quarterly or monthly data). Observing the PPP failures as a reality, there have been several attempts to improve the PPP puzzle.

For improvement of empirical results of PPP, Clostermann and Schnatz (2000) offers three solutions: first, using longer data sets such as those of Frankel and Rose (1995). Second, we may improve the results of PPP by introducing fractional cointegration. Third, literature can shift away from time series and go for the panel methods which enhance the information in the data.

Time series analysis however may be problematic, because the long data samples required for statistical analysis may not be available, and the exchange rate regime change could influence the results. In the 1990s, with the introduction of the panel conintegration method and panel unit root tests, several studies could produce better results for the PPP hypothesis. Using a panel of 150 countries and 45 years data, Frankel and Rose (1996) investigate the PPP. Their results are compatible with the results of the long time series. Therefore, applying a panel approach in a group of countries could extract the information which is not attainable in times series methods. In summary, traditional PPP, as a static equilibrium exchange rate which ignores the real factors, is not successful in explaining equilibrium exchange rates. The failure of PPP brings the attention of several authors[91] to the link between the real exchange rate and fundamentals, such as commodity prices, productivity and net foreign assets. Before moving to the equilibrium exchange rate approaches which use fundamentals to explain real exchange rate, we review an enhanced version of PPP.

3.1.2 The Monetary Extension of PPP

As MacDonald (2000) argues, the monetary model is an extended version of the PPP which endogenises the price in two countries based on the supply and demand for money. Generally, it is based on a two-country, two-money, two perfect substitutable bonds model in which all goods are tradable, and the law of one price holds. The monetary model has another version

[91] See Meese and Rogoff (1983), Frankel and Rose (1995) and in MacDonald (1995).

which is based on assumption of sticky price. In the sticky model, PPP does not hold for the short run, but it does for the long run. Following Crespo-Cuaresma et al. (2005), the money demand relationships are given by standard Cagan-style log-linear relationships:

$$m_t^D - p_t = \beta_0 y_t - \beta_1 i_t \tag{18a}$$

$$m_t^{D*} - p_t^* = \beta_0^* y_t^* - \beta_1^* i_t^* \tag{18b}$$

where $\beta_0, \beta_1, \beta_0^*, \beta_1^* > 0, m^D$ denotes money demand, p denotes the price level, y is output, i the interest rate. Lowercase letters indicate that a variable has been transformed into natural logarithms (apart from the interest rate) and an asterisk denotes a foreign magnitude. We assume the money market is in equilibrium. Therefore:

$$m_t^D = m_t^S = m_t \tag{19a}$$

$$m_t^{D*} = m_t^{S*} = m_t^* \tag{19b}$$

then, using the conditions in Equations 18a, 18b, 19a and 19b, we obtain:

$$p_t - p_t^* = m_t - m_t^* - \beta_0 y_t + \beta_0^* y_t^* + \beta_1 i_t - \beta_1^* i_t^* \tag{19}$$

Using Equation 13, which confirms the PPP theory, we obtain a base-line monetary Equation as:

$$e_t = m_t - m_t^* - \beta_0 y_t + \beta_0^* y_t^* + \beta_1 i_t - \beta_1^* i_t^* \tag{20}$$

Dornbusch (1976) introduces the sticky-price version of the monetary model where PPP is relaxed. However, the empirical evidence of the monetary models is not very convincing.

In a seminal paper, Meese and Rogoff (1983) show that monetary models might fit well in-sample, but their out-of-sample forecasting is very poor. They document that the forecasting of monetary models for exchange rates even cannot beat a random walk, and the monetary models which fit the data for the 1970s are rejected when the data sample is extended to the 1980s.[92] With all these pessimistic views, there are still some promising results.

For a group of developed countries, Husted and MacDonald (1998), Groen (2000) and Mark and Sul (2001) apply panel methods to the monetary model of the exchange rate and present convincing results for in and out-of-sample. Applying a multivariate cointegration technique, MacDonald and Taylor (1994) are able to get positive results for the long run sterling-dollar exchange rate. In another study, applying a nonlinear, exponential smooth transition autoregressive (ESTAR) model, Mark (1995) finds strong evidence of predictability at horizons of 2 to 3 years, but not at shorter horizons. Based on three structural exchange rate models, Chinn and Meese (1995) fail in short term forecasting, but their long run results are slightly more positive. In contrast to some positive evidences, other authors such as Cushman et al. (1996) document the rejection of long run monetary model. In summary, the dominant view in the literature still is that monetary models cannot forecast exchange rate in short run.[93]

The weak performance of the monetary models may be because of neglecting some important real (non-monetary) shocks that influence real exchange rate. For example, shocks (changes in fundamentals) may be new fiscal policies, change in world price of commodities, changes in productivity or discoveries of natural resources. After PPP and its monetary extension, which are the starting point for examining the equilibrium exchange rate, the 1980s witness the emergence of other approaches which emphasize the time varying nature of equilibrium exchange rate, and its dynamic links to fundamentals. In the 1980s and 1990s, most equilibrium exchange rate studies apply time series for individual countries. These studies usually suffer from short span of data; therefore, the results have not been reliable and robust.

In summary, as Costa (2005) argues, we can divide the equilibrium exchange rate approaches into two groups: structural approaches and direct approaches. The structural approach is based on the solution of a macroeconomic model when the model is in internal and external balance.

[92] Other papers such as Diebold et al. (1994) and Engel (1994) confirm the Meese and Rogoff conclusion.

[93] To explain and forecast the exchange rate in short run, in addition to the models based on macroeconomics, there is other literature based on microstructure which uses the action and behaviour of traders in influencing exchange rates.

In the direct approaches, we directly estimate equilibrium exchange rate based on an equation which links the fundamentals to the equilibrium exchange rate or by decomposing the real exchange rate with statistical or econometric techniques.

3.2 The Internal–External Balance (IEB) Approach

In the IEB approach, the equilibrium exchange rate is defined as the rate which satisfied both internal and external balance. Low inflation and full employment satisfy the internal balance, and a sustainable level of the current account manages the external balance. MacDonald (2000) represents the general form of the IEB approach as:

$$S - I = CA(q^{'}, Y) = -KA \tag{21}$$

Where S denotes national saving, I is investment spending, Y and $q^{'}$ are potential output and real exchange rate consistent with internal balance, respectively.

Within the IEB approach, there are several different approaches for the equilibrium exchange rate. Among them, we focus on the Fundamental Equilibrium Exchange rate (or FEER) of Williamson (1983) and the Natural Real Exchange Rate (NATREX) approach of Stein (1999).

3.2.1 The Fundamental Equilibrium Exchange Rate (FEER)

The FEER approach (also known as the Macroeconomic Balance model), as a medium run concept[94] which was introduced by Williamson (1983,1994) and Isard and Faruqee (1998), is a normative method and does not represent a theory of exchange rate determination.[95] It is the real exchange rate that simultaneously satisfies internal and external balances for a country or for a number of countries. The external balance is described by a sustainable level of the current account balance vis-à-vis other countries. The internal balance means that actual production equals the potential production with a reasonably stable inflation. As MacDonald (2000) argues, the FEER approach can be implemented either within a full-scale macroeconomic model or within a partial equilibrium framework.

[94] MacDonald (2007) considers the medium run as a period of 5 years in the future.

[95] Isard and Faruqee (1998) refer to the FEER as the macroeconomic balance approach.

In a fully specified macroeconomic model approach, we assume the internal and external balance and solve for the real exchange rate which is called the equilibrium rate; therefore, the FEER is the level of the exchange rate that would remain stable if all markets were in equilibrium. Unfortunately, the fully specified macroeconomic model is complicated but it does have two advantages: first, most of the model's variables are endogenous; therefore, the calculated exchange rate is consistent with a well defined economic equilibrium. Second, we can track the dynamic of the model from short to long run steady-state.

In the partial equilibrium model, as Wren-Lewis (1992) suggests, the current account is equalized to sustainable level of the capital account (stable net capital outflows). In the medium run, when the GDP is in its potential level, the real exchange rate which equates the current account to the structural saving-investment balance is called the equilibrium exchange rate based on FEER.[96] In this approach, money supply, domestic prices, domestic demand, employment and other quantities are exogenous. Furthermore, the FEER based on the partial equilibrium model ignores the possible feedback effects from the real exchange rate level to the GDP. Even by considering this feedback effect, as Driver et al. (2001) emphasize, the estimate of the FEER is not changed significantly. More precisely, the partial-approach FEER is the level of exchange rate that makes the current account balance equal to its target level, given that other markets are in equilibrium. Here, we follow Akram et al. (2004) for driving the partial FEER.

Let us assume that the import (IM) is determined by the domestic income level (Y) and the real exchange rate (Q). If the nominal exchange rate is the price of foreign currency in domestic currency units, then a rise in the income level has a positive effect on imports (IM), whereas a stronger real exchange rate has a negative effect on imports. Then the import function is:

$$IM = IM(\overset{+}{Y}, \overset{-}{Q}) \tag{22}$$

Similarly, the export (X) is assumed to depend positively on foreign income levels (Y^f) and the real exchange rate (Q):

$$X = X(\overset{+}{Y^f}, \overset{+}{Q}) \tag{23}$$

Using Equations 23 and 24, the trade deficit (TD) is a function of the real exchange rate, domestic and foreign income

[96] See Isard and Faruqee (1998) and Isard et al. (2001).

$$TD = TD(\overset{+}{Y}, \overset{-}{Y^f}, \overset{-}{Q}) \tag{24}$$

The trade deficit decreases with the income level abroad and the real exchange rate, but increases with the income level at home. In most versions of the FEER approach, the level of equilibrium current account, over the medium run, is exogenously determined. On the other hand, current account can be described as follows:

$$Ca = NFAR - TD \tag{25}$$

where the $NFAR$, as the returns on net foreign assets, is assumed to be zero or relatively small when compared to TD and Ca is the currenct account. Solving for Q in equation 24:

$$Q = Q(\overset{+}{Y}, \overset{-}{Y^f}, \overset{-}{TD}) \tag{26}$$

Estimating Equation 26, the FEER can be defined as the level of the real exchange rate when the trade deficit and domestic and foreign income levels are at their equilibrium levels:

$$Q^{FEER} = Q(\overline{Y}, \overline{Y}^f, \overline{TD}) \tag{27}$$

where an overbar indicates the variables are at their equilibrium levels.

The equilibrium level for the trade deficit (TD) depends on the value of net foreign assets. It can be set equal to the return of net foreign assets, if the net foreign asset is positive. In long run, if there is no return from foreign assets, TD must be zero. In contrast, for the short and medium run, trade deficit can be set to a sustainable level of borrowing. Overall, the FEER approach, as a normative method which is not built on a theory of exchange rate determination, has some drawbacks.

First, in the FEER approach, as MacDonald (2000) and Driver and Wren-Lewis (1999) argue, the long run estimates are very sensitive to the method of estimation of the trade elasticities (coefficients in Equation 26). If the trade elasticities are not accurate then the FEER will be biased.[97] Second, the FEER approach does not describe the path of exchange rate from the current level to the long term equilibrium rate. Therefore, it ignores the short run dynamic, and we do not know much about the dynamic path of adjustment toward the FEER. Hence, the FEER does not take into account the interaction between deviations from equilibrium and the equilibrium path itself. In this context, Bayoumi et al. (1994) and MacDonald (2000) mention the possibility that different equilibrium values may have different dynamic adjustment paths which confirm the existence of a "Hysteresis Effect" in the real exchange rate.

Third, to satisfy the internal balance as one of the conditions of the FEER approach, we need to estimate the output gap. This is a controversial issue especially in developing countries where the structure of economies is changing. In the literature, there are two methods to manage the internal balance: applying a decomposition filter, such as that of Hodrick and Prescott (1997) or Beveridge and Nelson (1981); or, as Égert et al. (2006a) suggest, we can determine the magnitude of potential growth based on economic theory.

Fourth, the sensitivity of the FEER approach to the targeted sustainable capital account is another problem. Driver and Wren-Lewis (1999) show that different assumptions for the sustainable capital account lead to significantly different exchange rates in the FEER approach. For example, by changing the sustainable capital account relative to the GDP by 1 per cent, the value of the FEER is changed by 5 per cent.[98]

Fifth, the FEER approach may not be a proper method of determination of equilibrium exchange rate in two kinds of countries: countries with high economic growth and countries which host large volumes of capital inflow (large current account deficits). In the case of large capital inflow, we need to predict how this capital inflow will in future increase production and boost the current account.

There are two methods of calculating the targeted sustainable capital account and consequently satisfying the external balance of the FEER approach. The first is the Williamson procedure which is a normative method based on the judgment regarding the appropriate value of the external debt to GDP ratio. For example, by assuming that the targeted current account surplus is equal to 1 per cent of GDP, Bayoumi et al. (1994) estimate the FEER of major currencies for 1970. The other way is to estimate the current account in terms of saving and

[97] Goldstein and Khan (1985) argue that most empirical studies estimate the trade elasticities to be very low.

[98] Borowski and Couharde (2003) show a high sensitivity of the FEER estimates to the choice of current account norm.

investment balances based on some explanatory variables, such as population growth, the fiscal position or openness, then calculating the fitted values for the current account.

In summary, decades after the introduction of the FEER approach, it is still not a perfect method for examining equilibrium exchange rates. As we reviewed the drawbacks of the FEER approach, there are serious sensitivity issues related to the assumptions of the building blocks of the FEER. Several studies such as Buscaglia et al. (2011) empirically document the drawbacks of the FEER, especially the sensitivity and uncertainties in the normative nature of the FEER. They focus on the problem of the three building blocks of the FEER: the description of the current account norm, exchange rate pass-through assumptions and the calculated elasticities. Other studies in the equilibrium exchange rate literature criticize the application of panel methods in the FEER approach for a group of heterogeneous countries, and the stability and accuracy of the relationship between real exchange rates and output gaps. Overall, much further work must be done on the FEER approach to make it a reliable benchmark in examining equilibrium exchange rate.

3.2.2 Natural Real Exchange Rate (NATREX)

Based on dynamic stock flow model, Stein (1994) introduces the NATREX theory which is an extension of the FEER, and similar to the BEER, the reduced form of the NATREX is based on a cointegration method. Through a set of fundamental variables, it links the real exchange rate to savings, investment and the current account. In contrast to the FEER which is focused on medium term, the NATREX describes the dynamic of the medium to long run when three conditions are satisfied: first, unemployment is at its natural rate. Second, there are no speculative and cyclical elements, and third, foreign debt and capital stock are assumed to converge to their long run steady state.

Similar to the FEER, the economy is in equilibrium if the current account is equal to the sustainable capital flows (net savings). Net saving is the function of saving and investment which are influenced by the rate of time preference and Tobin's q ratio (link to productivity in the domestic economy and abroad), respectively. Stein represents the time preference and productivity measures by the ratio of the sum of private and public consumption to GNP and a moving average of the growth of real GDP, respectively. As Sallenave (2010) argues, a rise in the time preference rate (less savings) causes appreciation of the real exchange rate in the medium run and its depreciation in the long run while an increase in productivity (more investment) induces an appreciation in the medium term and has an ambiguous effect in the long run.

3.3 Behavioural Equilibrium Exchange Rate (BEER)

Clark and MacDonald (1998) introduce the BEER method as a general approach to exchange rate modelling which is not based on any specific exchange rate model. The behavioural models, in reduced form equation, usually identify the exogenous variables (fundamentals) which influence the internal and external balances. In contrast to the short term effects of capital flows, the fundamentals are expected to play a role over the medium term. Therefore, in contrast to the FEER, we do not need to be concerned about the current account and the external position, as they are endogenous to the model.

Following Clark and MacDonald (1998), we define Z_{1t} as a set of fundamentals which are expected to have persistent effects on the long run real exchange rate, and Z_{2t} as a set of fundamentals which have persistent effects in the medium run (over the business cycle). Usually Z_{1t} represents the terms of trade, net foreign assets and productivity while Z_{2t} covers real interest rate representing business cycle. Therefore, we represent the real exchange rate in the following way:

$$q_t = \theta_1 Z_{1t} + \theta_2 Z_{2t} + \delta T_t + \epsilon_t \tag{28}$$

where T is a set of transitory and ϵ_t is a random error.

The current equilibrium exchange rate,q_t', is derived when we remove T_t and ϵ_t from equation 29:

$$q_t' = \theta_1 Z_{1t} + \theta_2 Z_{2t} \tag{29}$$

The related current misalignment, cm_t, is defined as:

$$cm_t = q_t - q_t' = q_t - \theta_1 Z_{1t} - \theta_2 Z_{2t} = \delta T_t + \epsilon_t \tag{30}$$

As the current values of the economic fundamentals can deviate from the sustainable levels, Clark and MacDonald (1998) also define the total misalignment, tm_t, as the difference between the actual and real rate given by the sustainable, or long run, values of the economic fundamentals, denoted as :

$$tm_t = q_t - \theta_1 \bar{Z}_{1t} - \theta_2 \bar{Z}_{2t} \tag{31}$$

Equation 32 can be rewritten as:

$$tm_t = \delta T_t + \epsilon_t + \left[\theta_1 (Z_{1t} - \bar{Z}_{1t}) + \theta_2 (Z_{2t} - \bar{Z}_{2t}) \right] \tag{32}$$

Equation 33 decomposes the total misalignment into the effect of the transitory factors, the random disturbances, and the extent to which the economic fundamentals are away from their sustainable values. As we see in Equations 31 and 33, the BEER approach covers both current and total misalignments. Other methods of the equilibrium real exchange rate such as the FEER and the Capital Enhanced Equilibrium Exchange Rate (CHEER) present total and current misalignment, respectively.

Following Clark and MacDonald (1998), the BEER approach is built on the uncovered interest rate parity (UIP):

$$E_t \left[\Delta e_{t+k} \right] = -(i_t - i_t^*) + \pi_t \tag{33}$$

where e_t is the foreign currency price of a unit of domestic currency, i_t, denotes a nominal interest rate, $\pi_t = \lambda_t + k$ is the risk premium that has a time-varying composition, λ_t, Δ is the first differences operator, E_t is the conditional expectations operator and $t + k$ defines the maturity horizons of the bonds.

By subtracting the expected inflation differential, $E_t(\Delta p_{t+k} - \Delta p^*_{t+k})$, from both sides of Equation 34, we get the real relationship:

$$q_t = E_t\left[q_{t+k}\right] + (r_t - r_t^*) - \pi_t \tag{34}$$

where $r_t = i_t - E_t\left[\Delta p_{t+k}\right]$ is the *ex ante* real interest rate. Based on Equation 35, we can explain the current equilibrium exchange rate by three factors: the expectation of real exchange rate in period t+k, the real interest rate differential with maturity t+k, and the risk premium. Clark and MacDonald (1998) continue by assuming the time-varying component of the risk premium term as a function of the relative supply of domestic to foreign government debt:

$$\lambda_t = g(\frac{gdebt_t}{gdebt_t^*}) \tag{35}$$

Assuming $E_t\left[q_{t+k}\right]$ is determined solely by the long run economic fundamentals,Z_1, they denote the long run equilibrium exchange rate as:

$$\hat{q}_t = E_t\left[q_{t+k}\right] = E_t\left[\theta_1 Z_{1t}\right] = \theta_1 Z_{1t} \tag{36}$$

In different studies a wide range of variables are assigned for fundaments (Z_{1t}), these could be the terms of trade (commodity price), the Productivity Differentials (Balassa-Samuelson Effect), Net Foreign Assets, Output Gaps, Openness, Government Spending (Fiscal Balance) and Demography. Clark and MacDonald (1998) focus on three variables:

$$\hat{q}_t = f(tot_t, tnt_t, nfa_t) \tag{37}$$

where *tot* is the terms of trade, *tnt* is the Balassa-Samuelson Effect, i.e. the relative price of non-traded to traded goods, and *nfa* is the net foreign assets.

Equations 35, 37 and 38 imply the following general Equation:

$$q_t^{BEER} = (r_t - r_t^*, tot_t, tnt_t, nfa_t, \frac{gdebt_t}{gdebt_t^*}) \tag{38}$$

Clark and MacDonald (1998) derive Equation 39 which is a reduced-form equation that relates the current real exchange rate to the real interest rate differential and to a set of fundamental variables influencing the long run equilibrium rate. As we have already mentioned, the starting point for Equation 39 is the UIP; however, an important issue here is whether the UIP is valid or not. In contrast to several studies such as Meese and Rogoff (1988) and Froot (1990) which reject the relationship between real exchange rate and interest rate, there are other studies such as MacDonald (1998) and MacDonald and Nagayasu (2000) which support the UIP. In summary, the BEER approach is not built on normative elements; it relies on a single equation approach and, applying either time series or panel methods, it can be implemented in three steps.

First, based on cointegration methods, we investigate and estimate the exact form of the relationship between the real effective exchange rate and the fundamental variables. Second, we need to determine the equilibrium level of any fundamentals which are significant in explaining the real effective exchange rate. Third, substituting the equilibrium level of fundamentals from the second step to the relationship in the first step, we can calculate the equilibrium of the real effective exchange rate. The BEER approach has its pros and cons which will be reviewed in the following.

First, applying cointegration methods, the BEER approach is a meaningful method for the equilibrium concept. It is not complicated, and we do not need to investigate the detailed mechanism of all factors involved in the economy, and the channels through which the real exchange rate and the fundamentals are linked. Second, in the FEER approach, we estimate misalignment indirectly by calculating the exchange rate for a normative level of current account while the BEER approach directly estimates equilibrium exchange rate and the possible misalignment. Third, by including the interest rate, the BEER approach covers the short run (cyclical) dynamic of capital account and consequently the current account and the behaviour of the exchange rate. Fourth, in contrast to the FEER, in the BEER approach, we can analysis the effect of each fundamental variable on the movement of the equilibrium exchange rate. However, with all its advantages, the BEER has several drawbacks.

First, by applying econometric methods to historical data, the BEER approach builds a relationship between the fundamentals and the exchange rate. Especially in developing countries where the structure of the country's economy changes substantially, these data may not be reliable and represent the current status of the economy. Maeso-Fernandez et al. (2005, 2006) argue that the usual BEER is built for mature economies where historical data may be used for describing exchange rate levels. As an alternative to the traditional BEER, they introduce a two-step procedure, the "Out-of-Sample" version of the BEER. In the first step, after excluding the transition economics, they apply the panel method to estimate the relationship between fundamentals and the real exchange rate. In the second step, equilibrium exchange rates for transition economics are extrapolated on the basis of the estimated structural relationships.

Second, as Cline and Williamson (2007) argue, the BEER approach is built based on the assumption that the exchange rate is on average in equilibrium over the estimation period. Therefore, it is not an absolute measure of the equilibrium exchange rate; it solely represents an indicator of a country's undervaluation or overvaluation relative to its own past averages. Therefore, it does not (and cannot) take into account that a currency might be undervalued or overvalued over the full sample. Third, lack of longer term data may hurt the BEER method, especially in the studies based on time series analysis. Consequently, in the 1990s, we observe a shift away from time series to the panel techniques in the BEER literature. Fourth, as Stein (2002) argues, the choice of fundamental variables in the BEER approach is not based on any theory or exact procedure.

The other important issue in the BEER literature is the choice between time series (single country) or panel (group of countries) techniques. In contrast to the panel cointegration which increases the efficiency of the estimators, single country time series estimation may not cover a long span of data and may consequently suffer from low power. On the other hand, in the panel methods, we impose the same long term parameters to different countries which may not be appropriate.

There is an extensive literature of empirical applications of the BEER approach in developed, developing and emerging countries. A bulk part on the recent BEER approach is about the Central and Eastern Europe (CEE) countries which have joined the Euro. Égert and Halpern (2006) in a meta-regression analysis show the overall result of this literature is that the equilibrium real exchange rate appreciates with a rise in per capita GDP, the real interest rate differential, the terms of trade, productivity and government expenditure; whereas it depreciates with a rise in openness, and the debt service ratio. Some other studies include: Edwards (1994) for a panel of 12 developing and emerging economies; Dufrenot and Yehouh (2005) for a sample of 64 developing countries; MacDonald and Dias (2007) for ten industrialised and emerging market economies that rank within the top 15 contributory economies to global imbalances; MacDonald and Ricci (2004) for South Africa; Melecky and Komarek (2007) and Babetskii and Égert (2005) for the Czech Republic; Bénassy-Quéré et al. (2009) for the G20 countries; MacDonald (2004) for Singapore; Elbadawi (1994) for Chile, Ghana and India;

Spatafora and Stavrev (2003) for Russia; Kinkyo (2008) for South Korea; Doroodian et al. (2002) for Turkey; Mongardini (1998) for Egypt and Mathisen (2003) for Malawi. In section 4, we review some of the BEER studies for commodity (oil) exporting countries.

3.3.1 The Fundamental Variables of the BEER

The equilibrium real exchange rate is a dynamic path of real exchange rate over time which is influenced by the current and expected values of some fundamental variables which determine the internal and external equilibrium. In large economies such as the US, the exogenous variables are changes in time preference and shocks to productivity while, in a small economy, variables such as the terms of trade (commodity prices) and the world interest rate are considered as exogenous variables. A critical part in the BEER approach is the selection of the fundamental variables.

As MacDonald and Ricci (2004) argue, the selection of most fundamental variables is based on a simple neoclassical theoretical framework. In this model, across different countries, the prices of tradable goods are equal; therefore, the change in the prices of non-tradable goods causes the movements of the real exchange rate. In a realistic scenario, if the prices of tradable goods across countries are not equal, in addition to the relative price of non-tradable goods, the real exchange rate is also a function of the relative price of traded goods. Some of the candidate fundamentals are:

- **Net Foreign Assets**

  The effect of net foreign assets[99] to GDP on real exchange rate is controversial, and the estimated impact of the net foreign assets position differs across studies. Based on a stock-flow consistent exchange rate model such as portfolio balance, we expect a positive effect of net foreign assets on the real exchange rate. Several studies such as Faruqee (1995) for the USA and Japan; MacDonald and Ricci (2004) for South Africa; MacDonald (2002) for New Zealand; Coudert and Couharde (2009) for a large sample of emerging and developing countries; Bénassy-Quéré et al. (2009) for the G20 and G7 countries; Bénassy-Quéré et al. (2008) for the USA and Euro Area and Gagnon (1996) the G20 countries find that in the long run, higher net foreign assets are associated with more appreciated real exchange rates. Lane and Milesi-Ferretti (2002, 2004) confirm that countries with lower international net assets positions tend to have weaker currencies. With decrease

[99] As an alternative to net foreign assets, MacDonald and Dias (2007) introduce trade balance where a positive long run relationship between net foreign assets and real effective exchange rate implies a negative long run relationship between trade balance and real effective exchange rate.

in net foreign assets (an increase in foreign debt) a country must increase its exports to manage the higher debt servicing costs.[100] We can explain the relationship between net foreign assets and real exchange rate in two other ways: first, through the wealth effect, a higher net asset increases the demand for domestic goods; consequently, the price of non-tradable goods increases, then this appreciates the real exchange rate. Second, an increase in net foreign assets can compensate a worse current account balance which is linked to a more appreciated real exchange rate.

In contrast, some studies such as Alonso-Gamo et al. (2002) and Burgess et al. (2003) find a negative relationship between net foreign assets and real exchange rate for Lithuania and the Baltics, respectively. In another study, using two different panels for the Organisation for the Economic Co-operation and Development (OECD) countries and the CEE countries, Égert et al. (2003) investigate the impact of the net foreign assets variable on real exchange rate. The sign of the net foreign assets variable is positive for the panel of the OECD countries while it is negative for the CEE countries. We may consider the OECD panel results as the long run behaviour of the transition economies. As Égert et al. (2006a) show, some of the CEE countries are already in their long run, and they observe a positive impact from net foreign assets to real exchange rate.

The reason for the ambiguity of the effect of net foreign assets on real exchange rate is explained by the shortness of the sample period and separating the impacts in medium-run or long run. As Detken et al (2002) argue, the real appreciation and decline in net foreign assets (net capital inflows) occur simultaneously when an increase in net foreign reserves cause a depreciation of the domestic currency in the medium run but most likely an appreciation in the long run. Based on the NATREX model with the net foreign assets as an endogenous variable, Égert et al. (2006b) explain this process: a capital inflow decreases the net foreign asset and increases investment. This decline in net foreign assets depreciates the real exchange rate in the medium run. However, when investment boosts the trade balance thorough the current account, net foreign assets are increased and consequently appreciate the real exchange rate in long run.

- **Productivity Differentials (Balassa-Samuelson Effect)**

Since the 1980s, there has been a focus on productivity growth as a determinant of the real exchange rate. Balassa (1964) and Samuelson (1964) suggest that relatively larger increases in productivity in the tradable goods sector compared to the non-tradable goods sector are linked with a real appreciation of the domestic currency; or that the real exchange rate should be positively related to productivity in tradable goods, but negatively related to productivity in non-tradable goods. MacDonald (2000) describes

[100] Coudert et al. (2007) show that the US net foreign assets intermediate between oil price and the US dollar; therefore, the effect of oil price on the US dollar transmits through the US net foreign assets position which reconfirms the wealth effect.

several requirements for the Balassa-Samuelson Hypothesis. Terms of trade should be fixed; factors of production such as labour are mobile between tradable and non-tradable sectors; production functions are constant return to scale and the assumption of perfect capital movement is satisfied. A rise in the productivity of tradable goods increases the wages in this sector. Because of wage equalisation across the economy, wages in non-tradable goods are increased; hence, based on equation 10, we face an increase in relative prices of non-tradable to tradable goods and consequently an appreciation of the real exchange rate. However, the measurement of productivity has been a controversial issue.[101]

Unfortunately, in most cases, there are no accurate data to measure the relative productivity per person employed; however, there are several proxies to measure productivity differentials. The first one, which is employed by Macdonald (1998), Clark and MacDonald (1998), Alshehabi and Ding (2008), Kakkar and Ogaki (1999) and Hossfeld (2010), is defined as the ratio of the domestic CPI to the domestic wholesale or the PPI relative to the corresponding weighted average of partner country ratios.[102] However, Crespo-Cuaresma et al. (2005) criticize representing the Balassa-Samuelson Effect with a relative price term, because it picks up the demand side effects in addition to the supply side productivity influences. In another study, Bénassy-Quéré et al. (2009) argue that some factors such as tax changes, the nominal exchange rate or relative demand effects which are not linked to the Balassa-Samuelson Effect may influence the CPI/PPI ratio.[103]

The second proxy for measure productivity differentials is real GDP per capita relative to trading partners, which is used by MacDonald and Ricci (2004), and Chudik and Mongardini (2007). Alexius and Nilson (2000) argue that this approximation is acceptable, if the productivity growth in the non-tradable sector is similar across countries and most of the total productivity growth is coming from the tradable sector. However, it has its limitations. For example, Ricci et al. (2013) show that an equal increase in the productivity of tradable and non-tradable sectors would increase GDP per worker; but in a small open economy, it would not influence the real exchange rate. They suggest that labour productivity in tradable and non-tradable sectors is highly correlated with GDP per worker, but the difference between these variables is not. Therefore, GDP per worker may not be a proper representative of Balassa-Samuelson Effect. As one of the fundamentals, Ricci et al. (2013) use the difference in output per worker between tradable and non-tradable goods (relative to trading partners) which has a positive effect on the real exchange rate.

- **Output Gap**

[101] For transition economies, see Égert (2002) and MacDonald and Wójcik (2004).

[102] Usually, the CPI basket covers a higher weight of non-tradable goods than the PPI; therefore, the ratio CPI/ PPI may represent the prices of non-tradable to tradable goods. Even so, some authors such as Chinn (2006) argue that the CPI may not be a good measure of non-tradable prices.

[103] Engel (1999) criticizes using the CPI/ PPI ratio as a proxy for the Balassa-Samuelson Effect also.

The output gap in the domestic economy relative to the output gap in the trading partner economies could be one of the fundamentals influencing real exchange rate. MacDonald (2002), applying the BEER approach for New Zealand, considers this variable among the fundamentals in this study and presents two reasons for this. First, it can represent growth potential and, second, it provides the counterfactual experiences as can the FEER approach.

- **Unemployment rate**

  Wadhwani (1999) in a BEER study for the UK Pound-Deutsche Mark exchange rate considers the relative unemployment rate as one of the fundamentals which influences real exchange rate. The relative unemployment rate could be a representative of the output gap. Wadhwani (1999) explains this relationship based on two arguments. First, the relative unemployment rate may represent the supply side; therefore, international capital and investment may flow into the countries with lower unemployment rates. Second, when employment falls the external balance will worsen and consequently the exchange rate should depreciate. Therefore, a relatively high unemployment rate in a country signals the worsening of the current account and hence depreciation of its currency.

- **Openness**

  This is a proxy for trade restrictions which is defined as the ratio of exports plus imports to GDP. Dufrenot and Yehoue (2005) emphasize that this variable is more likely to be relevant for developing or emerging countries than for industrial ones. The effect of openness on real exchange rate is ambiguous as it depends on the effect of openness on the current account. If the current account decreases, the real exchange rate depreciates, and if the current account improves, it appreciates. Goldfajn and Valdes (1999) argue that a more open trade regime is likely to decrease the price of tradable goods which therefore lowers the overall price level and depreciate real exchange rate. Another issue is the endogeneity of the openness to the real exchange rate which could be corrected by proper econometric methods.

- **Government Spending (Fiscal Balance)**

  The impact of government spending as a percentage of GDP relative to trading partners on the exchange rate is controversial. The main point here is to distinguish the composition of government spending. Depending on how the government spending is divided between traded or non-traded goods, it impacts the real exchange rate differently. De Gregorio et al (1994) and Galstyan and Lane (2009) confirm that if most government spending goes to non-tradable goods, then it increase the relative price of non-tradable goods and cause appreciation of the real exchange rate. However, if most government spending goes to tradable goods, we do not face appreciation. Other studies such as

Dibooglu (1996) and Iossifov and Loukoianova (2007), show that if government spending goes toward non-tradable (or tradable) goods, it appreciates (or depreciates) the real exchange rate. In reality, it seems that government spending is more focused on non-tradable goods; therefore, we may observe an increase in the price of non-tradable goods leading to appreciation of the real exchange rate. Rogoff (1992) confirms this by modification of the Balassa-Samuelson model. He adds the aggregate demand shocks (government spending) to the model and shows that changes in the relative price of non-tradable goods can influence the real exchange rate. Government may manage the increases in its expenditure through raising taxes or increasing public debt.

Increase in tax decreases people's income; therefore they are less able to buy non-tradable goods. This causes a decline in the price of non-tradable goods and consequently depreciates the real exchange rate. Therefore, there are two forces which are against each other. As Égert et al. (2006a) mentions, the majority of empirical studies confirm that the first effect dominates the second, and hence an increase in relative government spending is more likely to appreciate the real exchange rate.

Another important issue is the time frame in the studying of the effect of government spending on the real exchange rate. Several studies distinguish the effect of government spending on real exchange rate in the short and in the long run. Monacelli and Perotti (2010) and Kim and Roubini (2008) confirm that in long run government spending appreciates the real exchange rate; however, it could possibly depreciate the real exchange rate in the short run.

- **Administrative Price Control Variable**

  In some developing countries such as the CEE countries and oil exporting countries in the Persian Gulf, governments apply some price controls and may subsidise a part of the consumption basket. This artificial pricing influences the real exchange rate thorough price deflators. To account for this, some authors such as Ricci et al. (2013) define a variable for administrative price controls which is the share of administered prices in the CPI which proxies for the deviation of prices from their market value. By removing these price controls, we observe a rise in administered prices toward market levels; hence, a rise in CPI implies a real appreciation. For example, for Slovakia, Ricci et al (2013) show that by liberalizing 20 per cent of the price basket between 1997 and 2004, the real exchange rate appreciates by 12 per cent. Therefore, in transition economies, a lower share of administered (higher share of market) prices in the consumer price index is associated with a more appreciated real exchange rate.

- **Risk Premium**

  For a given real interest rate differential, more debt of a country in comparison to that of other countries represents riskier assets and causes the depreciation of the currency.

Several authors such as Koske (2008) and MacDonald and Dias (2007) do not include the risk premium as one of the fundamentals in their equilibrium exchange rate models. Furthermore, Chionis and MacDonald (2002) confirm that no variable is supported as a representative of risk premium in the literature. Others define risk premium as the government debt to GDP ratio in the country divided by the weighted average of similar variable in other countries. In another study, as a proxy for the Korean risk premium, Kinkyo (2008) uses the fiscal balance divided by the GDP and is able to get a significant coefficient with the expected sign which is a negative impact of the risk on the equilibrium exchange rate.

- **Demography**

  In contrast to the vast literature of the effect of population age structure on the current account, savings and capital flows, there are not many studies analysing the impact of demography on real exchange rate. Gente (2001) introduces a two sector, two period overlapping generation model where a fall in the birth rate causes a long run real exchange rate appreciation. On the empirical side, Andersson and Österholm (2005, 2006) document that demography has significant impact on the real exchange rate in Sweden and the OECD countries, respectively. Recently, for a panel of 23 OECD countries over 1980-2009 period, Salim and Hassan (2013) examine the effect of demography on the real exchange rate. They show that the demographic share of both the working age and elderly dependent population appreciate the real exchange rate while the share of the young dependents depreciate the real exchange rate.

- **Real Interest Differential**

  The literature considers the interest-rate differential as a stationary series which does not influence the real exchange rates in long run; therefore, it is usually not included in the long term relationship. In line with theory, this is confirmed by some studies such as: Campbell and Clarida (1987), Meese and Rogoff (1988), Baxter (1994), Edison and Melick (1999) and Clostermann and Schnatz (2000), and MacDonald (1998). By contrast, Clostermann and Friedmann (1998), MacDonald and Nagayasu (2000) and MacDonald and Ricci (2004)[104] treat the real interest rate differential as $I(1)$ variable. Using a panel data set for 14 industrialized countries, MacDonald and Nagayasu (2000) show that a significant cointegration relationship exists between real exchange rates and real interest rate differentials. Other studies, such as MacDonald and Clark (1998), Paiva (2006) and Maeso-Fernandez et al. (2002), find borderline results, but treat the series as $I(1)$variable.

- **Investment**

[104] MacDonald and Ricci (2004) argue for a positive impact of real interest rate differential on the real exchange rate. They describe the mechanism through three channels: aggregate demand, productivity, and persistent monetary policy.

Usually, more investment (through technology) as a percentage of GDP relative to trading partners boosts productivity and consequently appreciates the real exchange rate. However, the source of investment is an issue. If it comes from abroad, it will have an adverse effect on the trade balance and current account leading to real exchange rate depreciation. These two forces are against each other; therefore, its overall impact on real exchange rate is ambiguous.

- **Terms of Trade**

  Terms of trade is defined as the ratio between the unit value of export and the unit value of import. It may cause appreciation or depreciation in the real exchange rate. For small open economies, the terms of trade is considered an exogenous variable. However, for some countries such as the USA it could be endogenous; although even for the USA, some external shocks such as a jump in oil price may exogenously influence the terms of trade.

  The price elasticities of the contents of terms of trade determine the effect of change in price on quantity and consequently the dynamic of the revenue. For example, for primary goods with low price elasticities, an increase in the terms of trade boosts the export revenues, improving the trade balance and causing an appreciation of the real exchange rate. By contrast, if the export volumes are highly influenced by the price of export, then an increase in terms of trade does not necessarily cause improvement in trade balance. Therefore, by increase in export prices, the price elasticities of domestic supply and foreign demand indicate increasing (or decreasing) trade, causing the real exchange rate to appreciate (or depreciate). In a very unique and unrealistic case, if the price of exported goods were the same as the price of consumer goods, and if the price of imports were the same as the price of consumer goods in the country's main trading partners, then movements in terms of trade and the real exchange rate may be exactly the same. Although, in commodity exporting countries, terms of trade is a function of commodity prices, the link between commodity price and terms of trade is controversial. Therefore, we should distinguish between behaviour in terms of trade and commodity prices especially in commodity exporting countries.

  Deaton and Laroque (1992) show that terms of trade is not a perfect representative of the prices of major exports. In another study, for developing countries, Bidarkota and Crucini (2000) and Baxter and Kouparitsas (2000) document that the real commodity prices are much more volatile than terms of trade. In contrast by comparing domestic oil prices with terms of trade for each of the US, Germany and Japan, Amano and Norden (1998b) show that oil prices could explain most terms of trade fluctuations, and that the point correlation between terms of trade and one-period lagged price of oil is -0.78, -0.57 and -0.92 for Japan, the US and Germany, respectively. The next step is the investigation of the differences in the impact of commodity price or terms of trade on real exchange rate.

Several authors such as MacDonald (2002), Chen and Rogoff (2003) and Cashin et al. (2004) show that commodity prices are strongly cointegrated with the real exchange rate of commodity exporting countries while some studies document a significant effect of the terms of trade on the real exchange rate. MacDonald and Ricci (2004) explain this phenomenon based on two reasons. First, there is no unique and standard method for constructing a country-specific export and import deflator, however the commodity prices are much more accurate than terms of trade. The other reason is related to data availability. In comparison to the terms of trade, commodity prices are released more frequently and can influence markets more effectively. The starting point in this empirical literature is a theoretical link between terms of trade (commodity price) and real exchange rate.

There are different theoretical models which describe the relationship between terms of trade (commodity price) and real exchange rate. Neary (1988) presents a complicated model which links the real exchange rate to all price elasticities of supply and demand in the non-traded sectors, as well as to the income elasticity of demand. De Gregorio and Wolf (1994) introduce a simplified version of this model with the assumption of zero consumption of the exporting commodity in the domestic market. The model is based on an economy with two different sectors: one produces the exportable goods and the other non-traded goods, and the domestic agents consume non-tradable and imported tradable goods. Therefore, the increase in commodity price does not raise demand, and we can solely focus on the supply side. In this model, the price of tradable goods is determined exogenously in international markets by world supply and demand, the supply and demand in the home country dictates the price of non-tradable goods. In this model, an improvement in the terms of trade appreciates the domestic currency. The mechanism starts by the terms of trade shock (increase in the commodity price in the international market) which increases wages in the commodity sector. The wages in the two sectors are equal, thus the wage in the non-traded section goes up. This raises the relative prices of non-tradable to tradable goods in the country, and we face a real exchange rate appreciation. For a small open economy, Mendoza (1995) describes a theoretical model with incomplete markets and three types of goods (tradable exporting, tradable importing, and non-tradable) facing exogenous terms of trade and total factor productivity shocks. Confirming the De Gregorio and Wolf (1994) model, Mendoza (1995) predicts that positive terms of trade shocks appreciate the real exchange rate. In another model, to describe the effect of terms of trade on real exchange rate especially in the oil exporting countries, Tokarick (2008) modifies the theoretical link by adding a non-resource tradable sector to the model.

In the literature, there are two other channels which explain the effects of terms of trade on real exchange rate: real wealth or income effects. As Diaz-Alejandro (1982) argues, a positive terms of trade shock increases domestic demand; hence it causes an increase in the relative price of non-tradable goods which leads to a real exchange rate appreciation. For the income effect, based on an internal-external balance approach, an improvement in the terms of trade increases real wages in the export sector of the economy, and consequently causes a trade surplus. To manage the external balance, the real exchange rate should be appreciated.

The simplified version of De Gregorio and Wolf (1994) is similar to the Balassa-Samuelson Effect. The improvement in productivity of tradable goods and the assumption of the law of one price for tradable goods together increase relative prices of non-tradable to tradable goods and consequently appreciate the real exchange rate. As Cashin et al. (2004) argue this appreciation in the real exchange rate would be through a nominal exchange rate appreciation, or increase of price level which is caused by the expansion of domestic demand and increase of the price of non-tradable goods. The appreciation in the real exchange rate encourages factors of production to transfer to non-tradable goods, consequently it expands the non-tradable sectors and contracts (crowds out) manufacturing (de-industrialization) and non-export commodity traded goods. This is the Dutch Disease.

However, we should not name just any de-industrialization combined with a high price of commodity as the Dutch Disease. As Bayoumi and Mühleisen (2006) note for Canada, the decline in the manufacturing sector comes from a standard long run deindustrialization trend which corresponds with government policies, and is not influenced by oil export fluctuations.

Facing a high commodity (oil) price in a commodity (oil) exporting country, Égert et al. (2006b) describe the Dutch Disease in the following propositions: (1) The real exchange rate appreciates; (2) The manufacturing growth and exports of the non-commodity (oil) goods decline; (3) Expanding and inflation in the non-tradable sector of the economy; and (4) Improvement in the trade balance (balanced or surplus).

To make sure a country is suffering from the Dutch Disease, in addition to the positive effect of commodity prices on the real exchange rate, other conditions such as de-industrialization and crowding out of the non-export tradable sector should be satisfied. In the most famous paper of the Dutch Diseases literature, Sachs and Warner (1995) document this phenomenon for emerging Asian economies and in Sub-Saharan Africa. However, there are an increasing number of studies against the Dutch Disease phenomenon.

There are countries with abundant natural resources which do not suffer from this disease and use their natural resources efficiently through their development process. Spilimbergo

(1999) argue against the Dutch Disease in Chile and South Africa. In another study, Gylfason (2001) argues that the main barrier for growth in some developing countries with abundant natural resources is not the Dutch Disease, but rather corruption, political turmoil and the lack of proper institutions. Finally, by controlling for these anti-growth factors, Papyrakis and Gerlagh (2004) show two findings: first, natural resources do not necessarily slow economic growth. Second, several countries rich in natural resources can successfully avoid the Dutch Disease.

For our five oil exporting countries in the Persian Gulf, in addition to the proper institutions and establishing of Sovereign Wealth Funds, the Dutch Disease could be dampened through two channels. First, as Neary (1988) underlines, diversification of exports from crude oil to petrochemical goods and expansion of non-oil export could be helpful to decouple the economy from fluctuations of oil price. Second, as Razgallah (2008) suggests, the remittances sent abroad by the foreign labourers in these countries could be a part of the dampening process of the Dutch Disease.

3.3.2 Permanent Equilibrium Exchange Rate (PEER)

After estimation of the BEER equation, we can apply a Hodrick and Prescott (1997) filter with a proper smoothing factor to extract the temporary fluctuations in the fundamentals out of long run equilibrium values of these variables. For quarterly data, Hodrick and Prescott (1997) suggest a smoothing factor of 1,600. A larger (or smaller) factor would generate a smoother (or less smooth) equilibrium real exchange rate path. MacDonald and Ricci (2004) argue that this filter does not provide reliable results for both the ends of the series. Another method of filtering is the Beveridge and Nelson (1981) decomposition which was applied by Elbadawi (1994) and Baffes et al. (1999). We get the real equilibrium exchange rate by substituting these long run equilibrium values of fundamentals in the BEER equation. In contrast to this simple filter, there is another way to extract the PEER.

Applying the Johansen methodology, Clark and MacDonald (2004) directly drive the PEER from the BEER estimates. They decompose the fundamentals of the BEER into their permanent and transitory components.[105] In this alternative way of the PEER approach, they use the statistical technique of Gonzalo and Granger (1995). The decomposition of Gonzalo and Granger (1995) separates the cointegration relationship into a non-stationary permanent component and a stationary transitory component. In this context, the permanent component of the real exchange rate represents its equilibrium path and the transitory component reflects

[105] For more on the PEER, see Hansen and Roeger (2000) and Maeso-Fernandez et al. (2002).

the deviations from equilibrium. However, as Hansen and Roeger (2000) suggest, the Gonzalo and Granger method may not be accurate, and it could wrongly present the goodness of fit.

Clark and MacDonald (2004) mention two main advantages of providing the PEER beside the BEER. First, the BEER consists of a permanent and a transitory part. By comparing the BEER and the PEER, especially when they are very different, we can distinguish the effect of transitory component on the currency misalignment. This could help for policy purposes. Second, analysing the BEER beside the PEER is helpful in identifying the source of non-stationarity among our fundamental variables. In the PEER, we work with fundamentals which influence the equilibrium exchange rate; however, there are other purely statistical methods which extract the equilibrium exchange rate directly from the real exchange rate.

Huizinga (1987) and Cumby and Huizinga (1991) extract the PEER directly from the real exchange rate by applying univariate and mulitivariate Beveridge-Nelson decompositions. In another purely statistical method, Frait et al. (2004) apply the Hodrick-Prescott and Band-Pass Filters directly to the real exchange rate to obtain the PEER. In all these time series decomposition methods, any persistent (or transitory) shock is treated as a sustainable (or unsustainable) phenomenon. This is not always true. For example, if a country suffers from imbalance for a long time, some persistent shocks may not be sustainable. Because of the absence of any theory of exchange rate behaviour, MacDonald (2000) calls this method the Atheoretical Permanent Equilibrium Exchange Rate (APEER).

3.4 Capital Enhanced Equilibrium Exchange Rate (CHEER)

This equilibrium exchange rate approach is made of the PPP and the UIP theories. It was been introduced by Jusellius (1995), Johansen and Juselius (1992) and MacDonald and Marsh (1997, 1999). MacDonald (2000) labels such estimates as CHEERs (Capital Enhanced Equilibrium Exchange Rates). As a measure of the equilibrium exchange rate, CHEER is a medium run model, and it does not impose stock-flow consistency. In the absence of enough reliable data for developing economies, the CHEER method can provide reasonable measures of equilibrium exchange rate. However, the CHEER approach may cause higher estimated speeds of convergence than a PPP model.

The CHEERs approach may be presented by the following vector:[106]

[106] Juselius and MacDonald (2004) extend CHEER by including both short and long run interest rates.

$$x_t = [e_t, p_t, p_t^*, i_t, i_t^*] \tag{39}$$

The CHEER out-of-sample exchange rate forecasts are convincing. For example, applying a cointegration relationship between nominal interest rate differentials, relative prices and the nominal exchange rate, MacDonald and Marsh (1997) successfully beat a random walk in forecasting bilateral exchange rates even at horizons as short as two months.

The major advantage of all these equilibrium exchange rate models over the simple PPP is that they do not consider the equilibrium real exchange rate as a static equilibrium and instead they link its movements to the fluctuations of fundamentals. For policymakers, this is a tool to control the effect of each fundamental variable on the real exchange rate.

3.5 IMF Evaluations of Equilibrium Exchange Rate

One of the IMF mandates is the evaluation of the exchange rates of its members. In the mid 1990s, it formed a framework for assessing exchange rates. Based on a panel analysis, the IMF Consultative Group on Exchange Rate Issues (CGER) focused on a number of advanced economies, but it has been expanded to both key advanced economies and major emerging market economies. Lee et al. (2008) present the three methodologies of the CGER: The Macroeconomic Balance Approach (MB); a reduced-form Equilibrium Real Exchange Rate Approach; and an External Sustainability Approach (ES). The MB and the ES approaches belong to the FEER family, and they are different only by the method by which they define the current norm.

3.5.1 Macroeconomic Balance (MB) Approach

This is the FEER approach which Lee et al. (2008) describe in three steps. First, using a data set of 54 advanced and emerging market economies over 1973-2004 and panel econometric techniques, they estimate the relationship between current account balances and a set of fundamentals. Second, for each country using the coefficients in step one, they calculate the current account norms as a function of the levels of medium run fundamentals. Third, they estimate the relationship between current account and real exchange rate, and drive the corresponding real exchange rate which is linked to the targeted current account in step two. Lee et al. (2008)

show that a 1 percentage point increase in the government budget balance (relative to trading partners) leads to a 0.2 percentage point increase in the current account balance in percentage of GDP. For net foreign assets relative to the GDP, a 10 per cent increase raises the current account balance by about 0.2 per cent of GDP. In contrast to the ES approach which is stock flow equilibrium, the MB approach is flow equilibrium.

3.5.2 Equilibrium Real Exchange Rate Approach (ERER)

This is the BEER method which directly (and without referring to internal and/ or external equilibrium of the economy) estimates an equilibrium real exchange rate for each country as a function of medium term fundamentals such as the net foreign asset position of the country, the relative productivity differential between the tradable and non-tradable sectors, and the terms of trade. For 48 countries over 1980-2004, Lee et al. (2008) describe this approach in three steps: first, the panel regression techniques are used to estimate an equilibrium relationship between real exchange rates and a set of fundamentals. Second, equilibrium real exchange rates are calculated as a function of the medium term level of the fundamentals. Third, by comparing the equilibrium exchange rate from step two with the actual real exchange rate, we can find out the misalignment. Lee et al. (2008) show that a 10 per cent increase in the domestic productivity relative to trading partner countries appreciates the equilibrium exchange rate by about 1 to 2 per cent. For commodity terms of trade, a 10 per cent increase implies an equilibrium appreciation of 4 to 6 per cent, and a 1 percentage point increase in government consumption to GDP ratio causes an appreciation of the equilibrium real exchange rate of 2.5 to 3 per cent.

3.5.3 External Sustainability (ES)

Similar to the MB approach, the ES approach is a medium term equilibrium concept. By contrast with the MB approach, the ES method does not employ any econometrics to target the current account norm. In the ES method, first we determine the ratios of trade or current account balance to GDP that would stabilize the net foreign asset position at given "benchmark" values. Ajevskis et al. (2012) describe the relationship between the current account norm (ca) and the net foreign asset position ($\overline{nfa}$) as:

$$ca = \frac{g + \pi}{(1 + g)(1 + \pi)} \overline{nfa} \tag{40}$$

where g is the growth rate of real GDP, π is the inflation rate, whereas $\overline{nfa}$ and ca are the net foreign assets and current account norm as shares of GDP, respectively. Here, we get the current account norm which stabilizes the net foreign asset position at a given "benchmark" value. Then, similarly to the MB approach, we track the change in real exchange to satisfy the current account at the desired level. Lee et al. (2008) start the ES approach by targeting the ratio of net foreign assets to GDP at its estimated level in 2006, and then they drive the current account norm. Their results confirm that emerging market countries seem likely to improve their net asset positions while the USA position worsens.

4 Exchange Rate in Commodity Exporting Countries

Many authors have studied the effect of commodity prices on real exchange rates in commodity exporting countries. This is the overlap between literature on the equilibrium exchange rate and on the Dutch Disease. These studies cover a wide range of developed and developing countries with different commodities and various econometrics approaches including the use of time series for individual countries and of panel for group of countries. The literature covers both developed and developing countries.

For developed economies, a study by the Bank of Canada in the 1990s presents interesting results for Canada. In this study, for monthly data over the 1973-1993 period, Amano and Norden (1995) find that non-energy commodity prices have a positive impact on the real exchange rate of Canada (the Canada-US bilateral exchange rate), and the long run elasticity between the two variables is 0.8. For energy prices, Amano and Norden (1995) document negative and significant estimated long run elasticity.[107] A 10 per cent increase in oil prices causes a 2.2 per cent depreciation of the Canadian dollar relative to the US dollar. Built on Amano and van Norden (1995), Issa et al. (2006) revisit the relationship between energy prices and the Canadian dollar. They extend the data and apply structural break tests. The authors observe a break point in the sign of this relationship which changes from negative to positive in the early 1990s. This result is consistent with the new role of Canada as an oil exporter in the 1990s, and it is confirmed by Lizardo and Mollick (2010).

[107] In their view, Canadian domestic energy policies may explain this. During the 1970s, the Canadian government subsidised energy prices, but in 1985 when the oil price declined; they deregulated the energy prices.

In other time series study for quarterly data over 1984-2001 period, Chen and Rogoff (2003) focus on three developed countries that rely heavily on commodity exports: Australia, Canada and New Zealand. For Australia and New Zealand, they document a long run elasticity of 0.7 to 1 between commodity prices as explanatory variables and real exchange rates. Cashin et al. (2004) consider a mix of 58 developed and developing countries (not including our five oil exporting countries in the Persian Gulf). In a time series study for annual data over the 1980-2001 period, they determine how many commodity exporting countries have 'Commodity Currencies', in that real commodity prices and their real exchange rates are cointegrated. For a third of these countries, with the long run elasticity of between 0.1 to 0.2, they confirm that real commodity prices have an effect on real exchange rates. Among the developed countries in their sample, they are able to establish the relationship between commodity prices and real exchange rate in Australia and Iceland, but not in Canada, New Zealand, or Norway.

Back to the BEER approach, MacDonald and Ricci (2004), for quarterly data over the 1971-2001 period, apply the BEER approach to South Africa as a commodity exporter and estimate a long run equilibrium real exchange rate path. In this study, the main fundamental variables are: commodity price, net foreign assets, productivity and real interest rate differentials vis-à-vis trading partner countries, measures of openness and the size of the fiscal balance. After applying alternative specifications, they observe the commodity price variable as being the most stable and robust coefficient. They find the long run elasticity between the two variables to be around 0.5 which means that a 10 per cent rise in the commodity terms of trade implies a 5 per cent appreciation of the real effective exchange rate in the long run.

Oil as a commodity is not an exception from this relationship between commodity price and real exchange rate. As a strategic commodity, not only it influences the real exchange rate of oil exporting countries, but it may also affect the real exchange rate of other countries. Applying a monetary model of exchange rates with oil price, Lizardo and Mollick (2010) can explain movements in the value of the US dollar against major currencies. Amano and Norden (1998a) investigate the relative importance of real vs. monetary shocks in explaining the US real effective exchange rate over the post-Bretton Woods period. They show that oil prices may have been the main factor of persistent real exchange rate shocks. Similar results are obtained by Amano and Norden (1998b). For Germany, Japan, and the US, they find that the real domestic price of oil is the most important factor determining real effective exchange rates in the long run. Moreover, Chaudhuri and Daniel (1998) investigate 16 OECD countries and find that the non-stationary behaviour of the US dollar real exchange rate is because of the non-stationary behaviour of real oil prices. Furthermore, for a monthly panel of G7 countries from 1972:1 to 2005:10, Chen and Chen (2007) study the long run relationship between real oil prices and real exchange rates. They show that the real oil price and real exchange rates are cointegrated, and the former may have been the dominant source for movement of the later. Several other authors study this relationship in oil exporting countries either in context of the individual country or as a group of countries.

For Norway, as a developed oil exporting country, several studies such as Bjørnland and Hungnes (2008) and Akram (2004) have reported statistically insignificant or numerically weak relationships between the Norwegian Krone and the oil price. Akram (2004) presents the long run relationship between Norwegian real exchange rate with differences in productivity growth and the interest rate differential. In another time series study for Norway, Russia and Saudi Arabia, Habib and Kalamova (2007) investigate the effect of real oil price on real exchange rate. They use the theoretical model developed by Cashin et al. (2004) which is built on De Gregorio and Wolf (1994) and Obstfeld and Rogoff (1996). For Russia, they confirm the existence of the relationship between real oil price and real exchange rate with a long run elasticity of 0.29. However, they could not document a significant impact of the real oil price on the real exchange rates of Norway and Saudi Arabia. These results may be explained by the accumulation of foreign assets and institutional differences among these countries. With high volatility of oil price, several oil exporting countries have introduced Sovereign Wealth Funds to isolate a large portion of the oil and gas revenues from the economy.[108] Rickne (2009) documents the role of a country's legal and political institutions in the influence of oil price on real exchange rate in oil exporting countries. Using a panel of 33 oil exportering countries over 1985-2005 period Rickne empirically confirms that currencies in countries with high bureaucratic quality and strong legal systems are less affected by oil price changes.

In another study on Russia, using four measures of exchange rate (both real effective exchange rate and bilateral real exchange rate against both the Euro and the US dollar), Suseeva (2010) confirms the impact of oil price on the bilateral real exchange rate against Euro and the US dollar. In contrast to Habib and Kalamova (2007), this relationship does not hold for the real effective exchange rate. The differences in data for the real effective exchange rate in Suseeva (2010) and Habib and Kalamova (2007) may explain this. Habib and Kalamova (2007) apply their own measure of real effective exchange rate with a small sample size, but Suseeva (2010) uses the International Financial Statistics of the IMF data bank.

In country specific contexts for developing oil exporting countries, Koranchelian (2005) for Algeria, Zalduendo (2006) for Venezuela, Ozsoz and Akinkunmi (2012) for Nigeria, and Kutan and Wyzan (2005) for Kazakhstan, document the significant impact of oil price on the real

[108] For Sovereign Wealth Funds in oil exporting countries, Norway is the pioneer with the Government Pension Fund with 737 billion dollars. For Saudi Arabia, the UAE, Kuwait and Qatar, the related funds are SAMA Foreign Holdings with 675 billion dollars, the Abu Dhabi Investment Authority with 627 billion dollars, Kuwait Investment Authority with 386 billion dollars and the Qatar Investment Authority with 115 billion dollars, respectively.

exchange rate. Koranchelian (2005) confirms that oil price and the Balassa-Samuelson effect influence the equilibrium real exchange rate of Algeria. Similarly, Zalduendo (2006), applying a vector error correction model, shows that oil prices and productivity have an effect on the real equilibrium exchange rate in Venezuela, and that productivity differential relative to the main trading partners becomes worse. In this study, long run elasticity of real effective official and parallel exchange rates with respect to the real oil price are around 1 and 0.44, respectively.

Shifting to the panel method, to explore the effect of commodity price on real exchange rate, Bodart et al. (2012) focus on a large sample of developing countries which are specialized in the export of one leading commodity. Our five oil exporting countries in the Persian Gulf are included in their sample. Using the non-stationary panel techniques robust to cross-sectional dependence, they find that the price of the dominant commodity has a significant long run impact on the real exchange rate when the exports of the leading commodity have a share of at least 20 per cent in the country's total exports.

Comparing commodity and oil exporting countries, Coudert et al. (2011) use the panel cointegration approach over the 1980-2007 period, for two samples of countries: 52 commodity exporters and 16 oil exporters. They compare the impact of commodity (oil) price on real exchange rate in these two groups of countries. They confirm the co-movement of real exchange rate with commodity price. For the group of oil exporting countries, they show the same relationship but somewhat weaker. Coudert et al. (2011) explain these differences in the result between these two groups of countries due to (i) greater fluctuations in the oil price than in commodity price and (ii) pegged exchange rates that prevent the nominal adjustment from happening.

Interestingly for the case of our five oil exporting countries in the Persian Gulf, as expected, the pegged currencies are highly dependent on the behaviour of their anchor. Coudert et al. (2011) show that currencies of these oil exporting countries which are pegged to the US dollar were pushed down by the dollar fall and were undervalued at the end of the period whereas the Euro pegged currencies were being pushed upwards by the euro appreciation. For the equilibrium exchange rate, they show that the currencies of Qatar and United Arab Emirates are slightly overvalued. This is confirmed by Kamar and Ben Naceur (2007) who show that, among the GCC countries, these two countries are quite different from the others. Indeed, while the real exchange rates of Bahrain, Kuwait, Oman and Saudi Arabia are positively correlated, the Qatar riyal and the UAE dirham are weakly and negatively correlated with these four currencies. To achieve monetary union in the GCC countries, Kamar and Ben Naceur (2007) recommend coordination in their policies.

Applying the panel dynamic OLS (DOLS) procedure proposed by Kao and Chiang (2001) and Mark and Sul (2003), Dauvin (2014) investigates the link between energy prices and real exchange rates in countries which export fossil fuel products (such as coal, natural gas and crude oil). Dauvin considers two sets of countries: 10 energy exporting[109] and 23 commodity exporting countries over the period 1980-2011. For the 10 energy exporting countries, Dauvin shows a positive long term relationship between energy terms of trade and the real effective exchange rate: a 10 per cent increase in energy price leads to a 2.5 per cent appreciation of their currency. The elasticity is consistent with other studies such as Habib and Kalamova (2007) and Coudert et al. (2011).

Back to oil exporting countries, Korhonen and Juurikkala (2009) apply the BEER approach for twelve oil exporting countries: nine OPEC countries[110] and three CIS (Commonwealth Independent States) countries over 1975-2005 and 1993-2005, respectively. The econometrics method for cointegration is the Pooled Mean Group (PMG) estimator of Pesaran et al. (1999) which presents different short run responses for each country in addition to the same long run coefficients for all countries. The effect of oil price on the real exchange rate of these courtiers has a long run elasticity around 0.4 to 0.5 which is in the line with other commodity exporting countries. Higher oil price appreciates the real exchange rate and oil price is the only fundamental with a consistent and statistically significant effect on the real exchange rate. In contrast to other studies of real exchange rate in commodity exporting countries, Korhonen and Juurikkala (2009) cannot confirm real per capita GDP as a significant fundamental influencing the real exchange rate. They initially include the net foreign asset as a variable, but either the empirical results do not support it as a statistically significant variable or its sign contradicts with theory. Therefore, they then omit the net foreign asset position in their estimations. Interestingly, Zalduendo (2006) estimates similar elasticity of the real exchange rate with respect to the oil price results for Venezuela and Oomes and Kalcheva (2007) and Spatafora and Stavrev (2003) for Russia. In another panel study of seven OPEC countries including Kuwait and Saudi Arabia, for monthly data from 2000:01 to 2007:12, Nikbakht (2010) demonstrates the important influence of oil prices on the real exchange rate. Nikbakht confirms that real oil price has been the main source of real exchange movement. In another study applying time series methods, Jahan-Parvar and Mohammadi (2008) confirm the relationship in a sample of fourteen oil exporting countries (including Kuwait and Saudi Arabia) over the annual period of 1970-2007. Based on Pesaran et al. (2001), they apply the Autoregressive Distributed Lag (ARDL) bounds tests of cointegration and show the existence of a stable relationship between real exchange rates and real oil prices in all countries.

[109] The 10 energy exporting countries are: Algeria, Australia, Canada, Colombia, Iran, Nigeria, Norway, Saudi Arabia, South Africa and Venezuela. This sample includes 5 OPEC countries, 3 coal exporters and 2 gas-oil exporting countries.

[110] The sample consists of Algeria, Ecuador, Gabon, Indonesia, Iran, Kuwait, Nigeria, Saudi Arabia and Venezuela.

Overall, the literature confirms that commodity (oil) prices influence the real exchange rates of commodity (oil) exporting countries. Our literature review also proposes that, for the Persian Gulf oil exporting countries as a group, the effects of oil price on the equilibrium exchange rate and real exchange rate have been studied relatively little. We aim to contribute to this part of the literature.

5 Data Description

This study covers five oil exporting countries in the Persian Gulf, namely Qatar, Kuwait, Saudi Arabia, Oman and the UAE. The Data are annual and cover the period from 1980 to 2011. The CPI based real effective exchange rate from Darvas (2012), in logs ($lreer$), are new to this literature.[111] An increase in the REER implies a real appreciation of the domestic currency. The Oil price ($loil$) deflated by the unit price of manufacturing exports (MUV) in logs are from the IMF International Financial Statistics (IFS) database and the net foreign assets (nfa) is obtained from the updated and extended version of dataset constructed by Lane and Milesi-Ferretti (2007) as a percentage of GDP.

We do not have access to labour productivity data for these five countries; therefore, as often in estimation of equilibrium exchange rates in the literature, we employ the log of real PPP based GDP per capita in current USD with respect to trading partner countries ($lrgdpc$) as a proxy for the Balassa-Samuelson Effect.[112] The data is from the World Data Bank, we construct the data for productivity deferential based on the average trade of these countries with their trade partners from 2005 to 2010.

As we can see in Figure 7, there is a steady decline in the productivity differentials of these countries. Zalduendo (2006), Koranchelian (2005), and MacDonald and Ricci (2004) identify similar declines in Venezuela, Algeria and South Africa, respectively. We model the REER

[111] Darvas uses data on exchange rates and consumer price indices and the weighting matrix derived by Bayoumi et al. (2006) to calculate consumer price index-based REER. To our knowledge, this chapter is the first with a complete data set for the REER of these countries.

[112] To describe the productivity differential, some studies use CPI/ PPI as a proxy for the Balassa-Samuelson Effect. In these oil exporting countries, some elements of the CPI (such as utility prices) are still under government control, and some other elements are subsidized. Therefore, CPI/ PPI relative to their trading partners cannot a proper representative of the productivity differential. Moreover, as Chinn (2000) argues, the CPI/ PPI ratio may be influenced by tax changes, relative demand effects or the nominal exchange rate itself which are not related to the Balassa-Samuelson Effect. Therefore, in this study, we prefer to use PPP based GDP per capita relative to trading partners.

based on three explanatory variables as follows:

$$lreer = [loil \;\; lrgdpc \;\; nfa]$$

where variables are as previously defined.

6 Empirical Strategy (Time Series)

Based on the maximum likelihood approach of Johansen (1988, 1991, and 1995), we apply single country econometric time series techniques and check for the existence of cointegration among the variables of each country. In addition to the Johansen method, for robustness check of the long run relationship for each country, we apply the Autoregressive Distributed Lag (ARDL) approach of Pesaran et al. (2001). For comparison, given the usual problems of short term time series analysis, we apply the panel data econometric techniques. The single country time series unit roots and cointegration tests may suffer from shorter spans of data with associated less degrees of freedom and low power. Therefore, the panel analysis which is based on time series and cross country information compensates for the shortness of time series data and allows more variation in the data that results in increased efficiency of the estimators. However, some assumptions of panel analysis (such as the equality of the long run parameters across the different members of the panel, or averaging them) may not be true.

6.1 Unit Root Tests

We test for the presence of unit root for all the series used in the analysis. The Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP)[113] Unit Root tests are employed to test the integration level.[114] The results for each country are provided in Table 16. In both tests, the null hypothesis is the non-stationarity of the time series.

[113]The PP approach, which computes a residual variance that is robust to auto-correlation, allows for the presence of unknown forms of autocorrelation with a structural break in the time series and conditional heteroscedasticity in the error term.

[114]The ADF and PP tests are based on Dickey and Fuller (1981) and the Phillips and Perron (1988), respectively.

Table 16- Unit Root Tests

Qatar	ADF	P-Value	Conclusion	PP	P-Value	Conclusion
$lreer$	-2.26	0.02	$I(1)*$	-1.63	0.09	$I(1)$
$lrgdpc$	-4.01	0.00	$I(0)$	-4.01	0.00	$I(0)$
nfa	-2.81	0.20	$I(1)$	-3.00	0.14	$I(1)$
Kuwait	ADF	P-Value	Conclusion	PP	P-Value	Conclusion
$lreer$	-2.83	0.00	$I(0)$	-2.05	0.04	$I(0)$
$lrgdpc$	-3.43	0.06	$I(1)$	-3.44	0.06	$I(1)$
nfa	-2.13	0.03	$I(0)$	-2.23	0.02	$I(0)$
Saudi Arabia	ADF	P-Value	Conclusion	PP	P-Value	Conclusion
$lreer$	-1.11	0.91	$I(1)$	-1.34	0.85	$I(1)$
$lrgdpc$	-1.14	0.22	$I(1)$	-2.44	0.016	$I(1)*$
nfa	-3.01	0.00	$I(0)$	-3.08	0.00	$I(0)$
Oman	ADF	P-Value	Conclusion	PP	P-Value	Conclusion
$lreer$	-1.45	0.54	$I(1)$	-1.28	0.87	$I(1)$
$lrgdpc$	-3.42	0.06	$I(1)$	-3.45	0.06	$I(1)$
nfa	-1.33	0.86	$I(1)$	-1.40	0.84	$I(1)$
The UAE	ADF	P-Value	Conclusion	PP	P-Value	Conclusion
$lreer$	-1.96	0.59	$I(1)$	-2.16	0.49	$I(1)$
$lrgdpc$	-3.31	0.08	$I(1)$	-2.43	0.35	$I(1)$
nfa	-2.29	0.02	$I(0)$	-2.34	0.02	$I(0)$
Oil Price	ADF	P-Value	Conclusion	PP	P-Value	Conclusion
$loil$	-1.51	0.80	$I(1)$	-1.23	0.88	$I(1)$

Note: In Both ADF and PP tests the Null Hypothesis is the non-statinarity of the variable. For each variable, first we investigate whether it has intercept and trend or not, then based on the result, we apply the proper specification of each test. For all P-values, we consider 5 per cent significance level. * denotes the variables are I (0) and I (1) with 5 per cent and 1 per cent significance level, respectively.

For Oman and Qatar, we document the non-stationarity of four variables ($lreer, lrgdpc, nfa$ and $loil$) and three variables ($lreer, nfa$ and $loil$), respectively. For the UAE and Saudi Arabia, we observe the non-stationarity of the three variables ($lreer, lrgdpc$ and $loil$).[115]

[115] The appropriate lag-length for the dependent variable in each test is chosen using the Schwarz Information Criterion.

6.2 Cointegration Tests

The results in the previous section suggest that in four of the five countries, some of the fundamentals and the REER have unit root. To avoid spurious regressions, we check for the possibility of cointegration and long run equilibrium relationship among the variables, in particular the relationship between the REER and its fundamentals. The Johansen (1995) procedure is employed to test for the existence and number of cointegrating equations. The country by country cointegration tests are reported in Tables 17 to 20. The procedure indicates that there is one cointegrating vector for Saudi Arabia. Table 21 shows the results of VECM analysis. The speed adjustment parameter of the VECM for Saudi Arabia is positive and insignificant which does not support the existence of conintegration among the variables.

Table 17– Johansen Cointegration Test - Qatar ($lreer, loil, nfa$)

No. of CE(s)	Trace test	Prob.	Max-Eigen test	Prob.
None	0.45	0.09	0.45	0.15
At Most 1	0.22	0.29	0.22	0.45
At Most 2	0.08	0.11	0.08	0.11

Table 18- Johansen Cointegration Test - Saudi Arabia ($lreer, loil, lrgdpc$)

No. of CE(s)	Trace test	Prob.	Max-Eigen test	Prob.
None	48.18	0.00	38.39	0.00
At Most 1	9.79	0.29	9.77	0.22
At Most 2	0.01	0.88	0.01	0.88

Table 19- Johansen Cointegration Test - Oman ($lreer, loil, lrgdpc, nfa$)

No. of CE(s)	Trace test	Prob.	Max-Eigen test	Prob.
None	40.44	0.20	18.42	0.46
At Most 1	22.02	0.29	16.10	0.21
At Most 2	5.91	0.70	5.70	0.65
At Most 3	0.20	0.64	0.20	0.64

Table 20- Johansen Cointegration Test - The UAE ($lreer, loil, lrgdpc$)

No. of CE(s)	Trace test	Prob.	Max-Eigen test	Prob.
None	24.39	0.18	14.90	0.29
At Most 1	9.48	0.32	9.29	0.26
At Most 2	0.18	0.66	0.18	0.66

Note: The number of lags based on Schwarz information criterion for Qatar, Saudi Arabia, Oman and the UAE are 2, 1, 1 and 1, respectively.

Table 21- Results of VECM for Saudi Arabia

Country	Saudi Arabia
Number of cointegrating vectors	1
$lreer\ (-1)$	1.00
$loil\ (-1)$	0.30 (2.53)
$lrgdpc\ (-1)$	0.96 (5.12)
c	0.02
$CointEq1$	0.007 (0.35)
$P-Value\ for\ CointEq1$	0.72

6.3 ARDL Method-Bound Test

Pesaran et al. (2001) introduce the ARDL bound test. Firstly, the ARDL cointegration test in Pesaran et al. (2001) assumes that only one long run relationship exists between the dependent variable and the exogenous variables, and this method can be applied with a mixture of I (0) and I (1), but not I (2) time series. Secondly, in compare to the Johansen method, the ARDL is a simple method which is built on a single equation set up. After the confirmation of the existence of a cointegration relationship and selection of the proper number of lags, the model can be estimated by the OLS. In contrast to the Johansen method which is build on a VAR, the ARDL reduces the number of parameters to be estimated and improving efficiency in small samples. Thirdly, different variables can be assigned different lag-lengths as they enter the model. The ARDL approach consists of the following steps: first, we construct the Unrestricted Error Correction form of the ARDL model:

$$\Delta y_t = c + \alpha t + \phi y_{t-1} + \sum_{i=1}^{n} \theta_i x_{it-1} + \sum_{j=1}^{p} \lambda_j \Delta y_{t-j} + \sum_{i=1}^{n} \sum_{j=0}^{q} \varpi_{ij} \Delta x_{it-j} + e_t \tag{41}$$

Where, y_t is the dependent variable; x_{it} is explanatory variable; e_t is a residual; c and t are drift and trend, respectively; ϕ and θ_i are long run coefficients; λ_j and ϖ_{ij} are short run coefficients; p and q are lag orders. We observe long run relationship if ϕ (the coefficient on y_{t-1}) is negative and statistically significant.

The ARDL method is sensitive to lag order; therefore, we should correctly define the lag order of the first differenced variables. The optimal lag order is characterized by minimizing the Akaike and Schwarz criteria and at the same time removing serial autocorrelation of the residuals. After constructing the proper ECM, the second step is to test for existence of cointegration between variables. We apply a wald test (F-Test) on the long run coefficients of equation 42. The null hypothesis is that there is no cointegration between long run variables ($\phi = \theta_i = 0$), while the alternative hypothesis is that there is cointegration between variables ($\phi \neq \theta_i \neq 0$).

In the ARDL analysis, the F-statistics have non-standard distribution. We take the asymptotic critical value bounds for the F-statistics from a specific table prepared by Pesaran et. al (2001). The two sets of critical values provide critical value bounds for all classifications of the regressors into purely I (1), purely I (0) or mutually cointegrated. The lower bound is based on the assumption that all of the variables are I (0), and the upper bound is based on the assumption that all of the variables are I (1). If the computed F-statistics is higher than the upper bound of the critical values, given significance level, then the null hypothesis of no cointegration is rejected and we conclude that we have cointegration. If the computed F statistics is less than the lower bound of the critical values, given significance level, then the null hypothesis of no cointegration is accepted. The cointegration test result is inconclusive if the computed F-statistics falls between upper and lower bands.

For Qatar, Kuwait, Saudi Arabia and Oman, the ECM model does not have trend and intercept. We take the critical values from Table CI (i) on page 300 of Pesaran et al. (2001). The lower and upper bounds for the F-statistics at the 5 per cent significance levels are [2.45, 3.63]. For the UAE, the ECM model has intercept and trend. We take the critical values from Table CI (v) on page 301 of Pesaran et al. (2001). The lower and upper bounds for the F-statistics at the 5 per cent significance levels are [4.01, 5.07]. As the Table 22 only shows data for Qatar, the F-Statistics exceeds the upper bound at the 5 per cent significance level; therefore, we can conclude that there is evidence of a long run relationship between the time-series (at this level of significance or greater). For Kuwait, Saudi Arabia and the UAE, the

F-statistics is less than the lower bound. Therefore, there is no cointegration relationship for these three countries. For Oman, the computed F-statistics falls between the upper and lower bounds, consequently the cointegration test result is inconclusive. In summary, based on the ARDL Bound test, Qatar is the only country among our five countries which has cointegration. We apply the CUSUM and the Breusch-Godfrey LM tests to check the stability and serial correlation, respectively. Both tests confirm the stability and lack of serial correlation.

Table 22- F-Statistics for Testing the Existence of Long Run Relationship -Wald Test

Country	Qatar	Kuwait	Saudi Arabia	Oman	The UAE
Computed F-Statistic	5.42	2.13	1.40	2.80	3.78
Critical Value (Upper)	3.63	3.63	3.63	3.63	5.07*
Critical Value (Lower)	2.45	2.45	2.45	2.45	4.01*

Note: The upper and lower bound critical values are for the case of 5 per cent significance with no intercept and no trend. * denotes the critical values for the case of 5 per cent significance with trend and intercept.

As the final check as it is recommended by Pesaran et al. (2001), we should also perform a bound t-test of $H_0 : \phi = 0$, against H_1: $\phi < 0$. If the t-statistic for y_{t-1} in Equation 42 is greater than the critical value bounds of the t-statistic in Table CII (i) on pages 303 and 304 of Pesaran et al. (2001), then this would support the conclusion that there is a long run relationship between the variables. If the t-statistic is less than the lower bound critical value, we conclude that the data are all stationary. In the Qatar case, the t-statistic is -3.66 and the upper and lower critical values are [-195, -3.33]. Based on the general to specific procedure, we remove non-significant coefficients and again run the Equation 42. The following is the long run relationship for Qatar:

$$lreer = 0.13\ loil\ + 0.24\ lrgdpc \tag{42}$$

Table 23- The final ECM model for Qatar, Dependent Variable: *Dlreer*

Variables	Coefficient	t-Stat	P-Value
$lreer\ (-1)$	-0.34	-3.66	0.00
$loil\ (-1)$	0.04	2.01	0.05
$lrgdpc\ (-1)$	0.08	3.27	0.00
$Dloil$	0.11	3.99	0.00
$Dlrgdpc$	0.18	2.52	0.01
$Dlreer\ (-1)$	0.49	4.35	0.00
$Dnfa\ (-1)$	-0.02	-2.99	0.00

7 Empirical Strategy (Panel)

Given the limited length of the sample (32 years) and low power of individual country by country tests for unit root and cointegration, estimating separate equations for each country (time series) does not provide us with precise results. Therefore, to increase the efficiency of the estimators, we employ panel analysis to overcome the problems of short time series and the low power of time series unit root tests and cointegration analysis. However, panel analysis has its drawbacks. It either assumes the same long term estimators for each country or represents averages across the different countries of the panel, neither of which is necessarily appropriate for every country.

For the estimation method, we do not use the OLS estimator because in finite sample panel models it is not reliable and may produce strong bias. As Pedroni (2000) argues, only under very restrictive conditions, i.e. homogeneity across members of the panel and the exogeneity of the regressors, is the OLS estimator asymptotically consistent and have a standardized distribution. In other studies for non-stationary data, Pesaran et al. (1996, 1999) show that a simple fixed effect model or a pooled OLS will lead to spurious regressions, and Kim and Korhonen (2005) emphasize the dynamic nature of exchange rate models and state that static estimators are unlikely to capture the essential features of such processes. Furthermore, as Loayza and Ranciere (2006) argue, the static panel estimators do not consider the short run relationship beside the long run one. Therefore, we apply dynamic panel methods.

We proceed with three steps. In the first step, we investigate the existence of unit root in the data and find them to be integrated of order one. In the second step, using several different panel cointegration tests, we show the cointegration among some fundamentals and the REER. In the third step, using the pooled mean group estimator (PMG) of Pesaran et al. (1999) for these five oil exporting countries, we calculate the equilibrium exchange rates and the misalignments.

7.1 Panel Unit Root Tests

We apply several panel data unit root tests in order to exploit the extra power in the cross sectional dimension of the data. We employ the panel unit root tests proposed by Levin et al. (2002), Im et al. (2003), Maddala and Wu (1999) and Hadri (2000). The Levin, Lin and Chu (LLC) and the Hardi tests assume a common autoregressive parameter for all panels, so these tests do not allow for the possibility that the REER of some countries contain unit roots while others do not. The LLC test considers the unit root as the null hypothesis, while the Hadri test (as the panel equivalent of time series Kwiatkowski-Phillips-Schmidt-Shin (KPSS) unit root test) uses a null of no unit root. The LLC test fits an augmented Dickey-Fuller regression for each panel. We use the Akaike information criterion (AIC) to set the number of lags. Unlike the LLC test which under alternative assumes all series are stationary, the Im, Pesaran and Shin test (IPS) and Maddala and Wu test (MW) are both consistent under the alternative that only a fraction of the series are stationary. The MW test is a Fisher-type ADF or a Phillips-Perron (PP) test which combines the p-values from N independent unit root tests. Based on the p-values of individual unit root tests, the Fisher test assumes that all series are non-stationary under the null hypothesis against the alternative that at least one series in the panel is stationary.

Table 24 reports the test results based on the inclusion of an intercept and trend. Overall, our findings show that the panel of REER are I (1) series. All five tests provide evidence of non-stationarity at 1 per cent level of significance. For 5 per cent level of significance, all tests (with the exception of LLC) confirm the non-stationarity of the REER panel. Maddala and Wu (1999) show the superiority of the Fisher-type tests to the LLC test. Therefore we consider our REER panel as a non-stationary process, which is a common finding. Concerning the explanatory variables ($lrgdpc, nfa, loil$), all tests strongly support the non-stationarity process.

Table 24 - Panel Unit Root Tests, Sample of Five Oil Exporting Countries (1980-2011)

	LLC	IPS	ADF-Fisher	PP-Fisher	Hardi's Z-stat
$lreer$	-1.68(0.046)	-0.96(0.16)	12.13(0.27)	8.1(0.61)	3.92(0.00)
$lrgdpc$	-1.04(0.14)	0.34(0.63)	7.18(0.70)	4.92(0.89)	7.50(0.00)
nfa	0.28 (0.61)	-0.20(0.42)	9.51(0.48)	10.44(0.40)	5.94(0.00)
$loil$	1.66(0.95)	2.12(0.98)	1.77(0.99)	1.68(0.99)	6.65(0.00)

Note: LLC and IPS tests are based on Levin et al. (2002) and Im et al. (2003), respectively. P-values are reported in parentheses. We allow for individual deterministic trends and constants. All tests but Hardi are based on the unit root null of Hypothesis. Series are demeaned. Levin, Lin, and Chu test suggest this procedure to mitigate the impact of cross-sectional dependence.

7.2 Panel Cointegration Tests

After establishing the order of integration of the data, we use panel cointegration approaches to test for a long run equilibrium relationship among variables (Tables 25 to 27). Among the 1st generation tests which are residual based, we apply Pedroni (1999, 2004), Kao (1999) and Johansen Fisher panel cointegration tests proposed by Maddala and Wu (1999).

Table 25 - Pedroni Panel Cointegration Test

Panel Cointegration tests				
Specifications	v-Stat	rho-Stat	pp-Stat	adf-Stat
$[lreer, loil, lrgdpc, nfa]$	-0.08(0.53)	1.09(0.86)	0.39(0.65)	-1.19(0.11)
$[lreer, loil, lrgdpc]$	3.03(0.00)	-1.43(0.07)	-1.73(0.04)	-2.55(0.00)
$[lreer, loil, nfa]$	-.65(0.74)	1.11(0.86)	0.31(0.62)	0.54(0.70)
Group mean Cointegration tests				
Specifications		rho-Stat	pp-Stat	adf-Stat
$[lreer, loil, lrgdpc, nfa]$		1.89(0.97)	0.93(0.82)	-1.06(0.14)
$[lreer, loil, lrgdpc]$		-0.62(0.26)	-1.88(0.02)	-3.27(0.00)
$[lreer, loil, nfa]$		1.52(0.93)	0.43(0.66)	0.53(0.70)

Note: All tests are based on the null hypothesis of no cointegration. P-values are in parantheses.

Table 26 - Westerlund ECM Panel and Kao Residual Cointegration Tests

Specifications	Gt	Ga	Pt	Pa	Kao Stat
$[lreer, loil, lrgdpc, nfa]$	-1.07(0.91)	-2.10(0.97)	-2.32(0.68)	-2.01(0.78)	-0.34(0.36)
$[lreer, loil, lrgdpc]$	-2.69(0.00)	-10.37(0.03)	-5.76(0.00)	-10.07(0.00)	-1.94(0.02)
$[lreer, loil, nfa]$	-1.68(0.26)	-4.33(0.72)	-3.23(0.19)	-2.88(0.43)	-0.39(0.34)

Note: The null hypothesis in the Westerlund and Kao tests is no cointegration. Optimal lag/lead length determined by Akaike Information Criterion.

Table 27 - Maddala and Wu (1999) Fisher Panel Cointegration Tests

Specifications					
$[lreer, loil, lrgdpc, nfa]$	No. of CE(s)	Trace test	Prob.	Max-Eigen test	Prob.
	None	43.66	0.000	32.04	0.000
	At most 1	19.43	0.035	13.66	0.189
	At most 2	13.76	0.184	10.30	0.414
$[lreer, loil, lrgdpc]$	No. of CE(s)	Trace test	Prob.	Max-Eigen test	Prob.
	None	26.74	0.002	21.48	0.018
	At most 1	14.41	0.155	16.77	0.079
	At most 2	2.86	0.984	2.862	0.984
$[lreer, loil, nfa]$	No. of CE(s)	Trace test	Prob.	Max-Eigen test	Prob.
	None	13.73	0.185	7.05	0.720
	At most 1	13.00	0.223	10.71	0.380
	At most 2	11.85	0.295	11.85	0.295

As a residual based test, the Pedroni panel cointegration test is the panel equivalent of the Engle-Granger test in time series analysis. The Pedroni test contains seven tests, of which three are group-mean tests (between-dimension) and the remaining four are pooled tests (within-dimension). The between-dimension statistics are less restrictive than the within-dimension; therefore, the cointegrating vectors may be the different among the members of the panel. The Kao (1999) test is very similar to the Pedroni (1998) tests, but imposes cross-section specific intercepts and homogeneous coefficients on the first-stage regressors. Its null hypothesis is the non-stationarity of residuals (i.e., there is no cointegration) and its alternative hypothesis is stationarity of residuals (i.e., there is a cointegrating relationship among the variables). The third test is the Johansen type panel cointegration test which was developed by Maddala and Wu (1999). This test combines tests of individual cross-sections to produce a test statistic for the full panel. Its results are based on p-values for Johansen's cointegration trace test and maximum eigenvalue test.

These residual based tests may fail to reject the no-cointegration test null, even in cases where conintegration is strongly suggested by theory. Banerjee et al. (1998) and Kremers et al. (1992) refer to this as a common factor restriction which is the strong assumption of equality of long run parameters for the variables in their level with the short run parameters for the variables in their differences. They show that the common factor restriction can cause a significant loss of power for residual based cointegration tests. As a response to this, Westerlund (2007) introduces four panel conintegration tests that are based on structural not residual. The Westerlund test checks the null hypothesis of no cointegration by testing whether the error correction term in a conditional panel error correction model is equal to zero. We apply all these panel cointegration tests but for different specifications.

We test the three specifications: the first specification consists of the REER and all three explanatory variables. The second and third are made up of the REER, productivity differential and oil price; and the REER, oil price and net foreign asset, respectively. For the first specification, except for the Johansen Fisher panel test, all the other cointegration tests confirm the non-conintegration. For the second specification, Kao, Westerlund and Johansen-Fisher tests all strongly suggest cointegration. For the Pedroni test, out of 7 tests, 6 and 5 support cointegration for 10 per cent and 5 per cent level of significance, respectively. In summary, we do not get cointegration relationship for the two specifications with the nfa. This is in line with other studies such as Dauvin (2014), Coudert et al. (2011) and Korhonen and Juurikkala (2007) which do not consider nfa in their REER model. For the third specification, all tests strongly support non-cointegration. On the whole, these results tend to show that there exists a cointegrating relationship between $lreer, loil$ and $lrgdpc$.[116]

7.3 Long Run Relationship

With the preliminary findings of the unit root and cointegration tests, we now turn to the estimation of long run relationship between the REER and its fundamental variables. Pesaran et al. (1999) present the error correction Pooled Mean-Group (PMG) estimator which is a combination of two procedures that are commonly used in panels. The first one is the traditional

[116] Even if we assume the cointegration relationship for the first and third specifications which contain nfa, we get statistically insignificant coefficient for nfa and even a sign which is not supported by theory.

pooled estimators (such as the fixed or random effects estimators) which set different intercepts, but the same coefficients for each group. The second one is the Mean Group (MG) estimator of Pesaran and Smith (1995) which estimates for each group separately then averages the group specific coefficients. Pesaran et al. (1999) emphasize that the MG estimator does not take into account the fact that certain parameters may be the same across groups. However, for consistency, the MG estimator should be applied for a case with a large number of cross sections and a large time-series dimension. Hence, it is sensitive to outliners, especially with a low number of cross sections.

The PMG estimator suggested by Pesaran et al. (1999) combines pooling and averaging, and it provides a method to test for homogeneity in the sample. This estimator imposes the same long run coefficients but different intercepts, short run coefficients and error variances across groups. Providing the short run dynamic beside the long run coefficients is the advantage of the PMG estimator in comparison to the Fully-Modified OLS (FMOLS)[117] and the Dynamic OLS (DOLS).[118]

In order to check whether the results are robust, we additionally present results obtained from the Dynamic fixed effect (DFE), DOLS and FMOLS regressions. The DFE, with different country-specific intercepts, imposes restrictions on the slope coefficient (short and long run) and the speed of adjustment coefficient to be equal across all countries. Using leads and lags, the DOLS blocks the feedback effect from the dependent variables to the regressors. Therefore (in contrast to the OLS) even if the regressors are endogenous, the DOLS is consistent. In a similar way, the FMOLS estimator takes care of the endogenous regressors but (contrary to the DOLS estimator) the FMOLS corrects the bias in a non-parametric way.

The PMG estimator is built on an autoregressive distributed lag (ARDL) model of order (p, q) where p and q are the autoregressive orders of the dependent and independent variables, respectively. Its ECM can be expressed as:

$$\Delta y_{it} = \theta_i(y_{i,t-1} - \beta_i^{'} X_{i,t-1}) + \sum_{j=1}^{p-1} \lambda_{ij} \Delta y_{i,t-j} + \sum_{j=0}^{q-1} \acute{\delta}_{ij} \Delta X_{i,t-j} + \mu_i + \varepsilon_{it} \tag{43}$$

where y_{it} is the dependent variable (REER), X_{it} is the vector of fundamentals for country i, β_i is the vector of long run coefficients, θ_i is the error correction parameter, λ_{ij} and δ_{ij} are the coefficients of the short run dynamics, μ_i is the fixed effects and ϵ_{it} is a white noise process.

[117] Pedroni (2004) or Phillips and Moon (1999).

[118] The DOLS was been introduced by Saikkonen (1991) and Stock and Watson (1993) and extended to panel analysis by Kao and Chiang (1997).

The PMG estimator imposes the same long run coefficients for all countries; that is $\beta_i = \beta$ in Equation 42. If θ_i is significantly negative, then we have a long run relationship between y_{it} and X_{it}. To avoid inefficient estimators such as OLS, Pesaran et al. (1999) use a maximum likelihood estimator. Instead of the PMG, we can apply the MG estimator which is a consistent estimator even under the heterogeneity of the slopes. If the parameters are homogenous (the poolability assumption is valid), the PMG estimator is more efficient[119]. If the poolability assumption is invalid, then the PMG estimator is not consistent.

7.4 Estimation Results

Table 28 reports the estimation results. The error correction speed of adjustment parameter and the long run coefficients are of primary interest. Table 28 reports three alternative estimates: of the PMG; the MG (the least restrictive, but potentially not efficient); and the DFE which allows intercepts to vary across countries. We expect the long run effects of real oil price and productivity differential on REER to be homogenous across countries, although the short run adjustments are more likely to differ across countries. All three estimators strongly support the positive effect of real oil price on the REER (i.e. higher real oil price leads to appreciation of the REER) which is consistent with theoretical predictions and the previous studies for commodity (oil) exporting countries. Based on the PMG estimator, the elasticity of the effect of real oil price on the REER is 0.19 which means that an increase of 10 per cent in real oil price causes 1.9 per cent appreciation of the REER. This result is in line with other studies such as Cashin et al. (2004) for commodity exporting countries, Coudert et al. (2011) for a group of oil exporting countries, Koranchelian (2005) for Algeria, and Dauvin (2014) for ten oil exporting countries which get the elasticity of 0.1 to 0.2, 0.22, 0.20 and 0.25, respectively.

For the Balassa-Samuelson Effect, as Table 28 reports, the productivity deferential does not have a significant effect on the REER in 1 per cent and 5 per cent level of significance. However, at 10 per cent level of significance, the productivity deferential elasticity is 0.10 which is consistent with the results of MacDonald and Ricci (2004) for South Africa and Lee et al. (2008) for 48 countries over 1980-2004. Korhonen and Juurikkala (2007) encounter similar results and get a significant coefficient for the effect of real oil price of the REER, but not for productivity differentials.

[119] The satisfaction of poolability assumption, which confirms homogeneity of slopes, does not mean that the coefficients are exactly the same across the countries. It means the pooled estimator is a good approximation of the mean of parameters across countries.

Table 28 - Results of Panel Estimations (PMG,MG and DFE)

Dep Variable: $lreer$	MG		PMG		DFE	
Explanatory Variables	LR Coef	P-Value	LR Coef	P-Value	LR Coef	P-Value
$loil$	0.15	0.00	0.19	0.00	0.24	0.00
$lrgdpc$	0.22	0.12	0.096	0.09	0.26	0.03
Error Correction Term	-0.28	0.00	-0.17	0.00	-0.11	0.00
Joint Hausman Test				0.90		0.92

We use the Hausman test to check the long run homogeneity hypothesis of the PMG. As Pesaran et al. (1999) argue, under the null hypothesis, PMG estimators are consistent and more efficient than MG estimators which impose no constraint on the regression. If the null is rejected, we cannot assume the same long run coefficients for all panels and the restriction imposed by PMG estimators is not valid. In that case, the MG estimator is preferred.

The Hausman tests do not reject the null hypothesis for homogeneity restriction at 1 per cent significance level, suggesting that the PMG is the preferred estimator to the MG and the DFE is preferred to the MG. The PMG estimator constrains the long run elasticities to be equal across all panels. The Hausman test confirms the restrictions; therefore, the pooling across countries yields efficient and consistent estimates.

We find a negative and statistically significant error correction term (ECT) indicating the existence of a stable cointegration relationship.[120] The ECT of the VECM based preferred regression suggests that in each year 17 percentage points of any misalignment between the actual and equilibrium REER is corrected. For a group of oil exporting countries, Dauvin (2014) suggests an ECT of 16 per cent which is very close to ours.

7.5 Robustness Check

For the purpose of robustness check, we utilize the DOLS and FMOLS estimators. Table 29 reports the results for the DOLS and FMOLS estimators. Both estimators provide very similar coefficients for real oil price and productivity differentials. They are significant and have positive

[120] The time (T) required to dissipate x percent (in this case, 50 percent) of a shock is determined according to $(1-\theta)^T = (1-x)$, where θ is the coefficient of the error-correction term and T is the required number of periods (years).

effect on the REER. In comparison to our PMG results, we observe a decrease in oil elasticity and an increase in productivity differential.[121] However, as Figure 8 shows, up to 2000, the equilibrium exchange rates of these five countries based on the FMOLS and DOLS or PMG estimation are almost identical. From 2000, we observe a stronger equilibrium exchange rate for the PMG estimation in comparison to the equilibrium exchange rate based on FMOLS or DOLS, which is explained by the stronger coefficient of oil price in the PMG method.

Table 29 - Results of Panel Estimations (DOLS and FMOLS)

Dep Variable: *lreer*	DOLS		FMOLS	
Explanatory Variables	LR Coef	P-Value	LR Coef	P-Value
loil	0.115	0.00	0.110	0.01
lrgdpc	0.189	0.00	0.188	0.00

Note: The DOLS estimation employs one lead and one lag.

The BEERs of Qatar, Kuwait and (to some extent) the UAE follow the REERs. From 2000, with the increase in oil price, the BEERs appreciate; however, with the fall of the US dollar, the REER of Oman and Saudi Arabia decline. Therefore, the currencies of Saudi Arabia and Oman get undervalued. Qatar and Kuwait currencies are close to their BEERs, and the UAE currency is slightly overvalued. Our results are in line with the results of Coudert et al. (2011) which apply PMG estimation for a panel of 16 oil exporting countries. Their heterogeneous sample consists of countries such as Norway, Mexico, Venezuela and other oil exporting countries in North Africa and the Middle East. They confirm the undervaluation of the currencies of Oman and Saudi Arabia after 2000. Our REER data are constructed based on the trade weights of each of these five countries with their trade partners; therefore, our data are more realistic and accurate, but the REERs in the study of Coudert et al. (2011) are calculated against the world basket of currencies, whether they are issued by trade partners or not.

8 Conclusion

Drawing on the existing literature and a new annual data set of the real effective exchange rates and productivity differentials which cover the period from 1980 to 2011, this study follows the

[121] The productivity differential elasticity based on DOLS and FMOLS estimation is in line with what Aguirre and Calderon (2005) get using DOLS.

Behavioural Equilibrium Exchange Rate (BEER) approach by Clark and MacDonald (1998) to derive the equilibrium real effective exchange rates and currency misalignments for five oil exporting countries in the Persian Gulf, namely Qatar, Kuwait, Saudi Arabia, Oman and the UAE. We estimate the REER series based on both single country (Johansen and ARDL) and panel-data cointegration techniques. In the time series analysis, the ARDL procedure shows cointegration for Qatar with the same explanatory variables, which is very close to our findings in the panel analysis. Given the limited length of the sample (32 years) and low power of individual country by country unit root and cointegration tests, estimating separate equations for each country (time series) does not provide us with precise results. Therefore, to increase the efficiency of the estimators, we employ panel analysis. We apply the pooled mean-group (PMG) of Pesaran et al. (1999) and four more panel estimators for the robustness check.

The main explanatory variables are found to be oil price and productivity differentials vis-à-vis trading-partner countries. Taking into account the whole set of regression results based on different panel estimators and annual data, this study shows a significant effect of real oil price and productivity differentials on the REER. The estimated long run relation between the REER and fundamentals is economically and statistically significant. In particular, a 10 per cent increase in real oil price causes 1.9 per cent appreciation of the REER, which is consistent with theoretical predictions and the previous studies for commodity (oil) exporting countries such as Cashin et al. (2004) for commodity exporting countries, Coudert et al. (2011) for a group of oil exporting countries, Koranchelian (2005) for Algeria, and Dauvin (2014) for ten oil exporting countries. On the other hand, the productivity deferential elasticity is 0.10 which is consistent with the results in the related literature such as those of MacDonald and Ricci (2004) for South Africa and Lee et al. (2008) for 48 countries over 1980-2004.

Our results confirm that these countries are not prepared for a currency union. Focusing on 2011, the last year of our analysis, the currencies of Oman and Saudi Arabia are undervalued and should be appreciated while the currency of the UAE is overvalued. The currencies of the other two countries, Kuwait and Qatar, are almost in equilibrium. In order to establish a currency union, many political and economic prerequisites must be satisfied. Based on the lessons from the establishment of the Euro in Europe, political convergence and harmonized institutions are the essential ingredients of a currency union. In the case of the Euro, there was a deep desire for political unification which was followed by establishment of the European Commission, the European Court of Justice and the European Parliament. The historical process of the European currency union confirms that the European central bank is built on the existence of proper institutions and convergence in political and economic reform, which is a very slow process. The political relationship among these oil exporting countries in the Persian Gulf (some of which are tribal kingdoms) is fragile and even sometimes hostile. The move of

Oman towards Iran and the hostility between Qatar and Saudi Arabia are the latest divergence among these countries. Therefore, the plan for a currency union in 2010 was premature and has already failed. They have a long way ahead to satisfy the political homogeneity of a common currency.

For the equilibrium exchange rate, which is the focus of this chapter and one of the economic prerequisites for currency union, our results show that before any step toward the establishment of a monetary union in these countries, the divergence in the fair value of their currencies should be removed. As was the focus of the second chapter,[122] these countries should move away from their current currency peg to the US dollar towards a basket of appropriate currencies and probably oil price to decouple their currencies from the US dollar as a major oil importer.

[122] A Monetary Policy for the Persian Gulf Oil Exporting Countries.

Part IV

Sources of Real Exchange Rate Fluctuations in a Developed Commodity Exporting Country

1 Introduction

There is a vast literature on factors which determine the dynamic of the exchange rate and its fluctuations. In the 1970s, the focus is on inflation differences and monetary factors. Based on this view, when a country faces high inflation in comparison to its trading partners, its currency would depreciate relative to its partners' currencies. In the 1980s, this theory is rejected when we simultaneously observe converging inflation across countries and high fluctuations in exchange rates. This contradiction directs the literature towards the non-monetary factors such as shocks to world prices of exports, fiscal policy and productivity. This establishes the important role of fundamentals in explaining the exchange rate and its fluctuations. During the 1990s, expansion of capital flow and invention of different financial instruments add new factors to determination of the exchange rate. This brings the expectation literature to the models of exchange rate determination. This chapter focuses on the real exchange rate dynamic of Canada as a commodity exporting country and the long run relationship of the US-Canada real exchange rate with fundamentals. For purposes of comparison, we extend the analysis to Australia as another developed commodity exporting country.

This chapter contributes to two types of literature: that of long run equilibrium relationship between real exchange rates and fundamental variables; and that of variance decomposition. MacDonald (1999) emphasizes two major points about real exchange rate dynamics: first, identification of a long run relationship between real exchange rate and fundamentals such as supply factors (e.g., the Balassa-Samuelson Hypothesis), demand-side variables (e.g., government spending) and terms of trade. Second, assigning the proper weight to these factors in explaining the variance of the real exchange rate. Information about the source of these fluctuations helps in evaluation of the empirical relevance of different classes of models of real exchange rate determination. This chapter should help monetary authorities determine whether fluctuations of the Canadian dollar are driven by fundamentals, as opposed to short run market forces, and thus help them in their policies.

For several reasons, the dynamic of the US-Canada real exchange rate as an energy and non-energy commodity exporting country is interesting. First, for a long time both Canada and the US have been under flexible exchange rate regimes. Second, because of their high volume of trade, terms of trade should be very influential on their real exchange rate. Third, most of Canada's trade is with the US; this may justify the approximation of the real effective exchange rate of Canada to its real exchange rate against the US dollar. Fourth, we can consider Canada as a small open economy where terms of trade is exogenously determined by outside forces. Fifth, the high flow of trade and capital between these two countries may synchronize their business cycles; therefore, we may expect lower volatility in their real exchange rate in comparison to Canada's other trade partners. Overall, we expect a major role for terms of trade in explaining the real exchange rate and its fluctuations and, on the other hand, a minor effect from monetary forces.

Whenever Canadian dollar goes towards parity with the US dollar, there is great concern that the high Canadian dollar may undermine economic growth prospects and harm the competitiveness of Canadian exports. The monetary authorities are under pressure to react against the currency appreciation. At the same time, the Bank of Canada must pursue its inflation targeting policy. This causes a conflict between these two goals: in its interest rate management, should the Bank of Canada concentrate on the exchange rate, or maintain focus on the inflation target?

In this chapter, using a new data set of Canada commodity price indices,[123] we review and update the Canada Bank Equation (which is a cointegration relationship between energy and non-energy commodity prices with real exchange rate) in three aspects: first, by extending the data and dividing the full sample into two subsamples based on the break point in the sign of the energy price coefficient. Second, in addition to commodity prices, we add some other fundamentals to the original Canada Bank Equation. Third, we use the new data of Canada commodity indices which are updated annually. Therefore, we take care of historical change in the composition of Canadian commodity production. Our cointegration relationship between real exchange rate and fundamentals successfully tracks the real exchange rate for 35 years, almost four decades.

This new version of the Canada Bank Equation checks whether the Canadian dollar is out of track with fundamentals or not. This helps policy makers to set the optimal interest rate for the ultimate goal of monetary policy which is inflation targeting. If the currency is clearly out of line with the fundamentals, the Bank of Canada may more easily reach the inflation target if the currency is brought to equilibrium. On the other hand, if the currency is in equilibrium (with fundamentals), then the Bank of Canada should simply ignore the real exchange rate and focus on its main goal: inflation targeting. After updating the Canada Bank Equation, we use a Structural Vector Error Correction Model (henceforth: SVECM) to drive impulse responses to different fundamental shocks and decompose the variance of the US-Canada real exchange rate. After each empirical analysis, we apply different robustness checks.

Furthermore, ignoring the long run relationship of real exchange rate and fundamentals in level, we proceed with the first difference analysis, and identify the source of fluctuations in the real exchange rate of Canada and the US. We review and modify the analysis of Clarida and

[123] To our knowledge, this is the first study using the new Canada commodity price indices in this literature.

Gali (1994) for Canada. For different data samples, we rerun their model and check the results. Built on Clarida and Gali (1994), for Canada as a commodity exporting country, in two steps we add energy and non-energy prices to their Structural Vector Autoregressive (henceforth: SVAR) analysis. In all stages, we apply extensive robustness checks and compare the results (in the form of impulse responses and variance decomposition) with the original work of Clarida and Gali.

To preview the results, we confirm the findings of Amano and van Norden (1995) for the period before 1993, and then we show the switch in the role of energy price in the Canada Bank Equation. We expand the Canada Bank Equation and introduce a long run equilibrium relationship between the real exchange rate of Canada and the US and the set of economic fundamentals including real non-energy commodity price index, relative productivity and government spending. For variance decomposition of real exchange rate in both cases, with or without cointegration, the identification scheme is based on long run restrictions.

For the variance decomposition in the case without cointegration, we confirm the findings of Clarida and Gali (1994) and show the dominant effect of the demand shock and a minor effect of the supply shock in explaining the variation of the real exchange rate. Incorporating non-energy commodity prices into the model of Clarida and Gali does little to challenge their conclusion that the demand shocks account for the major part of variation in the real exchange rate. Furthermore, by adding the energy price to the analysis, we still observe the domination of the demand shock in the variance decomposition of the real exchange rate. However, in the second subsample (post 1993), we observe a greater role for energy price. Studies in the SVAR literature following Clarida and Gali (1994) have showed that productivity (supply) shocks have negligible effects on real exchange rate fluctuations.

This study shows that explicitly taking into account the cointegrating relationship between the real exchange rate and fundamental variables, relative productivity shocks explain the major part of real exchange rate variance. Adding commodity price to the cointegration analysis of a commodity exporting country such as Canada, the variance decomposition of the real exchange rate reveals that supply shocks and the non-energy commodity price are the most important source of real exchange rate fluctuations. Therefore, results of the SVAR analysis, which fails to take into account the long run relationship, do not highlight the importance of productivity shocks in variance decomposition of the real exchange rate. For comparison, we apply the SVAR and SVECM analysis for Australia, as a commodity exporting country with a flexible exchange rate and a small open economy.

The remainder of this chapter is organized as follows. In section 2, we describe the theoretical model of the link between the real exchange rate and fundamentals. In section 3, we review the

Canada Bank Equation which is focused merely on terms of trade and separates the effect of energy and non-energy commodities. Second 4 elaborates on the Structural VAR and VECM literature, here we review factors which explain the fluctuations of the real exchange rate with or without a cointegration relationship. In section 5, the data used in the analyses is presented. Section 6 sets out the empirical analysis of this chapter: after unit root and cointegration tests, we introduce a new version of the Canada Bank Equation and update and extend the SVAR and SVECM analysis for Canada. In this section, empirical results are followed by a robustness test. In section 7, we rerun the SVAR and SVECM analysis for Australia as a commodity exporting country. Finally, section 8 contains our conclusion.

2 Theoretical Model

In this section, we review the theoretical model for analysing real exchange rate dynamics for a commodity exporting country. Based on Dornbusch (1976), the expected change of the real exchange rate is proportional to deviations from its equilibrium level:

$$E_t \Delta q_{t+1} = \theta(\overline{q}_t - q_t) \tag{44}$$

where $\overline{q}_t$ is the fundamental (or equilibrium) value of the real exchange rate, which may be subject to permanent shifts. Applying the uncovered real interest rate parity condition:

$$E_t \left[q_{t+k}\right] - q_t = r_t - r_t^* \tag{45}$$

where r_t and r_t^* represent the home and the foreign real interest rates, respectively.

Rearranging Equations 45 and 46 into an expression for the real exchange rate:

$$q_t = \overline{q}_t - \alpha(r_t - r_t^*) \tag{46}$$

Equation 47 describes the dynamics of the real exchange rate by the equilibrium level of the real exchange rate and the real interest rate differential.

The failure of the PPP hypothesis rejects a constant equilibrium value, since the speed of convergence towards the equilibrium is too slow to confirm a constant equilibrium exchange rate. Therefore, the literature links the equilibrium exchange rate to the fundamentals which are dynamic. Different models explain the related fundamentals, such as: productivity, government spending and terms of trade.

In theory, there are two main different models which explain the effect of productivity on the real exchange rate. The first is the Balassa-Samuelson Hypothesis which is based on Balassa (1964) and Samuelson (1964). Based on this hypothesis, if the relative productivity of traded goods to another sector in a country grows more that of their trading partners, the country will observe currency real appreciation. The wages in the more productive part of the economy increase, therefore prices will rise faster to reflect the productivity increase. The Balassa-Samuelson Hypothesis is based on four assumptions: first, for traded goods in the short run, the Purchasing-Power Parity (PPP) holds; second, in the two countries of the model, shares of the non-traded sector are the same and constant; third, within a country, labour is mobile between sectors; and fourth, labour is the only factor of production. The Balassa-Samuelson Hypothesis is not the only theoretical model of the effect of productivity on the real exchange rate.

Benigno and Thoenissen (2003) introduce an alternative model which is a two country sticky-price model of real exchange rate. In this theoretical model, the PPP does not hold and firms are not price takers. In contrast to the Balassa-Samuelson Hypothesis, this model considers price rigidities, intermediate goods, imperfect competition, and preference favouring local goods. For Canada, Helliwell et al. (2005) present the result of the effect of productivity on the real exchange rate which is consistent with the Benigno and Thoenissen model. Therefore, the faster productivity growth in the Canadian manufacturing sector than in the United States tends to depreciate the currency and vice versa for aggregate productivity growth.

An important issue in empirical studies of real exchange rate determination is the choice of variables which represent productivity. One suggestion is the relative output (real GDP per capita) which can be interpreted as a broad measure of labour productivity for the overall economy.[124] Alexius and Nilson (2000) assign two conditions for reliability of the real GDP per capita as a proxy for productivity: first, the productivity growth in the non-tradable sector should be similar across countries. Second, it should be a small proportion of the total factor productivity growth. Other measures of productivity differential that are employed are a relative price differential between traded and non-traded goods at home and abroad,[125] a total

[124] Gauthier and Tessier (2002), Clarida and Gali (1994), Chadha and Prasad (1997), Alexius (2005) and Zalduendo (2006) all use real GDP per capita as the proxy for productivity.

[125] Chinn (1999) and Kakkar and Ogaki (1999).

labour productivity differential,[126] and a sectoral productivity differential.[127]

In addition to productivity, the other factor influencing the fluctuation of the real exchange rate is the demand shock. By adding the demand shock to the Balassa-Samuelson analysis, Rogoff (1992) modifies the model. Rogoff uses the ratio of government spending to GDP as a proxy for aggregate demand. The ratio of government spending to GDP affects the real exchange rate through its impacts on the relative price of non-tradable goods. Based on this model, a positive demand shock appreciates the currency, since most likely the government spending is focused on non-tradable goods. This result is confirmed by the theoretical open macroeconomic model of Clarida and Gali (1994).

On the other hand, there are some studies which suggest that currency depreciates with a positive demand shock. Barro and Lee (1994) describe evidence that high government spending and higher tax are associated with lowered aggregate productivity growth which causes currency depreciation through the Balassa-Samuelson channel. In another study, Habermeier and Mesquita (1999) focus on cases where the increase in government spending is financed by distortionary taxes. This may discourage investment, and hence prevent productivity growth.

Another channel through which higher government spending may cause currency depreciation is the twin deficits phenomenon. Bailliu et al. (2007) consider periods when an economy faces current account and fiscal deficits at the same time, and the current account deficit is driven by fiscal deficit. Then, to improve a country's competitiveness and boost its exports, the currency is forced to depreciate; consequently, this improves the current account.

In addition to productivity and government spending differentials, changes in the terms of trade can also affect the real exchange rate. This effect is intensified in a commodity exporting country such as Canada. Based on the theoretical terms of trade models, wealth effect is the channel through which the terms of trade may influence the real exchange rate. An improvement in the terms of trade of a country will increase its wealth; and consequently raise demand. This extra demand will change relative prices in favour of foreign goods; therefore, it causes currency appreciation. The link between commodity price and real exchange rates is documented in the literature: studies such as Koya and Orden (1994) for Australia and New Zealand; Amano and van Norden (1995) for Canada; Chen and Rogoff (2003) for Australia, Canada and New Zealand; MacDonald and Ricci (2004) for South Africa; and Zalduendo (2006) for Venezuela. Therefore, in this literature for a commodity exporting country, using the real commodity price as a proxy for terms of trade is justified.

[126] MacDonald (2002) and Maeso-Fernandez et al. (2002).
[127] Chen and Rogoff (2003) and Chaban (2006).

3 Canada Bank Equation

In theory, many factors may influence the Canada-US real exchange rate: fiscal policy, interest rate differences, unemployment, relative inflation, productivity, and terms of trade, among others. These factors influence a currency's effective exchange rate rather than any particular bilateral rate. However, in the case of Canada, because of high volume of trade and capital movements between the US and Canada, we focus on the bilateral rate. Among all these factors, terms of trade in a commodity exporting country such as Canada has special weight.

In the first attempt to test the link between terms of trade and the Canada-US real exchange rate, Lafrance and Longworth (1987) fail to establish an empirical link between Canada's real exchange rate and the overall terms of trade. However, Amano and van Norden (1995) explain the Canada-US real exchange rate using terms of trade deflated by Consumer Price Indices (CPI). Covering monthly data from 1973 to 1992, besides the satisfactory results for in-sample data, their simple and stable error correction equation beat a random walk in out-of-sample forecasting.[128]

Based on a cointegration approach, Amano and van Norden (1995) use a single-equation error-correction model to present a long run relationship between the real exchange rate, real energy commodity price index and real non-energy commodity price index. To represent the short run dynamics, they include the Canada-US short term interest rate differential.[129] The equation can be written as follows:[130]

$$\Delta rfx = \alpha[rfx_{t-1} - \beta_0 - \beta_c com_{t-1} - \beta_e ene_{t-1}] + \gamma int_{t-1} + \varepsilon_t \tag{47}$$

where the dependent variable, rfx, is the nominal Can-US exchange rate deflated by the CPI and com, ene and int are non-energy commodity price index, energy price index and Can-US interest rate differential, respectively.

The empirical results confirm that the energy and non-energy commodity prices affect the

[128] To check the differences between bilateral and effective real exchange rates, they add an additional explanatory variable (the US real effective exchange rate against other countries). The results confirm that this variable is insignificant. Therefore, using the bilateral rate is legitimate.

[129] For the short run dynamic, the Canada Bank Equation literature uses the Canada-US Short term interest rate differential, but Amano and van Norden (1995) use the differential in the long-short term yield spread.

[130] Johansen (1992) mentions the special case in which, instead of working with the entire vector error-correction model, we can use a single equation model. The conditions are: firstly, there is only one cointegrating vector; secondly, all the other cointegrating variables are weakly exogenous with respect to the first variable under consideration.

Canadian dollar in different ways. Therefore, the split of the commodity price to energy and non-energy commodity prices is the key to the equation's success. While higher prices for non-energy commodities appreciate the Canadian dollar, higher energy prices depreciate it. As Amano and van Norden (1995) argue, the reason for this behaviour is that the Canadian manufacturing sector is more concentrated in energy intensive industries than that of its trading partners. Therefore, the possible explanation for the negative relationship between energy price and the Canadian dollar could be the outweighed adverse effects of higher oil prices on the competitiveness of Canada's relatively energy-intensive manufacturing exports in comparison to the direct benefits of oil exports.

Finally, based on the empirical results of Amano and van Norden (1995), a 10 per cent improvement in non-energy commodity price leads to a 8.11 per cent appreciation of the Canada-US real exchange rate while a 10 per cent improvement in energy price results in a 2.33 per cent depreciation of the real exchange rate. The speed of adjustment α is - 0.038 implying that 37.1 per cent of adjustment is completed within one year (a half-life of 17.9 months).

Amano and van Norden (1995) contribute to the literature in three aspects. First, they document a stable long run relationship between real exchange rate and terms of trade in Canada. Second, they split commodity price to energy and non-energy prices and show that these two prices influence the exchange rate differently. Third, in the framework of Meese and Rogoff (1983) , Amano and van Norden (1995) successfully beat a random walk in forecasting the US-Canada real exchange rate. However, in the long run, they only consider commodity prices and ignore other fundamentals.

As in the first extension of Amano and van Norden (1995), using quarterly data over the period 1972 Q2 to 1994 Q3, Lafrance and van Norden (1995) confirm the performance of Canada Bank Equation. As with Amano and van Norden (1995), the explanatory variables are significant and the influence of energy and non-energy commodity prices are different.

To improve the Canada Bank Equation, different studies have extended data and /or added some other fundamentals to the original equation. This literature may be categorized into two main groups: the first branch focusing on the historical change in the composition of Canadian commodity export (production) and the second investigating some new explanatory variables in the long run or short run part of the original model.

3.1 Change in the Share of Commodities in Canada's Export (Production)

Although Canada has been a commodity exporter, the composition of its commodity exports has changed over time. As Laidler and Aba (2001) mention, in the three decades from the 1970s to the 1990s, the composition of exports changed while the ratio of commodity exports to GDP has been stable at around 11 per cent. In this period, the share of commodities in Canada's exports decline from an average of 55 per cent in the 1970s to 47 per cent in the 1980s, to 37 per cent in the 1990s. Therefore, it is reasonable to observe a change in the effect of commodity and energy prices on the real exchange rate. This change in the dynamic of exports is ignored by Amano and van Norden (1995). Recognizing this issue, Laidler and Aba (2001), Issa et al. (2006, 2008), and Bergevin and Busby (2010) document the shift in the relationship between energy price and the Canada-US real exchange rate.

Using three separate coefficients on each variable for the 1970s, 1980s and 1990s, Laidler and Aba (2001) re-estimate the Bank of Canada equation. The US dollar prices of energy and non-energy commodities are the two variables in the cointegration part of the equation. In contrast to Amano and van Norden (1995) which use CPI, Laidler and Aba (2001) apply the US GDP deflator to deflate the nominal value of exchange rate, commodity and energy prices. The use of this GDP deflator, the price of a bundle of goods produced in the US, may give us a more accurate measure of the real exchange rate in comparison to the CPI which represents the price of a bundle of goods consumed there. Finally, according to the literature, the short term interest differential between the two countries represents the short run dynamic.

Laidler and Aba present decline in the effect of energy price after the 1970s. This causes the insignificance of energy price in explaining the real exchange rate after 1990. In contrast, for non-energy commodity prices, in the three decades of this study, there is a decline in the coefficient but it is significant. For the short run part of the equation, Laidler and Aba get a significant coefficient for the Canadian-US inflation differential. Therefore, the only major difference in the results between Laidler and Aba (2001) and Amano and van Norden (1995) is the decline and insignificance of effect of energy price in the Canada Bank Equation.

The insignificance of energy price index in the equation for the 1990s may be explained by the switching of the sign of the energy price coefficient which is caused by changes in the Canadian economy. In the 1990s, Canada converts from being an energy importer to an energy exporter. During this period, the effect of energy price on real exchange rate is changed; therefore, the insignificance of the energy price coefficient in the Canada Bank Equation represents this transition. Helliwell (2000) focuses on the high oil price in the 1970s and 1980s and argues that this high oil price causes more demand for the US dollar as a safe asset and consequently the appreciation of the US dollar against other currencies, including the Canadian dollar. Helliwell (2000) criticizes the Canada Bank Equation and argues that it wrongly interprets the depreciation of Canadian currency as the consequence of high oil price not US dollar appreciation.

Using a longer and richer data set, Murray et al. (2000) extend data to 1998 Q4, and run the Canada Bank Equation. Over the 1973 Q1-1998 Q4 period, the nominal bilateral exchange rate depreciated by 44 Canadian cents. Of this, more than 56 per cent is because of a decreasing trend in the relative price of non-energy commodities; the PPP, energy price and other factors contribute 23, 2 and 25 per cent, respectively. On the other hand, interest rate differential appreciates the currency by 7 per cent. This is a partial confirmation of Laidler and Aba (2001) which document the decline in the significance of energy price in the Canada Bank Equation during the 1990s. In another study, Issa et al. (2006, 2008) show 1993 Q3 as the break point of the change in the sign of energy price coefficient in the Canada Bank Equation.

Issa et al. (2006, 2008) revisit the Canada Bank Equation and show that the long run relationship between real exchange rate, energy and non-energy commodity prices are not stable for the full sample of 1973 Q1-2005 Q4. The energy price coefficient shifts and they find cointegration in two subsamples, not the full sample. Using a dummy variable, they present the change in the sign of energy price in the cointegration relationship:

$$\Delta rfx = \alpha[rfx_{t-1} - \beta_0 - \beta_c com_{t-1} - \beta_e ene_{t-1} - \delta_e I(t \succ \tau) ene_{t-1} - \delta_u I(t \succ \tau)] + \gamma int_{t-1} + \varepsilon_t \quad (48)$$

where $I(t \succ \tau)$ is a dummy variable which takes the value unity when $t \succ \tau$ for $\tau = 1993$ Q3 and 0 otherwise. The dummy variable represents the change in the sign of the energy price coefficient. Applying structural break tests with an unknown break date, they find a break point in the sign of this relationship, which changes from negative to positive in 1993 Q3. This shift in the effect of energy price is first suggested by Laidler and Aba (2001). Therefore, the result of Issa et al. (2006, 2008) indicates that the cointegrating relationship in the standard Canada Bank Equation is supported in the subsamples, not the full sample. In the first subsample, an increase of energy price depreciates the currency while in the second subsample it appreciates it. This transfer in the relationship is coincident with the increase of Canada's energy export which happens after establishment of the Canada-US Free Trade Agreement. Therefore, by considering a dummy variable for the change of energy price coefficient, they significantly improve the performance of the Canada Bank Equation in the full sample.

Given the evidence provided by Laidler and Aba (2001) and Issa et al. (2006, 2008) which acknowledges that the Canada Bank Equation coefficients may be changed as the composition of Canada's commodities production may have changed over time, Maier and DePratto (2008) apply a weighting scheme for energy and non-energy commodities content in Canada's exports and production. They use the model of Issa et al. (2006, 2008) as the base, and pre-multiply the price indices for energy and non-energy commodities by appropriate scaling factors which are derived from export or production weights.[131]

The scaling factor based on exports is the ratio of the value of energy exports (non-energy) to total exports for the energy (non-energy) variable. For the scaling factor based on production, they scale energy and non-energy commodities by a continuous series, indicating the degree to which Canada is a net importer or exporter of energy and non-energy commodities. By using these scaling factors, Maier and DePratto (2008) show the coefficients are more stable in comparison to the baseline model of Issa et al. (2006, 2008). Therefore, the exchange rate dynamic is linked to the composition and dynamic of Canada's export or production patterns. We use the new Canada commodity price indices which are updated annually based on the dynamic of the production composition; therefore, our data automatically satisfy these scaling factors.[132]

Following the decade by decade method of Laidler and Aba (2001), Bergevin and Busby (2010) run the Canada Bank Equation for almost four decades from 1973 Q1 to 2007 Q2. For each decade from the 1970s to the 2000s, they assign one coefficient for the commodity price and the other for energy price. Bergevin and Busby (2010) update the method of Laidler and Aba (2001) in three aspects. First, as do Maier and DePratto (2008), they distinguish between the commodity price indices of Canadian commodity exports and production. Second, they extend the data; therefore, they present the 2000s as the fourth decade. Third, in addition to interest rate differential, they add the IMF Financial Stress Index to the short run dynamic of the equation to describe the flight to safety phenomenon in financial markets during periods of financial crisis when the Canadian dollar depreciates against the US dollar.

Furthermore, Bergevin and Busby (2010) successfully track the historical exchange rate dynamic and beat the decade by decade model of Laidler and Aba (2001). Finally, Bergevin and Busby (2010) confirm the results of Issa et al. (2006, 2008) which document the shift in energy price from a negative influence on the Canadian dollar in the 1970s and 1980s, to a positive one in the 2000s. Therefore, the 1990s is the transition period for this sign change.

[131] To explain exchange rate, as Orr (1999) points out, it is more appropriate to use commodity price indices which are based on exports not production.

[132] Maier and DePratto (2008) add the squared value of the energy price to the equation to test the non-linear effects of energy prices on exchange rate, but the results are not promising.

Hence, after 2000, the Canadian dollar behaves similarly to an oil currency: it appreciates (or depreciates) with increase (or decrease) in oil price.

3.2 Search for Alternative Explanatory Variables

To find an improved version of the Canada Bank Equation, several new variables have been tested as alternative explanatory variables. Tessier and Djoudad (1999) is the first study to try different fundamentals, such as: government debt, foreign indebtedness, unemployment rates, productivity, and government spending. They do not get significant coefficients for these new variables. In another study, Murray et al. (2000) add two variables to the cointergation part of the original Canada Bank Equation: the difference in Canadian and US labour force productivity, and the difference in Canadian and US general government debt. In the cointegration test, they do not find a long run relationship between one or both of these variables and the real exchange rate. Then they run three versions of the original Canada Bank Equation with each of the two new variables and with both. These three modifications do not improve the performance of the original Canada Bank Equation.

In another study, over the 1975 Q1-1999 Q4 period, Helliwell et al. (2005) use the same two variables of Amano and van Norden (1995): the energy prices and the non-energy commodity prices deflated by GDP deflators rather than CPI. However, in the short run (beside the Canada-US short term interest rate differential) they add the change in relative public sector debt positions as a proportion of GDP. The coefficients of the non-energy commodity prices, interest rate differentials, and changes in relative public debt ratios have the correct sign and are all significant. Although the equation successfully explains 25 per cent of the variance of the real exchange rate, it does not justify the appreciation of the Canadian dollar in 2003. In line with Laidler and Aba (2001), and Bergevin and Busby (2010), Helliwell et al. (2005) show the insignificance of the energy price coefficient.

Helliwell et al. (2005) continue to look for the proper fundamentals; they run 13 different versions of Canada Bank Equation with different explanatory variables. The long run part of the equation with the best performance consists of real non-energy commodity prices and labour productivity differentials with the United States while the short run part consists of Canada-US short term interest rate differentials, the US dollar relative to other currencies excluding Canada, and a measure of risk. This version of the Canada Bank Equation explains the real exchange rate since 1975, both in-sample and out-of-sample, and successfully represents the appreciation of the Canadian dollar in 2003. However, this equation fails in two periods: first, during the LTCM (Long Term Capital Management) failure in 1998 when the dollar is going through speculative pressure. Second, during the terrorist attacks on the US in Sep 2001. Overall, it seems, under normal circumstances, the equation which is introduced by Helliwell et al. (2005) links the fundamentals to the real exchange rate. Helliwell et al. (2005) name this version of the Canada Bank Equation the Nominal Exchange rate model (NEMO). In the Canada Bank Equation literature, this study is the first which successfully shows the effect of productivity differential on real exchange rate.[133]

In addition to the VECM procedure which starts by recognizing the non-stationarity of variables and then testing for cointegration, Choudhri and Schembri (2014) investigate the Canada Bank Equation by using the Bounds Testing procedure suggested by Pesaran et al. (2001). There are two critical issues with the VECM method. First, as a part of the VECM method, the unit root tests have low power in recognizing the non-stationarity process. Second, excluding or including the trend in the unit root test may cause problems. In the Bounds Testing method, without unit root tests and regardless of stationarity or non-stationarity of the variables, we can test the long run relationship in levels. Choudhri and Schembri (2014) apply the Bounds Testing method and get different results for post-1990 and pre-1990. The effect of each variable has become stronger and in the second subsample a positive trend is present. As in Helliwell et al. (2005), the effect of productivity on real exchange rate is opposite to that predicted by the standard Balassa-Samuelson Hypothesis.

In addition to the productivity differential, another important fundamental is the global trade imbalances which may cause the trend depreciation of the US dollar against most major currencies including the Canadian dollar. Therefore, adding a variable representing the large US external imbalances may enhance the performance of the Canada Bank Equation. Using data for the period 1973 Q1 to 2005 Q4, Bailliu, Dib, and Schembri (2014) test for this effect by including the US fiscal and current account balances in the original Canada Bank Equation, and outperform the original Canada Bank Equation.

4 Structural VARs and VECMs Literature

Determining the relative importance of permanent real factors and transitory nominal factors to real exchange rate movements is an important strand of empirical research of the real exchange rate. Clarida and Gali (1994) is the leading study in this literature. To model changes in the real exchange rate and fundamental variables, they use SVAR[134] and the long run structural

[133] We can consider the NEMO as a kind of the Behavioural Equilibrium Exchange Rate (BEER) approach.

[134] See, e.g., Sims (1981, 1986), Shapiro and Watson (1988), and Blanchard and Quah (1989).

identification method of Blanchard and Quah (1989).[135] Then, they apply the variance decomposition techniques to present the effect of real and nominal shocks in explaining real exchange rate fluctuations.

For Germany, Canada and the UK currencies relative to the US dollar, Clarida and Gali (1994) develop a SVAR model in which real shocks are separated into shocks to real supply, demand and nominal. They contribute to the literature by recognizing the demand shocks as the main factor of real exchange rate fluctuations both in short and long run while the supply shock has a minor role. In the short run, the nominal shocks are not important for the UK and Canada but are for Japan and Germany, all relative to the US dollar.

After Clarida and Gali (1994), other studies, such as Chadha and Prasad (1997), MacDonald and Swagel (2000), and Filosa (2004), extend sample data or, as Rogers (1999) and Webber (1997), add some new explanatory variables. Although, Rogers (1999)[136] and Eichenbaum and Evans (1995) present larger relative effect of monetary shocks, the negligible effect of supply (productivity) shock in explaining the fluctuations of real exchange rate is accepted as the stylised fact in the literature on sources of real exchange rate fluctuations. Overall, the common result of all these studies is the minor effect of productivity shocks on real exchange rates at all horizons, which is the confirmation of the conclusion of Clarida and Gali (1994) as conventional wisdom.

Similar to Clarida and Gali (1994), a common characteristic of these SVAR studies is that they do not consider the long run cointegration relationship between the levels of the variables. Some of them, such as Clarida and Gali (1994), and Rogers (1999), reject the long run relationship between real exchange rate and fundamentals while others, such as Weber (1997), do not investigate it. On the other hand, based on the SVAR literature, productivity shock does not explain much of the variance in the real exchange rate. However, this is against a vast literature of long run relationship of fundamentals such as productivity and real exchange rate. MacDonald (1999) emphasizes the connection of the literature on long run relationships between real exchange rates and fundamentals (such as productivity) and on identifying the relative importance of shocks in explaining real exchange rate volatility. Hence, there is a gap between this variance decomposition literature and the literature of long run equilibrium relationships between real exchange rates and fundamental variables.

[135] For the first time, Blanchard and Quah (1989) suggest the use of long run restrictions to identify structural shocks in a VAR model without cointegration.

[136] Rogers (1999) could not find cointegration between the real exchange rate and fundamentals; therefore Rogers applies a SVAR model for over 100 years of data for the real Sterling-US dollar exchange rate. Rogers results show that from 19 to 60 percent of variation in real exchange rate is because of monetary shocks and 4 to 26 percent from fiscal and productivity shocks combined.

Focusing on long run relationship, the literature of sources of real exchange rate variability goes toward the cointegration analysis. Studies such as Fisher (1996); Gauthier and Tessier (2002); Alexius (2005) and Chanthapun (2010) provide a link between the literature on the cointegration relationship between real exchange rate and fundamentals with that on variance decomposition. For the decomposition of structural shocks, these SVECM studies apply different econometrics frameworks such as: King et al. (1991), Gonzalo and Ng (2001), and Pagan and Pesaran (2008).[137] Fisher (1996), Alexius (2005) and Gauthier and Tessier (2002) apply the framework of King et al. (1991) while Groen and Lombardelli (2004), Kishor (2007), and Veirman and Dunstan (2008) follow the decomposition approach of Gonzalo and Ng (2001). Chanthapun (2010) applies the framework of Pagan and Pesaran (2008) to analyse structural systems with permanent and transitory shock.

These SVECM analyses confirm that (if there is a long run relationship between the real exchange rate and fundamentals) then the SVAR models, such as that of Clarida and Gali (1994), which apply the first differences of data fail to present some characteristics of the model. The SVAR and SVECM approaches are different in the sense that, in the latter, we consider the cointegration relationship between variables while in the former we do not. However, they are similar in applying long run restrictions in the process of identifying structural shocks.

Based on a SVECM, Gautheir and Tessier (2002) link different explanatory variables to the Canadian real exchange rate. The fundamentals are the real aggregate commodity price index, relative government spending and relative productivity, all quarterly data from 1961 to 2000. Applying the econometrics frameworks of King et al. (1991) and using the long run restrictions for the identification method, they decompose the real exchange rate according to long run relationship. In contrast to Clarida and Galí (1994) who conclude that real demand shocks account for most of the movements in the real exchange rate, Gautheir and Tessier (2002) find that fluctuation in the Canadian real exchange rate is largely explained by commodity price shocks over the short and medium run, while supply shocks have the largest impact over the long run. In addition, in line with the Balassa-Samuelson Hypothesis, they find that supply shocks have a positive effect on the real exchange rate.[138]

In another study, Alexius (2005) documents the cointegration of real exchange rates and fundamentals. Following the method of King et al. (1991), the structural shocks are identified by imposing restrictions on their long run effects. The real exchange rates are the bilateral real exchange rates between the US dollar and the currencies of the United Kingdom, Germany and Japan; the fundamentals are relative real output, relative government spending and relative price levels. The VECM is constructed by four variables and one cointegration vector with three

[137] Others similar studies are: Jacobson et al. (1997), and Breitung et al. (2004).

[138] Alquist and Chinn (2002) confirm the results of Gautheir and Tessier (2002) for the Euro-US dollar exchange.

stochastic trends identified as a relative productivity shock, a government spending shock, and a monetary shock. All these shocks are allowed to affect the real exchange rate and the relative price level in the long run. Alexius assumes that the monetary shocks do not influence the relative output or government spending in the long run. For identification, she provides one more restriction. Following Rogers (1999), Alexius (2005) allows the government spending shocks to affect output, but the productivity does not affect government spending in the long run. In contrast to Clarida and Gali (1994), Alexius (2005) shows that relative productivity shocks dominate the long run variance decompositions of real exchange rates when long run equilibrium relationships are taken into account. For the robustness checks, she tests the results with respect to changes in the identifying assumptions and the included variables. Furthermore, she applies the SVAR analysis, as do Clarida and Gali (1994), and shows that productivity shocks are not a major source of real exchange rate movements. It seems by excluding the cointegration relationship between the real exchange rate and its fundamentals, the productivity shocks are not any more the major source of movement of real exchange rates.

Chanthapun (2010) studies the sources of fluctuations in the real exchange rate of three commodity currencies (namely Australia, Canada and New Zealand) relative to the US dollar. Chanthapun considers three permanent factors that may explain the long run variability and dynamics of these commodity currencies: real commodity prices, productivity differentials and demand-side factors; and two transitory factors: real interest rate differentials and risk premia. Based on a VECM, Chanthapun merely focuses on long run relationship and uses the econometric framework of Pagan and Pesaran (2008). First, for each of the three commodity currencies, Chanthapun documents a long run equilibrium relationship between the real exchange rate and a set of economic fundamentals including real commodity prices, relative output per capita and relative government spending. Second, Chanthapun confirms that the main sources of fluctuation in the real exchange rates for Australia and New Zealand are the relative supply shocks while it is the relative demand shocks that are the main sources for Canada, which is against Gautheir and Tessier's results. For the commodity price shocks, Chanthapun (2010) does not find an important role in explaining the variation in the real exchange rate of these three commodity currencies. These results should be considered with caution, because for all three countries, instead of using their individual commodity indices, Chanthapun applies the same global commodity price index. The effect of the supply shocks is in agreement with the Balassa-Samuelson Hypothesis, and the low effect of transitory shocks implies that the monetary authorities do not have much influence on the real exchange rate.

5 The Data

The Data are quarterly and obtained from Datastream which covers the period from 1972 Q1 to 2014 Q1. The real exchange rates based on CPI and GDP deflators are $qcpi$ and $qgdp$, respectively. A decrease in the real exchange rate implies a real appreciation of the Canadian currency relative to the US dollar. ene, com and tot (all in log) are energy commodity, non-energy commodity and total commodity price indices, respectively, in US dollars from the new Bank of Canada Commodity Price Index (BCPI). These new commodity price indices, called the Fisher BCPI, are constructed by three modifications: first, by updating the production weights on an annual basis, these indices present the dynamic of Canada commodities production. Second, the calculation method is the chain Fisher index method. Third, they cover a broader set of commodities. In contrast, the old BCPI was updated once a decade; therefore, they are biased and do not properly represent the dynamic of the composition of commodities produced in Canada. y_1 and y_2 represent the supply side of the economy which are the real GDP per capita and the CPI/ PPI, respectively. Whereas the fiscal or demand side measure is proxied by g, which is the ratio of government spending to GDP. The US-Canada CPI differential, in log, is p. All variables, except for the real commodity indices, are expressed in terms of differentials from the US.

6 Empirical Analysis

6.1 Unit Root Tests

We test for the presence of unit root for all the series used in the analysis. The Augmented Dickey-Fuller (ADF), Phillips-Perron (PP) and the Kwiatkowski, Phillips, Schmidt, and Shin (KPSS) Unit Root tests are employed to test the integration level.[139] In the ADF and PP tests, the null hypothesis is the non-stationarity of the time series. In contrast, the null hypothesis of the KPSS test is the stationarity of the time series. As shown in Table 30, for the first subsample (1972-1993), all tests confirm the non-stationarity of $qcpi$, $qgdp$, ene, com and tot. For the second subsample, (1994-2014), all tests approve the non-stationarity of all variables except y_2 which is showed to be $I(0)$ by two of the three tests.

[139] The ADF, PP and KPSS tests are based on Dickey and Fuller (1979), the Phillips and Perron (1988) and Kwiatkowski et al. (1992), respectively.

Table 30- Augmented Dickey-Fuller, Phillips-Perron and KPSS Unit Root Tests

1972-1993	ADF	P-v	Con	PP	P-v	Con	K	1%	5%	10%	Con
qcpi	-0.26	0.58	$I(1)$	-0.58	0.46	$I(1)$	0.49	0.73	0.46	0.34	$I(1)$
qgdp	-0.89	0.32	$I(1)$	-1.09	0.24	$I(1)$	0.51	0.70	0.46	0.34	$I(1)$
ene	-1.57	0.79	$I(1)$	-1.60	0.78	$I(1)$	0.26	0.21	0.14	0.11	$I(1)$
com	-4.84	0.00	$I(0)$	-3.12	0.10	$I(1)$	0.17	0.21	0.14	0.11	$I(1)$
tot	-2.98	0.14	$I(1)$	-2.93	0.15	$I(1)$	0.21	0.21	0.14	0.11	$I(1)$
1994-2014	ADF	P-v	Con	PP	P-v	Con	K	1%	5%	10%	Con
qcpi	-0.92	0.31	$I(1)$	-0.91	0.31	$I(1)$	0.79	0.73	0.46	0.34	$I(1)$
qgdp	-0.69	0.41	$I(1)$	-0.73	0.39	$I(1)$	0.90	0.73	0.46	0.34	$I(1)$
ene	-3.65	0.03	$I(0)$	-2.73	0.22	$I(1)$	0.15	0.21	0.14	0.11	$I(1)$
com	0.13	0.72	$I(1)$	0.07	0.70	$I(1)$	0.52	0.73	0.46	0.34	$I(1)$
tot	-3.47	0.048	$I(0)$	-1.68	0.43	$I(1)$	1.03	0.73	0.46	0.34	$I(1)$
y_1	-0.95	0.30	$I(1)$	-0.89	0.32	$I(1)$	0.71	0.73	0.46	0.34	$I(1)$
y_2	-3.62	0.03	$I(0)$	-4.24	0.00	$I(0)$	0.25	0.21	0.14	0.11	$I(1)$
g	-1.16	0.90	$I(1)$	-1.14	0.91	$I(1)$	0.31	0.21	0.14	0.11	$I(1)$

Note: P-v, Con, K, % are P value, Conclusion, KPSS test stat and Critical % level, respectively.

Table 31 - Augmented Dickey-Fuller, Phillips-Perron and KPSS Unit Root Tests (1980-2014)

1980-2014	ADF	P-v	Con	PP	P-v	Con	K	1%	5%	10%	Con
qcpi	-1.12	0.23	$I(1)$	-1.14	0.22	$I(1)$	0.48	0.73	0.46	0.34	$I(1)$
qgdp	-0.81	0.36	$I(1)$	-0.87	0.33	$I(1)$	0.66	0.73	0.46	0.34	$I(1)$
ene	-0.04	0.66	$I(1)$	0.03	0.69	$I(1)$	0.46	0.73	0.46	0.34	$I(1)$
com	-2.83	0.055	$I(1)$	-2.93	0.053	$I(1)$	0.67	0.73	0.46	0.34	$I(1)$
tot	-2.03	0.27	$I(1)$	-1.90	0.31	$I(1)$	0.49	0.73	0.46	0.34	$I(1)$
y_1	-1.80	0.06	$I(1)$	-1.79	0.06	$I(1)$	0.94	0.73	0.46	0.34	$I(1)$
y_2	-1.58	0.10	$I(1)$	-1.55	0.11	$I(1)$	0.97	0.73	0.46	0.34	$I(1)$
g	-0.73	0.39	$I(1)$	-0.98	0.29	$I(1)$	0.66	0.73	0.46	0.34	$I(1)$
p	-4.07	0.00	$I(0)$	-3.86	0.01	$I(0)$	0.13	0.21	0.14	0.11	$I(0)$

Note: P-v, Con, K, % are P value, Conclusion, KPSS test stat and Critical % level, respectively.

Table 31 reports the results for the full sample, all variables except p are $I(1)$.

6.2 Update of Amano and van Norden (Canada Bank Equation)

Using the new Bank of Canada Commodity Indices, we revisit the Canada Bank Equation and show that the long run relationship among real exchange rate, energy and non-energy commodity prices are not stable for the full sample of 1972 Q1-2014 Q1. As the literature shows, the energy price coefficient switches in sign around 1993. Therefore, we break our full sample into two subsamples: 1972-1993 and 1994-2014. As the different unit root tests suggest, the real exchange rate, the real price of energy and the non-energy commodities are $I(1)$. For both subsamples, we test the conintegration of these two fundamentals with the real exchange rate.

6.2.1 Cointegration Tests

Following the Johansen cointegration test, for the first subsample (1972-1993), the maximum eigenvalue and trace tests for the cointegration rank are performed, and are summarised in Table 32. At 5 per cent critical value, both tests confirm one cointegration vector among the real exchange rate (based on CPI), energy and non-energy commodity prices. The possibility of cointegration of energy and non-energy commodity prices solely with each other (and not with the real exchange rate) is checked and rejected; therefore, energy and non-energy commodity prices are only related to real exchange rate.

For the robustness check, we rerun the Johansen cointegration test with the alternative real exchange rate (based on the GDP deflator instead of CPI). As Table 32 presents, the result for the robustness test does not change and for the first subsample we reconfirm cointegration among the real exchange rate, energy and non-energy commodity prices.

We apply the same procedure for the second subsample (1994-2014). Table 33 reports the Johansen cointegration test, and its robustness check for the second subsample. Similarly to the first subsample, either for real exchange rates based on a CPI or GDP deflator, we confirm the existence of one cointegration vector among real exchange rate, energy and non-energy commodity prices.

Table 32- Johansen Cointegration Test (1972-1993)

$qcpi, com, ene$					$qgdp, com, ene$			
No. of CE(s)	Trace	Prob.	Max-E	Prob.	Trace	Prob.	Max-E	Prob.
None	36.17	0.00	22.73	0.02	39.51	0.00	24.00	0.01
At most 1	13.43	0.09	10.06	0.20	15.51	0.05	13.58	0.06
At most 2	3.36	0.06	3.36	0.06	1.93	0.16	1.93	0.16

Table 33 - Johansen Cointegration Test (1994-2014)

$qcpi, com, ene$					$qgdp, com, ene$			
No. of CE(s)	Trace	Prob.	Max-E	Prob.	Trace	Prob.	Max-E	Prob.
None	48.10	0.01	29.21	0.01	45.73	0.02	26.82	0.03
At most 1	18.89	0.28	13.35	0.30	18.90	0.28	13.93	0.25
At most 2	5.53	0.52	5.53	0.52	4.97	0.60	4.97	0.60

6.2.2 VECM Results for Canada Bank Equation

Usually in specifying VECMs, the lag length, the cointegration rank and any further restrictions have to be determined. Before further restrictions on VECM, we verify the lag order and the cointegration rank. For the lag selection, the most common procedure for VAR order selection is either by sequential testing or by model selection criteria such as: Akaike (AIC), Schwarz (SC) or Hannan-Quinn (HQ). For each case, we consider the lag order based on the AIC criteria.

The results of the VECM for the two subsamples are presented in Tables 34 and 35. In the first subsample (1972-1993) as Amano and van Norden (1995) show, an increase in the price of energy commodity depreciates the real exchange rate. A 10 per cent increase in energy price causes 2.9 per cent depreciation of the real exchange rate deflated by CPI while it depreciates the alternative real exchange rate (deflated by GDP deflator) by 2.2 per cent. This is close to the 2.3 per cent depreciation effect of a 10 per cent increase in energy price in Amano and van Norden's work. Therefore, using the new Bank of Canada commodity indices with quarterly data, we confirm the negative effect of Canadian energy commodities price on the real exchange rate during 1972-1993.

Table 34 - VECM Results for *qcpi* and *qgdp* - (1972-1993)

$qcpi$	Cof	t-Statistic	$qgdp$	Cof	t-Statistic
ECT	-0.05	-1.96	ECT	-0.07	-2.63
ene	0.29	-5.59	ene	0.23	-5.08
com	-0.45	4.47	com	-0.24	2.65
c	0.82		c	-0.27	

As in Amano and van Norden (1995), in contrast to energy price, there is a positive relationship for the effect of all non-energy commodities on the real exchange rate. A 10 per cent increase in non-energy commodity price causes 4.5 per cent appreciation in the real exchange rate deflated by CPI while it appreciates the alternative real exchange rate (deflated by GDP deflator) by 2.4 per cent. Amano and van Norden's estimation for this effect is 8.1 per cent. Our estimation of the speed of adjustment is –0.05 for the *qcpi* case which is close to theirs of –0.038.

Table 35 - VECM Results for *qcpi* and *qgdp* - (1994-2014)

$qcpi$	Cof	t-Statistic	$qgdp$	Cof	t-Statistic
ECT	-0.16	1.98	ECT	-0.11	1.87
ene	-0.10	3.46	ene	-0.12	3.98
com	-0.63	11.74	com	-0.65	12.56
$Trend$	0.0005	0.85	$Trend$	-0.001	3.19
c	4.62		c	4.58	

Table 35 presents the results for the second subsample (1994-2014). As Issa et al. (2006, 2008) show, an increase in the price of energy or commodity price appreciates the real exchange rate. Therefore, we confirm a switch in the sign of energy in the Canada Bank Equation. For the *qcpi* (or *qgdp*) equation, the coefficient of energy changes from 0.29 (or 0.23) in the first subsample (1972-1993) to -0.10 (or -0.12) in the second subsample (1994-2014). As in Choudhri and Schembri (2014), we confirm the presence of a trend in the second subsample.

6.3 Extension of Canada Bank Equation

After Amano and van Norden (1995), to improve the Canada Bank Equation, different studies have extended their work in three directions: first by extending data, second by adding some other fundamentals to the original equation and third, by considering the historical change in the composition of Canadian commodity exports (production). We satisfy all these three issues in our analysis. First, our quarterly data covers an extended period, 35 years (1980-2014). Second, beside energy and non-energy commodity prices, we test the possibility of bringing other fundamentals such as government spending and productivity to the Canada Bank Equation. And third, instead of the old BCPI with fixed-weight index of commodity prices, we use the new BCPI which is constructed by applying the Chain Fisher Index method to update production weights on an annual basis, and contains a broader set of commodities. To our knowledge, this is the first study using this new index for extending the Canada Bank Equation. The results based on the old BCPI are biased because of their fixed-weight index of commodity prices, with weights that were updated once a decade which ignore the dynamic of export (production) composition.

6.3.1 Cointegration Tests

For the full sample (1980-2014), after comprehensive investigation, we confirm the cointegration of real exchange rate with productivity and government spending differentials and non-energy commodity price. We do not consider the energy commodity index, since its effect on the real exchange rate switches in sign. Following the Johansen cointegration test, the maximum eigenvalue and trace tests for the cointegration rank are performed and are summarized in Table 36. At 5 per cent critical value, both tests confirm one cointegration vector among real exchange rate, productivity and government spending differentials and non-energy commodity price.

We apply two robustness checks. First, instead of real exchange rate deflated by CPI, we rerun the Johansen cointegration test with the alternative exchange rate which is deflated by the GDP deflator. As Table 36 shows, the result for the robustness test does not change and we reconfirm the conintegration in the base case. Second, we double check the cointegration by the Engle-Granger Cointegration Test. Table 37 presents the results, the null hypothesis of this test is the lack of cointegration among variables. The test rejects the null for both alternatives of the real exchange rate; therefore, we reconfirm the cointegration of four variables: real exchange rate, productivity and government spending differentials, and non-energy commodity price.

Table 36 - The Johansen Cointegration Tests (1980-2014)

$qcpi, com, g, y_2$					$qgdp, com, g, y_2$			
No. of CE(s)	Trace	Prob.	Max-E	Prob.	Trace	Prob.	Max-E	Prob.
None	73.44	0.00	33.85	0.03	86.37	0.00	46.09	0.00
At most 1	39.58	0.10	25.82	0.25	40.27	0.08	19.99	0.24
At most 2	19.79	0.23	11.45	0.46	20.28	0.21	11.58	0.45
At most 3	8.33	0.22	8.33	0.22	8.69	0.19	8.69	0.19

Table 37 - Engle-Granger Cointegration Test (1980-2014)

Dep	Tau-Stat	Prob	z-Stat	Prob	Dep	Tau-Stat	Prob	z-Stat	Prob
com	-5.41	0.00	-43.89	0.00	com	-5.87	0.00	-69.93	0.00
$qcpi$	-5.48	0.00	-48.75	0.00	$qgdp$	-5.68	0.00	-53.55	0.00
y_2	-5.04	0.01	-43.45	0.01	y_2	-4.58	0.04	-36.06	0.04
g	-4.20	0.10	-30.65	0.10	g	-6.12	0.00	-79.30	0.00

Note: Dep is Dependent Variable

6.3.2 VECM Results for the Extension of Canada Bank Equation

Table 38 reports the results for VECM analysis. The coefficient for non-energy commodity index is -0.35. A 10 per cent increase in non-energy commodity index causes 3.5 per cent appreciation of the Canadian dollar. This estimate is within the range of the results of Rogoff and Chen (2003). On the other hand, the coefficient is close to our results discussed above in section 6.2.2 for the update of the Canada Bank Equation, where we consider energy and non-energy commodity prices as the only two fundamentals.

For robustness check, instead of real exchange rate deflated by CPI, we rerun the VECM with the alternative real exchange rate (deflated by GDP deflator) and get a similar coefficient (-0.47). As Table 38 illustrates, an increase of 10 per cent in productivity differentials between the US and Canada (a negative supply shock for Canada) causes 15.6 and 15.3 per cent depreciation of the real exchange rate based on CPI and the real exchange rate based on a GDP deflator, respectively. This is in line with the Balassa-Samuelson Hypothesis. For the government spending differentials, a 10 per cent increase in this variable (a negative demand shock for

Canada) causes 3.5 and 4.7 per cent appreciation of the real exchange rate and the alternative real exchange rate, respectively. These results can be explained by the twin-deficit argument discussed above. Therefore, we confirm the results of Gautheir and Tessier (2002), and Chanthapun (2010), regarding the effect of productivity and government spending differentials on the Canadian real exchange rate against the US dollar.

Table 38 - VECM Results for *qcpi* and *qgdp* - (1980-2014)

$qcpi$	Cof	t-Statistic	$qgdp$	Cof	t-Statistic
ECT	-0.32	-3.77	ECT	-0.49	-4.76
y_2	1.56	12.26	y_2	1.53	16.36
g	-0.73	4.05	g	-0.73	5.45
com	-0.35	8.83	com	-0.47	16.08
$Trend$	-0.001	8.01	$Trend$	-0.002	20.98
c	2.30		c	2.85	

Tables 39 and 40 present the results for the DOLS and FMOLS Cointegrating Equations; the results are very similar to each other and very close to our VECM result in Table 38.

Table 39 - DOLS Cointegrating Equation (1980-2014)

$qcpi$	Cof (DOLS)	P-Value (DOLS)	$qgdp$	Cof (DOLS)	P-Value (DOLS)
y_2	1.69	0.00	y_2	1.57	0.01
g	-0.75	0.01	g	-0.72	0.00
com	-0.39	0.01	com	-0.49	0.01
$Trend$	-0.0017	0.00	$Trend$	-0.0029	0.02
c	2.51	0.01	c	2.96	0.01

Note: Automatic leads and lags specification (lead=0 and lag=1 based on SIC criterion, max=13)

Table 40 - FMOLS Cointegrating Equation (1980-2014)

$qcpi$	Cof (FMOLS)	P-Value (FMOLS)	$qgdp$	Cof (FMOLS)	P-Value (FMOLS)
y_2	1.74	0.00	y_2	1.63	0.01
g	-0.79	0.01	g	-0.76	0.01
com	-0.39	0.01	com	-0.50	0.00
$Trend$	-0.0018	0.00	$Trend$	-0.0030	0.02
c	2.51	0.01	c	2.98	0.01

Table 41 and 42 compare the DOLS and FMOLS Cointegrating Equations for the two subsamples. From sample one (1980-1993) to sample two (1994-2014), we observe an increase and decrease in the effect of non-energy commodity price and productivity differentials on real exchange rate, respectively.

Table 41 - FMOLS Cointegrating Equation for the Two Subsamples

$qcpi$ *	Cof	P-Va	$qgdp$*	Cof	P-Va	$qcpi$**	Cof	P-Va	$qgdp$**	Cof	P-Va
y_2	1.71	0.01	y_2	1.74	0.00	y_2	1.51	0.00	y_2	1.42	0.00
g	-0.84	0.02	g	-0.76	0.02	g	-0.82	0.01	g	-0.89	0.02
com	-0.35	0.00	com	-0.45	0.00	com	-0.52	0.01	com	-0.59	0.02
$Trend$	-0.002	0.02	$Trend$	-0.002	0.00	$Trend$	-0.001	0.00	$Trend$	-0.002	0.01
c	2.31	0.01	c	2.74	0.00	c	3.18	0.01	c	3.38	0.00

Note: * and ** show the first and second subsamples, 1980-1993 and 1994-2014, respectively.

Table 42 - DOLS Cointegrating Equation for the Two Subsamples

$qcpi$ *	Cof	P-Va	$qgdp$*	Cof	P-Va	$qcpi$**	Cof	P-Va	$qgdp$**	Cof	P-Va
y_2	1.65	0.00	y_2	1.73	0.01	y_2	1.44	0.00	y_2	1.3	0.02
g	-0.71	0.05	g	-0.71	0.04	g	-0.65	0.02	g	-0.71	0.02
com	-0.36	0.01	com	-0.47	0.00	com	-0.50	0.01	com	-0.57	0.00
$Trend$	-0.002	0.03	$Trend$	-0.002	0.02	$Trend$	-0.001	0.01	$Trend$	-0.002	0.02
c	2.40	0.00	c	2.83	0.01	c	3.04	0.00	c	3.25	0.00

Note: * and ** show the first and second subsamples, 1980-1993 and 1994-2014, respectively.

6.4 Update of Clarida and Gali

To identify different types of shocks, Clarida and Galí (1994) use a theoretical two-country framework based on the Mundell-Fleming-Dornbusch model to construct a VAR specification with three variables: the change of real GDP differential (Δy_1), the change of real exchange rate computed using consumer price index ($\Delta qcpi$), and the change of CPI differentials (Δp). Therefore, ϵ_t^s, ϵ_t^d and ϵ_t^m represent the supply, demand and monetary shocks, respectively. Clarida and Gali (1994) show the variables are $I(1)$, but not cointegrated; therefore, they proceed with the first differences analysis. They show that the real demand shocks explain the bulk of the variation in the real Canada-US exchange rate. In our case, p for the two subsamples and the full sample is $I(0)$. This justifies the first differences analysis.[140]

6.4.1 SVAR Identification Methodology

In the long run, the open macro model of Clarida and Galí (1994) is triangular. Therefore, only supply shocks influence the relative output levels in the long run, while supply and demand shocks may impact the real exchange rate in the long run. Based on the decomposition theorem of Wold, we can write the structural model in the following form:[141]

$$x_t = A_0\epsilon_t + A_1\epsilon_{t-1} + ... = \sum_{i=0}^{\infty} A_i\epsilon_{t-i} = A(L)\epsilon_t \tag{49}$$

where $\epsilon_t = \begin{bmatrix} \epsilon_t^s \\ \epsilon_t^d \\ \epsilon_t^m \end{bmatrix}$ and $x_t = \begin{bmatrix} \Delta y_1 \\ \Delta qcpi \\ \Delta p \end{bmatrix}$.

y_1, $qcpi$ and p represent the differential of real GDP, the real exchange rate based on CPI, and the CPI differentials, all in log. For simplification, the variance of the structural shocks is normalized to $E(\epsilon_t \acute{\epsilon_t}) = I$, the identity matrix.

The following autoregressive vector is estimated:

[140] For all SVAR and SVECM analysis, we use JMulTi software from Lutkepohl and Kratzing (2004).
[141] For simplification, the constant is removed.

$$x_t = \Pi_1 x_{t-1} + ... + \Pi_q x_{t-q} + e_t \tag{50}$$

where e_t is an estimated vector of residuals, q is the number of lags, and $E(e_t e_t^{'}) = \sum$. Then we get the following moving average representation:

$$x_t = e_t + C_1 e_{t-1} + ... = \sum_{i=0}^{\infty} C_i e_{t-i} = C(L) e_t \tag{51}$$

The reduced form residuals are related to those of the structural model by:

$$e_t = A_0 \epsilon_t \tag{52}$$

Solving Equations 50,52 and 53, we can show that the matrix of long term effects of the reduced form, $C(1)$, is related to the matrix of long term effects of the structural from, $A(1)$, as follows:

$$A(1) = C(1) A_0 \tag{53}$$

To explain their theoretical model, Clarida and Gali (1994) impose three restrictions on the matrix $A(1)$:

$$A(1) = \begin{bmatrix} a_{11} & 0 & 0 \\ a_{21} & a_{22} & 0 \\ a_{31} & a_{32} & a_{33} \end{bmatrix} \tag{54}$$

The first, second, and third columns of $A(1)$ represent the impact of supply shocks, demand shocks, and monetary shocks, respectively, on the real GDP differential (first row), the real exchange rate (second row), and the price level differential (third row). Real demand shocks and monetary shocks do not have long term effects on the GDP differential; this is illustrated by the zeros in the first row. In long run, monetary shocks do not impact the real exchange rate. This is shown by the zero in the second row.

For different shocks, the theoretical predictions of Clarida and Gali are: first, a positive supply shock in a country depreciates its currency. This is against the Balassa-Samuelson Hypothesis which predicts a currency appreciation after a positive supply shock. Second, in short and long run, a positive demand shock appreciates the currency. Third, a positive demand or monetary shock increases the CPI of the country, but it decreases with a positive supply shock. Fourth, the currency depreciates with a monetary shock in the short run. Fifth, a positive supply, demand or monetary shock in the short run increases the output relative to the other country. We rerun the model of Clarida and Gali for the full sample (1980-2014), the two subsamples (1980-1993) and (1994-2014). Then, we test the robustness of the results with alternative variables for productivity differentials (y_2) and real exchange rate ($qgdp$).

6.4.2 Impulse Response Analysis

Although the impulse responses are an important tool to describe the relations between the variables in a VAR or VECM, they have some drawbacks. First, they are not unique as, based on any VAR or VECM, we can compute different set of impulse responses. Therefore, to get a unique impulse response, in addition to data, we need some extra information which can be derived from economic theory. Second, missing important variables in SVAR or SVECM analysis leads to wrong impulse responses.

Following Clarida and Gali (1994) which is built on the Mundell-Fleming-Dornbusch model; we investigate the impulse response to the structural demand and supply shocks. In this model, a supply shock which improves the US output relative to the Canadian output is predicted to result in a real depreciation of the US dollar, which is against the Ballasa-Samuelson Hypothesis. Clarida and Gali (1994) test the model for the real exchange rate of the US against four currencies of: Germany, the UK, Japan and Canada for quarterly data from 1972 Q3 to 1992 Q4 which almost covers our first subsample. For the effect of a supply shock on the real exchange rate, their impulse responses support their theoretical model for Canada and Japan while the results for the UK and Germany are in line with the Balassa-Samuelson Hypothesis, which rejects their theoretical model.

As the first column of Figure 9 shows, similar to the results of Clarida and Gali (1994) for Canada and Japan, in the first subsample (1980-1993) and the full sample (1980-2014), a positive supply shock to the US (a negative one to Canada) causes an undershoot in the real exchange rate, deprecation in the US dollar and appreciation in the Canadian currency. This is in line with the theoretical model of Clarida and Gali (1994) and is against the Balassa-Samuelson Hypothesis.

In contrast, in the second subsample (1993-2014) similar to the results of Clarida and Gali (1994) for Germany and the UK, a positive supply shock to the US (a negative one to Canada) causes an overshoot in the real exchange rate, appreciation in the US dollar and depreciation in the Canadian currency, which confirms the Balassa-Samuelson Hypothesis. Therefore, we observe a change in the pattern of the effect of supply shock on real exchange rate of the US and Canada from the first subsample to the second one.

For the demand shock, according to the model of Clarida and Gali (1994), a demand shock in favour of US output should result in a real appreciation of the US dollar. The impulse responses for the four countries in Clardia and Gali (1994) are in line with their prediction for their model. As the second column of Figure 9 presents, in our two subsamples and the full sample, a positive demand shock to the US (a negative one to Canada) causes an increase in the real exchange rate which means appreciation of the US dollar and depreciation of the Canada dollar. Therefore, our impulse responses of the effect of demand shock on real exchange rate of Canada fit remarkably closely the prediction of the model.

6.4.3 Variance Decomposition

In Table 43, we report the results of conditional variance of the change in the log of real exchange rate at various horizons into the fraction of the variance due to unforecastable structural supply, demand and monetary shocks. For the full sample and the two subsamples, in line with Clarida and Gali (1994), the variations in the real exchange rate are dominated by the demand shocks. As is evident from Table 43, the convergences are rapid and around 80 and 10 per cent of the variations of the real exchange rate are caused by demand and supply shocks, respectively. In the second subsample (1994-2014), we observe a stronger role for the monetary shock in explaining the variation of exchange rate. After 20 quarters, the monetary shock explains 5 per cent of the variance of the real exchange rate in the first subsample and the full sample while, in the second subsample, the effect of monetary shock increases to 16 per cent.

Table 43 - Variance Decomposition of $\Delta qcpi$- The Base Model $(\Delta y_1, \Delta qcpi, \Delta p)$

1980-1993				1994-2014			1980-2014		
Horizon	Δy_1	$\Delta qcpi$	Δp	Δy_1	$\Delta qcpi$	Δp	Δy_1	$\Delta qcpi$	Δp
1	0.03	0.97	0.00	0.04	0.96	0.00	0.03	0.97	0.00
5	0.11	0.84	0.05	0.05	0.81	0.14	0.11	0.84	0.05
10	0.11	0.84	0.05	0.08	0.77	0.15	0.11	0.84	0.05
15	0.11	0.84	0.05	0.08	0.76	0.16	0.11	0.84	0.05
20	0.11	0.84	0.05	0.08	0.76	0.16	0.11	0.84	0.05

6.4.4 Robustness Check of Variance Decomposition

For the robustness check, we consider three alternatives: in the first one, instead of relative real GDP per capita, we use the alternative representative of productivity differential, relative CPI/ PPI. In the second one, instead of the real exchange rate based on CPI, we consider the alternative real exchange rate which is based on GDP deflators; and in the third one, we apply the first and second cases at the same time. The results in Table 44 confirm the base case in Table 43. Similarly to the results of Clarida and Gali, we confirm the dominated role of the demand shock in explaining the variance of the real exchange rate. As in Table 43, here in all versions of the robustness tests we observe a stronger role for the monetary shock in the second subsample. Regarding the alternative representation of productivity, as Table 44 suggests, by substituting relative CPI/ PPI instead of relative real GDP per capita, in the second subsample, the role of supply shock increases from 8 to 27 per cent.

Table 44 - Variance Decomposition - Robustness Check

1-Variance Decomposition of $\Delta qcpi$- Robustness Check Model 1: $(\mathbf{\Delta y}_2, \Delta qcpi, \Delta p)$

1980-1993				1994-2014			1980-2014		
Horizon	Δy_2	$\Delta qcpi$	Δp	Δy_2	$\Delta qcpi$	Δp	Δy_2	$\Delta qcpi$	Δp
1	0.13	0.87	0.00	0.24	0.76	0.00	0.13	0.87	0.00
5	0.12	0.82	0.06	0.25	0.58	0.17	0.12	0.82	0.06
10	0.12	0.82	0.06	0.28	0.55	0.17	0.12	0.82	0.06
15	0.12	0.82	0.06	0.27	0.54	0.19	0.12	0.82	0.06
20	0.12	0.82	0.06	0.27	0.54	0.19	0.12	0.82	0.06

2-Variance Decomposition of $\Delta qgdp$- Robustness Check Model 2: $(\Delta y_1, \mathbf{\Delta qgdp}, \Delta p)$

1980-1993				1994-2014			1980-2014		
Horizon	Δy_1	$\Delta qgdp$	Δp	Δy_1	$\Delta qgdp$	Δp	Δy_1	$\Delta qgdp$	Δp
1	0.01	0.99	0.00	0.02	0.98	0.00	0.01	0.99	0.00
5	0.09	0.87	0.04	0.04	0.84	0.12	0.09	0.87	0.04
10	0.09	0.87	0.04	0.08	0.78	0.14	0.09	0.87	0.04
15	0.09	0.87	0.04	0.08	0.78	0.14	0.09	0.87	0.04
20	0.09	0.87	0.04	0.08	0.77	0.15	0.09	0.87	0.04

3-Variance Decomposition of $\Delta qgdp$- Robustness Check Model 3: $(\mathbf{\Delta y_2}, \mathbf{\Delta qgdp}, \Delta p)$

1980-1993				1994-2014			1980-2014		
Horizon	Δy_2	$\Delta qgdp$	Δp	Δy_2	$\Delta qgdp$	Δp	Δy_2	$\Delta qgdp$	Δp
1	0.07	0.93	0.00	0.19	0.81	0.00	0.04	0.96	0.00
5	0.10	0.83	0.07	0.21	0.63	0.16	0.11	0.82	0.07
10	0.10	0.83	0.07	0.25	0.58	0.17	0.11	0.79	0.10
15	0.10	0.83	0.07	0.25	0.58	0.17	0.12	0.79	0.09
20	0.10	0.83	0.07	0.25	0.58	0.17	0.12	0.79	0.09

6.4.5 Adding Non-Energy Commodity Price to Clarida and Gali's Analysis

We modify the model of Clarida and Gali in a commodity exporting country by adding the non-energy commodity price index to the VAR. The VAR model includes the price of non-energy commodities, the real GDP differential, the real exchange rate, and the CPI differential. Thus, we assume a structural model responsive to four types of shocks: non-energy commodity price shocks; supply shocks; real demand shocks, and monetary shocks. The first differences of the variables are considered in the estimated stationary VAR, and the postulated matrix, can be written as follows:

$$\epsilon_t = \begin{bmatrix} \epsilon_t^c \\ \epsilon_t^s \\ \epsilon_t^d \\ \epsilon_t^m \end{bmatrix}, x_t = \begin{bmatrix} \Delta com \\ \Delta y_1 \\ \Delta qcpi \\ \Delta p \end{bmatrix}, A(1) = \begin{bmatrix} a_{11} & 0 & 0 & 0 \\ a_{21} & a_{22} & 0 & 0 \\ a_{31} & a_{32} & a_{33} & 0 \\ a_{41} & a_{42} & a_{43} & a_{44} \end{bmatrix} \tag{55}$$

As in Clarida and Gali, the identification restrictions are assigned in the levels of the variables. Therefore, no shock except a shock to the non-energy commodity price can have an impact on the non-energy commodity price in the long run (the three zeros in the first row of $A(1)$). In Equation 56, the rest zeros in $A(1)$ are assigned as in the model of Clarida and Gali in equation 55.

Impulse Responses and Variance Decomposition For a commodity exporting country such as Canada, by adding a non-energy commodity shock, we update the model of Clarida and Gali. Figure 10 presents the real exchange rate responses to commodity price, supply and demand shocks. For the two subsamples and the full sample, a shock to commodity price appreciates the Canadian currency. The effect of commodity price on the Canadian dollar increases from -0.003 in the first subsample to -0.025 in the second subsample.

For the supply shock, our results in Figure 10 are very similar to those in Figure 9. For the first subsample and the full sample, we confirm the theoretical model of Clarida and Gali (1994) which is against the Balassa-Samuelson Hypothesis. For the second subsample, in contrast to the base case in Figure 9, the real exchange rate response of a supply shock rejects the Balassa-Samuelson Hypothesis. Therefore, for the robustness case in Figure 10, in the two subsamples and the full sample, a positive supply shock in the US (a negative one in Canada) depreciates the US dollar and appreciates the Canadian Dollar. For the demand shock, the results for the two subsamples and the full sample in Figure 10 are very similar to the base case in Figure 9. As in the base case in Figure 9, a demand shock in favour of the US output should result in a real appreciation of the US dollar. This again confirms the theoretical model of Clarida and Gali (1994).

Table 45 presents the contribution of various shocks to the variance of the real exchange rate. By adding commodity price index to the analysis, we update the work of Clarida and Gali in a commodity exporting country such as Canada. The results of Clarida and Gali do not change significantly. The demand shock is still the main source of the variance in the exchange rate. Comparing Tables 43 and 45, by adding the non-energy commodity price to our base case, in the first subsample, supply shock is still the second contributor (after the demand shock) to the variance of the real exchange rate. This changes in the second subsample and the full sample where the non-energy commodity price shock is ranked second in explaining the variance of the real exchange rate. In the second subsample and the full sample, non-energy commodity price shocks explain 28 and 19 per cent of real exchange rate variance, respectively.

Table 45 - Variance Decomposition of $\Delta qcpi$- The Base Model $(\Delta com, \Delta y_1, \Delta qcpi, \Delta p)$

	1980-1993				1994-2014				1980-2014			
H	Δcom	Δy_1	$\Delta qcpi$	Δp	Δcom	Δy_1	$\Delta qcpi$	Δp	Δcom	Δy_1	$\Delta qcpi$	Δp
1	0.07	0.02	0.91	0.00	0.28	0.02	0.69	0.01	0.20	0.00	0.80	0.00
5	0.06	0.10	0.79	0.05	0.28	0.03	0.69	0.00	0.19	0.02	0.78	0.01
10	0.06	0.10	0.79	0.05	0.28	0.03	0.69	0.00	0.19	0.02	0.78	0.01
15	0.06	0.10	0.79	0.05	0.28	0.03	0.69	0.00	0.19	0.02	0.78	0.01
20	0.06	0.10	0.79	0.05	0.28	0.03	0.69	0.00	0.19	0.02	0.78	0.01

For the robustness checks, we consider three alternatives: in the first one, instead of relative real GDP per capita, we use the alternative representative of supply shock, relative CPI/ PPI. In the second one, instead of the real exchange rate based on CPI, we consider the real exchange rate based on GDP deflators; and in the third one, we consider the first and second cases at the same time. The results which are in Table 46 partially confirm our results in Table 45. In the first case of the robustness check in Table 46 where we only change the variable representing productivity differentials (supply shock) to its alternative, in the first subsample (1972-1994), we almost confirm our results in Table 45. However, for the full sample (1972-2014) and especially for the second subsample (1994-2014), we observe a decrease in the effect of demand shock and increase in the impact of supply and commodity price shocks. Although in both cases, the demand shock is still the greater contributing force to the variance of the real exchange rate.

Table 46 - Variance Decomposition - Robustness Check

1-Variance Decomposition of $\Delta qcpi$- Model 1: ($\Delta com, \mathbf{\Delta y_2}, \Delta qcpi, \Delta p$)

	1980-1993				1994-2014				1980-2014			
H	Δcom	Δy_2	$\Delta qcpi$	Δp	Δcom	Δy_2	$\Delta qcpi$	Δp	Δcom	Δy_2	$\Delta qcpi$	Δp
1	0.03	0.18	0.77	0.00	0.29	0.38	0.33	0.00	0.19	0.29	0.52	0.00
5	0.03	0.17	0.74	0.06	0.32	0.34	0.29	0.05	0.19	0.30	0.50	0.01
10	0.03	0.17	0.74	0.06	0.31	0.34	0.28	0.07	0.19	0.30	0.50	0.01
15	0.03	0.17	0.74	0.06	0.31	0.34	0.28	0.07	0.19	0.30	0.50	0.01
20	0.03	0.17	0.74	0.06	0.31	0.34	0.28	0.07	0.19	0.30	0.50	0.01

2-Variance Decomposition of $\Delta qgdp$- Model 2: ($\Delta com, \Delta y_1, \mathbf{\Delta qgdp}, \Delta p$)

	1980-1993				1994-2014				1980-2014			
H	Δcom	Δy_1	$\Delta qgdp$	Δp	Δcom	Δy_1	$\Delta qgdp$	Δp	Δcom	Δy_1	$\Delta qgdp$	Δp
1	0.07	0.01	0.92	0.00	0.29	0.01	0.70	0.00	0.21	0.00	0.79	0.00
5	0.07	0.09	0.81	0.03	0.29	0.02	0.68	0.01	0.21	0.02	0.77	0.00
10	0.07	0.09	0.81	0.03	0.29	0.02	0.68	0.01	0.21	0.02	0.77	0.00
15	0.07	0.09	0.81	0.03	0.29	0.02	0.68	0.01	0.21	0.02	0.77	0.00
20	0.07	0.09	0.81	0.03	0.29	0.02	0.68	0.01	0.21	0.02	0.77	0.00

3-Variance Decomposition of $\Delta qgdp$- Model 3: ($\Delta com, \mathbf{\Delta y2}, \mathbf{\Delta qgdp}, \Delta p$)

	1980-1993				1994-2014				1980-2014			
H	Δcom	$\Delta y2$	$\Delta qgdp$	Δp	Δcom	$\Delta y2$	$\Delta qgdp$	Δp	Δcom	$\Delta y2$	$\Delta qgdp$	Δp
1	0.03	0.13	0.84	0.00	0.28	0.34	0.38	0.00	0.20	0.23	0.57	0.00
5	0.04	0.12	0.79	0.05	0.21	0.31	0.34	0.14	0.21	0.24	0.55	0.00
10	0.04	0.12	0.79	0.05	0.20	0.33	0.33	0.14	0.21	0.24	0.55	0.00
15	0.04	0.12	0.79	0.05	0.20	0.33	0.32	0.15	0.21	0.24	0.55	0.00
20	0.04	0.12	0.79	0.05	0.20	0.33	0.32	0.15	0.21	0.24	0.55	0.00

6.4.6 Adding Energy and Non-Energy Commodity Prices to Analysis of Clarida and Gali

For the two subsamples, we modify the model of Clarida and Gali in a commodity exporting country by adding the non-energy commodity and energy price indices to the VAR.[142] The VAR model includes the price of energy, the price of non-energy commodities, the real GDP differential, the real exchange rate, and the CPI differential. Thus, we assume a structural model responsive to five types of shocks: energy price shock; non-energy commodity price shock; supply shock; real demand shock, and monetary shock. The first difference of each variable are considered in the estimated stationary VAR, and the postulated matrix can be written as follows:

$$\epsilon_t = \begin{bmatrix} \epsilon_t^e \\ \epsilon_t^c \\ \epsilon_t^s \\ \epsilon_t^d \\ \epsilon_t^m \end{bmatrix}, x_t = \begin{bmatrix} \Delta ene \\ \Delta com \\ \Delta y_1 \\ \Delta qcpi \\ \Delta p \end{bmatrix}, A(1) = \begin{bmatrix} a_{11} & 0 & 0 & 0 & 0 \\ a_{21} & a_{22} & 0 & 0 & 0 \\ a_{31} & a_{32} & a_{33} & 0 & 0 \\ a_{41} & a_{42} & a_{43} & a_{44} & 0 \\ a_{51} & a_{52} & a_{53} & a_{54} & a_{55} \end{bmatrix} \quad (56)$$

As in Clarida and Galí (1994), the identification restrictions are assigned in the levels of the variables. Therefore, no shock except a shock to the energy price can have an impact on the energy price in the long run (the four zeros in the first row of $A(1)$). On the other hand, the shocks to the price of energy are the only ones which affect the price of non-energy commodities (the three zeros in the second row). This is justified by the fact that energy is an important input into the production of many commodities, and may thus affect their long term price. In Equation 57, the rest zeros in $A(1)$ are assigned as in the model of Clardia and Gali in Equation 55.

Impulse Responses and Variance Decomposition Figure 11 presents the real exchange rates responses to energy price, commodity price, supply, demand and exchange rate shocks. As we review in the literature above, Amano and van Norden (1995) is the first study which uses energy and non-energy commodity prices separately for Canada, and shows their different effect

[142] We do not consider the full sample, since the energy price coefficient switches sign from the first to the second subsamples.

on the Canadian Dollar: an increase in energy price and non-energy commodity price depreciates and appreciates Canadian dollar, respectively. This is done for monthly data covering 1973 to 1992 which is very close to our first subsample. For our first subsample (1980-1993), we confirm the results of Amano and van Norden but in the second subsample we observe a change in the effect of energy price on real exchange rate which is in line with Issa et al. (2006, 2008) who show the change in the sign of energy price in the Canada Bank Equation in 1993.[143]

For the supply shock, our results in Figure 11 are very similar to Figure 10 for the two subsamples and confirm the theoretical model of Clarida and Gali (1994) which is against the Balassa-Samuelson Hypothesis. Therefore, a positive supply shock in the US (a negative one in Canada) depreciates the US dollar and appreciates the Canadian Dollar. For the demand shock, the results for the two subsamples in Figure 11 are very similar to the impulse responses of demand shocks in Figures 9 and 10. A demand shock in favour of the US output should result in a real appreciation of the US dollar. This again confirms the theoretical model of Clarida and Gali (1994).

Tables 47 and 48 present the contribution of various shocks to the variance of the real exchange rate and its alternative. Updating the work of Clarida and Gali in a commodity and energy exporting country such as Canada, by adding commodity and energy price indices to the analysis, the results of Clarida and Gali do not change significantly. In three out of four cases in Tables 47 and 48, the demand shock is Still the main source of the variance in the exchange rate.

Table 47 - Variance Decomposition of $\Delta qcpi$- $(\Delta ene, \Delta com, \Delta y_{\mathbf{1}}, \Delta qcpi, \Delta p)$

	1980-1993					1994-2014				
Horizon	Δene	Δcom	Δy_1	$\Delta qcpi$	Δp	Δene	Δcom	Δy_1	$\Delta qcpi$	Δp
1	0.01	0.11	0.02	0.86	0.00	0.19	0.22	0.04	0.55	0.00
5	0.04	0.11	0.11	0.66	0.08	0.31	0.20	0.04	0.45	0.00
10	0.04	0.11	0.11	0.65	0.09	0.31	0.19	0.04	0.44	0.01
15	0.04	0.11	0.11	0.65	0.09	0.31	0.19	0.04	0.44	0.01
20	0.04	0.11	0.11	0.65	0.09	0.31	0.19	0.04	0.44	0.01

Comparing the results for the two subsamples, in Table 47 where we use the real exchange rate based on CPI, the effect of energy price increases from 4 to 32 per cent. The same pattern

[143] We should note that here the shock is to the change of price.

is true for the alternative real exchange rate, $qgdp$. As Table 48 presents, the contribution of energy price in explaining the variance of real exchange rate increases from 3 per cent in the first subsample to 42 per cent in the second subsample. In the second subsample where we use $qgdp$ as the real exchange rate, the energy price effect is greater than the demand shock contribution.

Table 48 - Variance Decomposition of $\Delta qgdp$- $(\Delta ene, \Delta com, \Delta y_{\mathbf{1}}, \Delta qgdp, \Delta p)$

	1980-1993					1994-2014				
Horizon	Δene	Δcom	Δy_1	$\Delta qgdp$	Δp	Δene	Δcom	Δy_1	$\Delta qgdp$	Δp
1	0.00	0.12	0.01	0.87	0.00	0.31	0.20	0.02	0.47	0.00
5	0.03	0.15	0.08	0.68	0.06	0.42	0.17	0.02	0.38	0.01
10	0.03	0.15	0.08	0.67	0.07	0.42	0.17	0.03	0.37	0.01
15	0.03	0.15	0.08	0.67	0.07	0.42	0.17	0.03	0.37	0.01
20	0.03	0.15	0.08	0.67	0.07	0.42	0.17	0.03	0.37	0.01

In the following section, we use the full sample and investigate the determinants of fluctuations of the real exchange rate between the US and Canada when we consider the cointegration relationship.

6.5 SVECM Identification Methodology

For the full sample (1980-2014), in section 6.3.1, the cointegration tests confirm the existence of only one cointegrated vector among the four variables: real exchange rate, non-energy commodity price, productivity differentials and government differentials. Therefore, we estimate the following VECM:

$$\begin{bmatrix} \Delta com_t \\ \Delta y_{2t} \\ \Delta g \\ \Delta qcpi_t \end{bmatrix} = \sum_{i=1}^{q-1} \Gamma_i \begin{bmatrix} \Delta com_{t-i} \\ \Delta y_{2t-i} \\ \Delta g \\ \Delta qcpi_{t-i} \end{bmatrix} + \alpha \acute{\beta} \begin{bmatrix} com_{t-1} \\ y_{2t-1} \\ g \\ qcpi_{t-1} \\ t \end{bmatrix} + \mu + e_t \tag{57}$$

where com, y_2, g, $qcpi$, all in log, are non-energy commodity price index, productivity differentials, government spending differentials and real exchange rate based on the CPI, respectively. The model is estimated with one lag on quarterly data over 1980-2014. Then, we need to apply the identification methodology. King et al. (1991) develop an identification methodology that allows for a structural interpretation of a cointegrated VAR. The reduced-form VECM can be inverted to obtain the following MA representation:

$$x_t = e_t + C_1 e_{t-1} + ... = \sum_{i=0}^{\infty} C_i e_{t-i} = C(L)e_t \tag{58}$$

where e_t is a (nx1) vector of innovations. We want to identify the following structural model:

$$x_t = \Gamma_0 \epsilon_t + \Gamma_1 \epsilon_{t-1} + ... = \sum_{i=0}^{\infty} \Gamma_i \epsilon_{t-i} = \Gamma(L)\epsilon_t \tag{59}$$

where both the structural shocks, ϵ_t and Γ_i matrices are unknown.

As section 6.3.1 confirms, there is one cointegration vector among our four variables: real exchange rate, non-energy commodity price, differentials of productivity and government spending. Therefore, with three fundamentals, the stochastic trend in the real exchange rate can be expressed as a linear combination of the three other stochastic trends. By applying the long run restrictions, we can identify three permanent shocks. In contrast to VAR models, in structural VAR models the order of the variables matters and in the context of long run restrictions the variables are put in decreasing order of long run exogeneity. Here, with four $I(1)$ variables and one cointegration relation, we need to impose three constraints. The long run matrix of the structural shocks, $\Gamma(L)$, is as follows:

$$\Gamma(L) = \begin{bmatrix} * & 0 & 0 & 0 \\ * & * & 0 & 0 \\ * & * & * & 0 \\ * & * & * & 0 \end{bmatrix} \tag{60}$$

Where * is the non restricted number. With four variables and one cointegration vector, we face three restrictions. The first two zeros in the first row of Equation 61 are the first two restrictions which confirm that the non-energy commodity price index is not affected in the long run by permanent shocks to output and government spending. Therefore, the non-energy commodity price index is the most exogenous variable in the long run and is dependent on extraction technology, transport cost and political environment in the main exporting countries and on other factors on the global level. The third constraint (the first zero in the second row of Equation 61) implies that only non-energy commodity price shocks and supply shocks can have a long run impact on the output differential. Thus, technology shocks that improve efficiency in commodity production are allowed to have a permanent impact on output. The short run dynamics are unrestricted and the other long run relations are estimated freely.

With the exception of the order of the output differential and government spending, these constraints are consistently are based on Rogoff's (1992) theoretical model which was applied by Rogers (1999) to identify structural VARs. In this model, supply shocks do not affect government spending (demand side) in the long run. Therefore, the demand shocks may influence the supply side. But, as Gautheir and Tessier (2002) argue, this indirect effect on the supply side is small in comparison to the purely supply shocks. Furthermore, this alternative ordering is similar to the argument of Atkinson and Stiglitz (1980): the positive correlation of the government spending with GDP in following output in long run. This means that the richer countries are more likely have higher government spending. We run the VECM for both real exchange rates, deflated with CPI and GDP deflator. Equations 62 and 63 are the long run matrix of the structural shocks, $\Gamma(L)$, for *qcpi* and *qgdp*, respectively:

$$For\ qcpi\ Equation : \Gamma(L) = \begin{bmatrix} 0.0561 & 0 & 0 & 0 \\ -0.003 & 0.0149 & 0 & 0 \\ -0.0009 & -0.0045 & 0.0112 & 0 \\ -0.0148 & -0.0201 & -0.0084 & 0 \end{bmatrix} \tag{61}$$

$$For\ qgdp\ Equation : \Gamma(L) = \begin{bmatrix} 0.0571 & 0 & 0 & 0 \\ -0.0031 & 0.0150 & 0 & 0 \\ -0.0004 & -0.0041 & 0.0104 & 0 \\ -0.0223 & -0.0200 & -0.0077 & 0 \end{bmatrix} \tag{62}$$

6.5.1 Impulse Response Analysis

For both real exchange rate and its alternative, the impulse responses of the Canadian real exchange rate to the structural shocks are presented in Figure 12. For the real exchange rate deflated by CPI, a positive non-energy commodity price shock has a permanent appreciation effect on the Canadian real exchange rate relative to the US dollar, as shown in Figure 12. This result is in line with the terms of trade theory of the real exchange rate. An overshooting effect in response to the non-energy commodity price shock is also evident. The overshoot behaviour occurs in the second quarter, and it is stabilized after ten quarters. Normalising the first column of Equation 62 on the real non-energy commodity price implies a long run elasticity, of the Canadian real exchange rate to the real non-energy commodity price, of 0.26. This estimate is greater than Chanthapun's (2010) result, 0.14, and is smaller than that of Chen and Rogoff (2003) which lies between 0.04 and 0.40. For the alternative real exchange rate which is deflated by the GDP deflator, the overshoot behaviour is reduced, and normalising the first column of Equation 63 on the real non-energy commodity price implies a long run elasticity, of the Canadian real exchange rate to the real non-energy commodity price, of 0.39.

The second row of Figure 12 presents the real exchange rate responses to a supply shock for both alternatives of real exchange rates, *qcpi* and *qgdp*. In the short run, we observe an overshooting behaviour and in the long run, following a positive supply shock to the US (a negative one to Canada), the Canadian dollar depreciates. For the *qcpi* (or *qgdp*), normalising the second column of Equation 62 (or 63) on the supply shock implies a long run elasticity of the Canadian real exchange rate to the supply shock price of 1.34 (or 1.33). The result in the long run supports the Balassa-Samuelson Hypothesis which suggests a real currency appreciation following a positive supply shock.

For the government spending shock, the Canadian currency appreciates following a shock that increases aggregate demand in the US relative to Canada as shown in Figure 12 (for both cases of real exchange rate, *qcpi* and *qgdp*). This result can be explained by the twin-deficit argument discussed above. For the *qcpi* (or *qgdp*), normalising the third column of Equation 62 (or 63) on the government spending shock implies a long run elasticity of the Canadian real exchange rate to the government spending shock of -0.75 (or -0.74). The last row in Figure 12 shows the impulse response of the exchange rate shock. This shock has a transitory effect (that is zero in the long run) on the real exchange rate. For the *qcpi* and *qgdp* equations, the impulse response of exchange rate shock takes 16 and 8 quarters to go to zero, respectively.

6.5.2 Variance Decomposition for SVECM

Table 49 presents the contribution of the various shocks to the variance of the real exchange rate. These results are quite different from those we find in the case without cointegration (SVAR). Here, the impact of productivity shock is the dominant factor in explaining the variation of the real exchange rate. The second contributor is the non-energy commodity price. Together, these two variables explain around 80 per cent of real exchange rate variance, and their role increases to 90 per cent in long run. Table 49 also presents the results where we use the alternative exchange rate ($qgdp$). The results are robust even for the alternative exchange rate. Again, the variables which explain the bulk of real exchange rate variations are non-energy commodity price and productivity differentials. In contrast to the $qcpi$ case, in long run, the effect of non-energy commodity price is a little greater than the influence of the supply shocks.

These results reconfirm the results of Amano and van Norden (1995) who find that commodity prices are the key long run determinant of the Canadian real exchange rate. On the other hand, our results are in line with the Balassa-Samuelson Hypothesis which relies heavily on productivity differentials in driving the real exchange rate. Our result for contribution of productivity differential on variance of real exchange rate in the long run (57 per cent) is very similar to that of Gauthier and Tessier (2002) of 61 per cent. In contrast to Chanthapun (2010) who assigns around 75 per cent of variation of real exchange rate to the demand shocks, we show a very a low effect of demand shock on the variance of the real exchange rate. One of the issues with Chanthapun (2010) is that he uses a general commodity index on the global level not the Canadian commodity index price.

Table 49 - Variance Decomposition of $qcpi$ and $qgdp$ (1980-2014)

Horizon	com	y_2	g	$qcpi$	Horizon	com	y_2	g	$qgdp$
1	0.28	0.33	0.00	0.39	1	0.29	0.29	0.00	0.42
5	0.32	0.51	0.01	0.16	5	0.41	0.44	0.01	0.14
10	0.32	0.56	0.03	0.09	10	0.46	0.43	0.03	0.08
15	0.32	0.57	0.05	0.06	15	0.48	0.43	0.04	0.05
20	0.32	0.57	0.06	0.05	20	0.49	0.43	0.05	0.03
40	0.32	0.57	0.08	0.03	40	0.50	0.42	0.06	0.02

6.5.3 Robustness Check

Following Rogers (1999) and Alexius (2005), we allow the government spending shock to affect output, but the productivity does not affect government spending in the long run. This changes the ordering in our SVECM from $(com, y_2, g, qcpi)$ to $(com, g, y_2, qcpi)$. Then with the new restriction, we run the VECM. Equations 64 and 65 are the long run matrix of the structural shocks, $\Gamma(L)$, for *qcpi* and *qgdp*, respectively:

$$For\ qcpi\ Equation : \Gamma(L) = \begin{bmatrix} 0.0561 & 0 & 0 & 0 \\ -0.0009 & 0.0121 & 0 & 0 \\ -0.0030 & -0.0055 & 0.0138 & 0 \\ -0.0148 & -0.0004 & -0.0218 & 0 \end{bmatrix} \tag{63}$$

$$For\ qgdp\ Equation : \Gamma(L) = \begin{bmatrix} 0.0571 & 0 & 0 & 0 \\ -0.0004 & 0.0112 & 0 & 0 \\ -0.0031 & -0.0055 & 0.0139 & 0 \\ -0.0223 & 0.0002 & -0.0215 & 0 \end{bmatrix} \tag{64}$$

For both real exchange rates (*qcpi* and *qgdp*), the impulse responses of the Canadian real exchange rate to the structural shocks are presented in Figure 13 which are very similar to the base case in Figure 12. For the *qcpi* case, a positive non-energy commodity price shock has a permanent appreciation effect on the Canadian real exchange rate relative to the US dollar. This result is in line with the terms of trade theory of the real exchange rate. As in the base case, in the second quarter, an overshooting effect in response to the non-energy commodity price shock is also evident and is stabilized after ten quarters. Normalising the first column of Equation 64 on the real non-energy commodity price implies a long run elasticity, of the Canadian real exchange rate to the real non-energy commodity price, of 0.26. This estimate is greater than Chanthapun's (2010) result of 0.14 and is within the range of Chen and Rogoff (2003). For the *qgdp* case, the overshoot behaviour is reduced, and normalising the first column of Equation 65 on the real non-energy commodity price implies a long run elasticity, of the Canadian real exchange rate to the real non-energy commodity price, of 0.39. Therefore, comparing the base and the robustness check cases, by switching the order of supply shock and government spending shock, nothing changes in long run elasticity of the Canadian real exchange rate to the real commodity price.

In contrast to the base case, here the most exogenous variable after non-energy commodity price is the government spending not the productivity. The second row in Figure 13 presents the real exchange rate behaviour for the government spending shock. In both *qcpi* and *qgdp* equations, we observe an overshoot which is much more than the base case, then real exchange rate appreciates and for *qcpi* (or *qgdp*), after 10 (or 8) quarters, it stabilizes at -0.004 (or 0.0002). For the *qcpi* (or *qgdp*), normalising the second column of Equation 64 (or 65) on the government spending shock implies a long run elasticity of the Canadian real exchange rate to the government spending shock price of -0.033 (or 0.017).

For the supply shock, as shown in the third row of Figure 13, for both alternatives of the real exchange rate, *qcpi* and *qgdp*, following a positive supply shock to the US (a negative one to Canada), the Canadian dollar depreciates. In the short term, such as in the base case, there is an overshoot, but it is much smaller. For the *qcpi* (or *qgdp*), normalising the third column of Equation 64 (or 65) on the supply shock implies a long run elasticity of the Canadian real exchange rate to the supply shock price of 1.57 (or 1.54). The result in the long run supports the Balassa-Samuelson Hypothesis which suggests a real appreciation following a positive supply shock. The fourth row of Figure 13 shows the impulse responses of the exchange rate shocks. It is the very similar to the base case. The effect of these shocks on the real exchange rate is transitory (and zero in the long run). For the *qcpi* and *qgdp* equations, the impulse responses of exchange rate shocks takes 16 and 8 quarters to go to zero, respectively.

Table 50 reports the Variance Decomposition of the real exchange rate (*qcpi*) and its alternative (*qgdp*). In comparison to the base case in Table 49, the results are not changed. Over 90 per cent of variance in real exchange rate is still explained by non-energy commodity price and productivity differentials where the latter is the dominant one. Again to test the robustness of our results, instead of *qcpi*, we use the alternative real exchange rate, *qgdp*. Similar to the base case in Table 49, we observe an increase (or decrease) in the effect of non-energy commodity price (or productivity differentials) on the variance of the real exchange rate.

Table 50 - Robustness Check-Variance Decomposition of *qcpi* and *qgdp* (1980-2014)

Horizon	com	g	y_2	$qcpi$	Horizon	com	g	y_2	$qgdp$
1	0.28	0.06	0.27	0.39	1	0.29	0.04	0.25	0.42
5	0.32	0.09	0.44	0.15	5	0.41	0.06	0.40	0.13
10	0.32	0.05	0.54	0.09	10	0.46	0.03	0.44	0.07
15	0.32	0.03	0.58	0.07	15	0.48	0.02	0.45	0.05
20	0.32	0.03	0.60	0.05	20	0.49	0.02	0.46	0.03
40	0.32	0.01	0.64	0.03	40	0.50	0.01	0.47	0.02

6.5.4 Alternative Specification of the SVECM

This section provides an alternative specification to the SVECM considered in the last section. In the last section, among all variables (com, y_2, g, $gcpi$), we assume the non-energy commodity price index is the most exogenous variable. Therefore, in long run, none of the variables can influence non-energy commodity price. However, because of the great size of the US economy, it may affect the non-energy commodity prices on the global level, thus one may expect that a productivity shock that raises the US output has a spillover effect to lower the real price of commodities permanently. To test this argument, we separate the productivity differential of the US and Canada to productivity of the US ($y_2(usa)$) and productivity of Canada ($y_2(ca)$). The VECM is:

$$\begin{bmatrix} \Delta y_{2t}(usa) \\ \Delta com_t \\ \Delta y_{2t}(ca) \\ \Delta g \\ \Delta qcpi_t \end{bmatrix} = \sum_{i=1}^{q-1} \Gamma_i \begin{bmatrix} \Delta y_{2t-i}(usa) \\ \Delta com_{t-i} \\ \Delta y_{2t-i}(ca) \\ \Delta g \\ \Delta qcpi_{t-i} \end{bmatrix} + \alpha \acute{\beta} \begin{bmatrix} y_{2t-1}(usa) \\ com_{t-1} \\ y_{2t-1}(ca) \\ g_{t-1} \\ qcpi_{t-1} \\ t \end{bmatrix} + \mu + e_t \tag{65}$$

Therefore, our new SVECM contains of $y_2(usa)$, com, $y_2(ca)$, g, and $qcpi$ with one cointegration vector among our five $I(1)$ variables.[144] The long run matrix of the structural shocks, $\Gamma(L)$, is as follows:

$$\Gamma(L) = \begin{bmatrix} * & 0 & 0 & 0 & 0 \\ * & * & 0 & 0 & 0 \\ * & * & * & 0 & 0 \\ * & * & * & * & 0 \\ * & * & * & * & 0 \end{bmatrix} \tag{66}$$

After running the VECM with restrictions in Equation 67, we get the long run matrix of the structural shocks, $\Gamma(L)$, for $qcpi$ and $qgdp$, as follows:

[144] The Johansen test confirms one cointegration relationship for these five variables.

$$For\ qcpi\ Equation : \Gamma(L) = \begin{bmatrix} 0.0108 & 0 & 0 & 0 & 0 \\ 0.0290 & 0.0483 & 0 & 0 & 0 \\ 0.0057 & 0.0060 & 0.0139 & 0 & 0 \\ -0.0056 & 0.0019 & 0.0033 & 0.0103 & 0 \\ -0.0135 & -0.0083 & 0.0217 & -0.0064 & 0 \end{bmatrix} \quad (67)$$

$$For\ qgdp\ Equation : \Gamma(L) = \begin{bmatrix} 0.0100 & 0 & 0 & 0 & 0 \\ 0.0258 & 0.0502 & 0 & 0 & 0 \\ 0.0055 & 0.0060 & 0.0139 & 0 & 0 \\ -0.0044 & 0.0019 & 0.0031 & 0.0102 & 0 \\ -0.0152 & -0.0135 & 0.0200 & -0.0072 & 0 \end{bmatrix} \quad (68)$$

Figure 14 presents the impulse responses of real exchange rates (*qcpi* and *qgdp*) to the following five shocks: US supply, commodity price, Canada supply, government spending differential and real exchange rate shocks. For the US supply shock (as shown in Figure 14) for both alternatives of the real exchange rate, *qcpi* and *qgdp*, following a positive supply shock to the US, the Canadian dollar depreciates. In the short term, we observe an overshooting behaviour. For the *qcpi* (or *qgdp*), normalizing the first column of Equation 68 (or 69) on the US supply shock implies a long run elasticity of the Canadian real exchange rate to the US supply shock price of 1.25 (or 1.52) which supports the Balassa-Samuelson Hypothesis.

For real exchange rate and its alternative (*qcpi* and *qgdp*) cases, a positive non-energy commodity price shock has a permanent appreciation effect on the Canadian real exchange rate relative to the US dollar, as shown in Figure 14. This result is in line with the terms of trade theory of the real exchange rate. Normalizing the second column of Equations 68 (or 69) on the real non-energy commodity price implies a long run elasticity of the Canadian real exchange rate to the real non-energy commodity price of 0.17 (or 0.26). After the non-energy commodity price shock, the real exchange rate, *qcpi* (or *qgdp*) is stabilized in 16 (or 12) quarters.

As shown in Figure 14, for both alternatives of real exchange rates, a positive supply shock to Canada appreciates the Canadian dollar. Normalizing the third column of Equation 68 (or 69) on the Canada supply shock implies a long run elasticity of the Canadian real exchange rate, *qcpi* (or *qgdp*), to the Canada supply shock of 1.56 (or 1.43) which supports the Balassa-Samuelson Hypothesis. For the government spending shock, the Canadian currency appreciates following a shock that increases aggregate demand in the US relative to Canada, as shown in Figure 14 (for both cases of real exchange rate of *qcpi* and *qgdp*). This result can be explained by the twin-deficit argument discussed above. For the *qcpi* (or *qgdp*), normalising the fourth column of Equation 68 (or 69) on the government spending shock implies a long run elasticity of the Canadian real exchange rate to the government spending shock price of -0.61 (or -0.70). Figure 14 shows the impulse responses of the exchange rate shock. It is the very similar to Figures 12 and 13, the base case and robustness check, respectively. The effect of the shock on the real exchange rate is transitory (and zero in the long run).

Table 51 presents the Variance Decomposition of *qcpi* and *qgdp*. In contrast to the base case in Table 49, for the long run, we observe a decrease of role of non-energy commodity price in explaining the variance of real exchange rate from 32 to 8 per cent and from 50 to 19 per cent in the *qcpi* and *qgdp* equations, respectively. For the effect of supply shock, here we decouple the productivity differential into the US and the Canadian supply shock. For the *qcpi* (or *qgdp*) equation, as shown in Table 51, the US supply shock explains 29 (or 31) per cent of real exchange rate variance and the Canada supply shock explains 58 (or 44) per cent of real exchange rate variance.

Table 51 - Robustness Check-Variance Decomposition of *qcpi* and *qgdp* (1980-2014)

Horizon	$y_2(usa)$	com	$y_2(ca)$	g	$qcpi$	$y_2(usa)$	com	$y_2(ca)$	g	$qgdp$
1	0.54	0.03	0.23	0.02	0.18	0.58	0.03	0.14	0.01	0.24
5	0.47	0.05	0.41	0.01	0.06	0.52	0.09	0.31	0.01	0.07
10	0.39	0.06	0.49	0.02	0.04	0.42	0.13	0.37	0.03	0.05
15	0.35	0.07	0.52	0.03	0.03	0.38	0.15	0.40	0.04	0.03
20	0.33	0.07	0.54	0.03	0.03	0.35	0.17	0.41	0.04	0.03
40	0.29	0.08	0.58	0.04	0.01	0.31	0.19	0.44	0.05	0.03

7 Another Commodity Exporting Country – Australia

Australia is a commodity exporting country with a flexible exchange rate and integrated in the global economy. It can be assumed to be a small open economy with commodity export as the bulk of its export. As the literature confirms, the Australian dollar is a good candidate for a commodity currency. To investigate the effect of different shocks on the variance of real exchange rate in both cases, with or without cointegration, we rerun the SVAR and SVECM for quarterly data from 1982 Q3 to 2014 Q4.

7.1 Analysis of Clarida and Gali (SVAR)

Similar to the SVAR analysis for Canada, we consider a VAR specification with the three variables: the change of real GDP differential (Δy_1), the change of real exchange rate computed using consumer price index ($\Delta qcpi$), and the change of CPI differentials (Δp). As Clarida and Gali (1994), we focus on long run restriction. That is, only supply shocks are expected to influence the relative output levels in long run, while supply and demand shocks may influence the real exchange rate in the long run. To better investigate the evolution of the real exchange rate dynamic of Australia against the US dollar, we divide our full sample (1982-2014) to two subsamples, the first and second subsamples, 1982-1998 and 1998-2014, respectively.

7.1.1 Impulse Responses Analysis

Following Clarida and Gali (1994) built on the Mundell-Fleming-Dornbusch model, we investigate the impulse response to the structural demand and supply shocks. As the first column of Figure 15 shows, for the two subsamples and the full sample, a positive supply shock to the US (a negative one to Australia) causes an overshoot in the real exchange rate, appreciation in the US dollar and depreciation in the Australian currency. This is in line with the Balassa-Samuleson Hypothesis, and is against the theoretical model of Clarida and Gali (1994). However, this is similar to the results of Clarida and Gali (1994) for Germany and the UK. In contrast our results for Canada, in our Australian findings, the pattern is not changed in the two subsamples.

As the second column of Figure 15 presents, in the two subsamples and the full sample, a positive demand shock to the US (a negative one to Australia) causes an overshoot in the real exchange rate and similarly to Canada, we observe appreciation of the US dollar and depreciation of the Australian dollar. Therefore, our impulse responses of the effect of demand shock on the real exchange rate of Australia are similar to those of Canada and in line with the prediction of the model of Clarida and Gali (1994).

7.1.2 Variance Decomposition

In Table 52, we report the results of conditional variance of the change in the log of real exchange rate of Australia against the US dollar (deflated by CPI) at various horizons into the fraction of the variance due to structural supply, demand and monetary shocks. In line with Clarida and Gali (1994), the variations in the real exchange rate are dominated by the demand shocks. As Table 52 reports, the productivity and monetary shocks totally explain just 4, 1 and 3 per cent of variation of the real exchange rate, in the first and second subsamples and the full sample, respectively.

Table 52 - Variance Decomposition of Real Exchange Rate - The Base Case (Australia)

1982-1998				1998-2014			1982-2014		
Horizon	Δy_1	$\Delta qcpi$	Δp	Δy_1	$\Delta qcpi$	Δp	Δy_1	$\Delta qcpi$	Δp
1	0.00	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00
5	0.04	0.91	0.05	0.01	0.98	0.01	0.03	0.96	0.01
10	0.04	0.91	0.05	0.01	0.98	0.01	0.03	0.96	0.01
15	0.04	0.91	0.05	0.01	0.98	0.01	0.03	0.96	0.01
20	0.04	0.91	0.05	0.01	0.98	0.01	0.03	0.96	0.01

7.1.3 Robustness Check for the Variance Decomposition

For the robustness test, similar to the case of Canada, we consider three cases. As Table 53 presents, in the first one, instead of relative real GDP per capita as the variable describing the supply shock, we use the alternative representation of supply shock, relative CPI/ PPI. Although we observe an increase in the effect of supply shock, for the three periods, the main contributor to the variance of the real exchange rate of Australia is still the demand shock. In the second robustness test, instead of real exchange rate deflated by CPI, we use the alternative real exchange rate which is deflated by a GDP deflator. Results are very similar to the base case. The alternative real exchange rate confirms the results of the base case in as shown in Table 52. Finally, in the third robustness test, we modify the SVAR by using the alternative real exchange rate and the alternative supply shock. We confirm that the demand shock still explains the bulk of variance in Australian real exchange rate.

Table 53 - Variance Decomposition -Robustness Check (Australia)

1-Variance Decomposition of $\Delta qcpi$- Robustness Check Model 1: $(\mathbf{\Delta y_2}, \Delta qcpi, \Delta p)$

1982-1998				1998-2014			1982-2014		
Horizon	Δy_2	$\Delta qcpi$	Δp	Δy_2	$\Delta qcpi$	Δp	Δy_2	$\Delta qcpi$	Δp
1	0.07	0.93	0.00	0.12	0.88	0.00	0.11	0.89	0.00
5	0.07	0.89	0.04	0.14	0.86	0.00	0.11	0.88	0.01
10	0.07	0.89	0.04	0.14	0.86	0.00	0.11	0.88	0.01
15	0.07	0.89	0.04	0.14	0.86	0.00	0.11	0.88	0.01
20	0.07	0.89	0.04	0.14	0.86	0.00	0.11	0.88	0.01

2-Variance Decomposition of $\Delta qgdp$- Robustness Check Model 2: $(\Delta y_1, \mathbf{\Delta qgdp}, \Delta p)$

1982-1998				1998-2014			1982-2014		
Horizon	Δy_1	$\Delta qgdp$	Δp	Δy_1	$\Delta qgdp$	Δp	Δy_1	$\Delta qgdp$	Δp
1	0.00	1.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00
5	0.04	0.92	0.04	0.01	0.99	0.00	0.02	0.97	0.01
10	0.04	0.92	0.04	0.01	0.99	0.00	0.02	0.97	0.01
15	0.04	0.92	0.04	0.01	0.99	0.00	0.02	0.97	0.01
20	0.04	0.92	0.04	0.01	0.99	0.00	0.02	0.97	0.01

3-Variance Decomposition of $\Delta qgdp$- Robustness Check Model 3: $(\mathbf{\Delta y_2}, \mathbf{\Delta qgdp}, \Delta p)$

1982-1998				1998-2014			1982-2014		
Horizon	Δy_2	$\Delta qgdp$	Δp	Δy_2	$\Delta qgdp$	Δp	Δy_2	$\Delta qgdp$	Δp
1	0.05	0.95	0.00	0.11	0.89	0.00	0.09	0.91	0.00
5	0.05	0.91	0.04	0.12	0.88	0.00	0.10	0.90	0.00
10	0.05	0.91	0.04	0.12	0.88	0.00	0.10	0.90	0.00
15	0.05	0.91	0.04	0.12	0.88	0.00	0.10	0.90	0.00
20	0.05	0.91	0.04	0.12	0.88	0.00	0.10	0.90	0.00

7.1.4 Adding Commodity Price to Analysis of Clarida and Gali

For Australia, we modify the model of Clarida and Gali in a commodity exporting country by adding the Australian commodity price index to the VAR. The VAR model includes the price of commodities, the real GDP differential, the real exchange rate, and the CPI differential. Thus, we assume a structural model responsive to four types of shocks: commodity price shocks; supply shocks; real demand shocks, and monetary shocks.

Impulse Response Figure 16 presents the real exchange rate ($qcpi$) responses to commodity price, supply and demand shocks. For the two subsamples and the full sample, a shock to commodity price appreciates the Australian currency. This is in line with the theoretical models which describe the relationship between terms of trade and real exchange rate. From the first to the second subsample, the notable difference from the case of Canada is that the impact of the commodity price on the Australian dollar decreases from -0.050 to -0.005. For the response of the real exchange rate to the supply shock, in the case of Canada, we reject the Balassa-Samuelson Hypothesis and confirm the theoretical model of Clarida and Gali (1994); while for Australia, as Figure 16 presents, we confirm the Balassa-Samuelson Hypothesis and reject the model of Clarida and Gali. For the demand shock, the results for the two subsamples and the full sample in Figure 16 are very similar to the base case in Figure 15.

Variance Decomposition Table 54 reports the contribution of various shocks to the variance of the Australian real exchange rate when we add commodity price to the model of Clarida and Gali. Similar to Canada, the dominant contributor to the variance of real exchange rate is still the demand shock. In the first subsample, the commodity price shock explains 32 per cent of the real exchange rate variance. This goes down to 16 and 9 per cent in the second subsample and the full sample, respectively. The total contribution of supply and monetary shocks shifts from 10 per cent in the first subsample to 7 and 4 per cent in the second subsample and the full sample, respectively.

Table 54 - Variance Decomposition of $\Delta qcpi$- The Base Case with Commodity Price (Australia) ($\Delta com, \Delta y_1, \Delta qcpi, \Delta p$)

	S1				S2				S3			
H	Δcom	Δy_1	$\Delta qcpi$	Δp	Δcom	Δy_1	$\Delta qcpi$	Δp	Δcom	Δy_1	$\Delta qcpi$	Δp
1	0.36	0.00	0.64	0.00	0.08	0.00	0.92	0.00	0.09	0.00	0.90	0.01
5	0.33	0.06	0.58	0.03	0.16	0.04	0.78	0.02	0.09	0.03	0.87	0.01
10	0.32	0.06	0.58	0.04	0.16	0.04	0.77	0.03	0.09	0.03	0.87	0.01
15	0.32	0.06	0.58	0.04	0.16	0.04	0.77	0.03	0.09	0.03	0.87	0.01
20	0.32	0.06	0.58	0.04	0.16	0.04	0.77	0.03	0.09	0.03	0.87	0.01

Note: S1, S2 and S3 are the two subsamples and the full sample, 1982-1998, 1998-2014 and 1982-2014, respectively.

Robustness Check for Variance Decomposition Table 55 shows the three robustness tests for the Australian SVAR with commodity price. In the first robustness check, we use the alternative representative of supply shock (y_2). As the first row of Table 55 presents, we get very similar results to the base case in Table 54. In fact, the demand shock is the main contributor to the variance of the real exchange rate of Australia in the three samples. We only observe an increase in the effect of supply shock for the second subsample and the full sample.

In the second robustness test, as the second row of Table 55 shows, instead of $qcpi$, we use the alternative real exchange rate ($qgdp$). The results are very similar to the base case in Table 54. In the third robustness test which is illustrated in the third row of Table 55, we simultaneously apply the first and second cases. We use the alternative variables for supply shock (y_2) and real exchange rate ($qgdp$) and confirm the results in the base case in Table 54.

Table 55 - Variance Decomposition - Robustness Check- The Base Case with Commodity Price (Australia)

1-Variance Decomposition of $\Delta qcpi$- Model 1: ($\Delta com, \mathbf{\Delta y_2}, \Delta qcpi, \Delta p$)

	S1				S2				S3			
H	Δcom	Δy_2	$\Delta qcpi$	Δp	Δcom	Δy_2	$\Delta qcpi$	Δp	Δcom	Δy_2	$\Delta qcpi$	Δp
1	0.30	0.06	0.64	0.00	0.07	0.20	0.73	0.00	0.10	0.14	0.76	0.00
5	0.30	0.06	0.63	0.01	0.16	0.17	0.65	0.02	0.11	0.15	0.72	0.02
10	0.29	0.06	0.63	0.02	0.16	0.18	0.64	0.02	0.11	0.15	0.72	0.02
15	0.29	0.06	0.63	0.02	0.16	0.18	0.64	0.02	0.11	0.15	0.72	0.02
20	0.29	0.06	0.63	0.02	0.16	0.18	0.64	0.02	0.11	0.15	0.72	0.02

2-Variance Decomposition of $\Delta qgdp$- Model 2: ($\Delta com, \Delta y_1, \mathbf{\Delta qgdp}, \Delta p$)

	S1				S2				S3			
H	Δcom	Δy_1	$\Delta qgdp$	Δp	Δcom	Δy_1	$\Delta qgdp$	Δp	Δcom	Δy_1	$\Delta qgdp$	Δp
1	0.37	0.00	0.63	0.00	0.08	0.00	0.92	0.00	0.12	0.00	0.88	0.00
5	0.34	0.05	0.58	0.03	0.21	0.08	0.66	0.05	0.11	0.02	0.85	0.02
10	0.34	0.05	0.58	0.03	0.21	0.09	0.66	0.04	0.11	0.02	0.85	0.02
15	0.34	0.05	0.58	0.03	0.21	0.09	0.66	0.04	0.11	0.02	0.85	0.02
20	0.34	0.05	0.58	0.03	0.21	0.09	0.66	0.04	0.11	0.02	0.85	0.02

3-Variance Decomposition of $\Delta qgdp$- Model 3: ($\Delta com, \mathbf{\Delta y2}, \mathbf{\Delta qgdp}, \Delta p$)

	S1				S2				S3			
H	Δcom	$\Delta y2$	$\Delta qgdp$	Δp	Δcom	$\Delta y2$	$\Delta qgdp$	Δp	Δcom	$\Delta y2$	$\Delta qgdp$	Δp
1	0.30	0.04	0.65	0.01	0.09	0.18	0.73	0.00	0.11	0.12	0.76	0.01
5	0.31	0.04	0.64	0.01	0.16	0.16	0.65	0.03	0.12	0.14	0.72	0.02
10	0.31	0.04	0.63	0.02	0.17	0.17	0.65	0.01	0.12	0.14	0.72	0.02
15	0.31	0.04	0.63	0.02	0.17	0.17	0.65	0.01	0.12	0.14	0.72	0.02
20	0.31	0.04	0.63	0.02	0.17	0.17	0.65	0.01	0.12	0.14	0.72	0.02

Note: S1, S2 and S3 are the two subsamples and the full sample, 1982-1998, 1998-2014 and 1982-2014, respectively.

7.2 Cointegration Analysis (SVECM)

For Australia, after applying the proper unit root and cointegration tests, as shown in Tables 56 and 57, we establish a cointegration relationship between the real exchange rate, commodity price, and relative productivity and government spending. Following the Johansen cointegration test, the maximum eigenvalue and trace tests for the cointegration rank are performed and are summarized in Table 56. At 5 per cent critical value, both tests confirm one cointegration vector among the real exchange rate, non-energy commodity price, productivity and government spending differentials. We double check the cointegration by the Engle-Granger Cointegration Test. Table 57 presents the results, the null hypothesis of this test is the lack of cointegration among variables. The test rejects the null.

Table 56 - Johansen Cointegration Tests - Australia (1982-2014)

$qcpi, com, g, y_1$				
No. of CE(s)	Trace	Prob.	Max-E	Prob.
None	62.47	0.00	31.15	0.02
At most 1	31.31	0.12	21.06	0.07
At most 2	10.24	0.61	6.13	0.77
At most 3	4.11	0.39	4.11	0.39

Table 57 - Engle-Granger Cointegration Test - Australia (1982-2014)

Dependent	Tau-Stat	Prob	z-Stat	Prob
com	-4.65	0.01	-42.49	0.01
$qcpi$	-4.40	0.02	-39.28	0.00
y_1	-4.74	0.02	-28.62	0.06
g	-4.35	0.03	-20.14	0.26

Table 58 presents the results for VECM analysis. The coefficient for commodity price is -0.51 which is close to -0.35, the coefficient of commodity price in our version of the Canada Bank Equation. A 10 per cent increase in the Australian commodity index causes 5.1 per cent appreciation of the Australian dollar. As Table 58 illustrates, an increase of 10 per cent in productivity differentials between the US and Australia (a negative supply shock to Australia) causes 26 per cent appreciation of the Canadian currency which is against the Balassa-Samuelson Hypothesis.

For the government spending differentials, a 10 per cent increase in US government spending relative to Canada (a negative demand shock for Canada) causes 4.3 per cent appreciation of the Canadian dollar. As Table 58 shows, we rerun the VECM analysis with alternative real exchange rate (*qgdp*). The results are similar to the base case.

Table 58 - VECM Results for *qcpi* and *qgdp* - (1982-2014)

qcpi	Cof	t-Statistic	*qgdp*	Cof	t-Statistic
ECT	-0.10	-4.02	*ECT*	-0.09	-5.06
y_1	-2.60	-4.19	y_1	-2.9	-5.87
g	0.43	3.80	g	0.54	4.90
com	-0.51	-8.15	*com*	-0.64	-8.87
c	2.87	12.52	c	2.85	12.93

Tables 59 and 60 present the results for the DOLS and FMOLS Cointegrating Equations, the results are very similar to each other and very close to our VECM result in Table 58.

Table 59 - DOLS Cointegrating Equation (1982-2014)

qcpi	Cof (DOLS)	P-Value (DOLS)	*qgdp*	Cof (DOLS)	P-Value (DOLS)
y_1	-2.77		y_1	-2.62	0.03
g	0.60		g	0.54	0.00
com	-.0.56		*com*	-0.52	0.01
c	2.77		c	2.68	0.00

Note: Automatic leads and lags specification (lead=0 and lag=1 based on SIC criterion, max=13)

Table 60 - FMOLS Cointegrating Equation (1982-2014)

qcpi	Cof (FMOLS)	P-Value (FMOLS)	*qgdp*	Cof (FMOLS)	P-Value (FMOLS)
y_1	-2.32	0.02	y_1	-1.73	0.01
g	0.44	0.03	g	0.57	0.00
com	-0.53	0.01	*com*	-0.52	0.02
c	2.75	0.00	c	2.66	0.00

7.2.1 Impulse Responses Analysis

Here, with four $I(1)$ variables and one cointegration relation, we need to impose three constraints. The long run matrix of the structural shocks, $\Gamma(L)$, is as follows:

$$\Gamma(L) = \begin{bmatrix} * & 0 & 0 & 0 \\ * & * & 0 & 0 \\ * & * & * & 0 \\ * & * & * & 0 \end{bmatrix} \tag{69}$$

where * is the non-restricted number. As in the SVECM analysis for Canada in section 6.5, with four variables and one cointegration vector, we face three restrictions. The first two zeros in the first row of Equation 70 are the first two restrictions which confirm that the commodity price index is not affected in the long run by permanent shocks to output and government spending. Therefore, commodity price index is the most exogenous variable in the long run and is dependent on extraction technology, transport cost, political environments in the main exporting countries and other factors on the global level. The third constraint (the first zero in the second row of Equation 70) implies that only commodity price shocks and supply shocks can have a long run impact on the output differential. Thus, technology shocks that improve efficiency in commodity production are allowed to have a permanent impact on output. The short run dynamics are unrestricted and the other long run relations are estimated freely. Equations 71 and 72 are the long run matrix of the structural shocks, $\Gamma(L)$, for *qcpi* and *qgdp*, respectively:

$$For\ qcpi\ Equation : \Gamma(L) = \begin{bmatrix} 0.0804 & 0 & 0 & 0 \\ -0.0022 & 0.0061 & 0 & 0 \\ 0.0001 & -0.0049 & 0.0122 & 0 \\ -0.0436 & -0.0322 & 0.0116 & 0 \end{bmatrix} \tag{70}$$

$$For\ qgdp\ Equation : \Gamma(L) = \begin{bmatrix} 0.0792 & 0 & 0 & 0 \\ -0.0021 & 0.0060 & 0 & 0 \\ -0.0001 & -0.0043 & 0.0119 & 0 \\ -0.0449 & -0.0287 & 0.0130 & 0 \end{bmatrix} \tag{71}$$

For both real exchange rate (*qcpi*) and its alternative (*qgdp*), we present the impulse responses of the Australian real exchange rate to the structural shocks in Figure 17. For the *qcpi* case, after an undershoot and then an overshoot in the short run, a positive commodity price shock has a permanent appreciation effect on the Australian real exchange rate relative to the US dollar. This result is in line with the terms of trade theory of the real exchange rate. Normalising the first column of the equation on the real commodity price implies a long run elasticity of the Australian real exchange rate to the real commodity price of -0.54. This is twice the effect of the commodity price on the Canadian real exchange rate in section 6.5.1. For the *qgdp* case, after a commodity price shock, we observe mild undershoot and overshoot in the short run. Normalising the first column of the equation on the real commodity price implies a long run elasticity, of the Australian real exchange rate to the real commodity price, of -0.56.

The second row of Figure 17 presents the real exchange rate response to a supply shock for both alternatives of real exchange rates, *qcpi* and *qgdp*. In the short run, we observe an undershooting behaviour and in the long run, following a positive supply shock to the US (a negative one to Australia), the Australian dollar appreciates. For the *qcpi* (or *qgdp*), normalising the second column of Equations 71 and 72 on the supply shock implies a long run elasticity of the Australian real exchange rate to the supply shock price of -5.27 (or -4.78). The result rejects the Balassa-Samuelson Hypothesis which suggests a real currency appreciation following a positive supply shock. The Australian currency depreciates following a government spending shock, that increases aggregate demand in the US relative to Australia, as shown in Figure 17 (for both cases of real exchange rate of *qcpi* and *qgdp*). For the *qcpi* (or *qgdp*), normalising the third column of Equations 71 (or 72) on the government spending shock implies a long run elasticity of the Australian real exchange rate to the government spending shock of 0.95 (or 1.09). The last row in Figure 17 shows the impulse response of the exchange rate shock. This shock has a transitory effect on the real exchange rate that is zero in the long run. For the *qcpi* and *qgdp* equations, the impulse response of exchange rate shock takes 10 quarters to go to zero.

7.2.2 Variance Decomposition

As Table 61 presents, similar to the SVECM analysis for Canada, the two main shocks which explain the real exchange of Australia against the US dollar are commodity price and productivity shocks. For Australia, in contrast to Canada, commodity price shock is the first contributor of explaining variance of real exchange rate; its effect is almost twice of the productivity shock. As shown in Table 61, we test the robustness of this SVECM analysis by alternative real exchange rate ($qgdp$). The results confirm our findings.

Table 61 - Variance Decomposition of $qcpi$ and $qgdp$ - Australia (1982-2014)

Horizon	com	y_1	g	$qcpi$	Horizon	com	y_1	g	$qgdp$
1	0.55	0.42	0.02	0.01	1	0.60	0.37	0.03	0.00
5	0.55	0.38	0.07	0.00	5	0.63	0.30	0.06	0.00
10	0.57	0.36	0.06	0.01	10	0.65	0.29	0.06	0.00
15	0.59	0.36	0.05	0.00	15	0.66	0.28	0.06	0.00
20	0.59	0.35	0.05	0.01	20	0.66	0.28	0.06	0.00

For quarterly Australian data from 1982 Q3 to 2006 Q3, Chanthapun (2010) considers three permanent factors that may explain the long run variability and dynamics of these commodity currencies: real commodity prices, productivity differentials and demand-side factors. Using the econometric framework of Pagan and Pesaran (2008), Chanthapun confirms that the main sources of fluctuations in the real exchange rates for Australia are the relative supply shocks. In contrast to our results, these results do not show a major role for commodity price in explaining the variance of the Australian real exchange rate. As for the Canadian case, and unlike our study, Chanthapun has used a global commodity price index for each country its own commodity price index.

8 Conclusion

For Canada as a developed commodity exporting country, this chapter contributes to two types of literature: the literature of long run equilibrium relationship between real exchange rate and fundamental variables and the Variance decomposition of real exchange rate literature. For the long run relationship between the real exchange rate of Canada and fundamentals, we update the Canada Bank Equation by three modifications: first, our quarterly data covers an extended period, 35 years (1980-2014). Second, in addition to the commodity price indices of energy and non-energy, we bring other fundamentals such as government spending and productivity differentials to the Canada Bank Equation. Third, to our knowledge, this is the first time that the new Canada commodity price indices are used to check the robustness of the Canada Bank Equation. In contrast to the old data set used by Amano and van Norden (1995) which was a fixed weight index of commodity prices, the new one is contains a broader set of commodities and the production weights are annually updated; therefore it considers the dynamic of the composition of commodity production in Canada.

For the pre 1993 period (first subsample), we confirm the findings of Amano and van Norden, the empirical results confirm that the energy and non-energy commodity prices affect the Canadian dollar in different ways. An increase in non-energy commodity price appreciates the Canadian currency while an increase in energy price depreciates it. For the post 1993 period (second subsample), we run the Canada Bank Equation and confirm the switch in the sign of the energy price coefficient on the US-Canada real exchange rate. Switching the sign of the energy price in the Canada Bank Equation is coincident with the transformation of Canada from an oil importing to an oil exporting country.

In the next step for the full sample (1982-2014), after extensive investigation for the different fundamentals, we get to a new version of the Canada Bank Equation consisting of three explanatory variables: non-energy commodity price index, productivity and government spending differentials. We do not consider the energy commodity price for the full sample, since its effect switches around 1993. For Australia, we introduce an equation similar to the Canadian one.

Comparing the real exchange rate responses to different shocks in Canada and Australia, we observe different reactions for demand and supply shocks, but the same pattern for a commodity price shock. For the effect of productivity differential shocks on the real exchange rate, for Canada, the empirical results of the cointegration analysis support the Balassa-Samuelson Hypothesis while in the Australian case, it does not. For the demand shock, an increase in government spending in Canada depreciates the Canadian currency while such a shock in Australia appreciates the Australian currency. Comparing the VECM results for Canada and Australia as two developed commodity exporting countries, the effect of the Canadian non-energy commodity price index on the Canada-US real exchange rate is close to the effect of the Australian commodity price index on the Australia-US real exchange rare. These results are confirmed by extensive robustness tests. The differences in the error correction term in these two countries are interesting; for Canada, it is -0.32 while it is -0.10 for Australia. Therefore, the time to dissipate 50 per cent of a shock is two and six quarters for Canada and Australia, respectively.

Furthermore, based on long run cointegration relationship, we build the SVECM analysis. For Canada, the two sources of real exchange rate fluctuations are productivity differential and non-commodity price with the productivity differential as the main contributor. Similarly, for Australia, the same two fundamentals explain most of the real exchange rate, but in the Australian case, the main contributor in explaining the variance of real exchange rate is commodity price. We apply different robustness tests; these results do not change.

The other part of this chapter updates and tests the analysis of Claria and Gali. We study the sources of real exchange rate fluctuations in Canada and Australia in the last three decades using a SVAR model. As do Claria and Gali (1994), we consider three types of macroeconomic shocks – supply, demand, and nominal shocks – and identify their impact on the Canadian and Australian real exchange rates. After extensive robustness tests for different samples, we confirm the stylized fact of Claria and Gali (1994): demand shocks explain a significant share of the variation in real exchange rate in these two countries.

A notable difference between Canada and Australia in the SVAR analysis is the increase in the effect of monetary shock in the Canadian case from the pre 1993 period to the post 1993 one, but we do not observe any significant changes in the effect of monetary shock on the Australian real exchange rate in the two Australian subsamples. Possibly Canada is more influenced by expansion of capital markets in our second subsample (1993-2014).

Our SVECM analyses confirm that if there is a long run relationship between the real exchange rate and fundamentals, then the SVAR models, such as that of Clarida and Gali (1994) which apply the first differences of data, fail to present some characteristics of the model. The SVAR and SVECM approaches are different in the sense that, in the latter, we do consider the cointegration relationship between variables while, for the former we do not. However, they are similar in applying long run restrictions in the process of identifying structural shocks. It seems that in Canada and Australia, by excluding the cointegration relationship between the real exchange rate and its fundamentals, the productivity shocks are not any more the major source of movement of real exchange rates.

These results suggest some implications for economic policy and the theoretical literature of real exchange rate determination. First (if they can obtain some reliable predictions of the future values of the fundamentals) our new version of the Bank of Canada Equation and the Australian one can be helpful in guiding policy makers to the future direction of the real exchange rate. Second, in contrast to the SVAR literature which followed Clarida and Gali (1994), the productivity differential shock is an important factor especially when we establish a long run cointegrating relationship between the real exchange rate and fundamental variables. Third, the empirical results for the effect of productivity differential in Canada support the Balassa-Samuelson Hypothesis while those in Australia do not. However, we should emphasize that the exchange rate equations in this chapter for Canada and Australia are built on a long run empirical relationship, and are not proper for studying the short and medium run.

Perhaps in future, including the short term variables (such as interest rates) and other explanatory factors (such as risk premium) to our long run Canada Bank Equation may cause an improvement in the equation. For Australia, although our long run equation passes extensive robustness tests, still it is premature to be introduced as the Reserve Bank of Australia Equation.

Other avenues for future research may be as follows: first, to test of the out-of-sample forecasting of our equations in Canada and Australia; do these equations beat a random walk? Second, to investigate the nature of the demand shocks in the SVAR analysis of the framework of Clarida and Gali; to what extend these shocks are linked to fiscal shocks. Third, to search for new explanatory fundamentals, especially variables which describe the dynamic of the US dollar against the other major currencies. Fourth, for Canada, we use the new BCPI data set which are built on the base of the composition weights of commodities production in Canada, so it would be good to construct a data set with weights of composition of commodities which Canada exports as well.

Part V

Conclusion

As introduced in chapter one, this thesis provides a better understanding of the dynamic of real exchange rates in developed and developing commodity exporting countries. For the former, we investigate the dynamic of real exchange rates of Canada and Australia and for the latter, we focus on five oil exporting countries in the Middle East.

We consider in chapter two a sample of five oil exporting countries in the Persian Gulf, namely: Qatar, Oman, Kuwait, Saudi Arabia and the UAE. Their currencies are pegged to the US dollar; therefore, any fluctuation of the US dollar against the Euro and Yen could be a destabilizing factor which hurts their economies. In addition, the weak synchronization of the business cycles these five countries with that of the US increases the cost of maintaining a peg exchange rate regime to the US dollar. Therefore, these countries need to adopt another exchange rate regime which helps them to dampen the incoming shocks to their economics more efficiently. The best candidate is a flexible exchange rate regime with Inflation Targeting, which is what the developed commodity exporting countries follow. However, the Middle East oil exporting countries are years behind in having the prerequisites for Inflation Targeting such as proper institutions, communication strategies, and an independent central bank. In the meantime, our proposal in chapter two may provide a medium term solution and a smooth path during this transition period.

Focusing on fiscal policy volatility, this chapter contributes to the literature of monetary policies in the commodity exporting countries by considering other possible anchors within the Inflation Targeting framework. We simulate the nominal and real oil prices of the Middle East oil exporting countries in local currencies under different counterfactual nominal exchange rate regimes. We conduct a set of counterfactual experiments and empirically simulate government deficits/ surpluses and government consumption expenditure under a hypothetical peg to a basket (containing oil price, the US Dollar, Yen and the Euro) and compare this simulation with whatever exchange rate regime each country actually followed in the period under study. We find that the real oil price in domestic currency is linked to government expenditure and fiscal balance as a share of GDP; and we find that when departing from the current exchange rate regime (peg to the US dollar), we may observe a less volatile economy.

Based on the results of our counterfactual experiments in this chapter, we recommend for these five countries a gradual shift from the current exchange rate regime to this basket of oil price, the US dollar, Euro and Yen. In the medium term, this recommendation and a self-insurance policy, in the form of oil funds, may be helpful; however, for the long term, focusing on the political economy, they should promote institutions and a Chilean style of fiscal policy (conservative assumption of oil price) and expand their non-oil exports.

A number of issues that we do not consider in this chapter are worthy of being pursued in further research. First, we assign equal weights to each of these three currencies but in future research, the weights of the various currencies in the basket may reflect the currency composition of trade. Second, a basket with variable weights (for oil price, US dollar, Yen and Euro) which are regularly updated may limit the volatility of fiscal policy even more. Third, in practice, applying a band around the basket peg may allow authorities to use monetary policy to support fiscal policy in satisfying internal objectives. Fourth, in all our simulations, to get the real oil price in local currency, we use the actual inflation. However, there is a major difficulty in performing this kind of counterfactual analysis with reduced form coefficients – the Lucas critique applies. There is bound to be a behavioural response to any new kind of monetary policy regime, which means that the counterfactual analysis may be misleading. Therefore, in future research, considering inflation as an endogenous variable may be helpful.

In the third chapter, we determine the equilibrium exchange rate (using BEER) of these five countries which are major oil exporters. We employ a new data set for the real effective exchange rate of these countries which is updated annually and covers the period from 1980 to 2011. We estimate the BEER series based on both single country (Johansen and ARDL) and panel cointegration techniques. In the time series analysis, the ARDL procedure shows cointegration for Qatar with the same explanatory variables, which is very close to our findings in the panel analysis. Given the limited length of the sample (32 years) and low power of individual country by country unit root and cointegration tests, estimating separate equations for each country (time series) does not provide us with precise results. Therefore, to increase the efficiency of the estimators, we employ panel analysis. We apply the pooled mean-group (PMG) of Pesaran et al. (1999) and four more panel estimators for the robustness check.

Taking into account the whole set of regression results based on different panel estimators and annual data, this study shows a significant effect of real oil price and productivity differentials on the real effective exchange rates of these countries. The estimated long run relation between the real effective exchange rates and fundamentals is economically and statistically significant. In particular, a 10 per cent increase in real oil price causes a 1.9 per cent appreciation of the real effective exchange rates, which is consistent with theoretical predictions and with previous studies for commodity (oil) exporting countries such as: Cashin et al. (2004) for commodity exporting countries; Coudert et al. (2011) for a group of oil exporting countries;

Koranchelian (2005) for Algeria; and Dauvin (2013) for ten oil exporting countries. Furthermore, the productivity deferential elasticity is 0.10 which is consistent with the results in the related literature such as those of MacDonald and Ricci (2004) for South Africa and Lee et al. (2008) for 48 countries over the period of 1980-2004.

The BEERs of Qatar, Kuwait, and (to some extent) the UAE, follow their real effective exchange rates. From 2000, with the increase in oil price, the BEERs appreciate while the real exchange rate of Oman and Saudi Arabia decline. Therefore, the Saudi Arabian and Omani currencies get undervalued while the currency of the UAE is overvalued. In 2011, the currencies of the other two countries, Kuwait and Qatar, are almost in equilibrium.

Focusing on equilibrium exchange rate, our results confirm that these countries are not prepared for a currency union. In order to establish a currency union, many political and economic prerequisites must be satisfied. Reviewing the lessons of the Euro experience, political convergence and harmonized institutions are the essential ingredients of a currency union. In the case of the Euro, there was a deep desire for political unification which was followed by establishment of the European Commission, the European Court of Justice and the European Parliament. On the other hand, the European central bank is built on the existence of proper institutions and convergence in political and economic reform, which is a very slow process. The political relationship among these oil exporting countries in the Persian Gulf is fragile and even sometimes hostile. Therefore, the plan for a currency union in 2010 was premature and has already failed. They have a long way ahead to satisfy the political homogeneity of a common currency.

For the equilibrium exchange rate, which is the focus of this third chapter and one of the economic prerequisites for currency union, our results show that before any step toward the establishment of a monetary union in these countries, the divergence in the fair value of their currencies should be removed. As was the focus of the second chapter, these countries should move away from their current currency peg to the US dollar towards a basket of appropriate currencies and oil price to decouple their currencies from the US dollar as a major oil importer. For future research, for the robustness check, we can apply other methods of determination of equilibrium exchange rate such as FEER.

Allocating chapters two and three to the real exchange rate of developing commodity exporting countries, in chapter four, we investigate the dynamic of real exchange rates for two developed commodity exporting countries: Canada and Australia. These countries have independent central banks and the proper institutions to implement flexible exchange rate regime and inflation targeting. The research in this chapter can shed light on the nature of real exchange rate in these developed commodity exporting countries. On the other hand, the results in this chapter should help the five developing oil exporting countries in the Persian Gulf to see where they will be in the long term, how they should shift to competitive banking system, adopt new legal framework and also their challenges in future.

In the fourth chapter, employing a new data set of Canadian commodity price indices, we revisit the Canada Bank Equation and introduce a new version with more fundamentals. From a monetary policy perspective, we must identify the forces which influence the real exchange rate. Different forces influencing a currency may need different monetary responses. For example, if there is an increase in global demand for Canadian commodities, this is a pressure linked to fundamentals. In this case, apart from some shifts between traded and non-traded factors, the monetary authorities do not need to do much. Another case may be the appreciation of the Canadian dollar because of the depreciation of the US dollar against all major currencies. In this case, an expansionary monetary policy in Canada may limit the reduction of the foreign demand for Canadian goods and services. Finally, a proper monetary reaction to fluctuations of the Canadian dollar which is rooted in non-fundamentals and speculative factors is necessary to protect the domestic economy by neutralizing these forces.

This chapter contributes to the literature of long run equilibrium relationship between real exchange rate and fundamental variables and the variance decomposition of real exchange rate literature. For the former, we update the Canada Bank Equation by three modifications: first, our quarterly data covers an extended period, 35 years (1980-2014). Second, in addition to the commodity price indices of energy and non-energy, we include other fundamentals such as government spending and productivity differentials. Third, to our knowledge, this is the first study that uses the new Canada commodity price indices to check the robustness of the Canada Bank Equation. In contrast to the old data set used by Amano and van Norden (1995) which was a fixed weight index of commodity prices, the new one contains a broader set of commodities and the production weights are annually updated; therefore it considers the dynamic of the composition of commodity production in Canada. We apply similar analysis for Australia and introduce a cointegration relationship between real exchange rate of Australia and its fundamentals. We should emphasize that these exchange rate equations present long run relationship; they are not aimed at explaining short term variations in the exchange rates.

For the pre-1993 period (first subsample) in the Canadian data, we confirm the findings of Amano and van Norden (1995). Our empirical findings show that the energy and non-energy commodity prices affect the Canadian dollar in different ways. An increase in non-energy commodity price appreciates the Canadian currency while an increase in energy price depreciates it. For the post-1993 period (second subsample), we confirm the switch in the sign of the energy price coefficient on the US-Canada real exchange rate. Switching the sign of the energy price in the Canada Bank Equation is coincident with the transformation of Canada from an oil importing to an oil exporting country.

Comparing the real exchange rate impulse responses to different shocks in Canada and Australia, we observe different reactions for demand and supply shocks but the same pattern for a commodity price shock. For the effect of a productivity differential shock on the real exchange rate, for Canada, the empirical results of the cointegration analysis support the Balassa-Samuelson Hypothesis; while in the Australian case, they do not. For a demand shock, an increase in government spending in Canada depreciates the Canadian currency while such a shock in Australia appreciates the Australian currency. Comparing the VECM results for Canada and Australia as two developed commodity exporting countries, the effect of the Canadian non-energy commodity price index on the Canada-US real exchange rate is close to the effect of the Australian commodity price index on the Australia-US real exchange rate and is in line with the results of Chen and Rogoff (2003) for Australia. These results are confirmed by extensive robustness tests. The differences in the error correction term in these two countries are interesting; for Canada, it is -0.32; while it is -0.10 for Australia. Therefore, the time to dissipate 50 per cent of a shock is two and six quarters for Canada and Australia, respectively.

For the variance decomposition of real exchange rate literature, we investigate the SVECM frameworks to decompose the variance of the real exchange rate of Canada and Australia. The productivity differential and commodity price are the two contributors to the variance of the real exchange rates of Australia and Canada. However, in Canada, the main contributor to variance of the real exchange rate is productivity differential; while in Australia, it is commodity price. Extensive robustness checks confirm these findings.

Furthermore, based on the SVAR analysis of Clarida and Gali (1994), we consider three types of macroeconomic shocks – supply, demand, and nominal shocks – and identify their impact on the Canadian and Australian real exchange rates. We confirm that, as in the literature, demand shock is the dominant force in explaining the variance of the real exchange rates of both countries. In Canada, this result does not change even by adding the energy and non-energy commodity price shock to the SVAR framework. For Australia, even by bringing commodity price to the analysis, the dominance of demand shock in explaining the variance of real exchange rate is unchanged.

Two notable points in the SVAR analysis are: first, for the monetary shock in the SVAR framework, comparing the pre-1993 to post-1993 periods, we observe a significant increase in the effect of monetary shock on variance of the real exchange rate of Canada but not Australia. Possibly Canada is more influenced by expansion of capital markets in our second subsample (1993-2014). Second, in the SVAR analysis where we apply the first differences of data, some characteristics of the models are ignored. In both countries, by excluding the cointegration relationship between the real exchange rate and its fundamentals, as SVAR does, the productivity shocks are no longer the major source of movement of real exchange rates. The approaches of SVAR and SVECM are different in the sense that, in the latter, we consider the cointegration relationship between variables while, in the former, we do not. However, they are similar in applying long run restrictions in the process of identifying structural shocks.

Our new equations for Canada and Australia contribute to our understanding of the dynamic of exchange rates in these two developed commodity exporting countries and for the ongoing debate about the place of the exchange rate regime in monetary policy. Our equations point to three forces influencing the real exchange rates of these countries: commodity price index in each country; the CPI of both countries against the US; productivity and government spending differentials relative to the US. Plugging any information or predictions regarding the future of these factors into our proposed equations for Australia and Canada, may provide us with the future dynamic of real exchange rates of these countries; consequently monetary authorities may better execute proper policies.

For future work, we suggest several research avenues. First, including short term variables (such as interest rates) and other explanatory factors (such as risk premium) to our long run Canada Bank Equation may cause an improvement in the equation. Second, in the Meese and Rogoff (1983) framework, the out-of-sample forecasting of our equations in Canada and Australia may be tested to find if it can beat a random walk. Third, investigating the nature of the demand shocks in the SVAR analysis of the framework of Clarida and Gali to find to what extent they are linked to fiscal shocks. Fourth, searching for new explanatory fundamentals, especially variables which describe the dynamic of the US dollar against the other major currencies, because these factors are not directly captured in the equation. Fifth, for Canada, we use the new BCPI data set which is built on the base of the composition weights of commodities production in Canada; so, as Orr (1999) points out, for real exchange rate analysis, it would be more appropriate to construct a data set with weights of composition of commodities which Canada exports. Sixth, in Canada, in addition to conventional oil wells, there are huge oil sand mines. With the increase in oil price in the last decade, profitable oil extraction from oil sands has already started. If the oil price passes a certain threshold, then this may bring non-linearity to the relationship between the real exchange rate and oil price. Seventh, in our analysis, any increase in commodity price is treated the same but a more clear modelling of real exchange rate dynamics may distinguish between a negative commodity supply shock and a positive demand shock – both of which raise commodity prices. Eighth, as noted by Rossi (2006), parameter instability can be a major problem in economic time series modelling. The evolution of our proposed equations may be better represented by time varying analysis. Ninth, for the decomposition of structural shocks in SVECM framework, we apply the method of King et al. (1991), it would be interesting to check other alternative methods such as that of Gonzalo and Ng (2001), and that of Pagan and Pesaran (2008).

The intention of this thesis is to contribute usefully to the fields of the real exchange rate of developed or developing commodity exporting countries and international finance; and to inspire further research.

Part VI

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Figures

Figure 1- Nominal Oil Price in US Dollar Versus Real Trade Weighted U.S. Dollar Index, 1988--2012

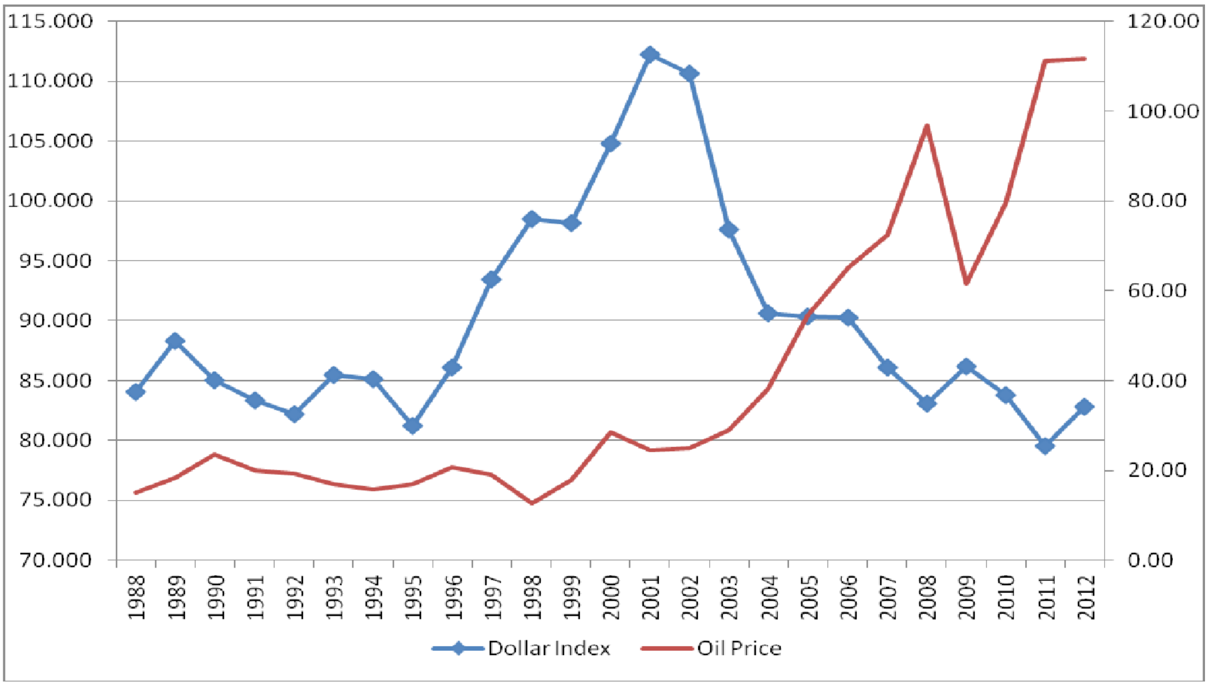


Figure 2 -- Inflation in some of the Persian Gulf Oil Exporting Countries, 1980-2011

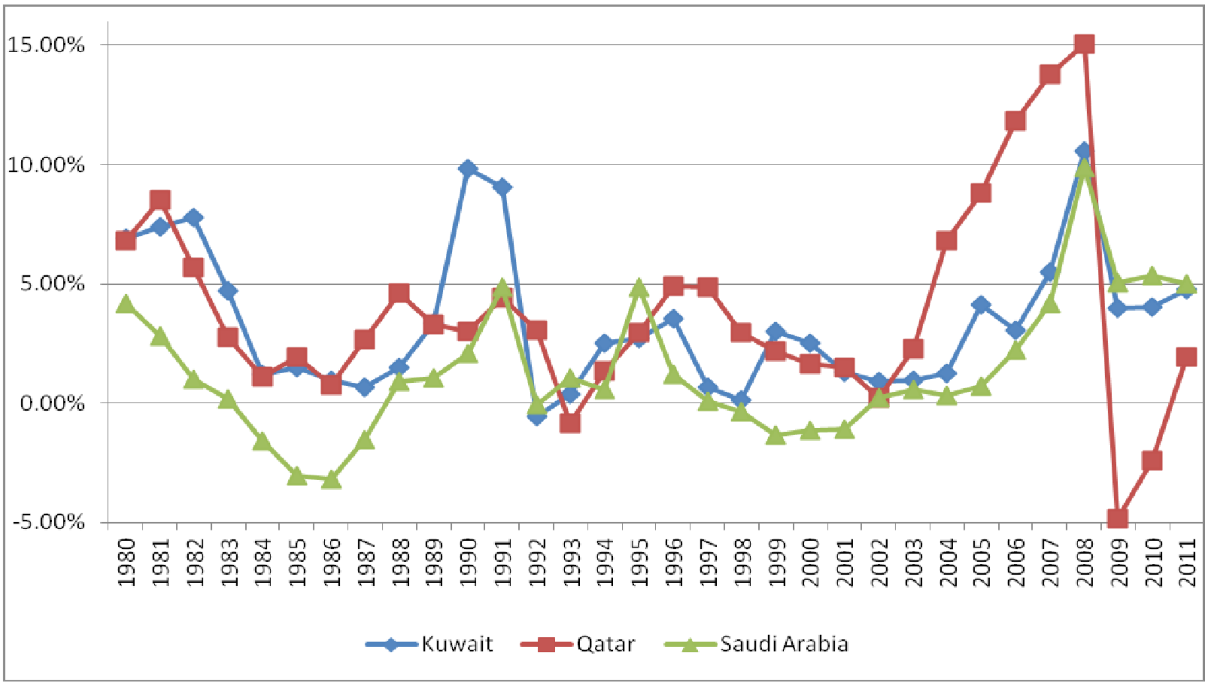


Figure 3- Correlations Between Government Spending and GDP, 1960-1999

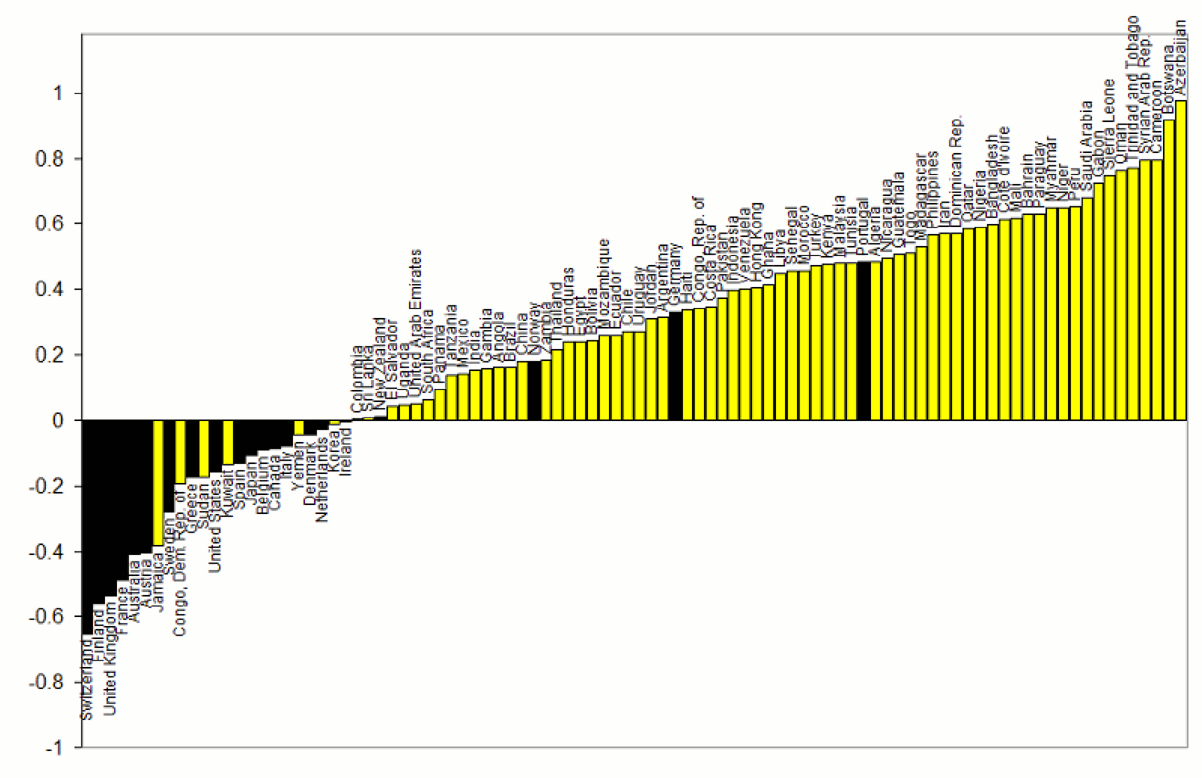


Figure 4- Correlations between Government Spending and GDP, 2000-2009

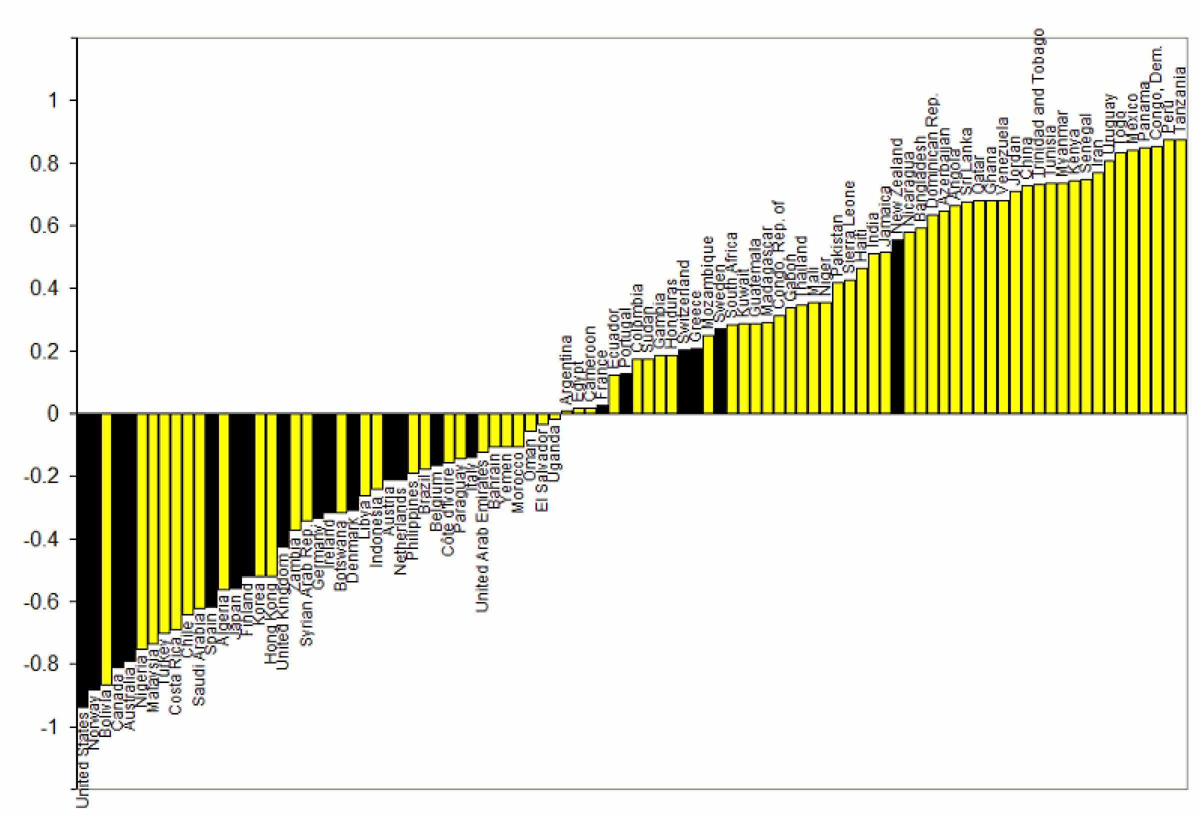


Figure 5 - Nominal Average Annual Oil Price in US $ (1980-2011)

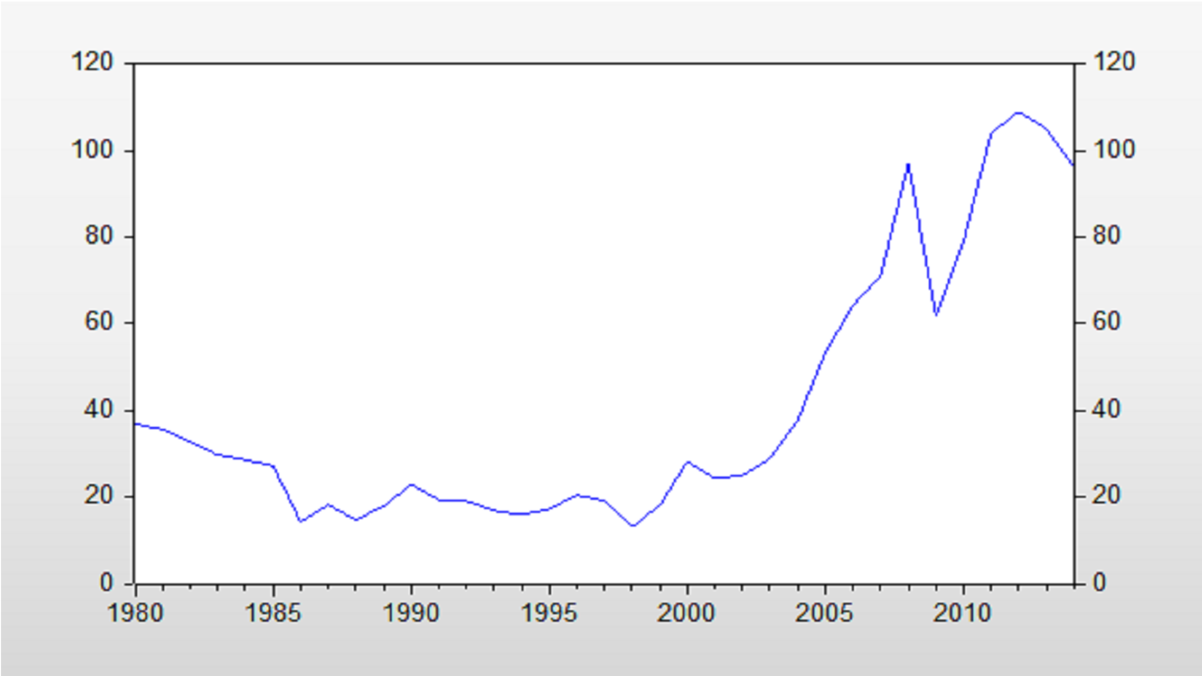


Figure 6 - Real Effective Exchange Rates, 1980--2011, (Index: 2007=100)

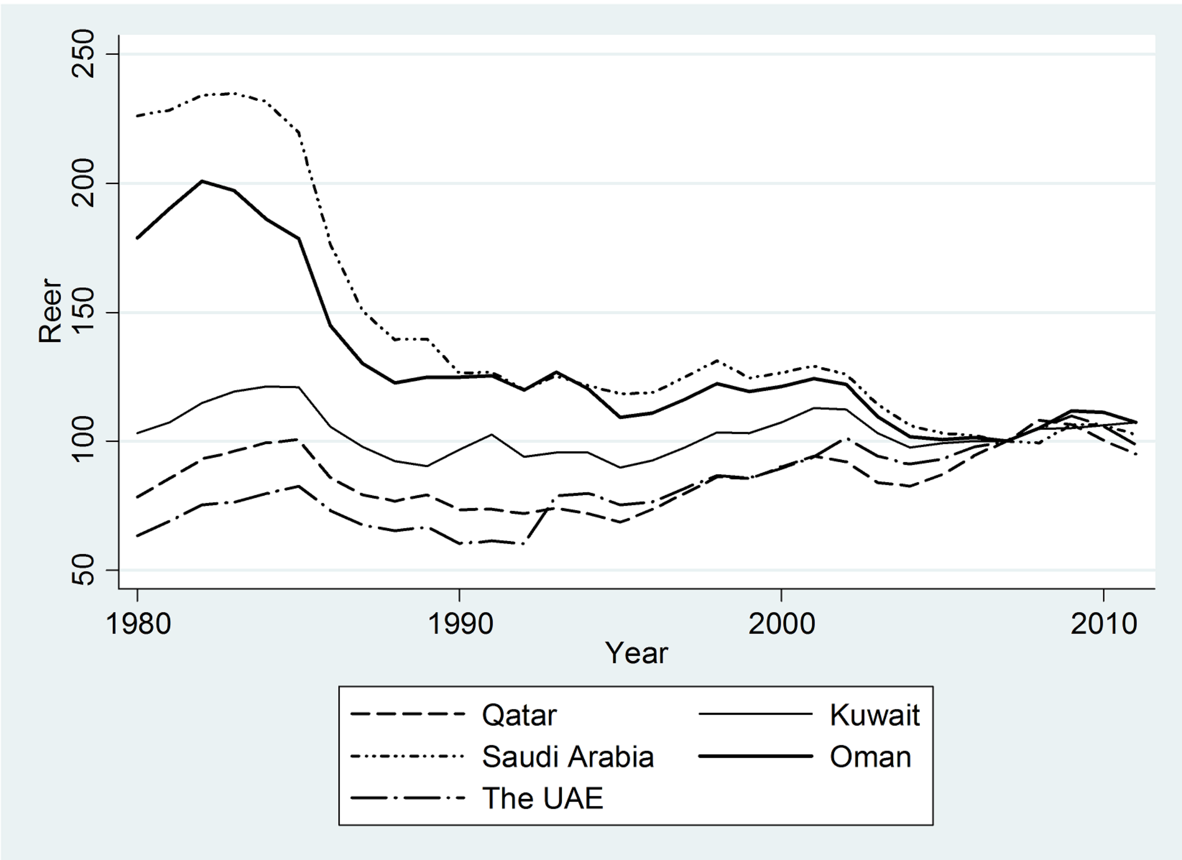


Figure 7 - Productivity Differentials (Relative to Main Trading Partners) in Logs

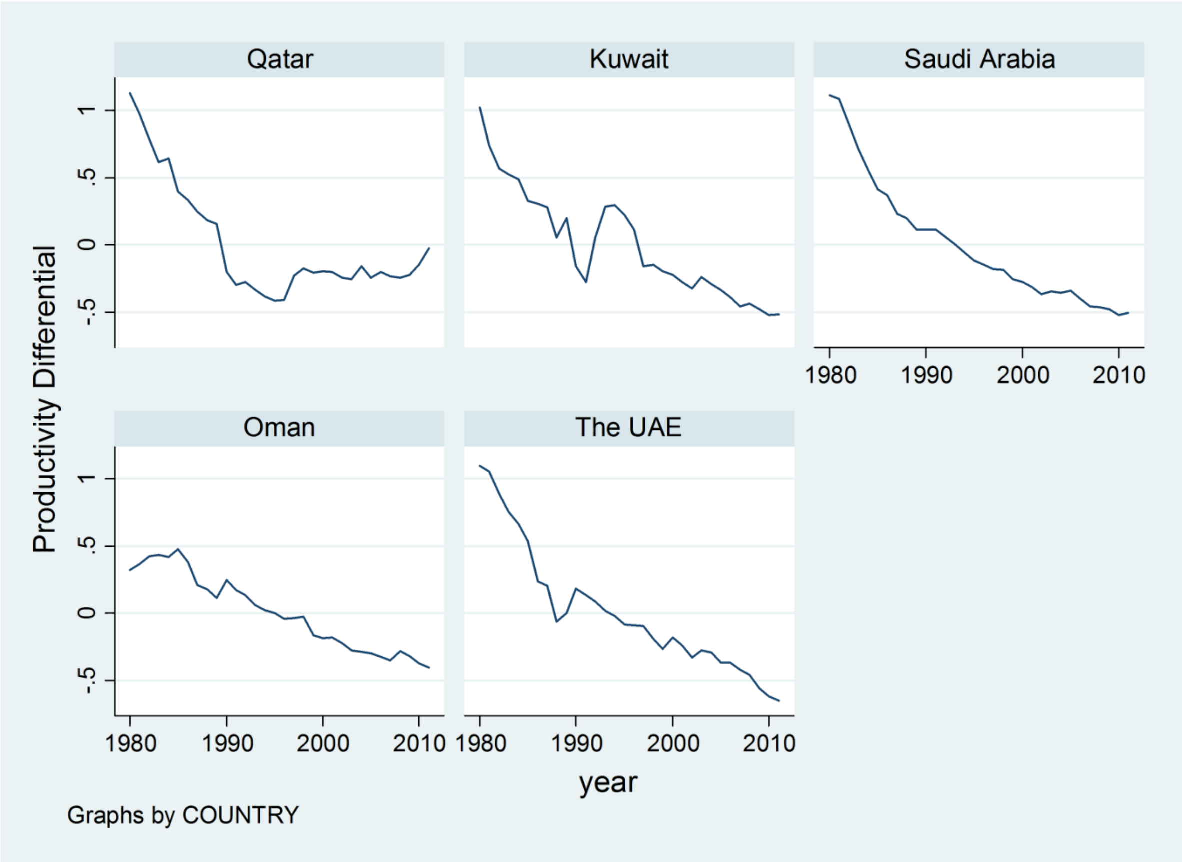
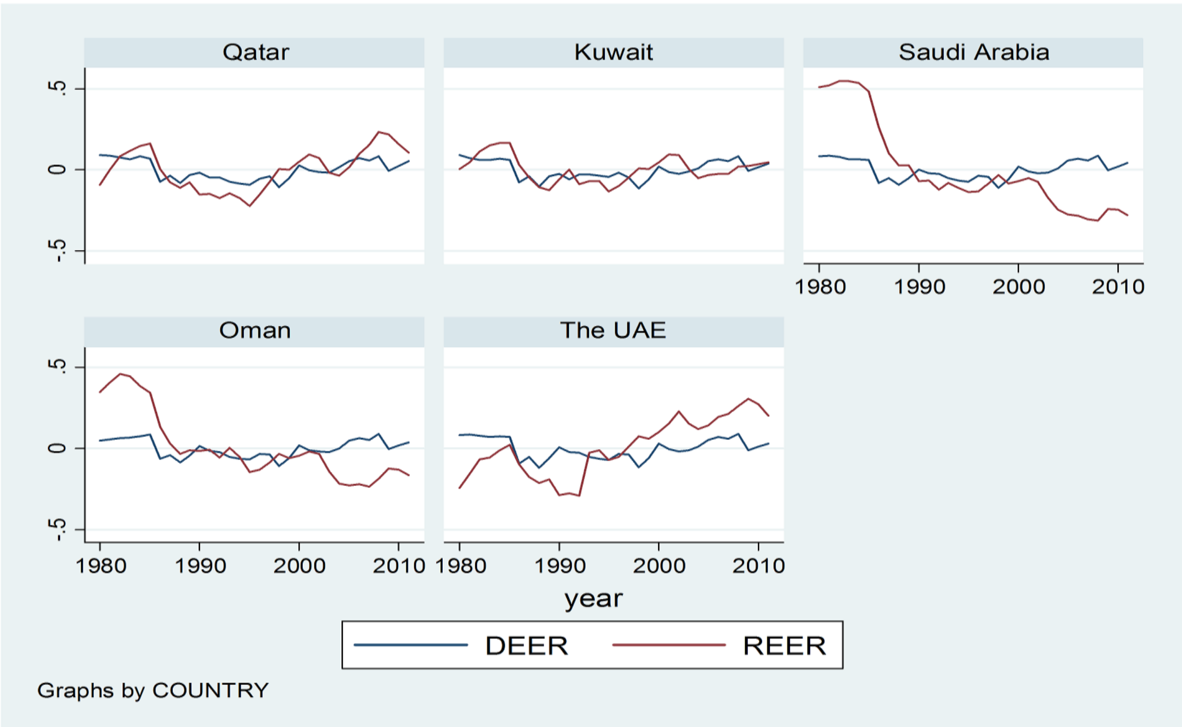
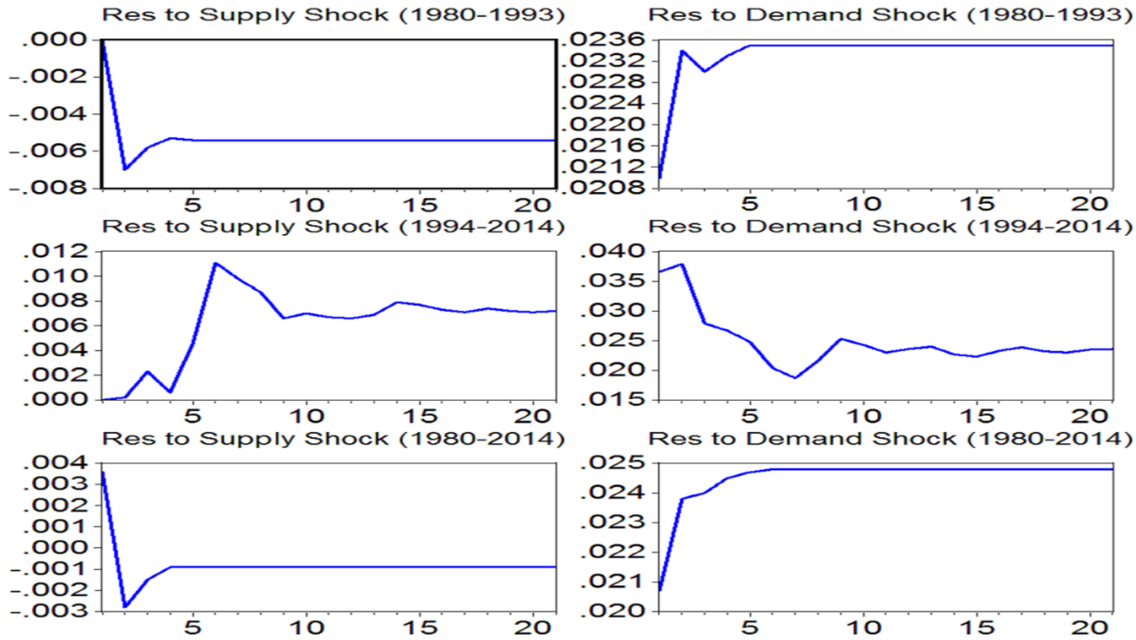


Figure 8 - REER and BEER based on PMG or FMOLS and DOLS (1980-2011)



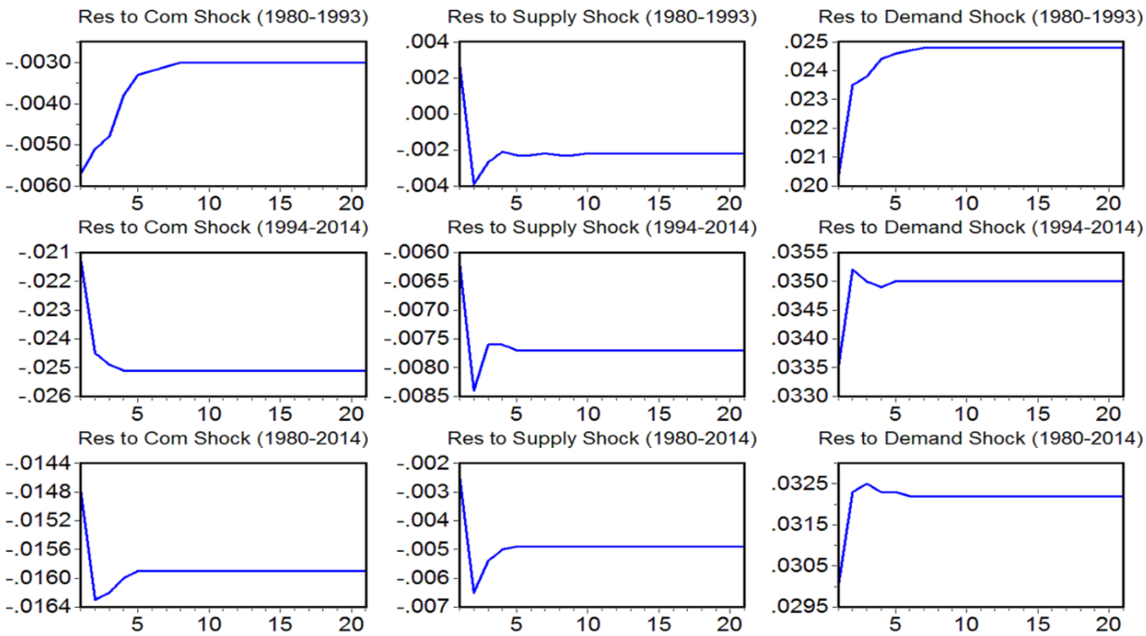
Note: The REERs and BEERs are in log and demeaned. The coefficients for the DOLS and FMOLS methods are very close; therefore, their BEER values are almost identical. (Index: 2007=100)

Figure 9 – Responses of Real Exchange Rate (qcpi) to Supply and Demand Shocks



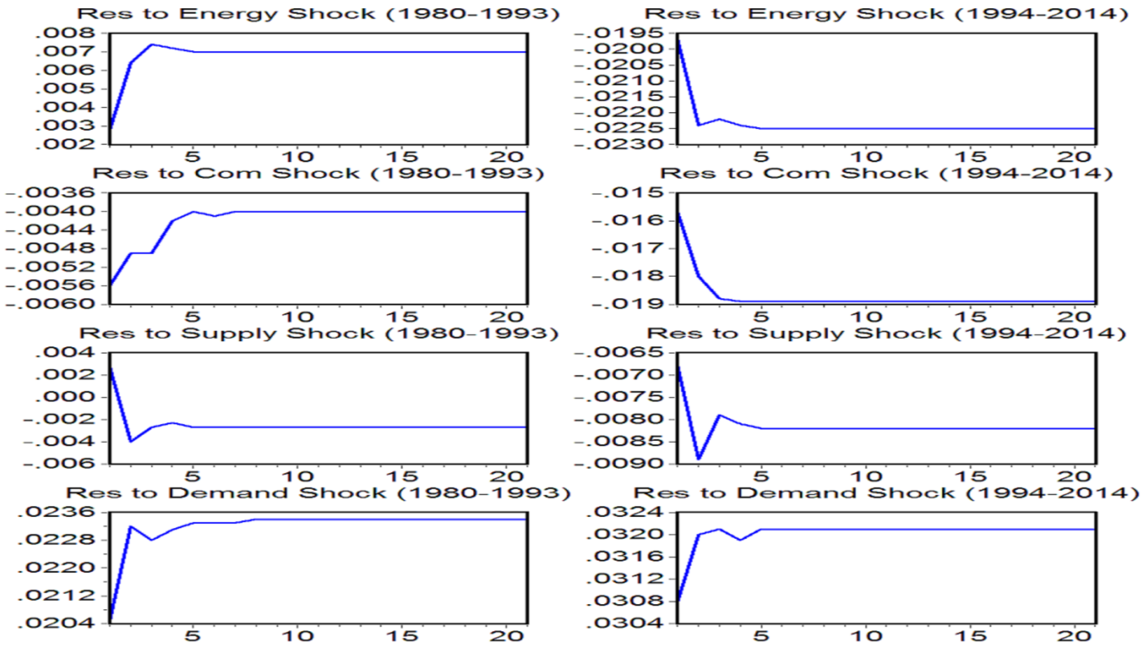
Note: Supply and Demand shocks are shock to Δy_1 and Δqcpi, respectively.

Figure 10 - Responses of Real Exchange Rate (qcpi) to Com, Supply and Demand Shocks



Note: Non-energy commodity, Supply and Demand shocks are shock to Δcom,Δy_1 and Δqcpi, respectively.

Figure 11 - Responses of Real Exchange Rate (qcpi) to Energy, Com, Supply and Demand Shocks



Note: Energy, Non-Energy commodity, Supply and Demand shocks are shock to Δene, Δcom, Δy_1 and Δqcpi, respectively.

Figure 12 - Responses of Real Exchange Rate (qcpi,qgdp) to Different Shocks (1980-2014)

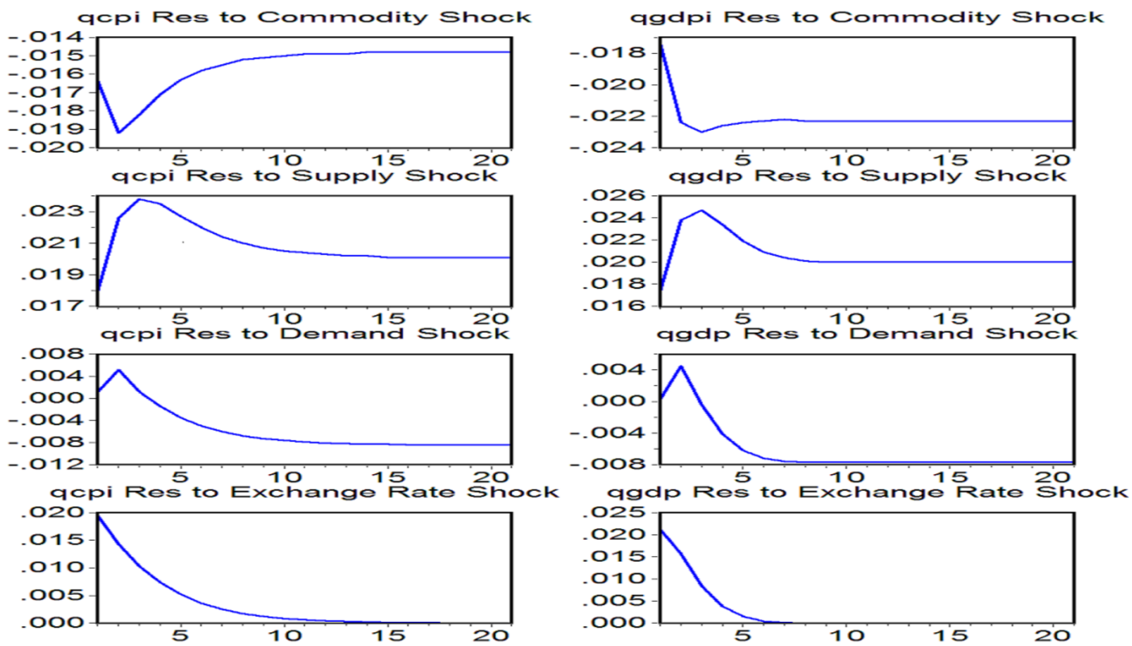


Figure 13 - Responses of Real Exchange Rate (qcpi,qgdp) to Different Shocks

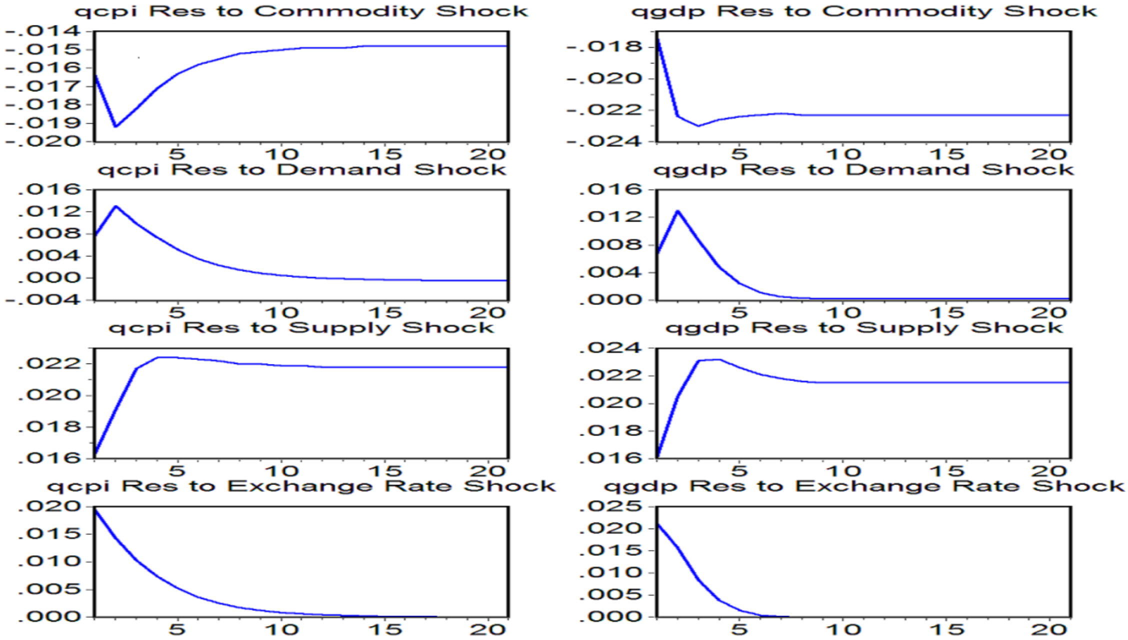


Figure 14 - Responses of Real Exchange Rate (qcpi,qgdp) to Different Shocks (In the alternative case)

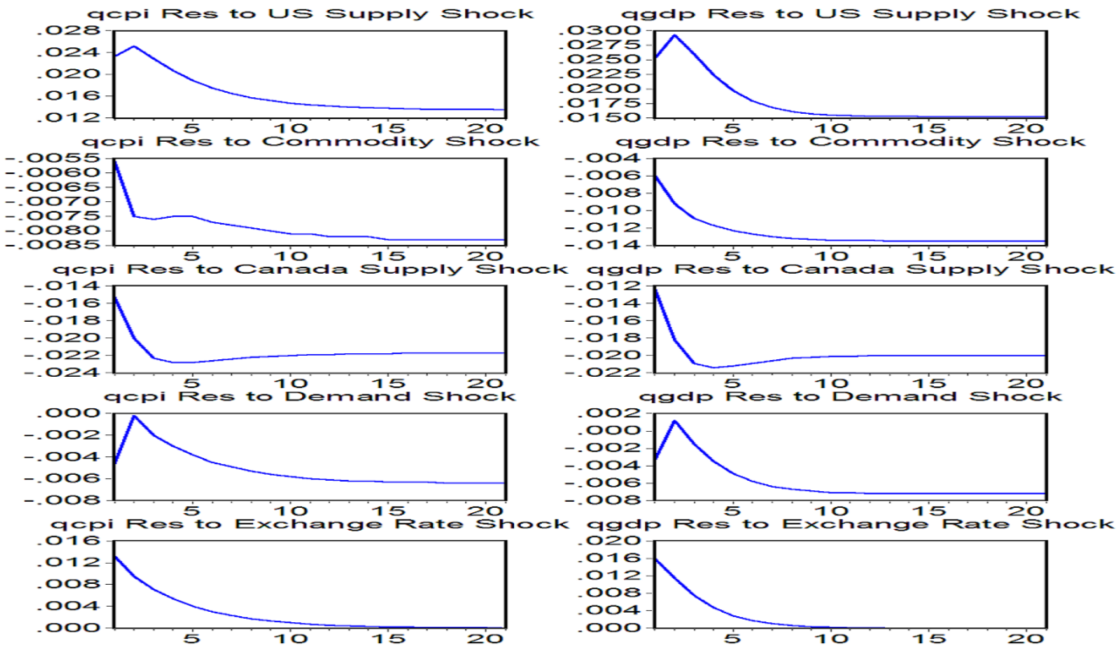


Figure 15 - Responses of Real Exchange Rate (qcpi) to Supply and Demand Shocks (Australia)

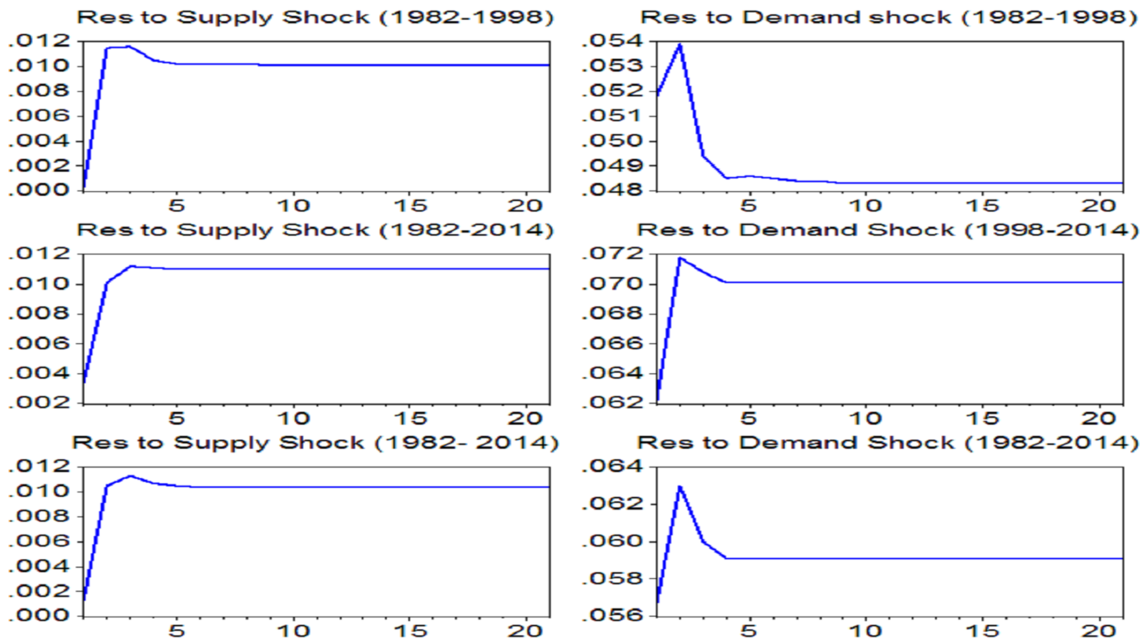


Figure 16 - Responses of Real Exchange Rate (qcpi) to Com, Supply and Demand Shocks

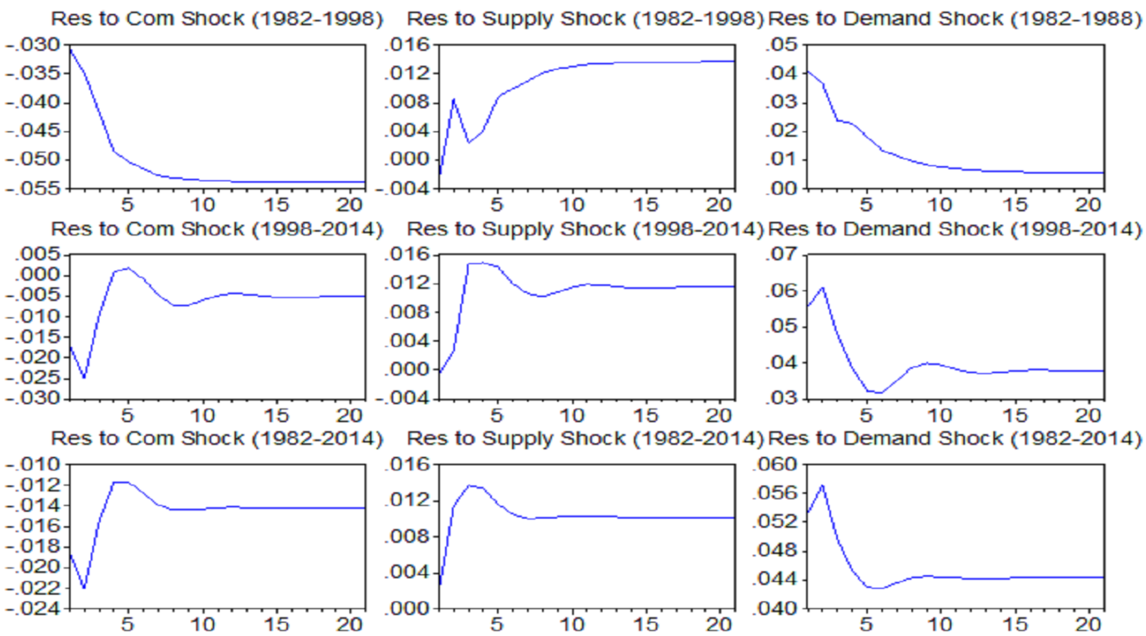


Figure 17 - Responses of Real Exchange Rate (qcpi;qgdp) to Different Shocks (1982-2014)