THE RELATIONSHIP BETWEEN EXCHANGE RATE, UNEMPLOYMENT AND INFLATION IN SOUTH AFRICA

by

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DECLARATION

I declare that the **"*The relationship between exchange rate, unemployment and inflation in South Africa*"** hereby submitted to the University of Limpopo, for the degree of Master of Commerce in Economics has not previously been submitted by me for a degree at this or any other University; that it is my work in design and execution, and that all material contained herein has been duly acknowledged.

Semosa, PD (Mr) **16 March 2017**

Surname, initials (title) **Date**

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ABSTRACT

The relationship between unemployment, exchange rate and inflation has been a subject of debate for many years. Given the fact that South Africa is faced with a very low economic growth rate, inflation rate which is likely to go beyond the upper band of 6 percent and a high level of unemployment, policy makers are often faced with the trade-off between unemployment and inflation rate in the country. The purpose of this study is to determine the relationship between exchange rate, unemployment and inflation in South Africa. The study employed Johansen cointegration procedures and the vector error correction model (VECM) to capture the relationship between the variables. The Engle-Granger causality test was also employed to analyse causality amongst the variables. The results of Johansen cointegration test indicate that there is a long-run equilibrium relationship between the variables. The VECM also confirmed the existence of short-run equilibrium relationship between the variables. The nature of the relationship indicates that there is a significant negative relationship between unemployment and inflation in South Africa. This implies that policy makers are been faced with the trade-off between these two variables. The results further indicate that inflation is positively related to exchange rate, meaning a depreciation of the Rand (South African currency) in the foreign exchange market will feed to inflation in the home country. Furthermore, it is also indicated that unemployment is positively related to exchange rate. Meaning, a depreciation of the Rand in the foreign exchange market increases the level of unemployment in South Africa. All the results appeared to be significant. Policies aimed at lowering unemployment and inflation rate are recommended. It is also recommended that policy makers in South Africa take measures to improve the quality of education, skills training and steps to increase the labour intensity of production.

Keywords: Exchange rates, Inflation rate, Unemployment, Vector Error Correction Model (VECM), Johansen cointegration and Augmented Dickey-Fuller test (ADF)

JEL Classification: B22, B23, E03, E10, F31 and F62

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LIST OF ABBREVIATIONS

ADF: Augmented Dickey-Fuller

COSATU: Congress of South African Trade Unions

CPI: Consumer Price Index

DTI: Department of Trade and Industry

EPWP: Extended Public Works Programme

GDP: Gross Domestic Product

LRPC: Long Run Phillips Curve

NGP: New Growth Path

PP: Phillip-Perron

PPI: Producer Price Index

RDP: Reconstruction and Development Plan

SARB: South African Reserve Bank

SRPC: Short Run Phillips Curve

Stats SA: Statistics South Africa

VAR: Vector Autoregressive

VECM: Vector Error Correction Model

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

The relationship between unemployment, exchange rate and inflation has been a subject of debate for many years. This came as a result of conflicting opinions and disagreements amongst different economic schools of thoughts. Unemployment is a universal problem with which the political leadership of almost every country has to fight against. Even the United States of America which has emerged as the dominant economy of the global village, has been forced to invest considerable resources in job creation and economic development programmes aimed at reducing institutional unemployment (Mafiri, 2002). It is noted that economic performance of a country depends to a large extent on the nature and quality of economic policies such as fiscal policy and monetary policy. That's one of the main contributing factors for the government of every country to try and come up with appropriate policies that can help in addressing the main macroeconomic objectives.

The process of globalisation plays a very important role in stabilisation of monetary policy of countries, achievement of price stability and decrease rates of inflation (Kochetkov, 2012). Policies have been suggested and implemented to address the issue of unemployment and economic growth in many countries, but still the unemployment level is very high and most economies are growing at a slower pace. The question on whether the existing policies that are meant to address unemployment and economic growth are failing is another topic to be researched

Just like other countries, South Africa is faced with the challenge of high level of unemployment and low rate of economic growth. This lodged a serious concern to different stakeholders in the country. Congress of South African Trade Unions (COSATU) and the manufacturing sector (2011) suggested that perhaps the South African government should take measures that can lead to depreciation of the rand in order to boost exports in South Africa. The belief in this view was that, as the rand weakens, more of the domestically produced goods will be bought in the international market and this will help in job creation and the growth of the economy.

Theoretically, it is accepted that a depreciated currency leads to a higher demand of the domestic goods and consequently a higher level of output and employment in the economy. A study by (Rodrik, 2003) also denote that if the exchange rate is preserved at a level competitive enough to encourage firms to participate in the global market, firms will invest more, hire more, and expand production. However, currency appreciation can hinder the competitiveness of domestic goods in the international market and boost domestic demand for foreign goods. This implies that if the domestic currency (which is the Rand in case of South Africa) becomes strong, the price of the domestically produced goods will be expensive in the international market and foreign buyers will go for cheaper products from other countries. On the other hand, currency appreciation will reduce the prices of imported capital and intermediate goods. This will reduce the cost of production for domestic firms that rely on imported capital and intermediates goods. It can also help in managing the rate of inflation as the prices of goods and services will tend to decrease in response to the decrease in the cost of production.

The exchange rate plays a vital role in a country’s level of trade and other transactions with economic agents in other countries. This is very much important in the world economy because countries need foreign currencies to perform international transactions for goods and services. The stability of the exchange rate is also important for economic growth and stability in the economy, especially for countries such as South Africa in which the exchange rate fluctuates frequently. According to (Mohr, 2012), the government authorities have control over aggregate demand through monetary and fiscal policies and hence over the level of unemployment and the corresponding rate of inflation. This implies that the level of unemployment and inflation depends on the structure of the economy and on the level and rate of change of aggregate demand.

The concept of a weak rand (South African currency) versus a strong rand has been a subject of debate by both the government, business sector and the labour unions. However, the debate on whether the South African government should devalue the rand to improve its economic growth and the level of unemployment is still another topic to be researched. Economists agree that there is a link between exchange rate, economic growth, unemployment and inflation. However, there can be favourable or unfavourable consequences of the fluctuations of the exchange rate on macroeconomic variables of a country depending upon the shared relationship (Rehman, 2014). The performance of the economy also influences the exchange rate fluctuations. The concept of exchange rate fluctuation should not be confused with rand devaluation. It must be noted that exchange rate fluctuation refers to a movement or change in the value of one currency against another currency due to various economic factors. Hence, rand devaluation refers to a decrease in the value of one currency against another currency by the government. Given the possible consequences of the exchange rate fluctuations, it is necessary to determine the relationship between the exchange rate, unemployment and inflation in South Africa. The study attempts to provide an in-depth analysis of the relationship between the exchange rate, unemployment and inflation in South Africa. The exchange rate or the exchange value of the rand will be measured against the US dollar because the US dollar is serving as the central reserve in the foreign exchange market.

1.2 RESEARCH PROBLEM

Given the fact that South Africa is faced with a very low economic growth rate, inflation rate which is likely to go beyond the upper band of 6 percent and a high level of unemployment, policy makers are often faced with the trade-off between unemployment and inflation rates in the country. Statistics South Africa (Stats SA) reported that the Gross Domestic Product (GDP) expanded by only 0.90 percent in the first quarter of 2013 with unemployment at a rate of 25 percent (Stats SA, 2013). In the first quarter of 2016 GDP was reported at -1.2 percent and unemployment rate was 26.7 percent. Inflation rate for April 2016 was reported at 6.2 and 7 percent for Consumer Price Index (CPI) and Producer Price Index (PPI) respectively (Stats SA, 2016). On the other hand, the exchange rate between the South African Rand and the US dollar was trading at roughly R15.77 per US dollar in the first quarter of 2016 (South African Reserve Bank, 2016). This launched a very serious concern to the government, trade unions, business sector and the unemployed citizens of South Africa.

The South African Reserve Bank (SARB) argued that a weak rand has contributed to a high inflation rate of 6.2% in the third quarter of 2013, which was beyond the target of between 3 to 6 percent (SARB, 2016). Tapiwa (2007) also noted that South Africa has a free floating exchange rate as well as an open trade policies which leave the country's export, producer and consumer prices vulnerable to the effects of exchange rate movements. Based on the arguments which were raised by COSATU and the manufacturing sector in 2011 the study also looks into perception that a strong rand constrain the export growth as well as economic growth. The study will also focus on whether a weak rand would indeed raise economic growth sustainably.

The adoption of inflation targeting framework in February 2000 by the South African Monetary Authorities seems to have created an impression that more attention is paid on the rate of inflation than the level of employment in the country. This led to suggestions by the manufacturing sector that perhaps the government should use the exchange rate policy to address the issue of unemployment and economic growth in the country. The problem for which an answer is sought in this study is whether a weak rand can be used to promote the level of employment as well as the growth of the economy sustainably. The study will look more into the relationship between exchange rate, unemployment and inflation in South Africa.

1.3 THE PURPOSE OF THE STUDY

An improved understanding of the relationship between the exchange rate, unemployment and inflation would provide policy makers and economic advisors with a greater depth of knowledge when making decisions about policies (Owen, 2005).

1.3.1 The aim of the study

The aim of the study is to determine the relationship between exchange rate, unemployment and inflation in South Africa.

1.3.2 Research questions

This dissertation is conducted more specifically to answer the following research questions:

- What is the relationship between unemployment and inflation in South Africa?
- What is the relationship between unemployment and exchange rate in South Africa?

- What is the relationship between inflation and exchange in South Africa?
- What is the degree of influence between exchange rate, unemployment and inflation?

1.3.3 The objectives of the study

More specifically, the study is conducted to achieve the following objectives:

- To determine the relationship between the unemployment and exchange rate in South Africa.
- To determine the relationship between inflation and the exchange rate in South Africa
- To determine the relationship between the unemployment and inflation rate in South Africa
- To find out the degree of influence between exchange rate, unemployment and inflation

1.4 SIGNIFICANCE OF THE STUDY

The need for this study arises because the South African economy has been faced with high level of unemployment and low economic growth. For years policies have been and are still even today been implemented to create an economy that is conducive for employment creation. These include policies such as Reconstruction and Development Plan (RDP), New Growth Path (NGP) and Extended Public Works Programme (EPWP). Their main aim was to create employment opportunities for the South African citizens, but judging by the persistent high rate of unemployment, one would be tempted to argue that these policies did not deliver much.

It has been noticed that the existence of both empirical and theoretical interaction between the exchange rate, unemployment and inflation has been established. Moreover, the interest of carrying out this study was also motivated by the fact, based on the literature reviewed, that most studies focused on other economies rather than the South African economy. The study will focus on the South African economy.

Therefore, the researcher hopes to contribute in a positive way on the existing academic literature by providing an in-depth analysis of the relationship amongst the selected macroeconomic variables. The study will also assist policy makers at the South African Reserve Bank, the department of trade and industries (DTI) and the government to come up with better policies that will help in the improvement of the South African economy.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter discusses the overview of unemployment, exchange rate and inflation in the country. The discussion of theoretical literature and empirical evidence related to this study is also discussed. The chapter starts by explaining the overview of variables individually. This is followed by the discussion of theoretical framework, which explains key variables and align them with theories that support the relationship between unemployment, exchange rate and inflation. In conclusion, the chapter present an empirical literature which outlines the findings of previous studies related to this study.

2.2 An overview of exchange rate, unemployment and inflation

This section presents the overview of exchange rate, unemployment and inflation in South Africa.

2.2.1 Exchange rate in South Africa

Foreign trade involves the payments of goods and services using other foreign currencies such as euro (€), pound sterling (£), US dollar ($) and Japanese yen (¥) (Mohr, 2012:109). South African industries or households who are willing to buy goods and services from other countries need to convert their home currency (Rand) into the foreign currencies where the goods and services are coming from. On the other hand, foreign citizens or companies which are interested in buying goods and services from South Africa also need to convert their home currencies into Rands. This process will help in the smooth running of transactions between countries. The most important question been asked by trading parties is how much to spend in order to get another currency, which is referred as the exchange rate, that is the price of foreign currency expressed in terms of the home currency (Feenstra and Taylor, 2008).

The exchange rate can be quoted in two different ways, namely; the direct method and the indirect method (Mohr, Fourie and Associates, 2005). The direct method shows how much of the home currency have to be paid for one unit of the foreign currency. For example, if South Africans need to pay R16.00 to obtain one US dollar, the direct method will state that $1 = R16.00 (Mohr, et al., 2005). Based on the above example, the indirect method will state that R1 = $0.0625, meaning only 0.0625 US cents is required to purchase one rand.

2.2.1.1 The history of the South African currency

The first official currency used in South Africa was the Guilder, which consisted of coins only. During the late 17th century, the country started to use the Rixdollar which was the first South African currency to include paper notes. History also tells us that during the British occupation, in 1826, the Cape colony was put on sterling basis, through other currencies, including the Spanish dollar, US dollar, French francs, and Indian Rupees. In 1921, the South African Reserve Bank (SARB) was established as the central bank of South Africa. In 1961, the South African Rand replaced the pound under a decimalised system.

2.2.1.2 Different kinds of exchange rate systems

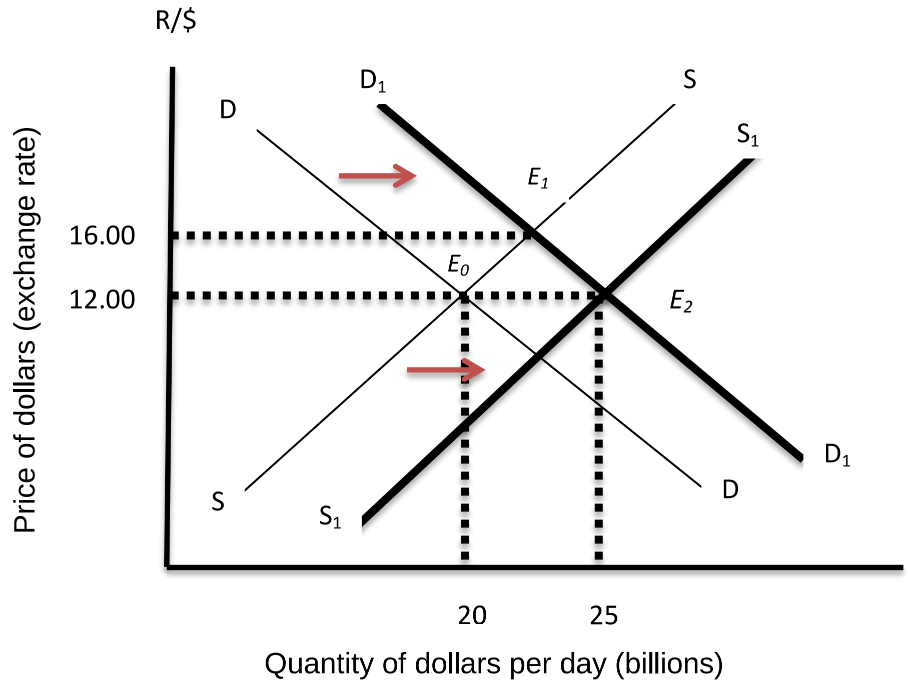
There are three different kinds of exchange rate systems, namely; fixed exchange rate, managed floating exchange rate and free floating exchange rate (Mohr, 2012). A fixed exchange rate refers to a country's exchange rate regime under which the government or central banks decide the official exchange rate to another country's currency (Parkin, Powell and Matthews, 1997). The exchange rate is determined by the decision from the government or the central bank and this will be achieved by the central bank's intervention in the foreign exchange market to block the unregulated forces of demand and supply (Parkin, 2013). The main purpose of a fixed exchange rate is to maintain a country's currency value within a very narrow band. The problem of using fixed exchange rate lies on the fact that the country has no control over its inflation rate (Parkin, 2013). Under managed floating exchange rate system; Owen (2005) argues that the value of a country's exchange rate is not fixed but rather influenced by the central bank's intervention in the foreign exchange market. This implies that the exchange rate is determined by the market forces but the central bank keeps a close eye to influence the value of a country's currency. However, in free floating exchange rate, the value of a country's currency exchange rate is determined by the market forces (which is the demand and supply of foreign exchange). If the country is using free floating exchange rate system, the government or central bank does not intervene direct in foreign exchange market. The market forces are freely to determine the prices of exchange rate.

Before the adoption of inflation targeting framework in February 2000, the SARB practiced the system of managed exchange rate from the 24th January 1979.

2.2.1.3 Managed-floating exchange rate system

The government of South Africa through the SARB might take measures that can influence the exchange rate, but as it stands they do not have complete control of the exchange value of the rand in the foreign exchange market. Figure 2-1 demonstrates how the SARB can influence the exchange value of the rand in the foreign exchange market.

Figure 2-1 Managed-floating exchange rate



Source: Author, adapted from Mohr (2012)

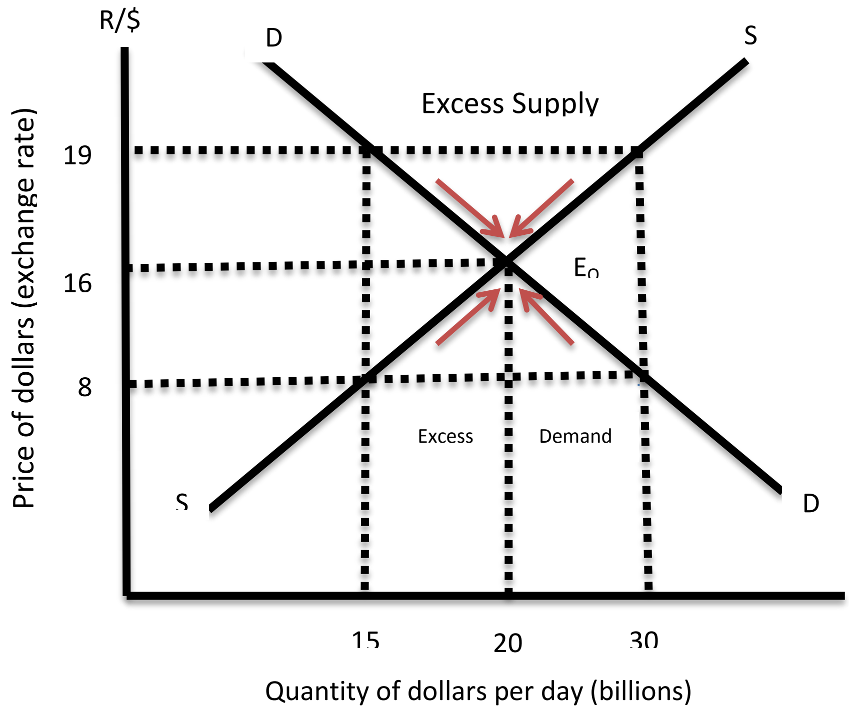
Figure 2-1 presents an illustration of the exchange rate between South Africa and the United State of America under the managed floating exchange rate system. The vertical axis measures the price of dollars and the horizontal axis measures the quantity of dollars exchanged per day, measured in billions. DD and SS represent the original demand and supply curves respectively. The equilibrium price is R12.00, while the equilibrium quantity is 20 billion per day. Point E_0 represents the original equilibrium point.

Suppose that the demand for US dollars increases on figure 2-1. This will shift the demand curve from DD to D_1D_1 and the exchange rate between the two currencies will increase from R12.00 to R16.00 per US dollar. In this case the South African rand will depreciate or it can be stated that the US dollar has been appreciated against the South African rand. If the SARB was monitoring the developments in the foreign exchange market and decides to intervene for the purpose of influencing the rate of exchange between the two currencies, the reserve bank can to do so by supplying foreign reserves from their balance of payment. The supply curve will shift from SS to S_1S_1. The exchange rate will remain at $1 = R12.00 and the quantities of dollars exchanged per day will now increase from $20 billion to $25 billion. One of the challenges that may face the SARB is the fact that it requires a lot of foreign reserves for the bank to have an influence in the foreign exchange market. If it happens that there is no enough foreign reserves in the country's balance of payment, the central bank will not have a full control over the influence of the exchange rate in the foreign exchange market.

2.2.1.4 Free-floating exchange rate system

From February 2000, South Africa started practising free floating exchange rate system. This means that there was no direct intervention in the foreign exchange market from either the SARB or the government of South Africa. The exchange rate was determined by the market forces as illustrated by figure 2-2.

Figure 2-2 Free-floating exchange rate



Source: Author, adapted from Parkin (2013)

Figure 2-2 is also based on the foreign exchange market between South Africa and the United State of America. The vertical axis measures the price of dollars and the horizontal axis measures the quantity of dollars exchanged per day. The original demand and supply curves are represented by lines DD and SS respectively. The equilibrium price is R16.00 and the equilibrium quantity is 20 billion dollars per day. Since there is no direct intervention in the market either by the government or the SARB, the exchange rate between the two countries is determined by the market forces.

At the price of R16.00 per US dollar, South Africans are willing to purchase 20 billion dollars per day and that exactly the quantity of dollars that suppliers are willing to sell at that particular price, and the market is said to be at the equilibrium level. Suppose that the price of dollars increases from R16.00 to R19.00 per US dollar, holding other things constant, the quantity of US dollars demanded per day will decrease from 20 billion to 15 billion. At the same time, the supply of US dollars will increase from 20 billion to 30 billion per day. The market will experience an excess supply of US dollars. However, if the exchange rate between the two currencies decreases, for example from R16.00 to R8.00 per US dollar, the market will experience an excess demand of US dollars. Suppliers are willing to supply 15 billion dollars per day while consumers are willing to purchase 30 billion dollars per day.

Since there is no government or central bank intervention in the market, it is expected that the excess supply and excess demand of dollars will be eliminated by the market forces. In the case of excess supply, the expectation is that the price of dollar per rands will decrease from R19.00 to R16.00, indicated by the arrows above the equilibrium point. In the case of excess demand, the expectation is that the rand will depreciate against the US dollar for the market to move back to equilibrium level. This is indicated by the arrows below the equilibrium point. The exchange rate will increase from R8.00 to R16.00 per US dollar. Although there is no direct intervention by the government or central bank in the system of free floating exchange rate, the government or central bank can take measures that can have an influence on the exchange rate. This can be achieved by applying the expansionary or contractionary monetary policy and fiscal policy.

2.2.2 Unemployment in South Africa

Unemployment is one of serious social and economic problems faced by South Africa. The society as a whole loses from unemployment because total production in the country is below its potential level (Dornbusch and Fischer, 1990). As much as everyone knows that unemployment is a bad thing to both the community and the unemployed, it is quite difficult to define and measure unemployment in the country (Mohr, et al., 2008). It is clear that everyone who is living without a job is unemployed, but not everyone who is unemployed is considered when measuring the level of unemployment in the country.

The estimates of the level of unemployment in South Africa are been regularly published by Statistics South Africa (Stats SA). Barker (1999) defines the unemployed person as the one who is without work, is currently available for work, and is seeking or looking for employment. This definition does not say anything with regard to age restriction and economically active population as per prescribed by Stats SA. Stats SA uses two definitions of unemployment, namely the official definition (also known as the narrow definition) and the expanded definition (Stats

SA, 2013). Before 1994, Stats SA used the official definition and arguments were raised that the estimates of the level of unemployment are very low while many people lives without jobs. From 1994 to May 1998, Stats SA switched to the expanded definition which omitted some requirements but the International Labour Office regarded the new official estimates as being too high (Mohr, et al., 2008).

The official definition defines the unemployed people as those people within the economically active population who did not work during the seven days prior to the interview. They are actively looking for work and they are also available to start within a week of interview. Furthermore they have taken active steps to look for work or to start some form of self-employment in the four weeks prior to the interview (Stats SA, 2016). This definition does not cover discouraged job seekers. The expanded definition state that unemployment occurs when a person who is unemployed is unable to find a job. The later definition includes discouraged job seekers who are not actively searching for employment. Although Stats SA publishes estimates from both definitions, they revised the definition of unemployment to the official definition because it is been used by the international labour organisation. Most definitions of unemployment requires that a person must not only want to work, but must also actively look for employment.

2.2.3 Inflation in South Africa

Inflation has been one of the most hotly debated macroeconomic issues and numerous theories have been advanced to explain this phenomenon. The problem of inflation has been experienced in each and every country in the world but the rate of inflation differs from country to country. The most common thing about this phenomenon is that it brings unpredictable gains and losses to borrowers and lenders, workers and employers, and it also diverts resources from producing goods and services to predicting inflation (Parkin, et al., 1997). According to Hyman (1992) inflation can make it difficult to plan for the future and can adversely affect the purchasing power of income and savings. Thus, inflation reduces the purchasing power of money. It is defined as a continuous and considerable rise in prices in general (Mohr, 2012). Parkin et al (1997) define it as a process of rising prices and a falling value of money. Most studies agree that it is a persistent rise in general price levels.

Economists have different perceptions on the concept of inflation. The Structuralists view it as a process that occurs through various factors within the economy. The approach retains the distinction between demand-pull and cost-push but places it in much broader text. According to the structuralist approach, inflation process is the result of interaction between three interrelated set of factors. This includes the following factors; the underlying, the initiating and the propagating factors. Therefore to explain inflation all three sets of factors have to be taken into consideration because a sustained inflation can only occur if all three factors are present.

According to the conflict approach, inflation is a symptom of fundamental disharmony in society which results in a continuous imbalance between the rate of growth in the real national income and the rate of growth of the effective claims on this income. This approach views it as a symptom of lack of economic effectiveness or political mechanism to achieve a prior reconciliation of the conflicting claims on the national income. The monetarist view inflation as a monetary phenomenon. Based on their believe, a sustained high rates of monetary growth cause inflation, and low money growth rates will eventually produce low inflation (Mohr, et al., 2008). This view is based on the quantity theory of money, which is also based on the equation of exchange.

Stats SA provides two estimates of the rate of inflation in South Africa, namely; the Consumer Price Index (CPI) and the Producer Price Index (PPI). The CPI measures how the cost of purchasing a certain standard market basket of goods and services varies from the cost of purchasing the same market basket in the base period (Hyman, 1992). It is calculated as the ratio of the current cost of a given market basket to the cost of the same market basket in the base period multiplied by 100. Once the figures for CPI are set, the inflation rate can be determined by calculating the percentage change in the CPI from one period to another.

As it has been already mentioned, another tool used to measure the rate of inflation in South Africa is the Producer Price Index (PPI). As much as the CPI measures the cost of a representative basket of goods and services to the consumer, the PPI measures prices at the level of the first significant commercial transaction (Mohr, Fourie, Associates, 2000). This includes the prices of imported goods when they enter the country and the price of manufactured goods when they leave the factory.

In general, CPI measures the cost of living while PPI measures the cost of production (Mohr, 2012).

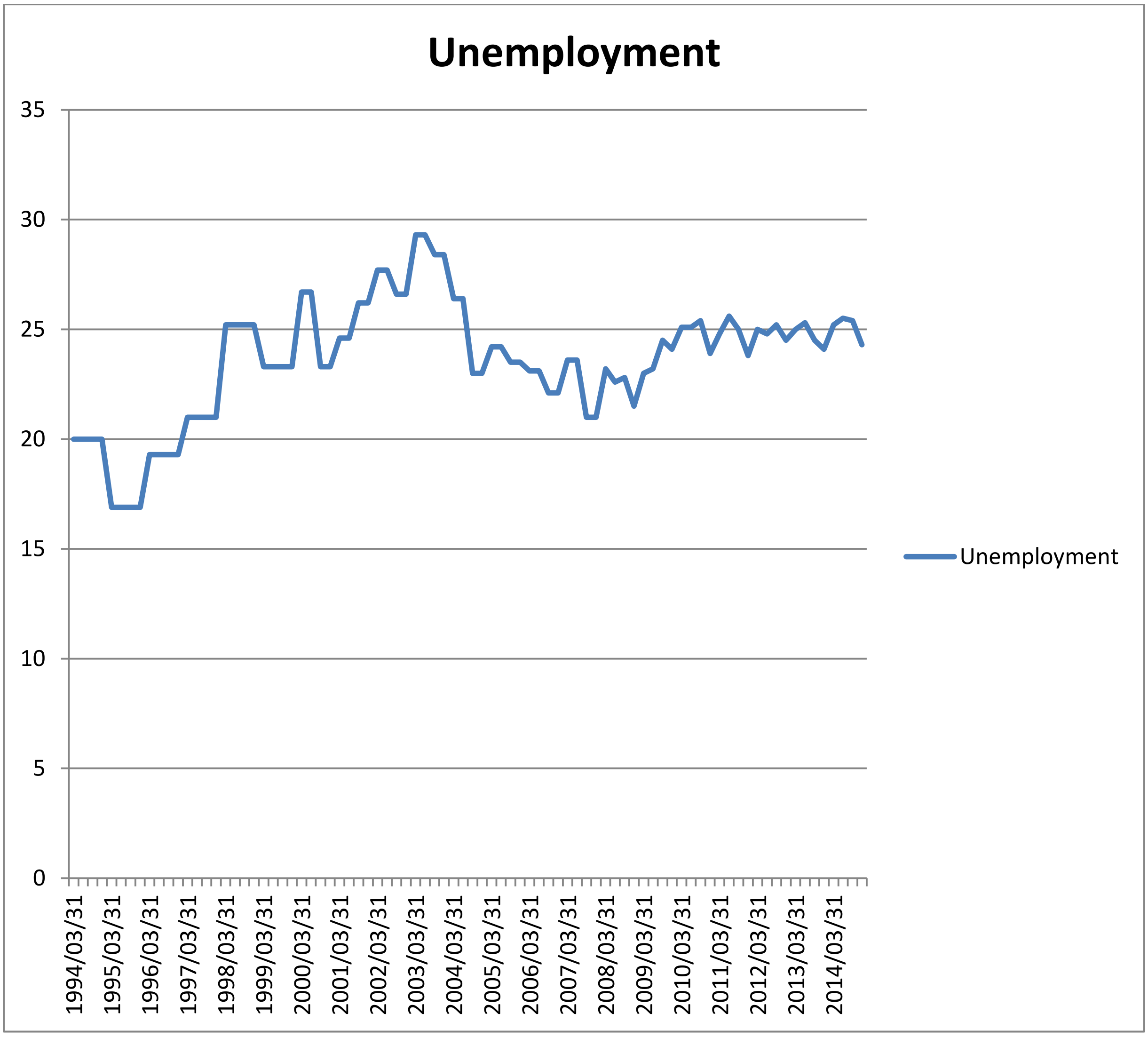
2.2.3.1 Inflation targeting framework in South Africa

Although the intentions of adopting inflation targeting framework was announced in August 1999, South Africa formally introduced it in February 2000. Inflation targeting is a monetary policy framework in which the central bank announces an explicit inflation target and implements policy to achieve this target directly (SARB, 2014). Inflation targets differ from country to country. The target in South Africa ranges between 3 and 6 percent. It is a responsibility of the SARB to achieve price stability (combat inflation) in the country. The SARB have been granted the freedom of using instruments of monetary policy to achieve the targeted inflation rate in the country. Although the SARB is operating independently, it is mandated to account to the government on regular basis. Finally SARB is using the interest rate as a monetary instrument to control inflation rate in South Africa.

2.2.4 Trends of unemployment rate, exchange rate, and inflation rate

This section discusses the trends of unemployment rate, exchange rate and inflation rate before and after the adoption of inflation targeting framework.

Figure 2-3 Trends of unemployment rate

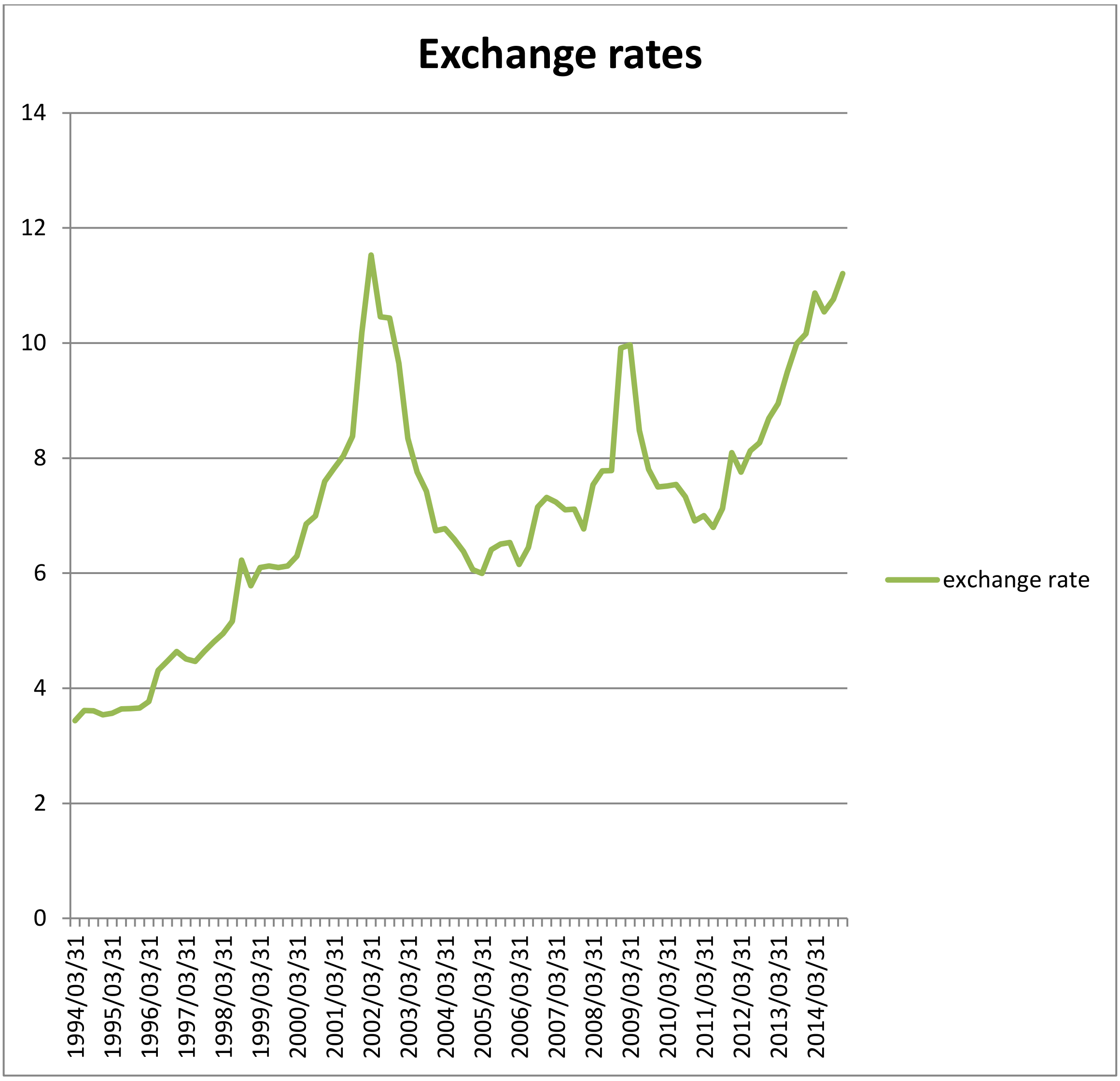


Source: Author's calculations (Data obtained from Stats SA)

In 1994, the level of unemployment in South Africa was sitting at 20% for all quarters. However, the rate decreased from 20% to 16.9% in 1995. The data shows that unemployment started to increase again from 1996 to 1998. During this period, unemployment reached 19.3%, 21% and 25.2% respectively. Later in 1999, the year in which the government announced the intentions to adopt inflation targeting framework, unemployment decreased from 25% to 23.3%. After the adoption of the framework in 2000, unemployment increased from 23.3% to 26.7% during first and second quarters. The overall analysis shows that unemployment has been over 20% from 2000 until 2014. In 2003 unemployment reached the highest level, reaching 29.3% during first and second quarter, and 28.4% during third and fourth quarter.

After the adoption of inflation targeting framework, a conclusion can be drawn that the level of unemployment has been ranging between 23% and 26%, taking into consideration that unemployment reached 29.3 in 2003.

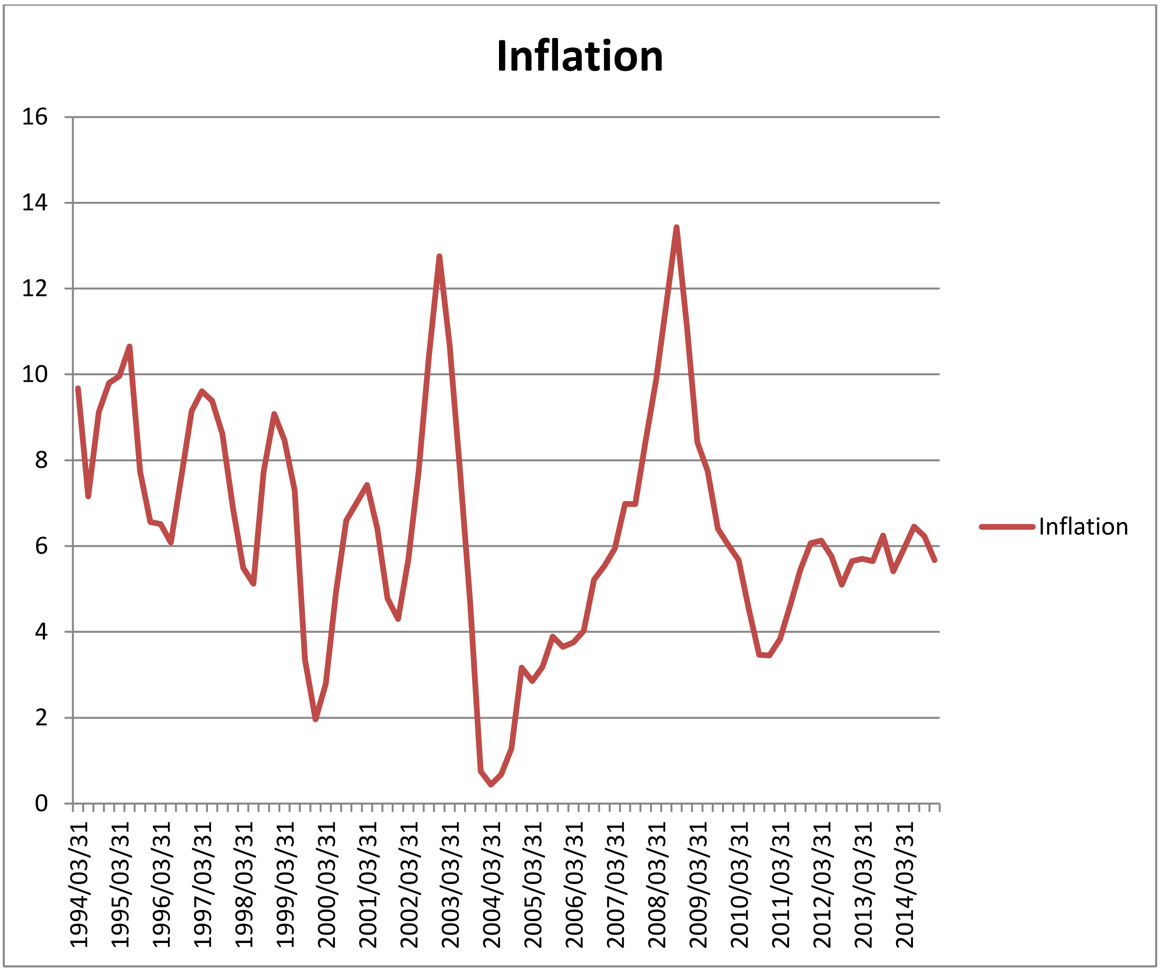
Figure 2-4 Trends of exchange rate



Source: Author's calculations (Data obtained from SARB)

The exchange rate between the South African rand and the US dollar was roughly between R3.00 and R5.00 per US dollar from 1994 until 1998 second quarter. During this period, South Africa was under the practice of managed floating exchange rate system. From 2000, the rand has been depreciating against the US dollar, reaching R11.50 per US dollar in the first quarter of 2002. The unemployment level was also on the increasing rate at that particular period. The rand appreciated from R10.00 to R8.00 per US dollar in the first and second quarter of 2003. During this particular period, unemployment reached the highest level in the country. The rand continued to gain strength from 2004 till 2008, with unemployment rate fluctuating around 23%. From 2009 the rand has been depreciating against the dollar and the unemployment level has been stuck around 25%.

Figure 2-5 Trends of inflation rate



Source: Author's calculations (Data obtained from SARB)

Inflation has been around 10% in 1994 and it has decreased to 7% in 1996. However, the rate increased to 10% again in 1997 and further decreased to 5% in 1998. After adopting the framework in 2000, the rate of inflation in the country went below 5%. In the year 2008, South Africa experienced the highest level of inflation in the country. During that particular period, inflation rate was 13.4%. This was during the period of world depression. From 2009 until 2014, the rate of inflation in the country has never over lapped the level of 7%. This can provide more evidence that the framework is really doing very well when coming to the issue of putting inflation rate within the target.

2.3 THEORETICAL FRAMEWORK

This section presents the theories that support the relationship between unemployment, exchange rate and inflation which includes the following: the Keynesian Theory of Unemployment, Unemployment in the theory of innovation, the quantity theory of money, the Market-Power theory of inflation, the Structural theories of inflation and the Purchasing Power Parity (PPP theory). The AD-AS model and the Phillips curve are also explained in this section. This is followed by the discussion of the overview of unemployment, exchange rate and inflation in the country. The history of the South African currencies is also discussed in this section.

2.3.1 The Keynesian theory of unemployment

Although the Classicalists believed that the way to maintain full employment was to cut wages and reduce taxes. John Maynard Keynes spoke out against this, stating that "The best way to destroy the capitalist system was to debauch the currency." Because the economy was determined by demand, the cut in wages would reduce employee income and decrease consumer spending. This reduces demand for products, leading to a reduction in production, forcing companies to not only cut wages, but lay off employees. Reducing taxes wasn't an option for the government when their budget was out of control due to the reduction of tax revenues. The only way to recovery was to encourage spending. Encouraging consumers and firms to increase spending will increase demand. This will increase quantity produced, leaving companies to hire more employees.

Keynes believed that Government interference is beneficial to an economy. Through Fiscal and Monetary policies, the government use spending of goods or services to reduce the business cycle. Government spending reduces the price for goods and services, making it more affordable. This increase demand and consumer spending. With the increase in demand, companies need to produce more. So, they will have to hire more employees. The newly hired employees will have more income, leaving them more able to spend. This also increases demand and consumer spending and consequently unemployment will be reduced.

2.3.2 Unemployment in the theory of innovation

The theory of innovation was originally developed by German economist Hans Karl Emil Von Mangoldt. His emphasises was that innovations that creates more jobs relative to job destruction is the basic force beyond the increases in employment and the decreases in unemployment (Adil, 2010). When entrepreneurs innovate something new such as the production of a new product, the finding of a new market, the finding of a new method of production, and the introduction of new technologies and a new organization they increase investments to materialize those innovations. Domestic investment expenditures will increase demand on economic resources and will increase their prices. Other entrepreneurs will imitate the leaders by adopting the new innovations. Labour and materials will be employed to produce the new items. Consequently, wages will be increasing and unemployment will be declining, assuming that employment creation will outweigh employment destruction due to the new innovations.

2.3.3 The quantity theory of money

The quantity theory of money is one of the oldest surviving economic doctrines. It states that changes in the general level of general prices are determined primarily by changes in the quantity of money in circulation. Based on this theory, a sustained high rates of monetary growth cause inflation, and low money growth rates will eventually produce low inflation. This theory was challenged by Keynesian economics, but updated and reinvigorated by the monetarist school of economics. While mainstream economists agree that the quantity theory holds true in the long run, there is still disagreement about its applicability in the short run. Critics of the theory argue that money velocity is not stable and, in the short-run, prices are sticky, so the direct relationship between money supply and price level does not hold.

2.3.4 The Market Power theory of inflation

Market-Power theory of inflation refers to a process whereby a single or group of producers decide on a new price different from the competitive price. Such groups keep the prices of their products at a high level to earn the maximum profit without considering the affordability of the consumers. Based on this theory, Oligopolists can increase the price to any level even if the demand does not rise. This hike in price levels occurs due to increase in wages (because of trade unions) in the oligopolistic industry. The increase in wages is compensated by the hike in prices of products, which will in turn increase the income of individuals and their purchasing power. This whole situation will further results in inflation.

2.3.5 The structural theories of inflation

According to structural theory of inflation, market power is one of the factors that cause inflation, but it is not the only factor. The supporters of structural theories believed that inflation arises due to structural maladjustments in the county or some of the institutional features of business environment. They have provided two types of theories to explain the causes of inflation, which are; the Mark-UP Theory and the Bottle-Neck Inflation.

2.3.5.1 The Mark-Up Theory

The Mark-Up Theory was built on the notion that inflation cannot occur alone by demand and cost factors, but it is the cumulative effect of demand-pull and cost-push activities. The increase in prices levels stimulates production, but increases demand for factors of production. Consequently, both the cost of production and price of the products will increase.

2.3.5.2 Bottle-Neck Inflation

Based on the Bottle-Neck inflation, the direct relationship between wages and prices of products is the main cause of inflation. In other words, inflation takes place when there is a simultaneous increase in wages and prices of products. However, the belief is that wage push or market-power theories alone are not able to provide a clear explanation of inflation. This theory emphasizes that inflation occurs due to the boom in capital goods and wage-price spiral.

2.3.6 The purchasing Power Parity (PPP theory)

The Purchasing Power Parity (PPP theory) explains the movements in the exchange rate. It is originated from the work of British economist David Ricardo. This theory takes its starting point from the law one price, which states that under conditions of free completion and absence of transportation costs and trade barriers, identical goods should have one price in any given country. PPP is an extension of the law of price. This theory asserts that the exchange rate between currencies of two countries equals the relation between the price levels of these two countries. Only in this way the purchasing power of currencies in both countries is the same.

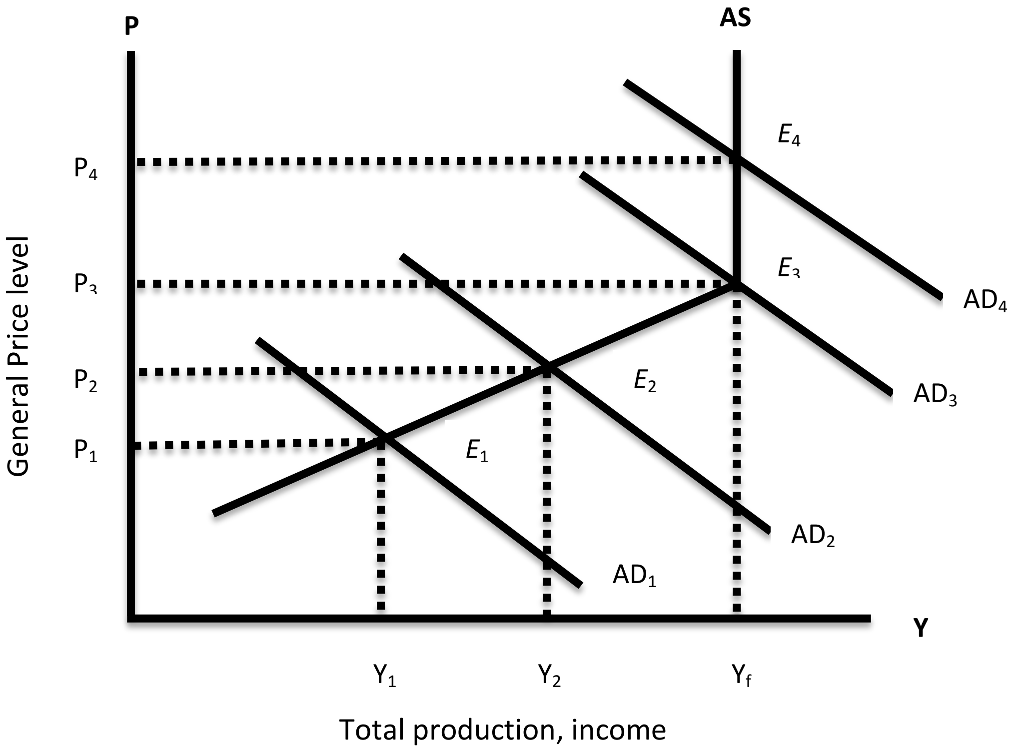
There are two versions of PPP, absolute and relative, the former is considered quite restrictive since it will be valid when financial markets are efficient and baskets of goods are identical, which does not occur due to market imperfections, transaction costs, product differentiation and international trade restrictions. However, relative PPP states that prices and exchange rates vary maintaining a constant ratio in the purchasing power of the domestic currency of each country regarding other currencies. Thus, the country with a higher inflation differential should raise the exchange rate of its currency regarding the other one, that is, it should recognize the loss of value of its currency (depreciation); being this raise in the exchange rate same as the difference between both inflation types.

2.2.7 The aggregate demand and aggregate supply model (AD-AS model)

The AD-AS model is one of the models that can be used to study the relationship between unemployment and inflation in the economy because it incorporates the views of different schools of thoughts about macroeconomics. According to Parkin (2013), inflation is a monetary phenomenon that occurs if the quantity of money grows faster than the potential Gross Domestic Product (GDP). Many factors can cause inflation in the short run but it depends on how real GDP and the price level interact. On the demand side, anything that can shift the AD curve to the right, *ceteris paribus*, will cause an increase in the general price level as well as total production in the economy (Lipsey and Chrystal, 2007). On the supply side, anything that will increase the cost of production, *ceteris paribus*, will shift the short run supply curve to the left. The general price level will increase and the total production in the economy will decrease. In this case, the economy will experience stagflation (a situation whereby there is an increase in the general price level accompanied by high rate of unemployment). The study uses the AD-AS model to differentiate between demand-pull and cost-push inflation.

Demand-pull inflation occurs when the aggregate demand for goods and services in the economy increases while aggregate supply remains unchanged. This can be as a result of the following factors; increase in the money supply, increase in government spending, increase in consumption spending by households, increase in export earnings and increase in investment spending (Mohr, 2012).

Figure 2-6 Demand-pull inflation (AD-AS framework)

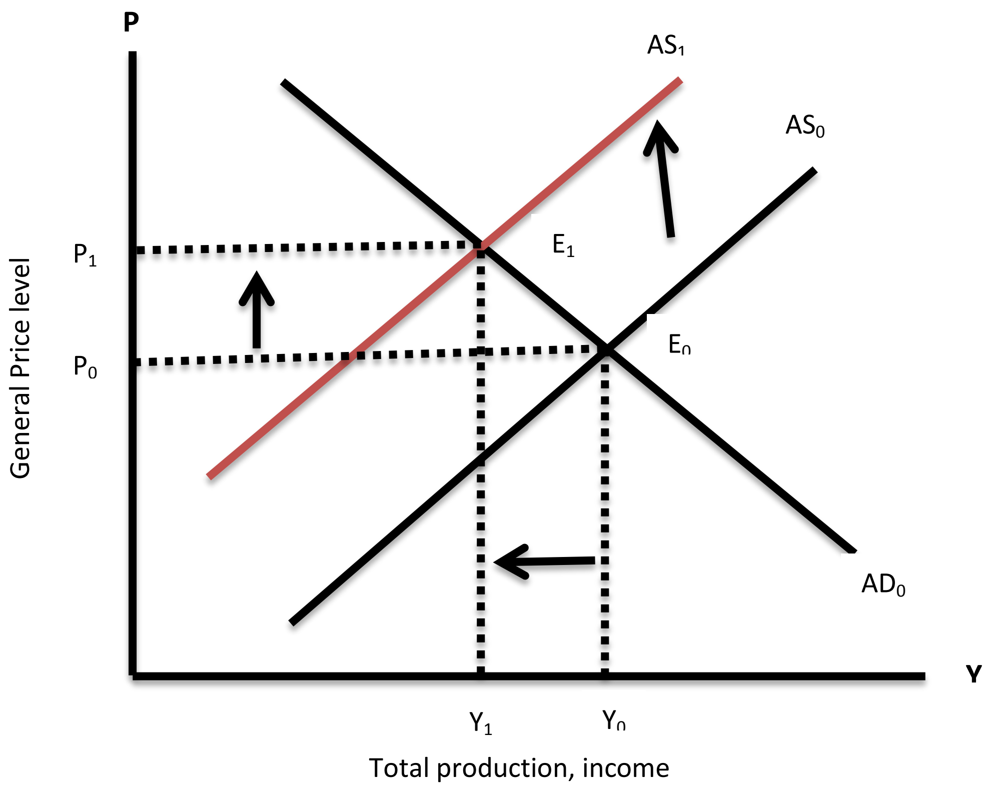


Source: Author, adapted from Mohr (2012)

Figure 2-6 presents the demand-pull inflation in the AD-AS framework. The vertical axis measures the general price level in the economy, while the horizontal axis measures total production and income in the economy. The initial general price level in the economy is P_1 and total production and income is Y_1. If one of the determinants of aggregate demand increases, holding other things the same, the aggregate demand curve will shift from AD_1 to AD_2, AD_3 and AD_4 (Mohr, 2012). As long as there is a room for production in the economy, total production and income will increase as the aggregate demand curve is shifting to the right but that will also increase the rate of inflation in the country. However, when the economy reaches full employment (Y_f), further increase in the aggregate demand (from AD3 to AD4) will only lead to an increase in the rate of inflation. The government or SARB can fight this kind of inflation by applying the contractionary or restrictive monetary and fiscal policies. This include the application of the following instruments; increases in the interest rate, increase in the tax rate and decrease in government spending.

Cost-push inflation occurs as a result of an increase the prices of factors of production. The main sources of cost-push inflation are; increases in wages and salaries, an increase in the price of imported capital and intermediate goods, natural disasters, decreased productivity in the economy and increases in profit margins by firms (Mohr, 2012).

Figure 2-7 Cost-push inflation (AD-AS framework)



Source: Author, adapted from Mohr (2012)

Figure 2-7 presents the analysis of cost-push inflation using the AD-AS framework. Just like figure 2-6, the vertical axis on figure 2-7 represents the general price level in the economy and the horizontal axis represent total production and income in the economy. AD_0 and AS_0 are the original aggregate demand and aggregate supply.

The general price level is at P_0 and total production and income is at point Y_0, with the equilibrium point been at point $E_{0.}$

As much as we know that a large portion of domestic spending in South Africa is on imported goods and services, particularly on capital and intermediate goods required by domestic industries. An increase in the price of imported goods and services or wages and salaries will shift the aggregate supply curve from AS_0 to AS_1. The general price level in the economy will increase from P_0 to P_1 and total production and income will decrease from Y_0 to Y_1. The economy will experience a situation whereby high prices on goods and services are accompanied by low productivity (stagflation). When total production and income decrease from Y_0 to Y_1, it is expected that some domestic firms will be forced to lay off some of their employees.

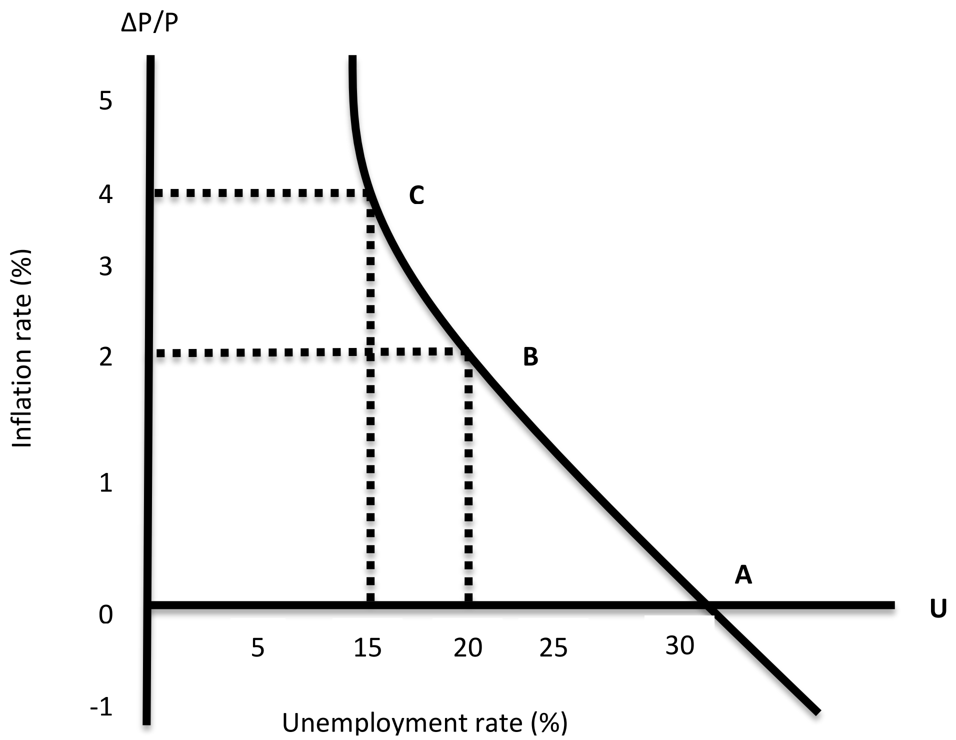
The situation will be worse in the economy because the country will be experiencing inflation accompanied by high level of unemployment. In this case it will be difficult for the government or SARB to apply expansionary or restrictive monetary and fiscal policies because inflation and unemployment occurred at the same time. If the government or SARB applies contractionary monetary or fiscal policy, the achievement will be on inflation because the general price level will decrease. However, this will have a negative impact on the level of unemployment because as the aggregate demand curve shift to the left because of contractionary monetary and fiscal policies, total production and income in the economy will also decrease and this will lead to high level of unemployment in the country.

If the government or SARB applies expansionary monetary or fiscal policy in this situation, the expectation is that aggregate demand will increase. As aggregate demand increases, total production and income will also increase but this will have a negative impact on the general price level (which will also increase). In this case the achievement will be on the side of the unemployment rate while the inflation rate is increasing. From the discussion above it is clear that demand-pull inflation can be managed effectively by the application of expansionary and restrictive monetary and fiscal policies. However, if the economy is experiencing cost-push inflation, it is advisable for the government or SARB to come up with measures that can shift the aggregate supply curve to the right. When the aggregate supply curve shift to right, the general price level will decrease and total production and income in the economy will increase. The government or SARB would be succeeded in keeping both inflation and unemployment low in the country.

2.2.8 The Phillips-Curve

The Philips-Curve was named after the New Zealand economist, A.W Phillips, after he researched about the relationship between unemployment and the changes in wages in the United Kingdom from 1861 to 1957 (Hyman, 1992). The results from his study indicated a negative relationship between unemployment and changes in wages. Even though there was a little theoretical background on the Phillips-Curve, it was regarded as a clear indication of the trade-off between unemployment and inflation (Mohr, 2012).

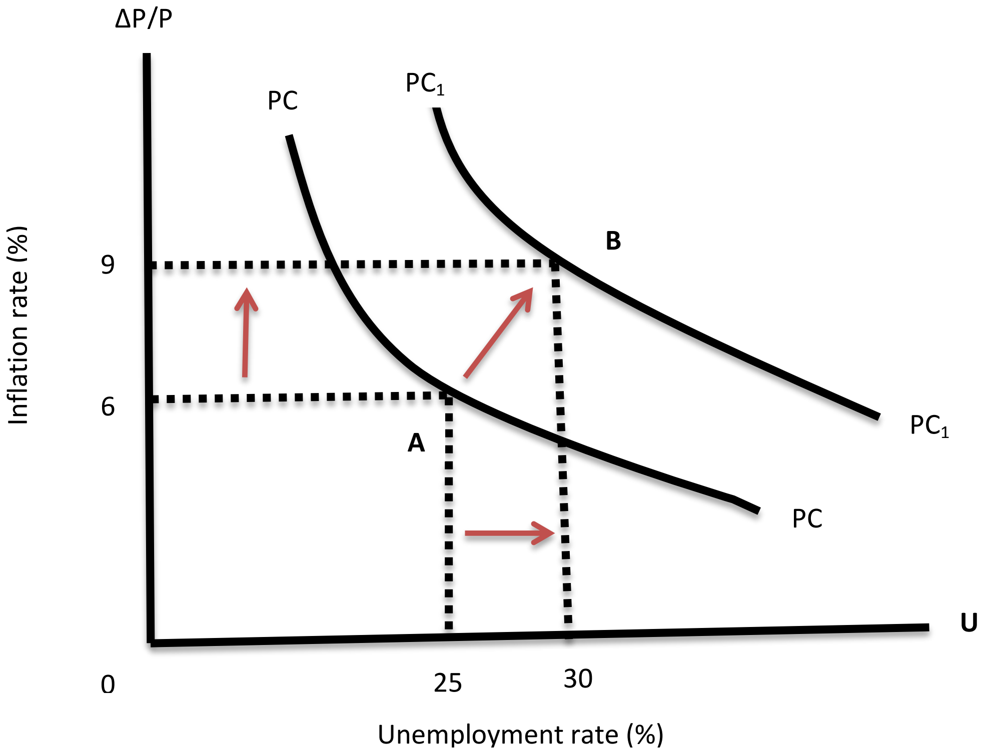
Figure 2-8 The Phillips curve



Source: Author, adapted from Mohr et al (2008)

Figure 2-8 presents the relationship between inflation and unemployment based on the Phillips curve. With line ABC sloping downwards from the left to the right, the figure shows a negative relationship between unemployment and inflation. Suppose that the government wants to achieve 0% inflation rate, based on figure 2-8, the unemployment rate will be 30% in the country. If the government wishes to stimulate the economy by applying expansionary monetary and fiscal policies, the unemployment rate can decrease from 30% to 20% (from point A to point B). However, this will be achieved by compromising the rate of inflation in the country (which will increase from 0% to 2%). A further reduction of the unemployment rate from 20% to 15% will again increase the inflation rate from 2% to 4%. This process demonstrates the trade-off between inflation and unemployment. One can raise a question on the Phillips curve, especially when coming to the situation whereby the economy is experiencing stagflation. The AD-AS model provided a clear indication in this regard by shifting the aggregate supply curve to the left. In the case of the Phillips curve, the curve shifts to the right as a result of simultaneous increase in the unemployment and inflation rate.

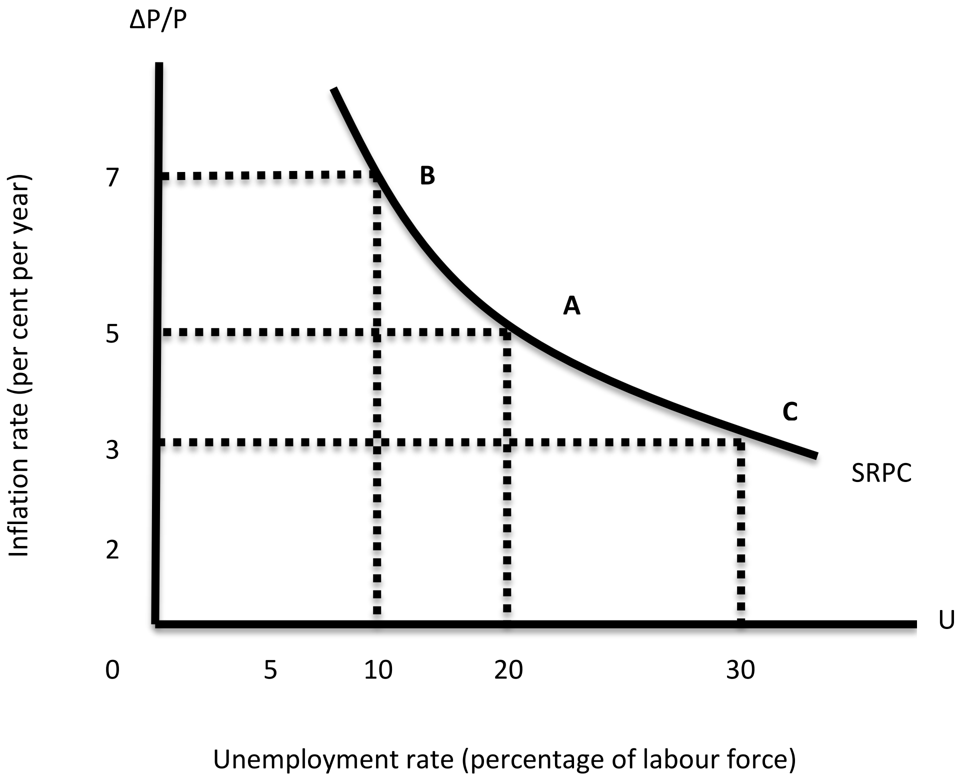
Figure 2-9 Shifts of the Phillips curve



Source: Author, adapted from Mohr et al (2008)

Based on figure 2-9 if the economy experiences stagflation, the Phillips curve will shift from PC to PC_1 (indicated by a movement from point A to point B). The inflation rate will increase from 6% to 9% and the unemployment rate will also increase from 25% to 30%. To reverse the situation, the government should take measures that will promote total production and income in the economy. In the case of the AD-AS model, the aggregate supply curve will shift to the right. However, the Phillips curve will have to shift to the left (Mohr, Fourie and Associates, 2008). As it was already pointed out in this chapter, economists have different views on the relationship between inflation and unemployment. Some believe that there is short and long-run relationship between inflation and unemployment, while others argue that the long-run relationship does not exist between the two variables.

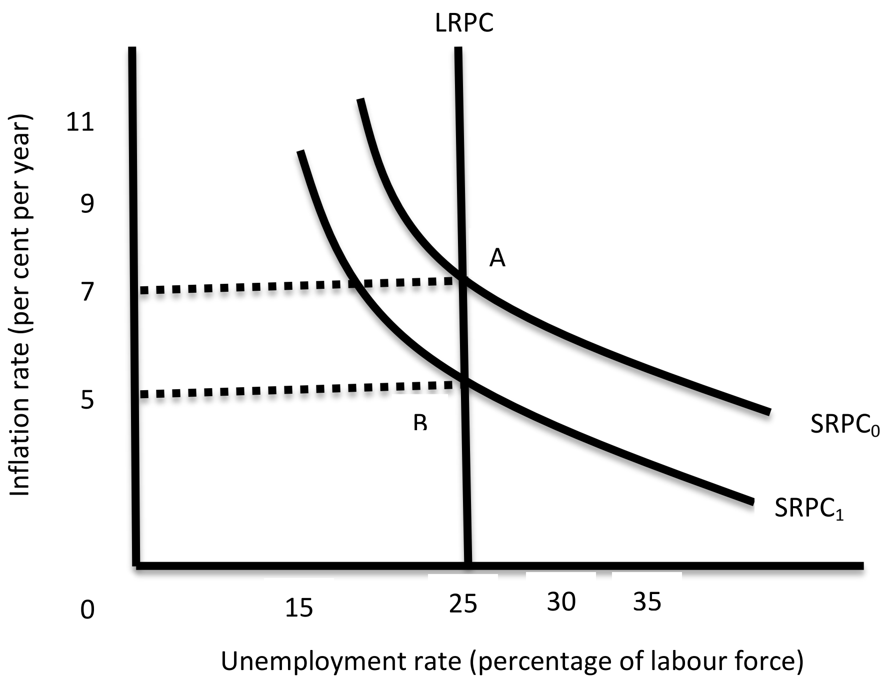
Figure 2-10 Short-run Phillips curve



Source: Author, Adapted from Parkin (2013)

The short-run Phillips curve provide a clear indication of the relationship between inflation and unemployment, holding constant , the expected inflation rate and the natural unemployment rate (Parkin, 2013). Suppose that the expected inflation rate is 5% per annum and the natural unemployment rate is 20% (point A on figure 2-5). If inflation rises above its expected rate (from 5% to 7%), unemployment falls below its natural rate (from 20% to 10%). This is illustrated by a movement from point A to point B. however, if inflation falls below its expected rate (from 5% to 3%), unemployment will rise above its natural rate (from 20% to 30%). This is indicated by a movement from point A to point B on figure 2-10.

Figure 2-11 Short-Run and Long-run Phillips curve

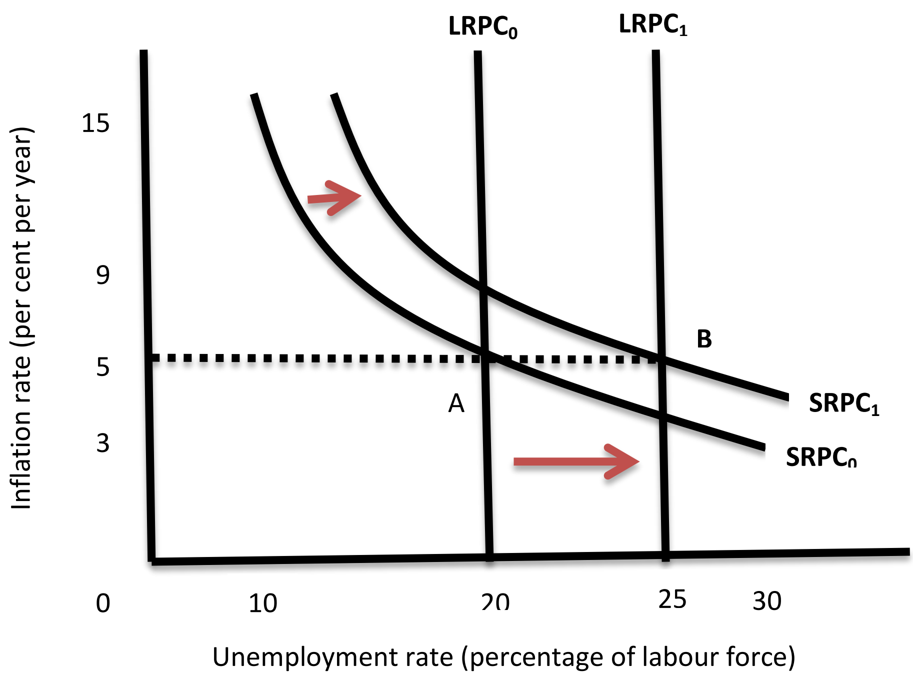


Source: Author, adopted from Parkin (2013)

Figure 2-11 presents the short-run and long-run Phillips curve. The long-run Phillips curve (LRPC) shows the relationship between inflation and unemployment when the actual inflation rate equals the expected inflation rate (Parkin, 2013). Unlike the original short-run Phillips curve ($SRPC_0$), the long-run Phillips curve is vertical at the natural unemployment rate. The long-run Phillips curve shows that any expected inflation rate is possible at the natural unemployment rate (Parkin, 2013).

Based on figure 2-11, the expected inflation rate is 7% per annum and the natural unemployment rate is 25%. The original short-run Phillips curve ($SRPC_0$) intersects with the long-run Phillips curve (LRPC) at the expected inflation rate. If the economy experiences a change in the expected inflation rate (from 7% to 5%), the short-run Phillips curve will shift from $SRPC_0$ to $SRPC_{1.}$ This will not shift the long-run Phillips curve (Parkin, 2013). However, the new short-run Phillips curve will intersects with the long-run Phillips curve at the new expected inflation rate (which is 5% per annum).

Figure 2-12 Change in the natural unemployment rate



Source: Author, adapted from Parkin (2013)

From figure 2-11, it was pointed out that a change in the expected inflation rate only shifts the short-run Phillips curve. Figure 2-12 presents a change in the natural unemployment rate. Suppose that the expected inflation rate is 5% and the natural unemployment rate is 20% (based on figure 2-12). The short-run Phillips curve is given by $SRPC_0$ and the long-run Phillips curve is given by $LRPC_0$. A change in the natural unemployment rate from 20% to 25% will shift both the short-run and long-run Phillips curves. The short-run Phillips curve shifts from $SRPC_0$ to $SRPC_1$, while the long-run Phillips curve shifts from $LRPC_0$ to $LRPC_1$. This is indicated by a movement from point A to point B. A change in the natural unemployment rate leaves the expected inflation rate unchanged.

2.4 EMPIRICAL LITERATURE

Ezirim, Amuzie and Emenyonu (2012) used the Vector Autoregressive (VAR) model to study the long-run equilibrium relationship between exchange rates and inflation in Nigeria and the results revealed a long-run equilibrium relationship between them. Using monthly data from November 2001 to November 2010, Ziran, Qin and Shouyang (2013) employed Cointegration analysis and Vector Error Correction

Model (VECM) to capture the relationships among the Chinese Renminbi (RMB) exchange rate, US-China bilateral trade, and the US unemployment rate. The results indicated that the US unemployment rate is negatively correlated with the Chinese RMB exchange rate. Furthermore, Kamin (1997) compared the response of inflation to changes in exchange rate competitiveness in various regions of the world and discovered that an empirical relationship exists between the rate of inflation and the level of real exchange rate. Furuoka (2008) used similar approach as Ziran et al and pointed out that there is an existence of cointegration relationship but no causal relationship was found between unemployment and inflation in the Philippines.

Berentsen, Menzio and Wright (2011) developed a theory in which both labour market and goods market were modelled using the search and bargaining approach. The study was aimed at determining the long-run relation between unemployment and monetary policy. The results indicated that unemployment is positively related to inflation and interest rates in the low-frequency data. A study by Conway, Drew, Haunt and Scoff (1998) also reached a conclusion that if there is any change in exchange rate, it will bring a rapid change in the rate of inflation. Many economies have become more dependent on exports due to slow domestic growth and a relative, weaker exchange rate would allow export goods to become more competitive (Kaiser and Wroughton, 2010). Owen (2005) also agrees that currency weakness is viewed as a pursuant of a strategy of export-led growth to many developing countries. This follows from the argument that a weaker home currency would reduce the price of exports making them cheaper in comparison to competitors within the export market ((Mussa and Rosen, 1978); (Auer and Chaney, 2009).

According to Owen (2005), the economy that grows as a result of greater demand of exports encourages higher domestic production and this boost employment level in the domestic country. Todaro and Smith (2009) argued that a weak rand may have negative consequences on the economy. The argument was based on the fact that aggregate demand for domestically produced goods may cause price inflation as a result of lower exports prices. According to (Rowbotham, 2011), a weak currency does not improve export performance and economic growth. Exports growth is associated with a stronger, relative floating exchange rate in efficiency-driven economies.

Herman (2010) studied inflation and unemployment in the Romanian economy. With the help of a Phillips curve relation type, the results on the evolution of inflation and unemployment between 1990 and 2009 could not be noticed. However, the results of the statistical analysis showed that between unemployment and inflation, one cannot identify a stable statistically significant relationship because the economic policies applied did not aim directly at the decrease of inflation rate based on the increase in unemployment. Herman (2010) further argued that in the short-run, it does not mean that there is no trade-off between inflation and unemployment. The results also suggested that there was a very strong and direct correlation between inflation and unemployment between 2000 and 2009. During this period, Romania experienced a decrease in unemployment as well as in inflation. The study concluded by recommending that in order to maintain inflation as well as unemployment at a low level, the fundamental economic relationship between salaries and productivity must be respected. This implies that pay rises should be based on the increase in the labour productivity.

The AD-AS model and the Phillips curve were incorporated in this chapter to understand the relationship between the selected variables. The chapter further discussed both theoretical framework and empirical evidence. From the literature reviewed, evidence pointed out that there is mixed results on the relationship between exchange rate, unemployment and inflation. Although the majority of the studies were conducted from different economies, using different econometric tactics, it will be interesting to compare the findings of this study with other economies. Furthermore, key variables were also explained in this chapter. The chapter also analysed trends of unemployment, exchange rate and inflation in South Africa.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 INTRODUCTION

This chapter provides the econometric analytical framework used. The study employed Johansen cointegration test and Vector Error Correction Model (VECM) to capture the relationship between the variables. The estimates of the VECM will be confirmed by the Wald Test. The Augmented Dickey-Fuller (ADF) and Phillip-Perron (PP) tests will be used to determine the unit root for time series data. In addition, the Engle-Granger causality test is also employed to determine the causality effect amongst the variables. Furthermore, diagnostic and stability tests will be performed to determine whether the model is correctly specified. In conclusion, the impulse response function will be carried out using both VECM and Vector Autoregressive (VAR) model.

The chapter is structured as follows; Data collection will be discussed first. This will be followed by the discussion of Data analysis which includes the following: unit root tests, Johansen cointegration procedures, VECM, VAR model, the Engle-Granger causality test, Diagnostic tests, Stability tests and the Impulse Response Function. All tests will be performed using the statistical package known as Eviews 8.

3.2 DATA

The study relies on quarterly time series data from the first quarter of 1994 to the fourth quarter of 2014. The data for unemployment is obtained from Statistics South Africa (Stats SA) and the data for Rand/US dollar exchange rate and inflation (consumer prices) are obtained from the South African Reserve Bank (SARB) online statistical query. The data for all the variables is measured in percentages.

3.3 DATA ANALYSIS

The model of the study consists of three variables, namely inflation rate, exchange rate and unemployment rate. In the model, inflation rate is the dependent variable whilst unemployment and exchange rate are the independent variables and their functional relationship is expressed as follows:

$$IF = f(EX, UN) \quad \text{.......} \quad 1$$

and as a linear equation,

$$IF_t = \beta o + \sigma_1 EX_t + \sigma_2 UN_t + \varepsilon_t \quad \text{.......} \quad 2$$

where:

βo = Constant

IF = Inflation rate

EX = Exchange rate

UN = Unemployment rate

σ = Parameters of the model with all real numbers

ε = Error term

3.3.1 Unit root tests

Johansen's Cointegration method, VAR, VECM and Granger causality involves initial testing of the time series to ensure the order of integration of the variable by means of testing for unit roots. As the model contains economic variables of a time series nature, the empirical analysis will start by examining their statistical properties. The essence of analysing these properties is to determine if the variables in the model are stationary, so as to avoid spurious regression which might lead to a high R^2 and thus, misleading results (Asteriou and Hall, 2011). To get reliable results from the analysis of econometric models, it is required that the time series data under consideration should be stationery.

The study will perform two different tests of unit roots, namely; informal test and formal test. Informal test results will be in the form of visual inspections presented in the form of graphs or figures. Formal test results will be presented in the form tables. In order to validate the characteristics in the time series data, the study utilises two different formal unit root tests, namely the ADF and PP tests. These tests are employed to determine the non-stationarity assumptions as well as to ensure that spurious results, problems of autocorrelation and heteroscedasticity are avoided (Dickey & Fuller, 1979). In general, these tests are consistent with each other; however, the study included both of them to ensure accuracy regarding the unit root test conclusion.

When running the ADF and PP tests, the main focus will be on the probability values, critical values and the t-statistics values. If the critical values are lower than the values of the t-statistics at different levels of significance, the null hypothesis is not rejected. Meaning there is a unit root or the time series data is not stationery. However, if the critical values are greater than the t-statistics at different levels of significance, the null hypothesis is rejected. Meaning there is no unit root. If variables are stationary in a model, they will tend to have a constant variance and some elements of autocorrelation over time (Noula, 2012). If a series is not stationary, it may become stationary only after differencing.

3.3.1.1 The Augmented Dickey-Fuller (ADF) test

The ADF test can be performed using three different kinds of regressions, namely; without intercept and deterministic time trend, with intercept and with both intercept and deterministic time trend. The lag length on these extra terms is either determined by the Akaike Information Criterion (AIC) or Schwartz Bayesian Criterion (SBC), or more usefully by the lag length necessary to whiten the residuals.

The equation for ADF is given by:

$$\Delta y_t = \alpha_0 + \beta t + \gamma y_{t-1} + \delta_1 \Delta y_{t-1} + ... + \delta_{p-1} \Delta y_{t-p+1} \text{...} 3$$

where α is the constant, β, the coefficient on a time trend and *P* is the lag order of the autoregressive process. In order to select the optimal lag length for the model, the log-likelihood function must be maximised (Maggiora & Skerman, 2009).

3.3.1.2 Phillip-Perron (PP) test

According to Asteriou and Hall (2011) Phillip-Perron (PP) test is a generalization of ADF test that allows for fairly mild assumption concerning the distributions of errors. The distribution theory supporting the Dickey-Fuller tests is based on the assumption that the error terms are statistically independent and have a constant variance. When using the ADF methodology, we have to make sure that the error terms are uncorrelated and that they really have a constant variance. The main reason this study conducts the PP as well is because the ADF test loses power for sufficiently larger values of *P* or the number of lags (Gujarati, 2004). The regression of PP is as follows:

$$Y_t = b_0 + b_1 Y_{t-1} + \mu_t \quad \text{.......} 4$$

3.3.2 Cointegration analysis

Cointegration analysis was introduced by Engle-Granger in the early 1980s, with improvements and additions made in the subsequent years (Maggiora and Skerman, 2009). They denote that cointegration is a modelling process that incorporates non-stationarity with both long-term relationship and short-term dynamics. To examine the time series data in economics using cointegration, the time series data in its level form should be non-stationary and integrated of order of 1, expressed as I(1). This means that the series becomes stationary after differentiating it once or twice. Variables are cointegrated if they are I(1) and have a linear combination which is stationary without the need to differentiate it (Maggiora and Skerman, 2009).

Cointegration analysis can be used to evaluate the link between the variables understudy because it establishes the long-term relationship by calculating the long-run equilibrium of the variables in question. If cointegration is established amongst the variables, the implication is that time series will not drift apart in the long-term, and will revert back to equilibrium levels following any short-term drift that may take place (Maggiora and Skerman:2009).

In the context of this study, the presence of cointegration means that there is a long-term link between exchange rates, unemployment, and inflation. There are three main cointegration methods that have been consistently been used throughout past studies, namely; Engle-Granger two-step method, Phillips-Ouliaris Methods and Johansen's Maximum Likelihood Method using either Trace statistic and Eigenvalue statistic. The study uses Johansen's Methods due to reasons mainly relating to the short-falls of Engle-Granger method and Phillips-Ouliaris methods.

The Engle-Granger method has several limitations. It identifies only a single cointegrating relation, among what might be many relations. This affects both test results and model specification. Another limitation of the Engle-Granger method is that it is a two-step procedure, with one regression to estimate the residual series and another regression to test for a unit root. Errors in the first estimation are necessarily carried into the second estimation. The estimated, rather than observed, residual series requires entirely new tables of critical values for standard unit root tests. The study by Cancer (1998) investigated whether the Phillips-Ouliaris methods are robust to infinite variance errors. The results showed that, regardless of the index of stability α , the residual-based tests are more robust to infinite variance errors than the likelihood ratio-based tests.

Johansen cointegration tests will be carried out to determine the long-run relationship between the variables in this study, provided there is a cointegration between the variables. However, if the results show no cointegration between the variables, the study will employ VAR model instead of the vector error correction model to determine the short-run relationship between exchange rate, unemployment and inflation in South Africa.

According to Gujaratti (2004), Johansen's method takes a starting point from the vector Autoregression (VAR) of order of *p* given by:

$$X_t = \Pi_1 X_{T-1} + \Pi_2 X_{T-2} + \dots\dots + \Pi_P X_{T-P} + \mu_T \dots\dots 5$$

where X_T is an *n x 1* vector of variables that are integrated of order of one, that is, I(1), and *n x 1* of innovations while through Π_P are *m x m* coefficient matrices. Reparameterising the equation …..1, that is, subtracting X_{T-1} on both sides leads us to:

$$\Delta X_t = \Gamma \Delta x_{t-1} + \Gamma_2 \Delta X_{t-2} + \dots\dots \Gamma_{p-1} \Delta X_{t-p+1} - \Pi X_{t-p} + \mu_t \dots\dots 6$$

where $\Gamma = \Pi_1 - 1, \Gamma_2 = \Pi_2 - \Gamma_1, \Gamma_3 = \Pi_3 - \Gamma_2 and \Pi = 1 - \Pi_1 - \Pi_2 - \dots\dots - \Pi_p$. The matrix Π determines the extent to which the system is cointegrated and is called the impact matrix

Returning to the general reparameterised equation3, considering the first system as:

$$\Delta X_{1t} = r_{11}\Delta X_{t-1} + r_{12}\Delta X_{t-2} + ... + r_{1-p}\Delta X_{t-p}\Delta X_{t-p} - \Pi_1^i X_{t-p} + \mu_{1t} ....7$$

where r_{11} is the first row of $\Gamma_j, j = 1,2........p-1$ and Π_1^i is the first row of Π.

Here ΔX_{1t} is stationary, that is I(0); j=1,2,……p-1 are all I(0), μ_{1t} is assumed to be I(0) and so for a meaningful equation, $\Pi_1^i X_{t-p}$ must be stationary, I(0).

If none of the components of X_t are cointegrated, they must be zero. On the other hand, if they are cointegrated, all the rows of Π must be cointegrated but not necessarily distinct. This is because the number of distinct cointegrating vectors depends on the row rank of Π (Ssekuma, 2011). The matrix Π is of order mxm. If it has a rank of m, that is , m number of linearity independent rows or columns, then it forms a basis of combination of the rows would lead to stationarity, meaning X_{t-p} has stationary components if the rank of Π is $r < m$.

This VAR can be re-written as:

$$\Delta Y_t = \mu + \Pi Y_{t-1} + \sum_{i=1}^{p-1} \Gamma_j \Delta Y_{t-1} + \varepsilon_1 ....8$$

where $\Pi = \sum_{i=1}^{p} A_i - 1$ and

$$\Gamma_i = -\sum_{j=i}^{p} A_j ....9$$

Y_t is an $nx1$ vector of variables that are integrated of order of one-commonly denoted by I(1)

Π Is (nxn) matrix of parameters, Γ is (nxn)) matrices of the parameters and ε_{tj} is the sequence of random *P*-dimension white noise vectors.

If the coefficient matrix Π has a reduced rank r>n, then there exist n x r matrices α and β each with rank r such that $\Pi = \alpha\beta^1$ and $\beta^1 Y_t$ is stationary

We may write $\Pi = \beta\alpha^i$ for a suitable mxr matrices, and β and α

α_1

α_2

$\alpha^i =.$ and $\beta = \beta_{1,}\beta_2............\beta_r$

.

$.r_r$

Then $\Delta X_{t-p} = \beta\alpha^i X_{t-p}$ and all linear combinations of $\alpha^i X_{t-p}$ are stationary. It should be noted that the study has to perform a unit root test to access the order of integration of each variables before applying Johansen's procedure.

The Johansen's procedure estimates the VAR subject to $\Pi = \beta\alpha^i$ for various values of *r* number of cointegrating vectors, using the maximum likelihood estimators

The question is how do we detect the number of cointegrating vectors?

Johansen proposed two likelihood ratio tests namely: the trace test and the maximum eigenvalue test to detect the number of cointegrating vectors.

3.3.2.1 The trace test

The trace test is used to tests the null hypothesis of *r* cointegrating vectors against the alternative hypothesis of *N* cointegrating vectors.

The test is given by:

$$\lambda_{trace}(r) = -T\sum_{i=r+1}^{n} 1n(1-\hat{\lambda}_{r+1})..10$$

3.3.2.2 The maximum eigenvalue test

The maximum eigenvalue test, on the other hand, tests the null hypothesis of *R* cointegrating vectors against the alternative hypothesis of (*r+1*) cointegrating vectors. Its test statistics is given by:

$$\lambda_{\max}(r, r+1) = -T1n(1-\hat{\lambda}_{r+1})..11$$

where:

T is the sample size, and $\hat{\lambda}_I$ is the *ith* largest canonical correlation.

β^1, represent the matrix of cointegrating vectors

α , represent the speed of adjustment coefficients

r , represent the number of cointegrating relationships

Π, determines the extent to which the system is cointegrated and is called the impact

Π Matrix is of order MxM if it has a rank M , that is M number of linearly independent rows or columns, and then it forms a basis for M -dimensional vector space. Any of these linear combination of the rows would lead to stationarity, meaning that it has a stationary components if the rank of Π of is $r < m$

If Π is equal to zero this means that there is no cointegration. The variables may be I(1); but that can be easily be corrected by taking the differences. If Π has a full rank then all Y_t must be stationary since the left hand side and the other right hand side variables are stationary(since the study limit itself to variables that are either I(0) or I(1). When Π is less than full rank but is equal to zero, it means there is cointegration. In this case Π can be written as $\Pi = \alpha\beta^1$(yes, this can β correspond to the cointegration matrix. Both α and β are nxr matrices. α and β are identical up to non-singular transformation since $\Pi = \alpha\beta^1 = \alpha f^{-1}(\beta f^1)^1$ for any non-singular f . This lack of identification can sometimes renders results from multivariate cointegration analysis impossible to interpret.

3.3.3 The Vector Error Correction Model (VECM)

The purpose of the vector error correction model in this study is to determine the short-run relationship between the variables. The VECM will only be carried out if there is cointegration between the variables from the Johansen cointegration test.

3.3.3.1 Model specification

$$\Delta X_t = \beta_{x0} + \beta_{xx1}\Delta_{t-1} + \beta_{x11}\Delta P^1{}_{t-1} + \beta_{x21}\Delta P^2{}_{t-1} + \nu^x{}_t \text{..........} 12$$

$$\Delta P^1{}_t = \beta_{10} + \beta_{1x1}\Delta_{t-1} + \beta_{111}\Delta P^1{}_{t-1} + \beta_{121}\Delta P^2{}_{t-1} + \nu^1{}_t \text{..........} 13$$

$$\Delta P^2{}_t = \beta_{20} + \beta_{2x1}\Delta_{t-1} + \beta_{211}\Delta P^1{}_{t-1} + \beta_{221}\Delta P^2{}_{t-1} + \nu^2{}_t \text{..........} 14$$

where: ΔX_t represent the unemployment variable, $\Delta P^1{}_t$ represent the exchange rate variable and $\Delta P^2{}_t$ represent the inflation variable. β Represent the coefficients of the variables, $_{t-1}$ represent the tests for unit root, while ($\nu^x{}_t, \nu^1{}_t, \nu^2{}_t$) represents the VECM error terms.

3.3.4 The Wald Test

According to Agresti (1990), the Wald test refers to the parametric statistical test named after the Hungarian statistician Abraham Wald. It is used to verify the true values of different parameters such that the statistical relationship between these parameters is to be modelled, based on the sample estimate. This study will also perform the Wald test to verify the existence of short-run equilibrium relationship amongst the variables. The Wild Test will also be used to affirms the significance of the Vector Error Correction Model (VECM).

3.3.5 The Vector Autoregressive model (VAR)

Vector Autoregression (VAR) was introduced by Sims in 1980 as a technique that could be used by macroeconomists to characterise the joint dynamic behaviour of a collection of variables without requiring strong restriction of the kind needed to identify underlying structural parameters (Sims, 1980). According to Sims (1980), the VAR approach sidesteps the need for structural modelling by modelling every endogenous variable in the system as a function of the lagged values of all the endogenous variables in the system.

The VAR model is one of the most commonly used models for applied macro econometric analysis and forecasting in central banks. Since this study has got three variables, which is, exchange rate (X), unemployment (Y) and inflation (Z), the study will employ three equations model for three variables. Thus, each variable will have separate equation.

However, the study will employ the VAR model to determine the relationship between the variables, only if the results from the Johansen cointegration test indicated that there is no cointegration between the variables. Meaning the VECM cannot be employed to determine the short-run relationship between the variables. The study will also use the VAR model to confirm the results of the impulse response function from the VECM.

The mathematical form of VAR is:

$$Y_t = A_1 y_{t-1} + ... + A_p y_{t-p} + Bx_t + \varepsilon_t \quad \text{...} 15$$

where y_t is the K vector of endogenous variable, X_t is the d vector of exogenous variable. $A_1, ..., A_p$ and B are the matrices of coefficients to be estimated, and ε_t is a vector of innovations that may be contemporaneously correlated with each other but are uncorrelated with their own lagged values and uncorrelated with all of the right-hand side variables (Sims, 1980).

3.3.5.1 Model specification:

$$Y_t = c_1 + a_{11} y_{t-1} + a_{12} x_{t-1} + a_{13} z_{t-1} + b_{11} y_{t-2} + b_{12} x_{t-2} + b_{13} z_{t-2} + d_{11} y_{t-3} + d_{12} x_{t-3} + d_{13} z_{t-3} + \varepsilon_{1,t} \quad \text{..........} 16$$

$$X_t = c_2 + a_{21} y_{t-1} + a_{22} x_{t-1} + a_{23} z_{t-1} + b_{21} y_{t-2} + b_{22} x_{t-2} + b_{23} z_{t-2} + d_{21} y_{t-3} + d_{22} x_{t-3} + d_{23} z_{t-3} + \varepsilon_{2,t} \quad \text{..........} 17$$

$$Z_t = c_3 + a_{31} y_{t-1} + a_{32} x_{t-1} + a_{33} z_{t-1} + b_{31} y_{t-2} + b_{32} x_{t-2} + b_{33} z_{t-2} + d_{31} y_{t-3} + d_{32} x_{t-3} + d_{33} z_{t-3} + \varepsilon_{3,t} \quad \text{..........} 18$$

3.3.5.2 The lag length selection criteria

An important preliminary step in model building is the selection of VAR lag order. Estimating the lag length of autoregressive process for a time series is a crucial econometric exercise in most economic studies. This study will apply some commonly used lag-order selection criteria to choose the lag order, such as Akaike Information Criterion (AIC), Hannan-Quinn (HQ), Schwartz Criterion (SC) and Final Prediction Error (FPE).

Using Akaike Information Criterion to choose lag order

$$AIC = -2\left(\frac{\log L}{T}\right)\frac{2K}{T}$$

Using Schwartz Criterion to choose lag order

$$SC = -2\left(\frac{\log L}{T}\right) + \frac{K \log T}{T}$$

Using Hannan-Quinn to choose lag order

$$HQ = -2\left(\frac{\log L}{T}\right) + 2K$$

3.3.6 Diagnostic and stability testing

In order to ensure that the results from the econometric models yield true estimates, the researcher will perform diagnostic tests. The study will carry out the Jarque-Bera test to determine if the residuals are normally distributed. The Breauch-Godfrey LM test will be used to test for serial correlation amongst the variables. Breauch-Pegan-Godfrey, ARCH and Harvey will also be used to determine the existence of heteroscedasticity amongst the variables. For stability test, the study will apply the Cusum and Cusum squares tests.

3.3.7 The Engle-Granger causality test

The concept of Granger causality starts with the premise that the future cannot cause the past. If event A occurs after event B, then A cannot cause B. Granger (1969) applied this concept to economic time series to determine whether one time series “causes” in the sense of precedes another. However, merely because event A occurs before B does not mean that A causes B. Therefore the Granger causality test will also be used to determine if there is causality between the exchange rate, unemployment and inflation as well as which one actually causes or predicts the other. It is stated that, if the probability value is significant at 5%, then the null hypotheses can be rejected. Gujarati (2004) specifies the procedure for testing the causal relationship between variables, and thus the models to be used are as follows:

3.3.7.1 Model specification

$$IF_t = \sum_{i=1}^{n} \alpha_i IF_{t-i} + \sum_{j=1}^{n} \beta_j EX_{t-j} + \sum_{k=1}^{n} \beta_k UN + u_t \quad \text{...19}$$

$$EX_t = \sum_{i=1}^{n} \alpha_i EX_{t-i} + \sum_{j=1}^{n} \beta_j UN_{t-j} + \sum_{k=1}^{n} \beta_k IF_{t-k} + u_t \quad \text{.. 20}$$

$$UN_t = \sum_{i=1}^{n} \alpha_i UN_{t-i} + \sum_{j=1}^{n} \beta_j EX_{t-j} + \sum_{k=1}^{n} \beta_K IF_{t-k} + u_t \quad \text{... 21}$$

Where: EX_t = Exchange Rate

UN_t = Unemployment Rate

IF_t = Inflation Rate

U_t = Error term

- Equation (19) above postulates that the current inflation is related to past values of itself as well as that of the exchange rate and unemployment
- Equation (20) above postulates that the current exchange rate is related to past values of itself as well as that of unemployment and inflation
- Equation (21) postulates that the unemployment is related to past values of itself as well as that of exchange rate and inflation

3.3.8 Impulse Response Function

More generally, an impulse response refers to the reaction of any dynamic system in response to some external change. Impulse response function (IRF) of a dynamic system is its output when presented with a brief input signal, called an impulse. The study employed the impulse response function to trace out the response of the current and future values of each of the variables to a one unit increase in the current value of one of the VAR errors. It shows the effects of an exogenous shock on the whole process over time. The impulse response sequence plots the difference between time series process without a shock and the time series with a shock. The study will first perform the impulse response function using the vector error correction model. To confirm the results, the study will also perform the impulse response function using the VAR model.

A VAR was vector MA (∞) form as $y_t = \mu + \varepsilon_t + \Psi_1 \varepsilon_{t-1} + \Psi_2 \varepsilon_{t-2} + ...$

Thus, the matrix Ψ_s has the interpretation $\frac{\partial y_{t-s}}{\partial \varepsilon'_t} = \Psi_s$ that is, the row I, column j element of Ψ_s identifies the consequences of one unit increase in the jth variable's innovation at date $t(\varepsilon_{jt})$ for the value of the ith variable at time $t + s\ (Y_{it+s})$, holding all other innovations at all dates constant.

$\frac{\partial Y_{it+s}}{\partial \varepsilon'_{jt}}$ as a function of S is called the impulse response function. It describes the response of Y_{it+s} to a one-time impulse in Y_{jt} with all other variables dated t or earlier held constant.

CHAPTER 4

EMPIRICAL RESULTS

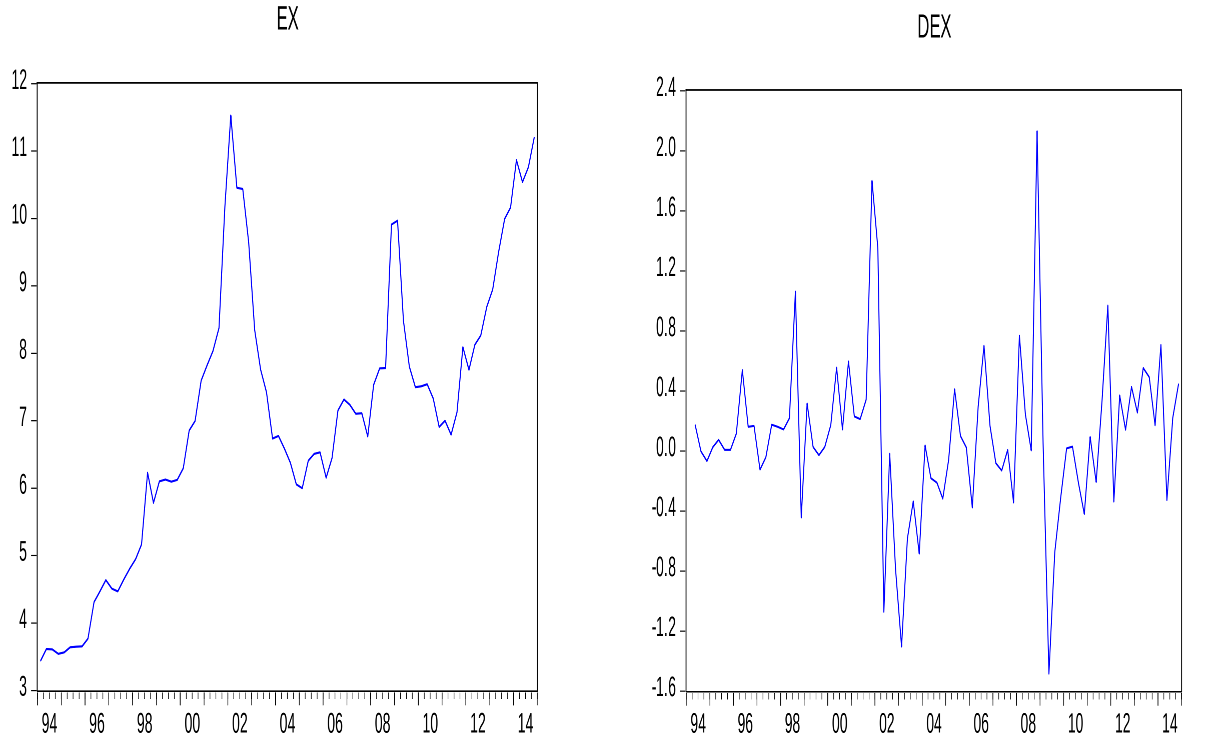
4.1 INTRODUCTION

This chapter presents and discusses the results of data analysis from the methodology adopted in this study. The chapter starts by discussing the unit root test results, followed by all other tests results such as the Johansen cointegration test, the VECM, the Wald Test, the Engle-Granger causality test, the diagnostic tests and the stability tests. In conclusion the chapter focuses on the impulse response function results from both the VECM and VAR model.

4.2 UNIT ROOT TESTS RESULTS

4.2.1 Visual inspection results

Figure 4-1 Exchange rate at level form and 1st difference

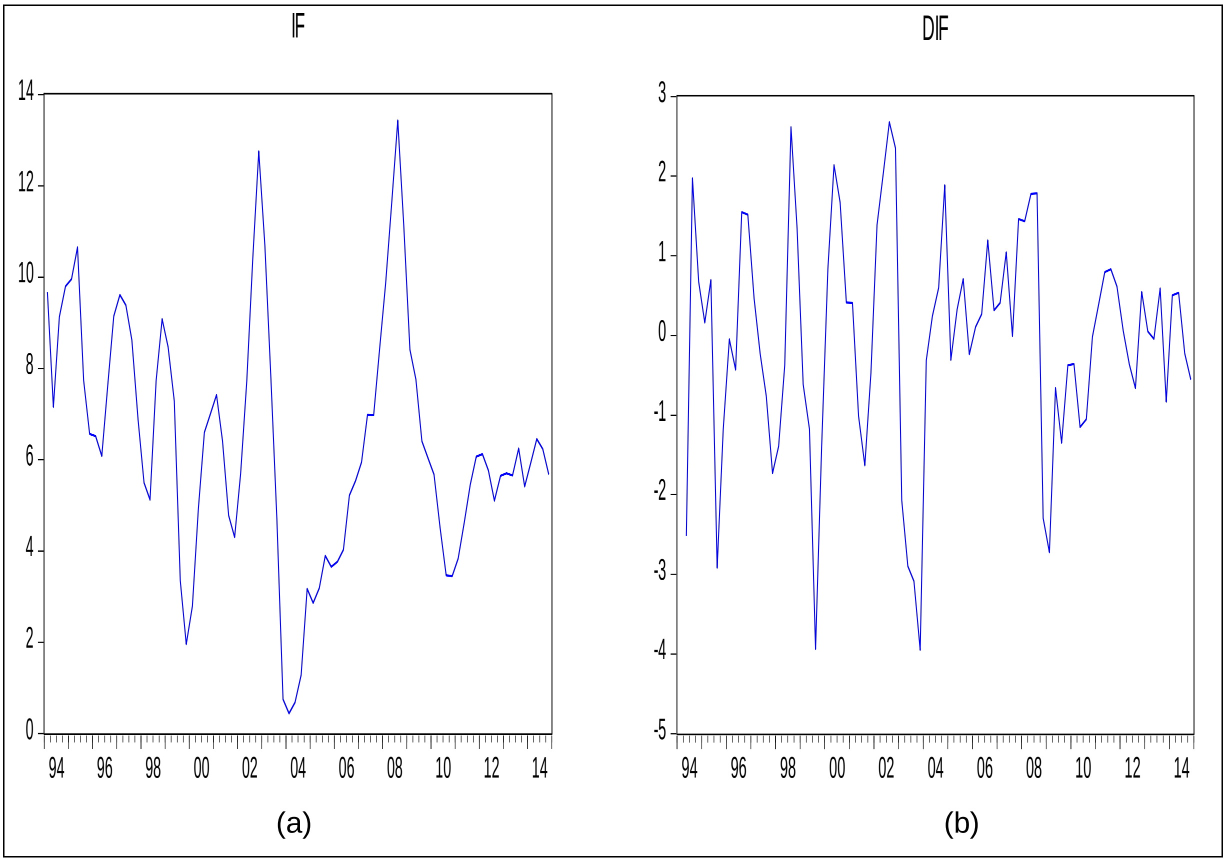


(a) (b)

Source: Author's calculations

Figure 4-1 (a) shows the unit root tests for exchange rate at level form and figure 4-1 (b) shows the tests after the time series was differenced once. Based on figure 4-1 (a), the time series data appears to be non-stationery because it is not hovering around the mean of zero. This implies that the null hypothesis of the existence of unit root cannot be rejected. The time series data became stationery after been differenced once. This is indicated by figure 4-1 (b) because the time series hovers around the mean zero.

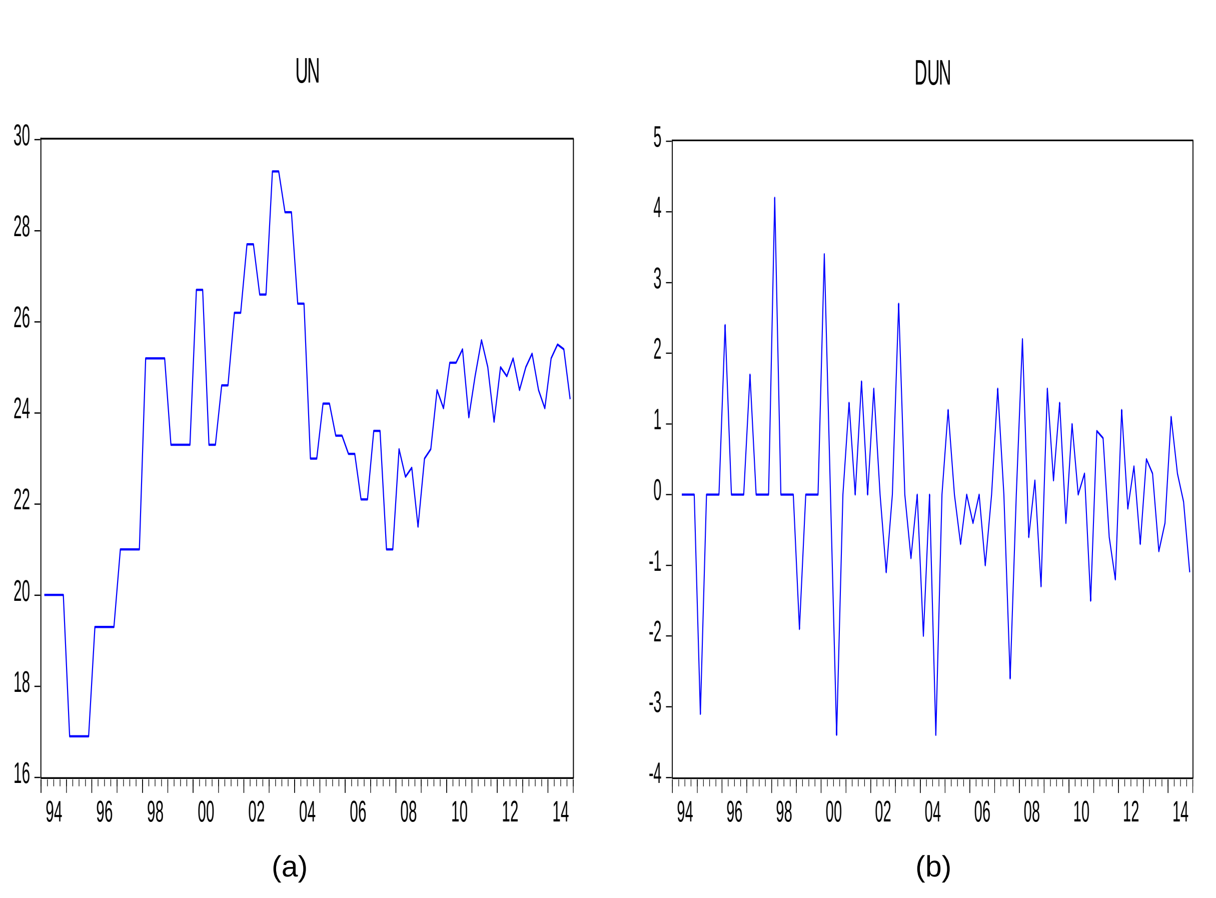
Figure 4-2 Inflation rate at level form and 1st difference



Source: Author's calculations

Figure 4-2 (a) and (b) shows the unit root tests for inflation rate at level form and after differencing respectively. Figure 4-2 (a) shows that the time series data is not stationery at level form because the mean is not hovering around zero. This implies that the null hypothesis of the existence of a unit root cannot be rejected at level form, meaning there is a unit root. After 1st differencing the time series data became stationery.

Figure 4-3 Unemployment at level form and 1st difference



Source: Author's calculations

Similarly, figure 4-3 (a) shows the unit root test results of for unemployment at level form and figure 4-3 (b) at first difference. Based on the line graph, unemployment seems to be nonstationary at level form because the mean is not hovering around zero and there is an impression of upward trending. This implies that the null hypothesis cannot be rejected, meaning there is a unit root. After first difference, the mean is now hovering around zero, indicating that the null hypothesis might be rejected.

4.2.2 Formal unit root test results

Tables 4-1 and 4-2 summarises the results of the ADF and PP tests respectively.

Table 4-1: ADF test results

Variables	t Statistics	Critical Value (10%)	Critical Value (5%)	Critical Value (1%)	Probability Value
EX Constant	-1.329431	-2.585861	-2.897223	-3.512290	0.6125
Trend and intercept	-2.180759	-3.159372	-3.465548	-4.073859	0.4935
None	1.230828	-1.614204	-1.944762	-2.593121	0.9433
DEX Constant	-7.063483	-2.585861*	-2.897223**	-3.512290***	0.0000
Trend and intercept	-7.022774	-3.159372*	-3.465548**	-4.073859***	0.0000
None	-6.940371	-1.614175*	-1.944811**	-2.593468***	0.0000
IF Constant	-3.169524	-2.586866*	-2.899115**	-3.516676**	0.0256
Trend and intercept	-3.246702	-3.161067*	-3.468459*	-4.080021*	0.0831
None	-1.184793	-1.614050	-1.945024	-2.594946	0.2141
DIF Constant	-4.045333	-2.586866*	-2.899115**	-3.516676***	0.0020
Trend and intercept	-4.011243	-3.161067*	-3.468459**	-4.080021**	0.0122
None	-4.057020	-1.614050*	-1.945024**	-2.594946***	0.0001
UN Constant	-2.331394	-2.585626	-2.896779	-3.511262	0.1647
Trend and intercept	-2.375260	-3.158974	-3.464865	-4.072415	0.3896
None	0.111922	-1.614204	-1.944762	-2.593121	0.7154
DUN Constant	-9.422212	-2.585861*	-2.897223**	-3.512290***	0.0000
Trend and intercept	-9.387023	-3.159372*	-3.465548**	-4.073859***	0.0000
None	-9.463364	-1.614175*	-1.944811**	-2.593368***	0.0000

* denotes the rejection of the null hypotheses at 10% level of significance
** denotes the rejection of the null hypotheses at 5% level of significance
*** denotes the rejection of the null hypotheses at 1% level of significance

Source: Author's calculations

Table 4-2: Phillip-Perron test results

Variables	**t Statistics**	**Critical Value (10%)**	**Critical Value (5%)**	**Critical Value (1%)**	**Probability Value**
EX Constant	-1.297472	-2.585626	-2.896779	-3.511262	0.6275
Trend and intercept	-2.106719	-3.158974	-3.464865	-4.072415	0.5343
None	0.923461	-1.614204	-1.944762	-2.593121	0.9039
DEX Constant	-7.072620	-2.585861*	-2.897223**	-3.512290***	0.0000
Trend and intercept	-7.032175	-3.159372*	-3.465548**	-4.073859***	0.0000
None	-6.963009	-1.614175*	-1.944811**	-2.593468***	0.0000
IF Constant	-2.655078	-2.585626*	-2.896779*	-3.511262*	0.0863
Trend and intercept	-2.632427	-3.158974	-3.454865	-4.072415	0.2675
None	-1.422927	-1.614204	-1.944762	-2.593121	0.1432
DIF Constant	-5.724454	-2.585861*	-2.897223**	-3.512290***	0.0000
Trend and intercept	-5.681595	-3.159372*	-3.465548**	-4.073859***	0.0000
None	-5.758033	-1.614175*	-1.944811**	-2.593468***	0.0000
UN Constant	-2.188613	-2.585626	-2.896779	-3.511262	0.2120
Trend and intercept	-2.242120	-3.158974	-3.464865	-4.072415	0.4602
None	0.254377	-1.614204	-1.944762	-2.593121	0.7575
DUN Constant	-9.610715	-2.585861*	-2.897223**	-3.512290***	0.0000
Trend and intercept	-9.712267	-3.159372*	-3.465548**	-4.073859***	0.0000
None	-9.626135	-1.614175*	-1.944811**	-2.593368***	0.0000

* denotes the rejection of the null hypotheses at 10% level of significance
** denotes the rejection of the null hypotheses at 5% level of significance
*** denotes the rejection of the null hypotheses at 1% level of significance

Source: Author's calculations

Based on the results from the ADF tests the time series data for exchange rate and unemployment became stationery after been differenced once. Inflation appeared to be stationery at level form on constant, but only at 5% and 10% levels of significance. The results further indicate that inflation is stationery only at 10% level of significance on trend and intercept. After first difference, exchange rate and unemployment became stationery at all different levels of significance. Furthermore, inflation appeared to be stationery at all different levels of significance on Constant and None. However, it appears that inflation is insignificance at 1% level of significance only on trend and intercept.

Unlike the ADF tests, the PP tests show that inflation is stationery only at 10% level of significance on level form. The results further indicate that all the variables are stationery at all different levels of significance after 1st difference. These results are in line with the visual inspections in figures 4-1 to 4-3, therefore the study concludes that all the variables became stationery after been differenced once.

4.3 JOHANSEN COINTEGRATION TEST

The results from the ADF and PP tests showed that the variables in the model are integrated in the same order. This provided a green light for this study to employ Johansen cointegration test to determine the long-run relationship between the variables. Before carrying with cointegration tests, the lag selection criteria is performed to determine the number of lags to be used in the model.

Table 4-3: Lag selection criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
1	-319.1302	NA	1.009393	8.522862	8.796813	8.632440
2	-292.6874	48.76462	0.642185	8.069802	8.617705*	8.288959*
3	-280.9126	20.79696	0.598888	7.997731	8.819585	8.326465
4	-273.7562	12.08239	0.631073	8.045614	9.141420	8.483927
5	-262.9408	17.41694	0.606508	7.998462	9.368219	8.546353
6	-250.3399	19.31048*	0.558624	7.904932	9.548640	8.562401
7	-239.8884	15.20222	0.546666*	7.867230*	9.784889	8.634277

Source: Author's calculations

Table 4-3 present the lag selection criteria for Johansen cointegration test. The results show that the Schwarz information criterion (SC) and Hannin-Quinn is chosen on lag 2. This is indicated by the asterisk (*) on the Schwarz information criterion value of 8.617705 and Hannin-Quinn criterion value of 8.288959. The results further indicated that the Akaike Information Criterion (AIC) and the Final Prediction Errors (FPE) is chosen on lag 7. This is indicated by the asterisk (*) on the Akaike information value of 7.867230 and the Final prediction error value of 0.546666 respectively. The study chose the lag length of lag 2 on the Schwartz criterion (SC).

The cointegration analysis was based on Trace and the Maximum Eigenvalue tests and the results are presented in table 4-4 and 4-5 respectively.

Table 4-4 Summary of the Trace test

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	Critical Value @5%	Prob.**
None *	**0.337946**	**47.16160**	**29.79707**	**0.0002**
At most 1	0.135584	13.75656	15.49471	0.0899
At most 2	0.023844	1.954746	3.841466	0.1621

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Source: Author's calculations

The trace test results indicate that there is 1 cointegrating equation at 5% level of significance. This is based on the fact that the trace statistics of 47.16160 is greater than the critical value of 29.79707 at 5% level of significance. The implication is that, the null hypothesis of no cointegration between the variables can be rejected and this provides more evidence that there is a long-run equilibrium relationship between the variables.

Table 4-5 Summary of Maximum eigenvalue test

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	Critical Value @5%	Prob.**
None *	**0.337946**	**33.40504**	**21.13162**	**0.0006**
At most 1	0.135584	11.80181	14.26460	0.1183
At most 2	0.023844	1.954746	3.841466	0.1621

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Source: Author's calculations

Table 4-5 presents the results from the maximum eigenvalue test. The results also indicate that there is 1 cointegrating equation at 5% level of significance. The null hypothesis of no cointegration between the variables is been rejected because the Max-Eigen statistics of 33.40504 is greater than the critical value of 21.13162 at the 5% level of significance. This also provides more evidence that there is a long-run relationship between exchange rate, inflation and unemployment.

Table 4-6 Normalised cointegrating equation

Normalised cointegrating coefficient (Standard error in parentheses)		
IF	EX	UN
1.000000	-0.199756	0.433688
	(0.26370)	(0.19387)

Source: Author's calculations

Inflation rate (IF) normalised to unity as endogenous variable of the regression. With the estimated cointegrated vector, the associated coefficients represent the long-run equilibrium relationship. The cointegrated vector is expressed as follows:

$IF + EX + UN = 0$ ………….……………………………………………………………25

Substituting independent variables with their values:

Thus: $IF - 0.199756EX + 0.433688UN = 0$ 26

The regression equation is given by:

IF = $0.199756EX - 0.433688UN$ 27

Equation 27 indicates the existence of a long-run positive relationship between inflation rate and exchange rate. This implies that a 1% Rand depreciation against the US dollar will lead to 0.199% increase in the rate of inflation. In the same logic, a 1% decrease in inflation will appreciate the value of the Rand per US dollar by 0.199%. In line with economic theory, the positive relationship between inflation and exchange rate is associated with prise inflation in the economy. These support the idea that a weak Rand will affect the economy in a negative way. Equation 27 further indicates a negative relationship between inflation and unemployment. This implies that a 1% increase in the unemployment rate decreases inflation rate by 0.43%. Inversely, an increase in inflation rate by 1% decreases the unemployment rate by 0.43%. This can be achieved by applying contractionary or expansionary monetary policy and fiscal policy explained under the section of demand-pull inflation.

4.4 VECTOR ERROR CORRECTION MODEL (VECM)

Even though the results from Johansen cointegration test confirmed that there is a long run relationship between the variables, the tests could not be used to explain if the variables are integrated in the short-run. To determine the short-run relationship between the variables, the VECM is employed. VECM serves to estimate both short term and long run effects of explanatory time series. It corrects long run disequilibrium through short run adjustments, leading the system to short run equilibrium. The study establishes VECM considering 1 cointegrating vector derived from the Johansen cointegration test, with lags interval of 1 to 2. The study chose 2 use lag 2 on the Schwartz criterion. The VECM was first checked for fitness to be used in the study and the results indicated that the model is significance to determine the short-run relationship between the variables.

Table 4-7 Significance of the VECM

Dependent Variable: D(IF)
Method: Least Squares
Date: 07/02/16 Time: 22:11
Sample (adjusted): 1994Q4 2014Q4
Included observations: 81 after adjustments
D(IF) = C(1)*(IF(-1) - 0.199756082173*EX(-1) + 0.433688374887*UN(-1) - 15.1999214084) + C(2)*D(IF(-1)) + C(3)*D(IF(-2)) + C(4)*D(EX(-1)) + C(5)*D(EX(-2)) + C(6)*D(UN(-1)) + C(7)*D(UN(-2)) + C(8)

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.293119	0.052064	-5.630009	0.0000
C(2)	0.629837	0.087351	7.210422	0.0000
C(3)	0.032152	0.096011	0.334877	0.7387
C(4)	0.142669	0.204545	0.697493	0.4877
C(5)	0.219401	0.207123	1.059280	0.2930
C(6)	0.126338	0.088955	1.420246	0.1598
C(7)	0.339334	0.087405	3.882341	0.0002
C(8)	-0.097453	0.108850	-0.895301	0.3736

Source: Author's calculations

Table 4-7 presents the results for the fitness of the VECM in this study. C(1) represents the coefficient of the speed of adjustment, C(2) is the inflation rate on lag 1, C(3) the inflation rate on lag 2. Furthermore, C(4) is the exchange rate on lag 1, C(5) exchange rate on lag 2, C(6) unemployment on lag 1, C(7) unemployment on lag 2 and finally C(8) represents the constant. The results indicate that the model is significance to be used in this study. This is indicated by the probability value of the coefficient C (1), which is less than 5% level of significance.

Table 4-8 Summary of VECM estimates

Variables	**Coefficients**	**Standard errors**	**t-statistics**
D (IF)	0.629837	0.08735	7.21042
D (EX)	0.142669	0.20455	0.69749
D (UN)	0.126338	0.08895	1.42025
CointEq1	-0.293119	0..5206	-5.63001
Constant	-0.097453	0.10885	-0.8953
R-squared = 0.58 Adjusted R-squared = 58			

Source: Author's calculations

Since VECM is a system of equations, the error term of the Cointegrating equation 1 in table 4-8 is negative (-0.293119) and significant. The implication is that the estimated coefficient of -0.29 indicates that about 29% of this disequilibrium is corrected between one quarter. The coefficient of correlation (R-squared of around 58%) of the series reveals that the VECM significantly translate short-term adjustments in all three variables and it explains adjustments in all the series according to short run changes. Based on the complete VECM results, the error correction terms indicate that inflation rate, unemployment and exchange rate substantially adjust to long run shocks affecting natural equilibrium.

4.5 THE WALD TEST

Table 4-9 Summary of the Wald Test

Variables	Probability value	Decision Rule
All the Variables	0.0000	Existence of short-run relationship
Inflation rate and exchange rate	0.0001	Existence of short-run relationship
Inflation rate and unemployment	0.0000	Existence of short-run relationship
Exchange rate and unemployment	0.0042	Existence of short-run relationship

Source: Author's calculations

Table 4-9 present the results for the Wald Test. They indicate the existence of short-run equilibrium relationship for all the variables when they are combined together. This is indicated by the probability value of the F-statistics, which is equal to 0.0000 and less than 5% level of significance. Based on table 4-9, all the variables appeared to have short-run equilibrium relationship even when they are separated because the probability values of their F-statistics is less than 5% level of significance.

4.6 THE ENGLE-GRANGER CAUSALITY TESTS

The Granger causality test was first conducted using lag (2) and the results indicated that there is no causality effect amongst the variables. This was proved by higher probability values of more than 5% on table 4-10.

Table 4-10 The Engle-Granger causality test on lag (2)

Pairwise Granger Causality Tests
Date: 07/26/16 Time: 17:25
Sample: 1994Q1 2014Q4
Lags: 2

Null Hypothesis:	Obs	F-Statistic	Prob.
EX does not Granger Cause IF	82	1.63678	0.2013
IF does not Granger Cause EX		0.42301	0.6566
UN does not Granger Cause IF	82	1.65884	0.1971
IF does not Granger Cause UN		0.72833	0.4860
UN does not Granger Cause EX	82	0.29902	0.7424
EX does not Granger Cause UN		3.08360	0.0515

Source: Author's calculations

Based on the results from Johansen cointegration tests, causality was expected because there was cointegrating equation amongst the variables. The lags were changed in order to determine whether there is causality on other lags.

Table 4-11 The Engle-Granger causality test on lag (4)

Pairwise Granger Causality Tests
Date: 06/06/16 Time: 05:55
Sample: 1994Q1 2014Q4
Lags: 4

Null Hypothesis:	Obs	F-Statistic	Prob.
EX does not Granger Cause IF	80	2.54324	0.0470
IF does not Granger Cause EX		0.36006	0.8362
UN does not Granger Cause IF	80	3.66954	0.0090
IF does not Granger Cause UN		3.35607	0.0142
UN does not Granger Cause EX	80	0.43094	0.7858
EX does not Granger Cause UN		1.57242	0.1911

Source: Author's calculations

Table 4-11 present the results of the Engle-Granger causality test using lag (4). They indicate that exchange rate does Granger cause inflation but inflation does not Granger cause exchange rate. This implies that exchange rate does have a causal effect on inflation. However, inflation does not have a causal effect on exchange rate. These support the theoretical perspective of a weak currency feeding to price inflation in the home country because of the high prices of imported intermediates capital. Furthermore, it is also indicated that unemployment and inflation has a causal effect on each other. Theoretically, this can be linked to the trade-off between the two variables which was well detailed in the Phillips curve and the AS-AD model. The results further indicate that there is no causality effect between unemployment and exchange rate.

4.7 DIAGNOSTIC TESTING

Table 4-12 Summary of diagnostic testing

TEST	Ho	P-VALUE	CONCLUSION
Jarque-Bera	Risiduals are normally distributed	0.577900	Do not reject Ho since PV is >5% L.O.S
Breusch-Godfrey	No serial Correlation	0.6531	Do not reject Ho since PV is > 5% L.O.S
Breusch-Pegan-Godfrey	No Heteroskedasticity	0.0724	Do not reject Ho since PV is > 5% L.O.S
ARCH	No Heteroskedasticity	0.0705	Do not reject Ho since PV is > 5% L.O.S
Harvey	No Heteroskedasticity	0.5529	Do not reject Ho since PV is > 5% L.O.S

At 5% level of significance

Source: Author's calculations

NB: PV = Probability Value

L.O.S = level of significance

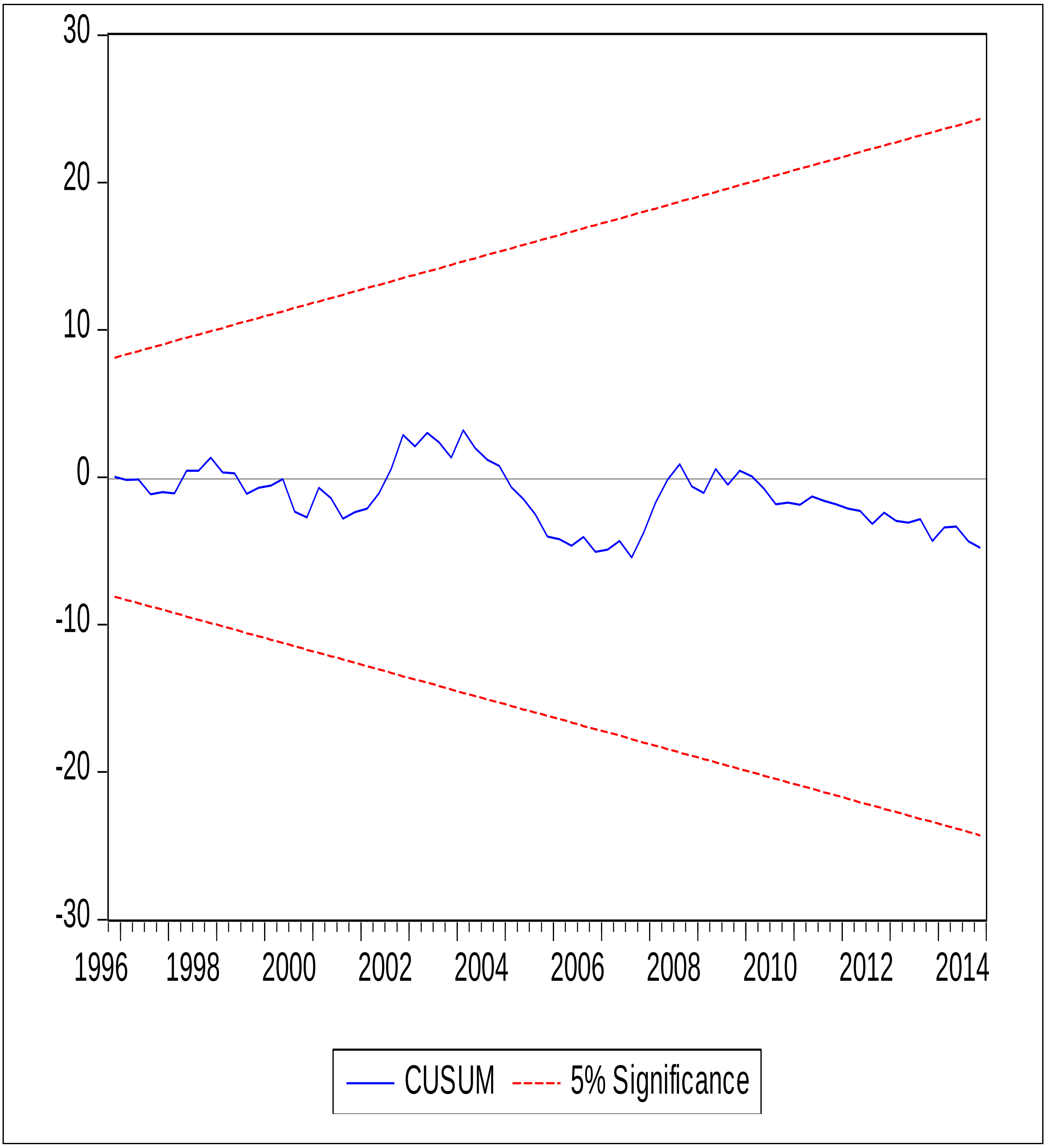
The diagnostic tests show that residuals are normally distributed in the model. This is indicated by the probability value of 0.577900 from Jarque-Bera test, which is more than 5% level of significance. They further indicate that there is no serial correlation between the variables, because the probability value of Breusch-Godfrey LM test is above 5% level of significance, which is 0.6531. This implies that the null hypothesis cannot be rejected.

Furthermore, it is indicated that the existence of heteroskedasticity amongst the variables is rejected by both Breusch-Pegan-Godfrey, ARCH and Harvey. This is indicated by the fact that the probability values of all the tests are greater than 5% level of significance.

4.8 STABILITY TEST

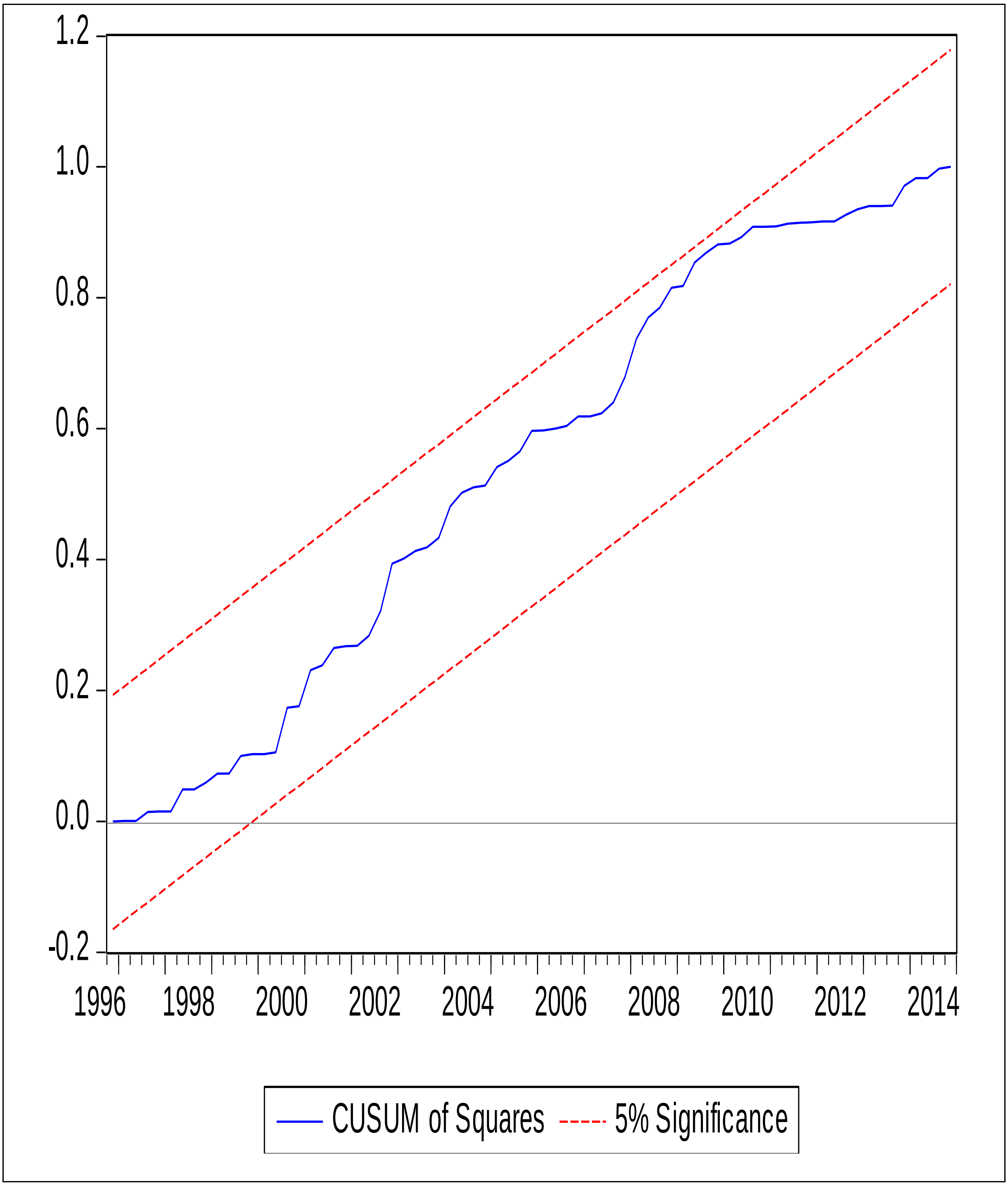
Figure 4-4 and 4-5 present the results from the for the Cusum Test and Cusum Squares respectively. They indicate that the model is fairly stable because the cumulative sums move inside the critical lines and continue to the end of the period. This is indicated by the movement between the lines of significance, which is within the 5% level of significance.

Figure 4-4 The Cusum Test



Source: Author's calculations

Figure 4-5 The Cusum Squares

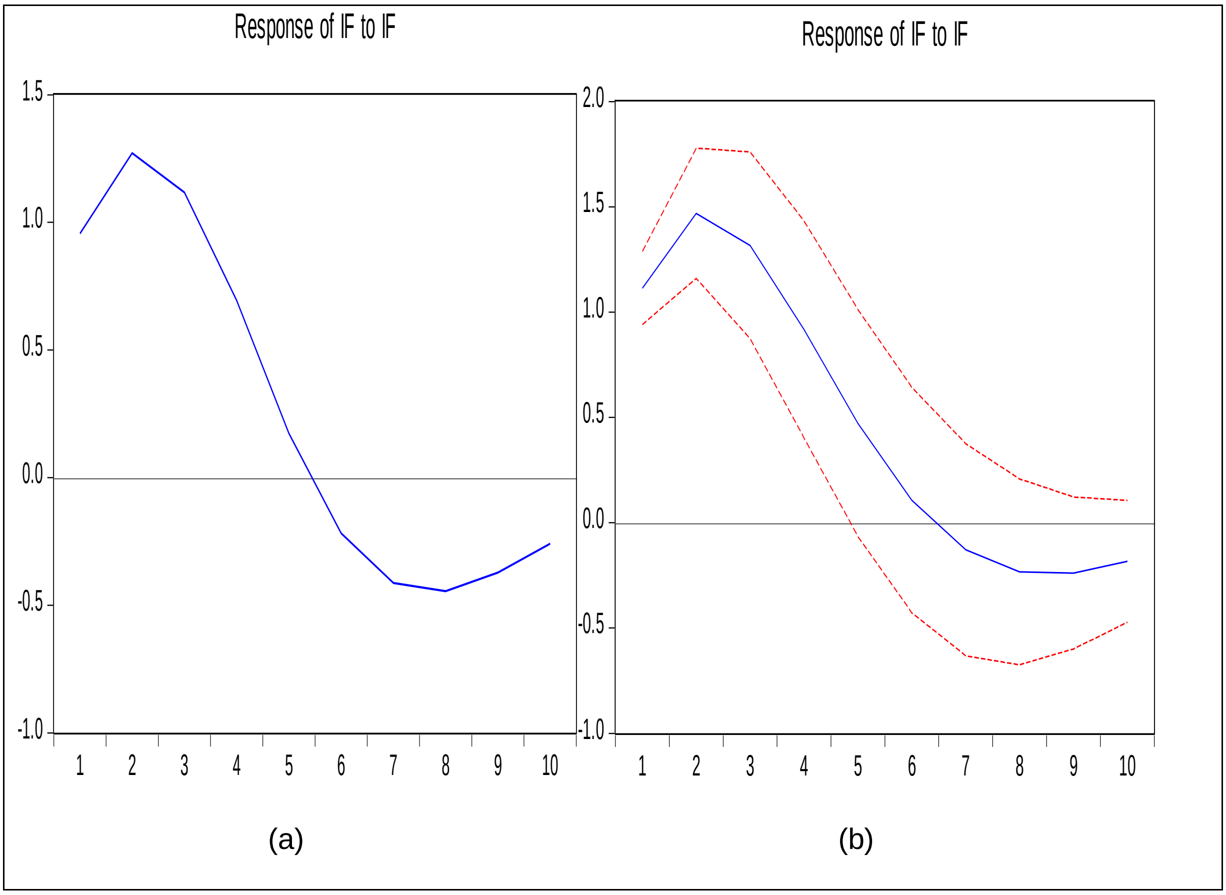


Source: Author's calculations

4.9 THE IMPULSE RESPONSE FUNCTION

This section present the impulse response function for both VECM and VAR model. In all the figures (figure 4-6 to 4-13), (a) represents the impulse response for VECM and graph (b) represents the impulse response for VAR model.

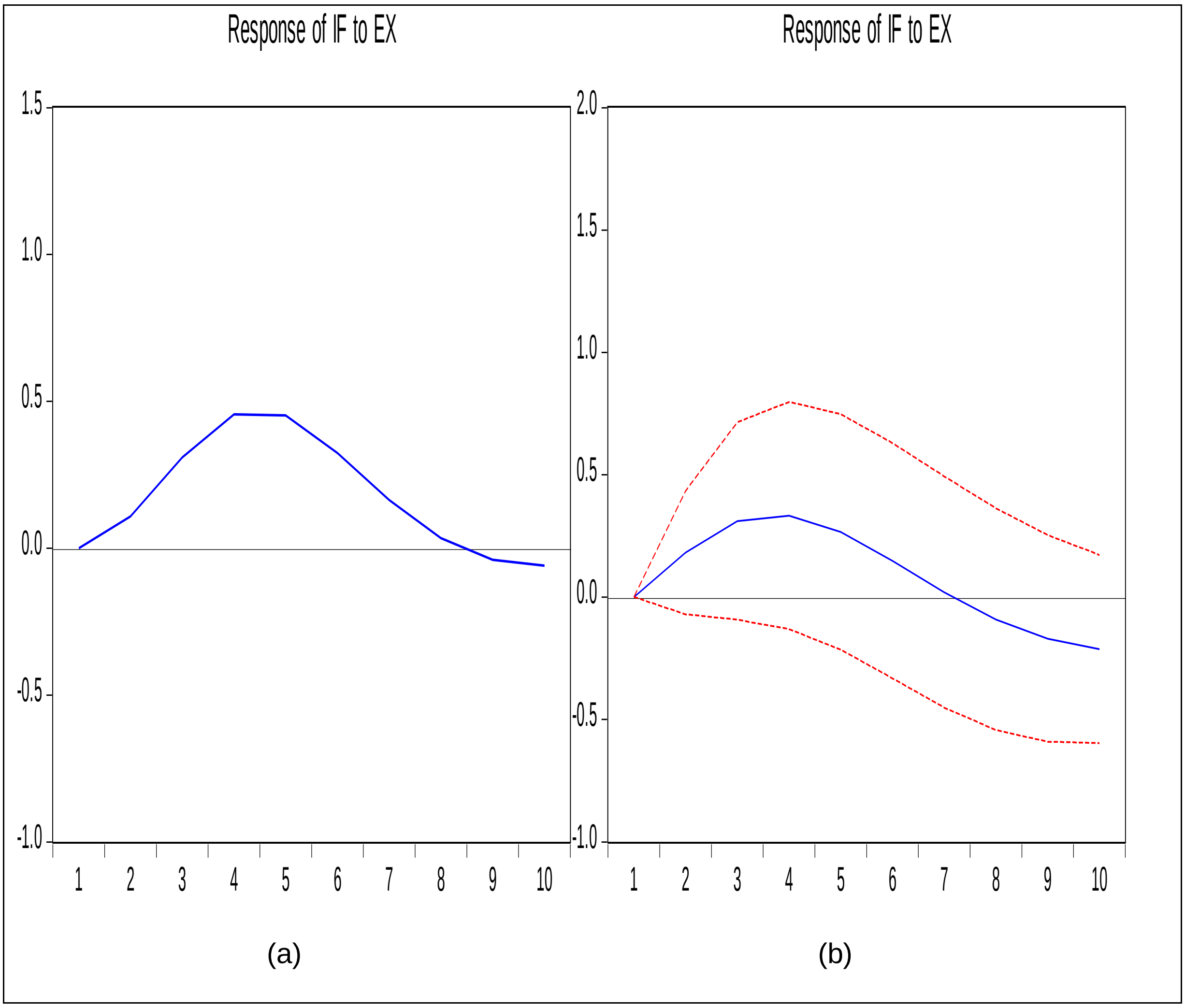
Figure 4-6 The response of inflation to inflation



Source: Author's calculations

Figure 4-6 shows that inflation rate responds positively to a shock on itself from period 1 to period 5. The response becomes negative from the 5.5 quarter until the end of the period. It si also indicated that the response is positive at a decreasing rate from period 3 to period 5. The results of the VECM appears to be in line with the results of the VAR model.

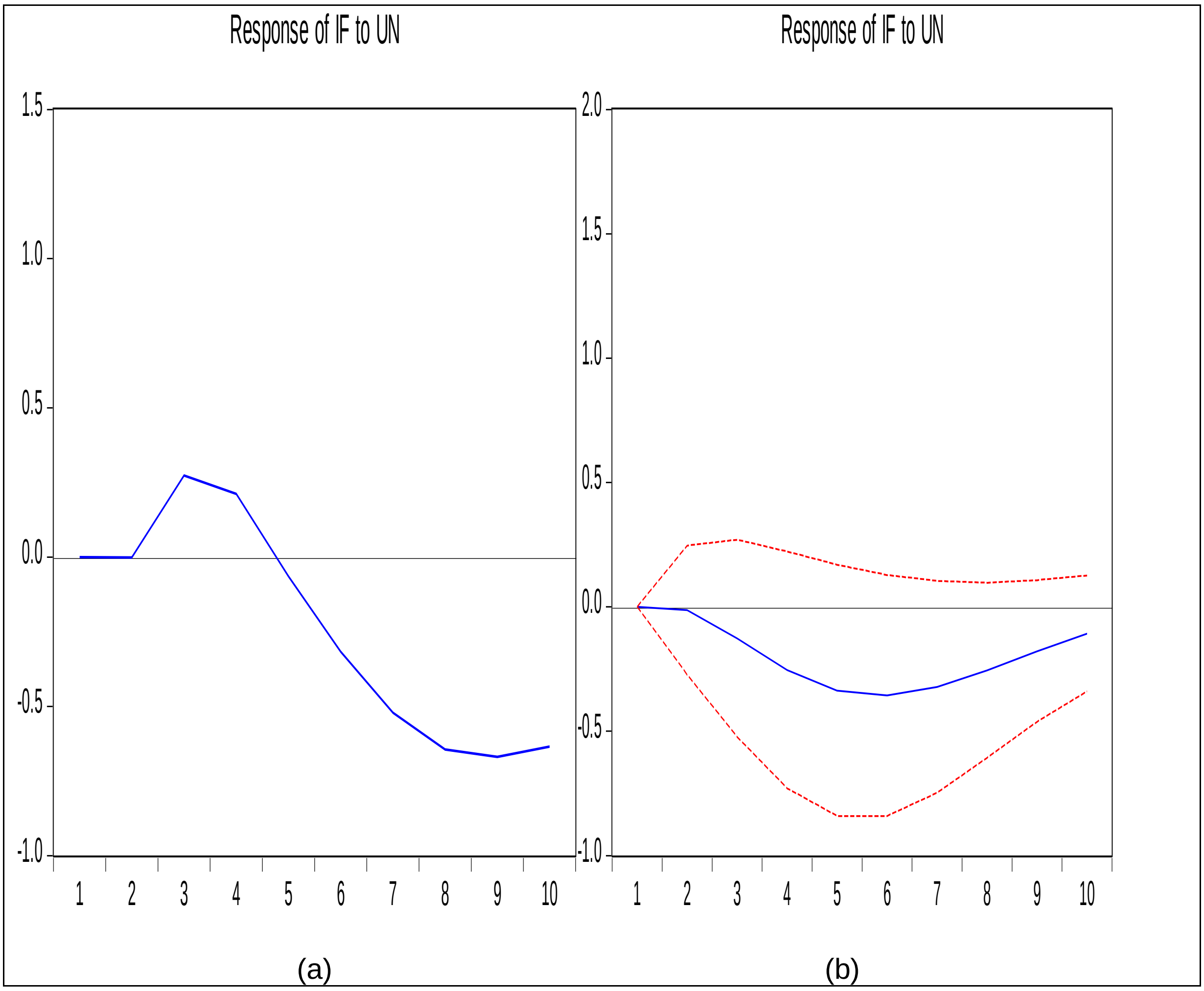
Figure 4-7 The response of inflation to exchange rate



Source: Author's calculations

Based on figure 4-7, the response of inflation to exchange rate is positive at an increasing rate from period 1 to period 4 and start declining from period 5 to period 8. The response appears to be negative on VECM from period 8.5 until the end period. However, on the VAR model the response started to be negative from period 7.5 until the end period. The results appears to be the same from both models with slight different on the start of the negative response.

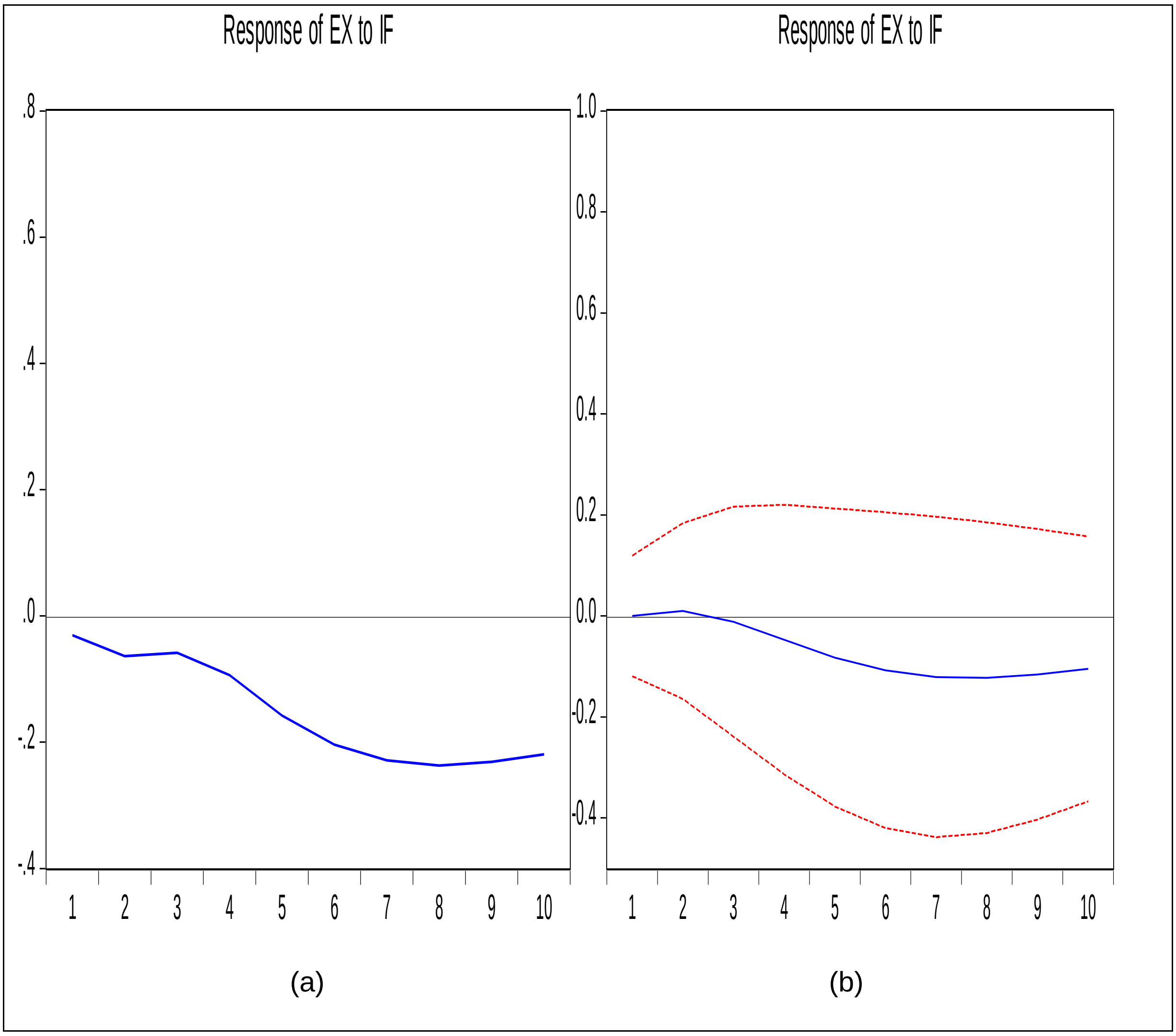
Figure 4-8 The response of inflation to unemployment



Source: Author's calculations

In figure 4-8 a shock on unemployment will not have an effect on inflation from quarter 1 to 2. The results from VECM indicate that the response of inflation rate to unemployment will be positive from period 2 to 5, and becomes negative from period 5 until the end period. The VAR model appears to be in contrary with the VECM from period 2 to 5 because the response is negative. Based on figure (b), the response of inflation rate to unemployment is negative from period 2 until the end period.

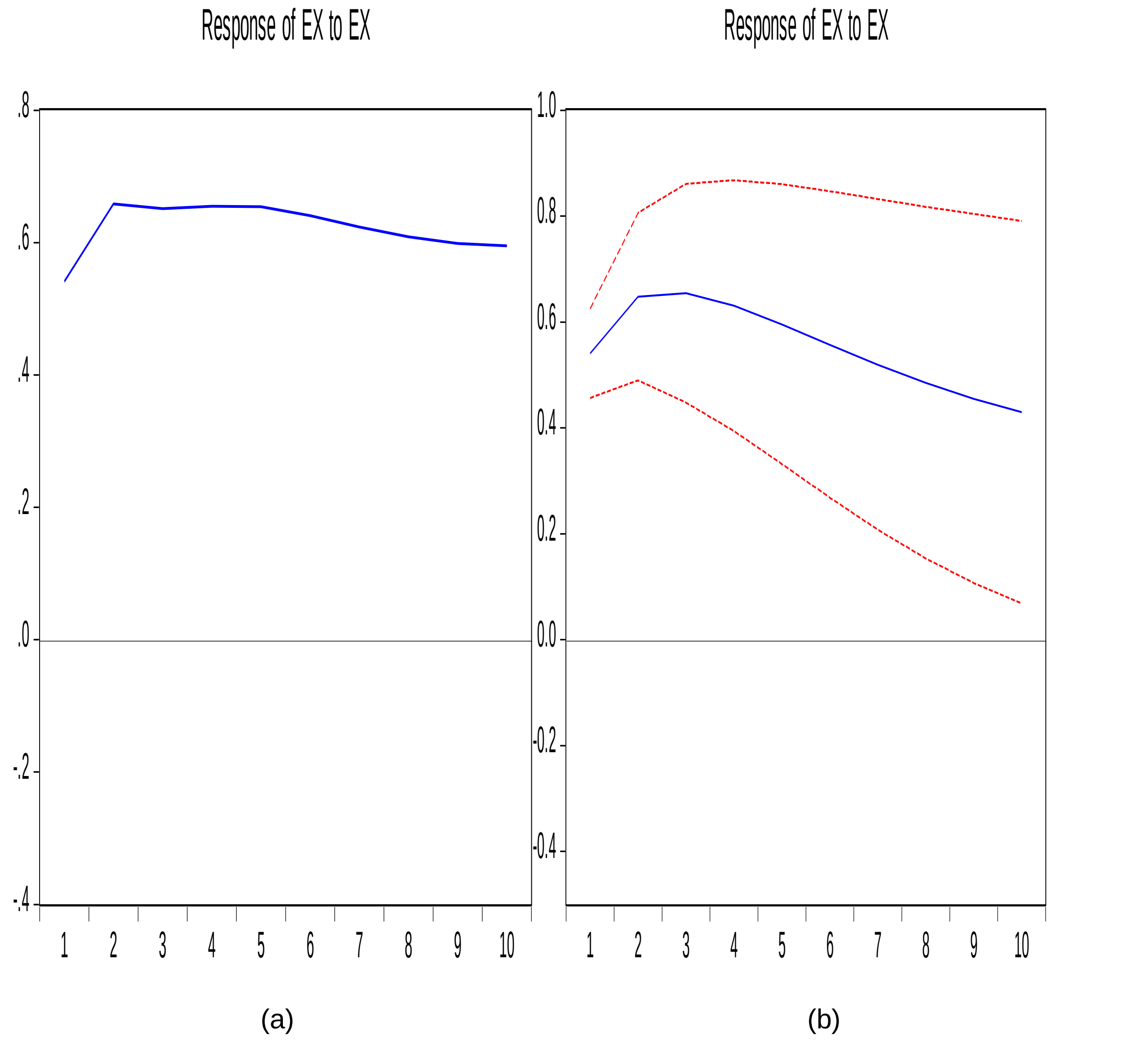
Figure 4-9 The response of exchange rate to inflation



Source: Author's calculations

Based on figure 4-9 (a), the response of exchange rate to a shock on inflation rate is negative from period 1 until the end period. However, figure 4-9 (b) indicates that a shock on inflation rate will not have an effect on exchange rate from period 1 to 3. The results further indicate that the response will be negative from period 3 until the end period.

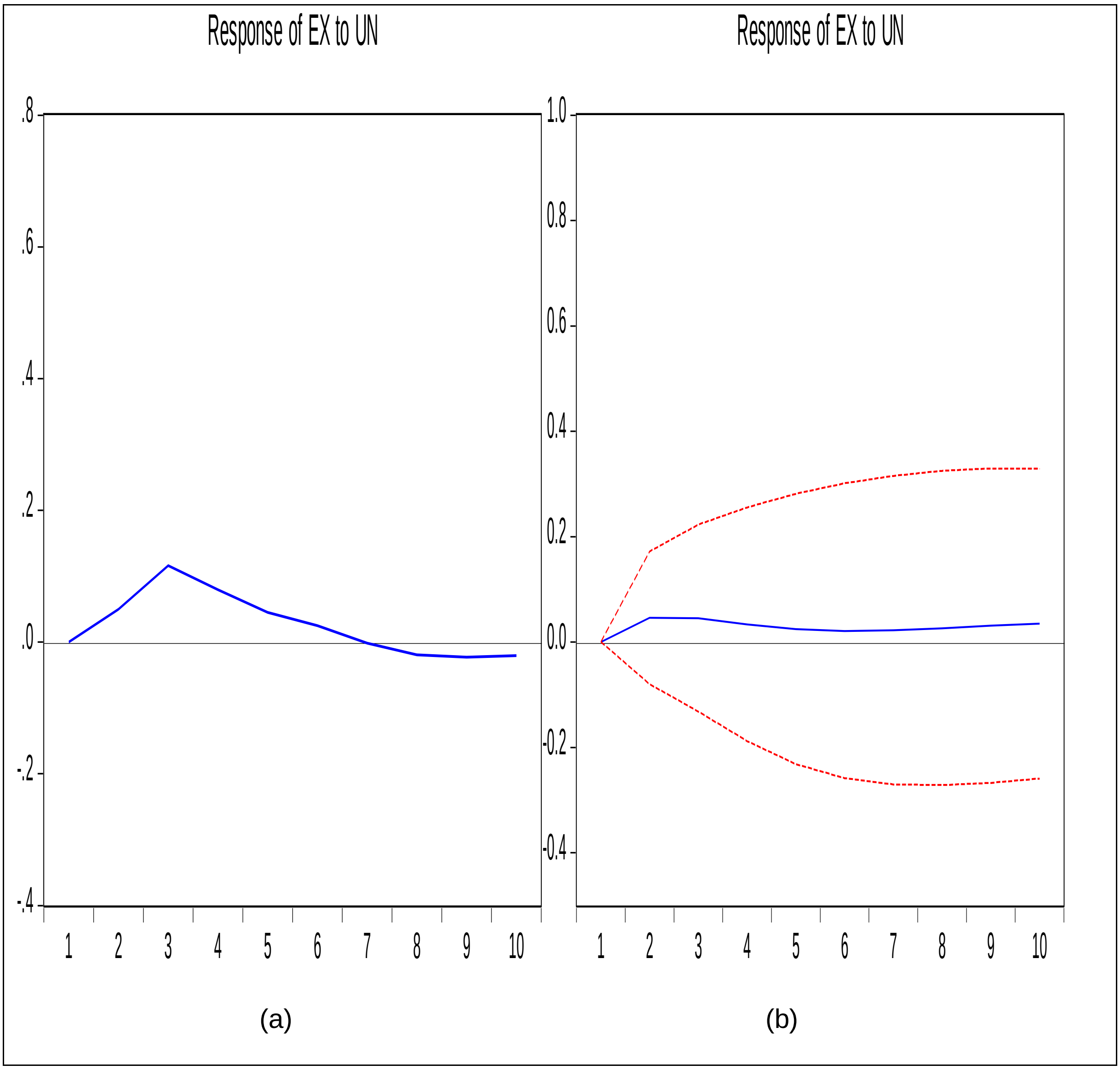
Figure 4-10 The response of exchange rate to exchange rate



Source: Author's calculations

Figure 4-10 shows that the response of exchange rate to a shock on exchange rate is positive from period 1 until the end period. Both (a) and (b) yields the same results.

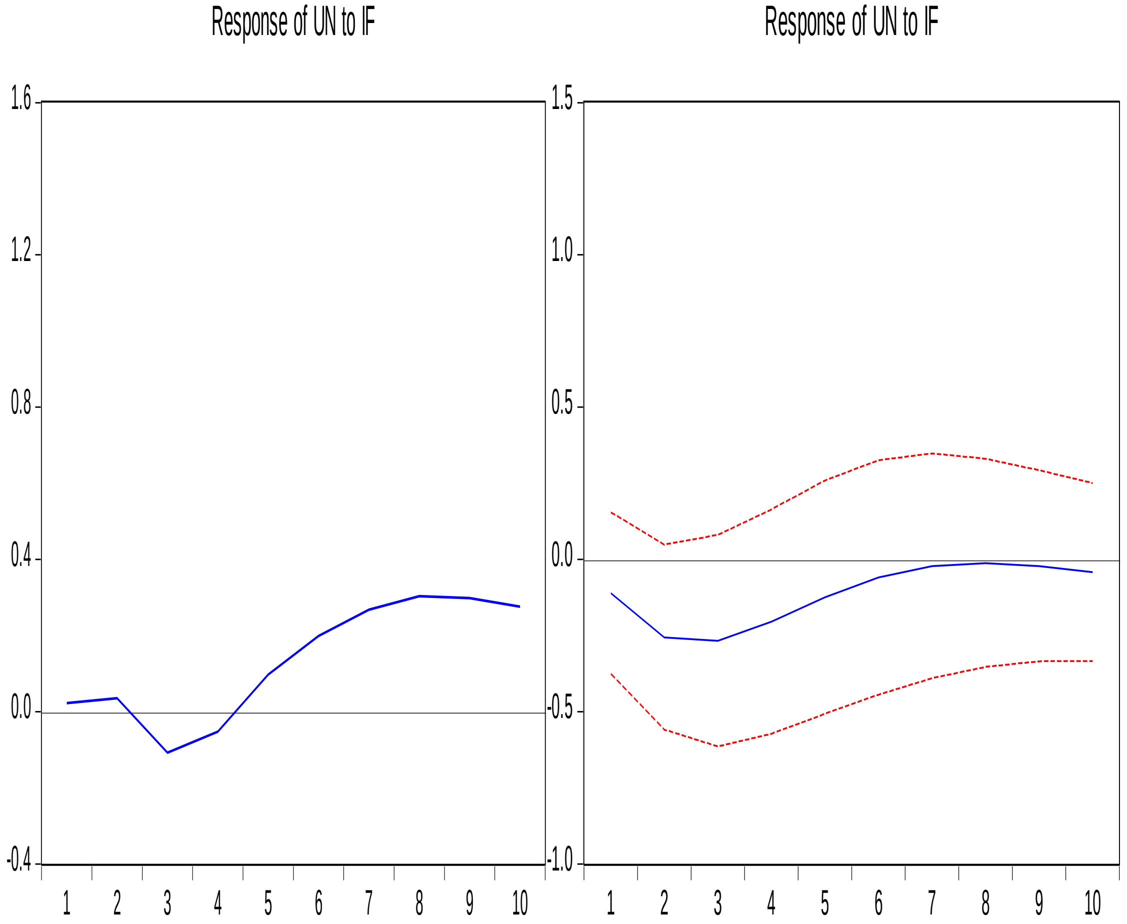
Figure 4-11 The response of exchange rate to unemployment



Source: Author's calculations

In figure 4-11 (a), the response of exchange rate to unemployment is positive at an increasing rate from period 1 to 3, but start declining at a decreasing rate from period 3 to 6.5 and then becomes negative from period 7 until the end period. Figure (b) indicates that the response of exchange rate to a shock on unemployment is negative from period 1 until the end period.

Figure 4-12 The response of unemployment to inflation

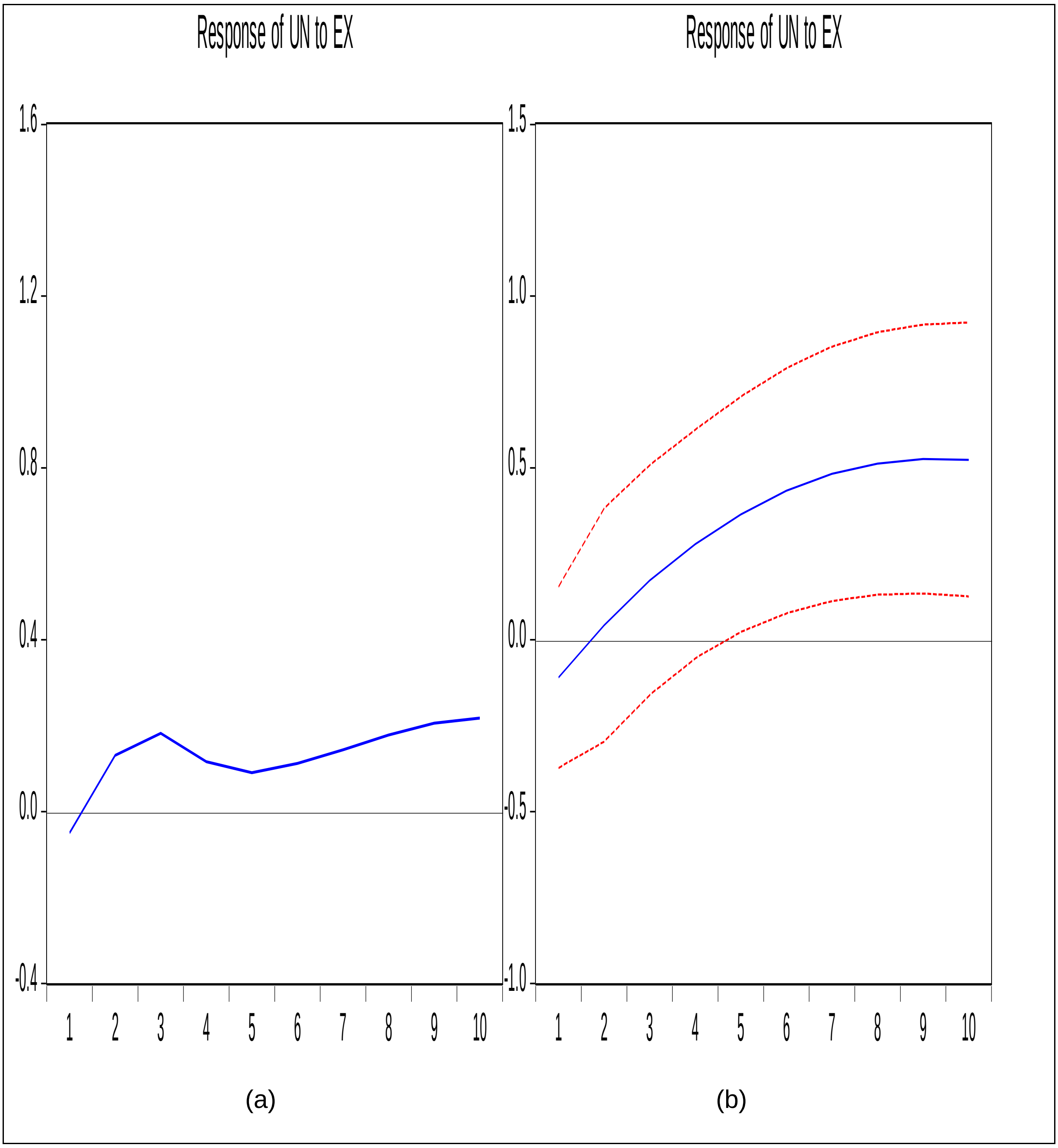


(a) (b)

Source: Author's calculations

As far as figure 4-12 (a) is concerned, a shock on inflation rate has got a little positive effect on unemployment from period 1 to 2, becomes negative from period 2 to 4, and then becomes positive again from period 4.5 until the end period. Figure (b) indicates that the response is negative from period 1 to period 6, have no effect between period 7 and 9, and then have little negative effect from period 9 until period 10. The two models did not yield the same results.

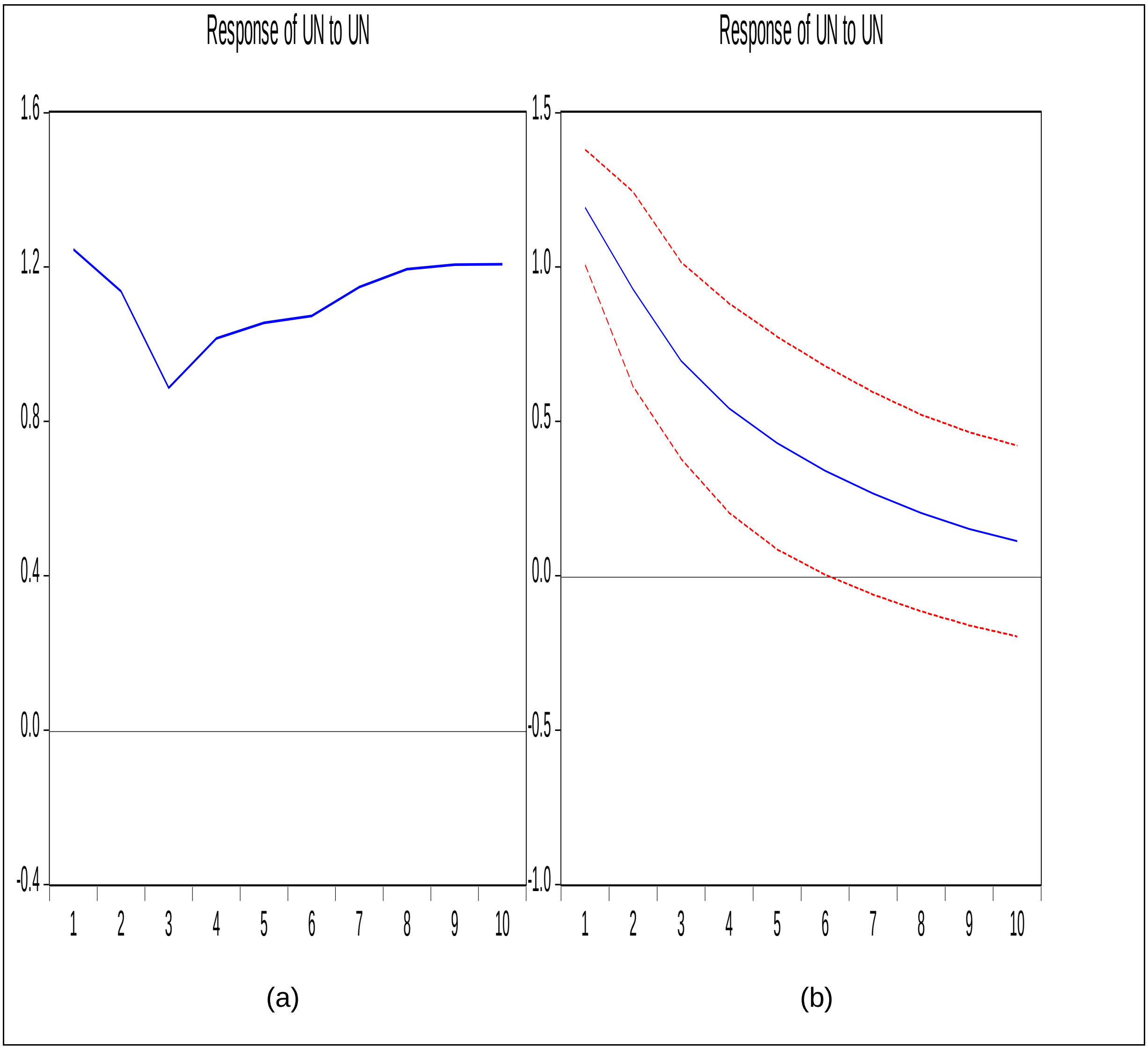
Figure 4-13 The response of unemployment to exchange rate



Source: Author's calculations

Figure 4-13 shows that the response of unemployment to a shock on exchange rate start negatively from period 1 to 1.5, then becomes positive from period 1.5 until the end period. Both figures yields similar results.

Figure 4-14 The response of unemployment to unemployment



Source: Author's calculations

Based on figure 4-14, the response of unemployment to a shock on unemployment is positive from period 1 until the end period. However, figure (a) indicates that the response is positive at a decreasing rate from period 1 to 3, then start being positive at an increasing rate from period 3 until the end period. Furthermore, figure (b) indicates that the response is positive at a decreasing rate from period 1 until the end period.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

The primary aim of this study was to determine the relationship between exchange rate, unemployment and inflation in South Africa. The secondary aim was to find out the degree of influence amongst the above mentioned variables. A comprehensive literature review was carried out to review the findings of other studies, however, there were mixed results from the literature reviewed. The ADF and PP tests were employed to test whether the time series data was stationery or not. The results showed that the time series data was not stationery at level form for all the variables; however, it became stationery after been differenced once.

In order to achieve the primary aim of this study, Johansen cointegration test and VECM were employed to test for long-run and short-run equilibrium relationship amongst the variables respectively. The trace and maximum eigenvalue test confirmed the existence of one cointegrating equation between the variables. This also confirmed the existence of long-run relationship between the variables. The normalised cointegrating equation was used to point out the nature of the relationship between the variables. The results pointed out an inverse relationship between unemployment and inflation in South Africa. These results are in line with the standard Phillips-Curve which pointed out negative relationship between inflation and unemployment in the United Kingdom between 1861 and 1957. This implies that policy makers in South Africa are been faced with the trade-off between unemployment and inflation.

Furthermore, it is also indicated that inflation is positively related to exchange rate. This implies that a depreciation of the Rand in the foreign exchange market will feed to price inflation in South Africa. Theoretically, this was supported by the AD-AS model on the sources of cost-push inflation. It was based on the notion that a weak Rand raises the cost of production, especially the prices of imported intermediate capital. This results support the findings of Todaro and Smith (2009), which argued that a weak Rand may have negative consequences on the economy. The argument was also based on the fact that aggregate demand for domestically produced goods may cause price inflation as a result of lower exports prices. Rowbotham (2011) also highlighted the fact that a weak currency does not improve export performance and economic growth. The results emphasised that export growth is associated with a stronger, relative floating exchange rate in efficiency-driven economies.

The results further indicated a positive relationship between unemployment and exchange rate. This implies that a depreciation of the Rand in the foreign exchange market will increase the level of unemployment in South Africa. This rejects the idea of using a weak currency as an instrument to reduce the level of unemployment as well as boosting the growth rate in the economy.

The results from VECM also indicated the existence of short-run relationship between the variables. Based on the completed VECM results, the error correction terms indicate that inflation rate, unemployment rate and exchange rate will be able to adjust to long run shocks affecting natural equilibrium at a rate of 29% quarterly.

In order to find out the degree of influence between the variables, the study employed the Engle-Granger causality tests. The test was first carried out using lag (2) and the results indicated no causality amongst the variables. The test was carried out again using lag (4) and the results indicated that exchange rate does have a causal effect on inflation, but inflation does not have a causal effect on exchange rate. This implies that monetary authorities in South Africa should keep a close eye on the fluctuations of the Rand value in the foreign exchange market, taking into consideration its significant effect on the rate of inflation and unemployment in the country.

The results further indicated that unemployment and inflation have a causal effect on each other. The implication of these results suggests that the rate of inflation in the country will have an effect on the level of unemployment. However, unemployment rate will also have an effect in the rate at which general prices are increasing. Furthermore, causality was not found between unemployment and exchange rate. Meaning the unemployment level in South Africa is affected by other factors other than exchange rate.

Diagnostic tests were also performed. The results indicated that there were no serial correlation and heteroskedasticity. They further indicated that residuals are normally distributed in the model. Furthermore, the Cusum test and Cusum squares confirmed that the model was stable. Meaning the model was correctly specified. In conclusion, the impulse response function carried out to trace out the behaviour of the variables should they be affected by external shocks.

5.2 Recommendations

Since the results of this study have demonstrated a negative relationship between unemployment and inflation, policies aimed at lowering unemployment and inflation rate are recommended. This can be achieved by adopting policies which can increase the level of production in the economy without raising the general price level. Inflation targeting framework seems to be doing a very good job in managing inflation rate in the country. However, the unemployment rate has been sitting around 25% for a long time so far. Statistics shows that structural unemployment is the main type of unemployment been experienced in South Africa. This implies that the labour market in South Africa is suffering from the shortage of skills and the oversupply of unskilled and semi-skilled labour (Mohr, 2012). It is therefore recommended that policy makers in South Africa take measures to improve the quality of education, training and skills. Steps can also be taken to increase the labour intensity of production. Small businesses and informal sector are said to be key drivers of labour intensity of production. Measures to promote small businesses and informal sector can also work as way of reducing the level of unemployment in the country.

The results further indicated that inflation rate is positively related to exchange rate. In this case, it is advisable to policy makers in South Africa to come up with policies that will help in strengthening the Rand.

5.3 Limitations of the study

This study determined the relationship between exchange rate, unemployment and inflation in South Africa. The study covered the period 1994Q1-2014Q4, meaning the relationship between the selected variables prior 1994 and after 2014 cannot be analysed by this study. It is also acknowledged that some of the variables and econometric models that might affect the results of this study were not included in this study. Perhaps a different approach can be used to determine the relationship between the selected variables in South Africa.

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APPENDICES

Appendix 1A: Augmented Dickey-Fuller test (Exchange rate at 1st Difference, Constant)

Null Hypothesis: D(EX) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-7.063483	0.0000
Test critical values:	1% level	-3.512290	
	5% level	-2.897223	
	10% level	-2.585861	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(EX,2)
Method: Least Squares
Date: 06/05/16 Time: 21:27
Sample (adjusted): 1994Q3 2014Q4
Included observations: 82 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(EX(-1))	-0.770722	0.109114	-7.063483	0.0000
C	0.072169	0.059809	1.206666	0.2311

R-squared	0.384107	Mean dependent var	0.003340
Adjusted R-squared	0.376409	S.D. dependent var	0.676674
S.E. of regression	0.534355	Akaike info criterion	1.608574
Sum squared resid	22.84280	Schwarz criterion	1.667275
Log likelihood	-63.95155	Hannan-Quinn criter.	1.632142
F-statistic	49.89279	Durbin-Watson stat	1.967805
Prob(F-statistic)	0.000000		

Appendix 1B: Augmented Dickey-Fuller test (Exchange rate at 1st Difference, Trend and Intercept)

Null Hypothesis: D(EX) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-7.022774	0.0000
Test critical values:	1% level	-4.073859	
	5% level	-3.465548	
	10% level	-3.159372	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(EX,2)
Method: Least Squares
Date: 06/05/16 Time: 21:28
Sample (adjusted): 1994Q3 2014Q4
Included observations: 82 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(EX(-1))	-0.770916	0.109774	-7.022774	0.0000
C	0.049307	0.122334	0.403052	0.6880
@TREND("1994Q1")	0.000538	0.002508	0.214637	0.8306

R-squared	0.384466	Mean dependent var	0.003340
Adjusted R-squared	0.368883	S.D. dependent var	0.676674
S.E. of regression	0.537569	Akaike info criterion	1.632382
Sum squared resid	22.82949	Schwarz criterion	1.720432
Log likelihood	-63.92764	Hannan-Quinn criter.	1.667733
F-statistic	24.67196	Durbin-Watson stat	1.968567
Prob(F-statistic)	0.000000		

Appendix 1C: Augmented Dickey-Fuller test (Exchange rate at 1st Difference, None)

Null Hypothesis: D(EX) has a unit root
Exogenous: None
Lag Length: 0 (Automatic - based on SIC, maxlag=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-6.940371	0.0000
Test critical values:	1% level	-2.593468	
	5% level	-1.944811	
	10% level	-1.614175	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(EX,2)
Method: Least Squares
Date: 06/05/16 Time: 21:28
Sample (adjusted): 1994Q3 2014Q4
Included observations: 82 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(EX(-1))	-0.749271	0.107958	-6.940371	0.0000

R-squared	0.372898	Mean dependent var	0.003340
Adjusted R-squared	0.372898	S.D. dependent var	0.676674
S.E. of regression	0.535857	Akaike info criterion	1.602221
Sum squared resid	23.25855	Schwarz criterion	1.631571
Log likelihood	-64.69106	Hannan-Quinn criter.	1.614005
Durbin-Watson stat	1.972942		

Appendix 1D: Phillip-Perron test (Exchange rate at 1st Difference, Constant)

Null Hypothesis: D(EX) has a unit root
Exogenous: Constant
Bandwidth: 3 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-7.072620	0.0000
Test critical values:	1% level	-3.512290	
	5% level	-2.897223	
	10% level	-2.585861	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	0.278571
HAC corrected variance (Bartlett kernel)	0.281426

Phillips-Perron Test Equation
Dependent Variable: D(EX,2)
Method: Least Squares
Date: 06/30/16 Time: 10:26
Sample (adjusted): 1994Q3 2014Q4
Included observations: 82 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(EX(-1))	-0.770722	0.109114	-7.063483	0.0000
C	0.072169	0.059809	1.206666	0.2311

R-squared	0.384107	Mean dependent var	0.003340
Adjusted R-squared	0.376409	S.D. dependent var	0.676674
S.E. of regression	0.534355	Akaike info criterion	1.608574
Sum squared resid	22.84280	Schwarz criterion	1.667275
Log likelihood	-63.95155	Hannan-Quinn criter.	1.632142
F-statistic	49.89279	Durbin-Watson stat	1.967805
Prob(F-statistic)	0.000000		

Appendix 1E: Phillip-Perron test (Exchange rate at 1st Difference, Trend and Intercept)

Null Hypothesis: D(EX) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 3 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-7.032175	0.0000
Test critical values:	1% level	-4.073859	
	5% level	-3.465548	
	10% level	-3.159372	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	0.278408
HAC corrected variance (Bartlett kernel)	0.281283

Phillips-Perron Test Equation
Dependent Variable: D(EX,2)
Method: Least Squares
Date: 06/30/16 Time: 10:27
Sample (adjusted): 1994Q3 2014Q4
Included observations: 82 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(EX(-1))	-0.770916	0.109774	-7.022774	0.0000
C	0.049307	0.122334	0.403052	0.6880
@TREND("1994Q1")	0.000538	0.002508	0.214637	0.8306

R-squared	0.384466	Mean dependent var	0.003340
Adjusted R-squared	0.368883	S.D. dependent var	0.676674
S.E. of regression	0.537569	Akaike info criterion	1.632382
Sum squared resid	22.82949	Schwarz criterion	1.720432
Log likelihood	-63.92764	Hannan-Quinn criter.	1.667733
F-statistic	24.67196	Durbin-Watson stat	1.968567
Prob(F-statistic)	0.000000		

Appendix 1F: Phillip-Perron test (Exchange rate at 1st Difference, None)

Null Hypothesis: D(EX) has a unit root
Exogenous: None
Bandwidth: 3 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-6.963009	0.0000
Test critical values:	1% level	-2.593468	
	5% level	-1.944811	
	10% level	-1.614175	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	0.283641
HAC corrected variance (Bartlett kernel)	0.290483

Phillips-Perron Test Equation
Dependent Variable: D(EX,2)
Method: Least Squares
Date: 06/30/16 Time: 10:27
Sample (adjusted): 1994Q3 2014Q4
Included observations: 82 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(EX(-1))	-0.749271	0.107958	-6.940371	0.0000

R-squared	0.372898	Mean dependent var	0.003340
Adjusted R-squared	0.372898	S.D. dependent var	0.676674
S.E. of regression	0.535857	Akaike info criterion	1.602221
Sum squared resid	23.25855	Schwarz criterion	1.631571
Log likelihood	-64.69106	Hannan-Quinn criter.	1.614005
Durbin-Watson stat	1.972942		

Appendix 1G: Augmented Dickey-Fuller test (Unemployment at 1st Difference, Constant)

Null Hypothesis: D(UN) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-9.422212	0.0000
Test critical values:	1% level	-3.512290	
	5% level	-2.897223	
	10% level	-2.585861	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(UN,2)
Method: Least Squares
Date: 06/05/16 Time: 21:32
Sample (adjusted): 1994Q3 2014Q4
Included observations: 82 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(UN(-1))	-1.057219	0.112205	-9.422212	0.0000
C	0.056207	0.140374	0.400410	0.6899

R-squared	0.526005	Mean dependent var	-0.013415
Adjusted R-squared	0.520080	S.D. dependent var	1.832341
S.E. of regression	1.269377	Akaike info criterion	3.339018
Sum squared resid	128.9055	Schwarz criterion	3.397718
Log likelihood	-134.8997	Hannan-Quinn criter.	3.362585
F-statistic	88.77807	Durbin-Watson stat	2.012241
Prob(F-statistic)	0.000000		

Appendix 1H: Augmented Dickey-Fuller test (Unemployment at 1st Difference, Trend and Intercept)

Null Hypothesis: D(UN) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-9.387023	0.0000
Test critical values:	1% level	-4.073859	
	5% level	-3.465548	
	10% level	-3.159372	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(UN,2)
Method: Least Squares
Date: 06/05/16 Time: 21:32
Sample (adjusted): 1994Q3 2014Q4
Included observations: 82 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(UN(-1))	-1.058912	0.112806	-9.387023	0.0000
C	0.177174	0.289910	0.611134	0.5429
@TREND("1994Q1")	-0.002844	0.005954	-0.477600	0.6343

R-squared	0.527369	Mean dependent var	-0.013415
Adjusted R-squared	0.515404	S.D. dependent var	1.832341
S.E. of regression	1.275546	Akaike info criterion	3.360525
Sum squared resid	128.5344	Schwarz criterion	3.448576
Log likelihood	-134.7815	Hannan-Quinn criter.	3.395876
F-statistic	44.07479	Durbin-Watson stat	2.015321
Prob(F-statistic)	0.000000		

Appendix 1I: Augmented Dickey-Fuller test (Unemployment at 1st Difference, None)

Null Hypothesis: D(UN) has a unit root
Exogenous: None
Lag Length: 0 (Automatic - based on SIC, maxlag=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-9.463364	0.0000
Test critical values:	1% level	-2.593468	
	5% level	-1.944811	
	10% level	-1.614175	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(UN,2)
Method: Least Squares
Date: 06/05/16 Time: 21:33
Sample (adjusted): 1994Q3 2014Q4
Included observations: 82 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(UN(-1))	-1.054854	0.111467	-9.463364	0.0000

R-squared	0.525055	Mean dependent var	-0.013415
Adjusted R-squared	0.525055	S.D. dependent var	1.832341
S.E. of regression	1.262781	Akaike info criterion	3.316630
Sum squared resid	129.1638	Schwarz criterion	3.345980
Log likelihood	-134.9818	Hannan-Quinn criter.	3.328413
Durbin-Watson stat	2.011970		

Appendix 1J: Phillip-Perron test (Unemployment at 1st Difference, Constant)

Null Hypothesis: D(UN) has a unit root
Exogenous: Constant
Bandwidth: 9 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-9.610715	0.0000
Test critical values:	1% level	-3.512290	
	5% level	-2.897223	
	10% level	-2.585861	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	1.572018
HAC corrected variance (Bartlett kernel)	1.124804

Phillips-Perron Test Equation
Dependent Variable: D(UN,2)
Method: Least Squares
Date: 06/30/16 Time: 10:38
Sample (adjusted): 1994Q3 2014Q4
Included observations: 82 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(UN(-1))	-1.057219	0.112205	-9.422212	0.0000
C	0.056207	0.140374	0.400410	0.6899

R-squared	0.526005	Mean dependent var	-0.013415
Adjusted R-squared	0.520080	S.D. dependent var	1.832341
S.E. of regression	1.269377	Akaike info criterion	3.339018
Sum squared resid	128.9055	Schwarz criterion	3.397718
Log likelihood	-134.8997	Hannan-Quinn criter.	3.362585
F-statistic	88.77807	Durbin-Watson stat	2.012241
Prob(F-statistic)	0.000000		

Appendix 1K: Phillip-Perron test (Unemployment at 1st Difference, Trend and Intercept)

Null Hypothesis: D(UN) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 10 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-9.712267	0.0000
Test critical values:	1% level	-4.073859	
	5% level	-3.465548	
	10% level	-3.159372	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	1.567492
HAC corrected variance (Bartlett kernel)	0.986011

Phillips-Perron Test Equation
Dependent Variable: D(UN,2)
Method: Least Squares
Date: 06/30/16 Time: 10:39
Sample (adjusted): 1994Q3 2014Q4
Included observations: 82 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(UN(-1))	-1.058912	0.112806	-9.387023	0.0000
C	0.177174	0.289910	0.611134	0.5429
@TREND("1994Q1")	-0.002844	0.005954	-0.477600	0.6343

R-squared	0.527369	Mean dependent var	-0.013415
Adjusted R-squared	0.515404	S.D. dependent var	1.832341
S.E. of regression	1.275546	Akaike info criterion	3.360525
Sum squared resid	128.5344	Schwarz criterion	3.448576
Log likelihood	-134.7815	Hannan-Quinn criter.	3.395876
F-statistic	44.07479	Durbin-Watson stat	2.015321
Prob(F-statistic)	0.000000		

Appendix 1L: Phillip-Perron test (Unemployment at 1st Difference, None)

Null Hypothesis: D(UN) has a unit root
Exogenous: None
Bandwidth: 9 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-9.626135	0.0000
Test critical values:	1% level	-2.593468	
	5% level	-1.944811	
	10% level	-1.614175	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	1.575169
HAC corrected variance (Bartlett kernel)	1.168142

Phillips-Perron Test Equation
Dependent Variable: D(UN,2)
Method: Least Squares
Date: 06/30/16 Time: 10:39
Sample (adjusted): 1994Q3 2014Q4
Included observations: 82 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(UN(-1))	-1.054854	0.111467	-9.463364	0.0000

R-squared	0.525055	Mean dependent var	-0.013415
Adjusted R-squared	0.525055	S.D. dependent var	1.832341
S.E. of regression	1.262781	Akaike info criterion	3.316630
Sum squared resid	129.1638	Schwarz criterion	3.345980
Log likelihood	-134.9818	Hannan-Quinn criter.	3.328413
Durbin-Watson stat	2.011970		

Appendix 1M: Augmented Dickey-Fuller test (Inflation at 1st Difference, Constant)

Null Hypothesis: D(IF) has a unit root
Exogenous: Constant
Lag Length: 4 (Automatic - based on SIC, maxlag=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.045333	0.0020
Test critical values:	1% level	-3.516676	
	5% level	-2.899115	
	10% level	-2.586866	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(IF,2)
Method: Least Squares
Date: 06/05/16 Time: 21:37
Sample (adjusted): 1995Q3 2014Q4
Included observations: 78 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(IF(-1))	-0.715821	0.176950	-4.045333	0.0001
D(IF(-1),2)	0.378658	0.127021	2.981062	0.0039
D(IF(-2),2)	0.191073	0.125157	1.526669	0.1312
D(IF(-3),2)	0.265405	0.111512	2.380062	0.0200
D(IF(-4),2)	-0.345673	0.103026	-3.355190	0.0013
C	-0.035604	0.108468	-0.328241	0.7437

R-squared	0.564328	Mean dependent var	-0.016050
Adjusted R-squared	0.534073	S.D. dependent var	1.399457
S.E. of regression	0.955253	Akaike info criterion	2.820123
Sum squared resid	65.70066	Schwarz criterion	3.001409
Log likelihood	-103.9848	Hannan-Quinn criter.	2.892695
F-statistic	18.65237	Durbin-Watson stat	1.919152
Prob(F-statistic)	0.000000		

Appendix 1N: Augmented Dickey-Fuller test (Inflation at 1st Difference, Trend and Intercept)

Null Hypothesis: D(IF) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 4 (Automatic - based on SIC, maxlag=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.011243	0.0122
Test critical values:	1% level	-4.080021	
	5% level	-3.468459	
	10% level	-3.161067	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(IF,2)
Method: Least Squares
Date: 06/05/16 Time: 21:38
Sample (adjusted): 1995Q3 2014Q4
Included observations: 78 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(IF(-1))	-0.719490	0.179368	-4.011243	0.0001
D(IF(-1),2)	0.380653	0.128386	2.964909	0.0041
D(IF(-2),2)	0.192876	0.126423	1.525636	0.1315
D(IF(-3),2)	0.266516	0.112447	2.370143	0.0205
D(IF(-4),2)	-0.343589	0.104401	-3.291058	0.0016
C	-0.074008	0.244011	-0.303298	0.7626
@TREND("1994Q1")	0.000859	0.004880	0.175997	0.8608

R-squared	0.564518	Mean dependent var	-0.016050
Adjusted R-squared	0.527716	S.D. dependent var	1.399457
S.E. of regression	0.961747	Akaike info criterion	2.845328
Sum squared resid	65.67201	Schwarz criterion	3.056828
Log likelihood	-103.9678	Hannan-Quinn criter.	2.929995
F-statistic	15.33961	Durbin-Watson stat	1.916876
Prob(F-statistic)	0.000000		

Appendix 1O: Augmented Dickey-Fuller test (Inflation at 1st Difference, None)

Null Hypothesis: D(IF) has a unit root
Exogenous: None
Lag Length: 4 (Automatic - based on SIC, maxlag=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.057020	0.0001
Test critical values:	1% level	-2.594946	
	5% level	-1.945024	
	10% level	-1.614050	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(IF,2)
Method: Least Squares
Date: 06/05/16 Time: 21:39
Sample (adjusted): 1995Q3 2014Q4
Included observations: 78 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(IF(-1))	-0.711615	0.175403	-4.057020	0.0001
D(IF(-1),2)	0.376414	0.126060	2.986001	0.0038
D(IF(-2),2)	0.188751	0.124191	1.519850	0.1329
D(IF(-3),2)	0.263852	0.110728	2.382876	0.0198
D(IF(-4),2)	-0.347717	0.102208	-3.402062	0.0011

R-squared	0.563676	Mean dependent var	-0.016050
Adjusted R-squared	0.539768	S.D. dependent var	1.399457
S.E. of regression	0.949398	Akaike info criterion	2.795978
Sum squared resid	65.79897	Schwarz criterion	2.947049
Log likelihood	-104.0431	Hannan-Quinn criter.	2.856454
Durbin-Watson stat	1.919915		

Appendix 1P: Phillip-Perron test (Inflation at 1st Difference, Constant)

Null Hypothesis: D(IF) has a unit root
Exogenous: Constant
Bandwidth: 2 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-5.724454	0.0000
Test critical values:	1% level	-3.512290	
	5% level	-2.897223	
	10% level	-2.585861	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	1.532572
HAC corrected variance (Bartlett kernel)	1.825541

Phillips-Perron Test Equation
Dependent Variable: D(IF,2)
Method: Least Squares
Date: 06/30/16 Time: 10:33
Sample (adjusted): 1994Q3 2014Q4
Included observations: 82 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(IF(-1))	-0.530727	0.096482	-5.500776	0.0000
C	0.001662	0.138469	0.012001	0.9905

R-squared	0.274433	Mean dependent var	0.023954
Adjusted R-squared	0.265363	S.D. dependent var	1.462298
S.E. of regression	1.253350	Akaike info criterion	3.313605
Sum squared resid	125.6709	Schwarz criterion	3.372305
Log likelihood	-133.8578	Hannan-Quinn criter.	3.337172
F-statistic	30.25854	Durbin-Watson stat	1.580935
Prob(F-statistic)	0.000000		

Appendix 1Q: Phillip-Perron test (Inflation at 1st Difference, Trend and Intercept)

Null Hypothesis: D(IF) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 2 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-5.681595	0.0000
Test critical values:	1% level	-4.073859	
	5% level	-3.465548	
	10% level	-3.159372	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	1.531782
HAC corrected variance (Bartlett kernel)	1.825872

Phillips-Perron Test Equation
Dependent Variable: D(IF,2)
Method: Least Squares
Date: 06/30/16 Time: 10:33
Sample (adjusted): 1994Q3 2014Q4
Included observations: 82 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(IF(-1))	-0.529810	0.097172	-5.452288	0.0000
C	0.052218	0.286620	0.182185	0.8559
@TREND("1994Q1")	-0.001189	0.005889	-0.201830	0.8406

R-squared	0.274807	Mean dependent var	0.023954
Adjusted R-squared	0.256447	S.D. dependent var	1.462298
S.E. of regression	1.260932	Akaike info criterion	3.337479
Sum squared resid	125.6061	Schwarz criterion	3.425530
Log likelihood	-133.8367	Hannan-Quinn criter.	3.372830
F-statistic	14.96823	Durbin-Watson stat	1.582987
Prob(F-statistic)	0.000003		

Appendix 1R: Phillip-Perron test (Inflation at 1st Difference, None)

Null Hypothesis: D(IF) has a unit root
Exogenous: None
Bandwidth: 2 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-5.758033	0.0000
Test critical values:	1% level	-2.593468	
	5% level	-1.944811	
	10% level	-1.614175	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	1.532574
HAC corrected variance (Bartlett kernel)	1.825511

Phillips-Perron Test Equation
Dependent Variable: D(IF,2)
Method: Least Squares
Date: 06/30/16 Time: 10:34
Sample (adjusted): 1994Q3 2014Q4
Included observations: 82 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(IF(-1))	-0.530761	0.095844	-5.537770	0.0000

R-squared	0.274431	Mean dependent var	0.023954
Adjusted R-squared	0.274431	S.D. dependent var	1.462298
S.E. of regression	1.245590	Akaike info criterion	3.289216
Sum squared resid	125.6711	Schwarz criterion	3.318566
Log likelihood	-133.8579	Hannan-Quinn criter.	3.301000
Durbin-Watson stat	1.580884		

Appendix 1S: Lag selection criteria

VAR Lag Order Selection Criteria
Endogenous variables: IF EX UN
Exogenous variables:
Date: 06/05/16 Time: 14:46
Sample: 1994Q1 2014Q4
Included observations: 77

Lag	LogL	LR	FPE	AIC	SC	HQ
1	-319.1302	NA	1.009393	8.522862	8.796813	8.632440
2	-292.6874	48.76462	0.642185	8.069802	8.617705*	8.288959*
3	-280.9126	20.79696	0.598888	7.997731	8.819585	8.326465
4	-273.7562	12.08239	0.631073	8.045614	9.141420	8.483927
5	-262.9408	17.41694	0.606508	7.998462	9.368219	8.546353
6	-250.3399	19.31048*	0.558624	7.904932	9.548640	8.562401
7	-239.8884	15.20222	0.546666*	7.867230*	9.784889	8.634277

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Appendix 1T: Johansen cointegration test

Date: 06/05/16 Time: 14:52
Sample (adjusted): 1994Q4 2014Q4
Included observations: 81 after adjustments
Trend assumption: Linear deterministic trend
Series: IF EX UN
Lags interval (in first differences): 1 to 2

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.337946	47.16160	29.79707	0.0002
At most 1	0.135584	13.75656	15.49471	0.0899
At most 2	0.023844	1.954746	3.841466	0.1621

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.337946	33.40504	21.13162	0.0006
At most 1	0.135584	11.80181	14.26460	0.1183
At most 2	0.023844	1.954746	3.841466	0.1621

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegrating Coefficients (normalized by b'*S11*b=I):

IF	EX	UN
0.490426	-0.097966	0.212692
-0.091418	0.655060	-0.628011
-0.049834	0.504973	0.016059

Unrestricted Adjustment Coefficients (alpha):

D(IF)	-0.597682	0.079175	0.042751
D(EX)	-0.093754	0.002828	-0.076789
D(UN)	0.194131	0.424374	-0.000641

1 Cointegrating Equation(s): Log likelihood -296.5320

Normalized cointegrating coefficients (standard error in parentheses)

IF	EX	UN
1.000000	-0.199756	0.433688
	(0.26370)	(0.19387)

Adjustment coefficients (standard error in parentheses)

D(IF)	-0.293119
	(0.05206)
D(EX)	-0.045979

	(0.02952)
D(UN)	0.095207
	(0.06797)

2 Cointegrating Equation(s):	Log likelihood	-290.6311

Normalized cointegrating coefficients (standard error in parentheses)

IF	EX	UN
1.000000	0.000000	0.249126
		(0.13902)
0.000000	1.000000	-0.923941
		(0.18224)

Adjustment coefficients (standard error in parentheses)

D(IF)	-0.300357	0.110417
	(0.05276)	(0.07005)
D(EX)	-0.046238	0.011037
	(0.03003)	(0.03987)
D(UN)	0.056411	0.258972
	(0.06455)	(0.08570)

Appendix 1U: Estimates of the vector error correction model (VECM)

Vector Error Correction Estimates
Date: 06/05/16 Time: 15:00
Sample (adjusted): 1994Q4 2014Q4
Included observations: 81 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1		
IF(-1)	1.000000		
EX(-1)	-0.199756		
	(0.26370)		
	[-0.75751]		
UN(-1)	0.433688		
	(0.19387)		
	[2.23695]		
C	-15.19992		
Error Correction:	**D(IF)**	**D(EX)**	**D(UN)**
CointEq1	-0.293119	-0.045979	0.095207
	(0.05206)	(0.02952)	(0.06797)
	[-5.63001]	[-1.55730]	[1.40076]
D(IF(-1))	0.629837	0.017207	-0.069822
	(0.08735)	(0.04954)	(0.11403)
	[7.21042]	[0.34735]	[-0.61229]
D(IF(-2))	0.032152	0.065196	-0.233905
	(0.09601)	(0.05445)	(0.12534)
	[0.33488]	[1.19740]	[-1.86615]
D(EX(-1))	0.142669	0.211835	0.344026
	(0.20455)	(0.11600)	(0.26703)
	[0.69749]	[1.82622]	[1.28834]
D(EX(-2))	0.219401	-0.074194	0.047101
	(0.20712)	(0.11746)	(0.27040)
	[1.05928]	[-0.63167]	[0.17419]
D(UN(-1))	0.126338	0.059665	-0.128308
	(0.08895)	(0.05045)	(0.11613)
	[1.42025]	[1.18276]	[-1.10487]
D(UN(-2))	0.339334	0.067862	-0.262698
	(0.08740)	(0.04957)	(0.11410)
	[3.88234]	[1.36910]	[-2.30225]
C	-0.097453	0.075850	0.034889
	(0.10885)	(0.06173)	(0.14210)
	[-0.89530]	[1.22878]	[0.24552]
R-squared	0.580406	0.110533	0.121788
Adj. R-squared	0.540171	0.025241	0.037576
Sum sq. resids	66.63931	21.43091	113.5719
S.E. equation	0.955441	0.541825	1.247309
F-statistic	14.42541	1.295940	1.446205

Log likelihood	-107.0303	-61.08462	-128.6225
Akaike AIC	2.840253	1.705793	3.373395
Schwarz SC	3.076742	1.942282	3.609884
Mean dependent	-0.042633	0.093837	0.053086
S.D. dependent	1.408983	0.548795	1.271425

Determinant resid covariance (dof adj.)	0.414831
Determinant resid covariance	0.303658
Log likelihood	-296.5320
Akaike information criterion	7.988444
Schwarz criterion	8.786594

Appendix 1V: Significance of the model (VECM)

Dependent Variable: D(IF)
Method: Least Squares
Date: 07/02/16 Time: 22:11
Sample (adjusted): 1994Q4 2014Q4
Included observations: 81 after adjustments
D(IF) = C(1)*(IF(-1) - 0.199756082173*EX(-1) + 0.433688374887*UN(-1) - 15.1999214084) + C(2)*D(IF(-1)) + C(3)*D(IF(-2)) + C(4)*D(EX(-1)) + C(5)*D(EX(-2)) + C(6)*D(UN(-1)) + C(7)*D(UN(-2)) + C(8)

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.293119	0.052064	-5.630009	0.0000
C(2)	0.629837	0.087351	7.210422	0.0000
C(3)	0.032152	0.096011	0.334877	0.7387
C(4)	0.142669	0.204545	0.697493	0.4877
C(5)	0.219401	0.207123	1.059280	0.2930
C(6)	0.126338	0.088955	1.420246	0.1598
C(7)	0.339334	0.087405	3.882341	0.0002
C(8)	-0.097453	0.108850	-0.895301	0.3736

R-squared	0.580406	Mean dependent var	-0.042633
Adjusted R-squared	0.540171	S.D. dependent var	1.408983
S.E. of regression	0.955441	Akaike info criterion	2.840253
Sum squared resid	66.63931	Schwarz criterion	3.076742
Log likelihood	-107.0303	Hannan-Quinn criter.	2.935136
F-statistic	14.42541	Durbin-Watson stat	2.062619
Prob(F-statistic)	0.000000		

Appendix 1W: The Wald Test (All the variables)

Wald Test:
Equation: Untitled

Test Statistic	Value	df	Probability
t-statistic	5.118264	73	0.0000
F-statistic	26.19663	(1, 73)	0.0000
Chi-square	26.19663	1	0.0000

Null Hypothesis: C(2)+C(3)+C(4)+C(5)+C(6)+C(7)=0
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(2) + C(3) + C(4) + C(5) + C(6) + C(7)	1.489731	0.291062

Restrictions are linear in coefficients.

Appendix 1X: The Wald Test (Inflation rate and exchange rate)

Wald Test:
Equation: Untitled

Test Statistic	Value	df	Probability
t-statistic	4.030568	73	0.0001
F-statistic	16.24547	(1, 73)	0.0001
Chi-square	16.24547	1	0.0001

Null Hypothesis: C(2)+C(3)+C(4)+C(5)=0
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(2) + C(3) + C(4) + C(5)	1.024059	0.254073

Restrictions are linear in coefficients.

Appendix 1Y: The Wald Test (Inflation rate and unemployment)

Wald Test:
Equation: Untitled

Test Statistic	Value	df	Probability
t-statistic	5.999822	73	0.0000
F-statistic	35.99787	(1, 73)	0.0000
Chi-square	35.99787	1	0.0000

Null Hypothesis: C(2)+C(3)+C(6)+C(7)=0
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(2) + C(3) + C(6) + C(7)	1.127661	0.187949

Restrictions are linear in coefficients.

Appendix 1Z: The Wald Test (Exchange rate and unemployment)

Wald Test:
Equation: Untitled

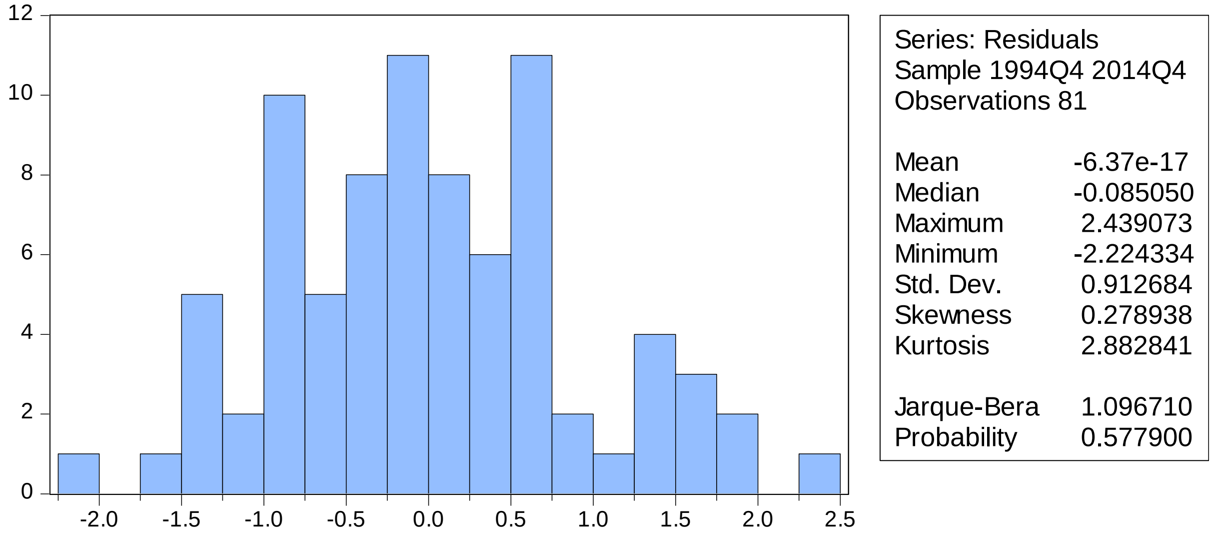
Test Statistic	Value	df	Probability
t-statistic	2.952995	73	0.0042
F-statistic	8.720182	(1, 73)	0.0042
Chi-square	8.720182	1	0.0031

Null Hypothesis: C(4)+C(5)+C(6)+C(7)=0
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(4) + C(5) + C(6) + C(7)	0.827743	0.280306

Restrictions are linear in coefficients.

Appendix 2A: Residuals normality test (Jarque-Bera)



Appendix 2B: Serial correlation (Breusch-Godfrey)

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	0.377333	Prob. F(2,71)	0.6871
Obs*R-squared	0.851902	Prob. Chi-Square(2)	0.6531

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Date: 08/01/16 Time: 11:32
Sample: 1994Q4 2014Q4
Included observations: 81
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.033557	0.068658	0.488751	0.6265
C(2)	0.066897	0.150955	0.443156	0.6590
C(3)	-0.010956	0.143222	-0.076496	0.9392
C(4)	-0.023567	0.208250	-0.113167	0.9102
C(5)	-0.044477	0.215909	-0.205997	0.8374
C(6)	0.006651	0.090592	0.073422	0.9417
C(7)	-0.003501	0.089449	-0.039138	0.9689
C(8)	0.008744	0.110259	0.079307	0.9370
RESID(-1)	-0.138850	0.227491	-0.610352	0.5436
RESID(-2)	-0.115924	0.168357	-0.688556	0.4933

R-squared	0.010517	Mean dependent var	-6.37E-17
Adjusted R-squared	-0.114910	S.D. dependent var	0.912684
S.E. of regression	0.963696	Akaike info criterion	2.879063
Sum squared resid	65.93845	Schwarz criterion	3.174674
Log likelihood	-106.6021	Hannan-Quinn criter.	2.997666
F-statistic	0.083852	Durbin-Watson stat	1.970209
Prob(F-statistic)	0.999791		

Appendix 2C: Heteroskedasticity (Breusch-Pegan-Godfrey)

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	1.903285	Prob. F(9,71)	0.0653
Obs*R-squared	15.74380	Prob. Chi-Square(9)	0.0724
Scaled explained SS	12.03840	Prob. Chi-Square(9)	0.2112

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 08/01/16 Time: 11:34
Sample: 1994Q4 2014Q4
Included observations: 81

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-2.031336	1.651739	-1.229817	0.2228
IF(-1)	0.216983	0.112927	1.921445	0.0587
EX(-1)	-0.159727	0.233213	-0.684896	0.4956
UN(-1)	-0.139914	0.106212	-1.317313	0.1920
IF(-2)	-0.203748	0.173202	-1.176356	0.2434
IF(-3)	0.149996	0.109048	1.375506	0.1733
EX(-2)	0.106547	0.364466	0.292337	0.7709
EX(-3)	0.103919	0.248823	0.417644	0.6775
UN(-2)	-0.022977	0.134269	-0.171130	0.8646
UN(-3)	0.226686	0.102517	2.211197	0.0302

R-squared	0.194368	Mean dependent var	0.822708
Adjusted R-squared	0.092246	S.D. dependent var	1.135925
S.E. of regression	1.082266	Akaike info criterion	3.111135
Sum squared resid	83.16226	Schwarz criterion	3.406746
Log likelihood	-116.0010	Hannan-Quinn criter.	3.229738
F-statistic	1.903285	Durbin-Watson stat	1.838249
Prob(F-statistic)	0.065258		

Coefficient

Appendix 2D: Heteroskedasticity (ARCH)

Heteroskedasticity Test: ARCH

F-statistic	3.325710	Prob. F(1,78)	0.0720
Obs*R-squared	3.271497	Prob. Chi-Square(1)	0.0705

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 08/01/16 Time: 11:45
Sample (adjusted): 1995Q1 2014Q4
Included observations: 80 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.664980	0.155673	4.271657	0.0001
RESID^2(-1)	0.201995	0.110764	1.823653	0.0720

R-squared	0.040894	Mean dependent var	0.832810
Adjusted R-squared	0.028597	S.D. dependent var	1.139425
S.E. of regression	1.123014	Akaike info criterion	3.094592
Sum squared resid	98.37053	Schwarz criterion	3.154142
Log likelihood	-121.7837	Hannan-Quinn criter.	3.118467
F-statistic	3.325710	Durbin-Watson stat	1.951267
Prob(F-statistic)	0.072035		

Appendix 2E: Heteroskedasticity (Harvey)

Heteroskedasticity Test: Harvey

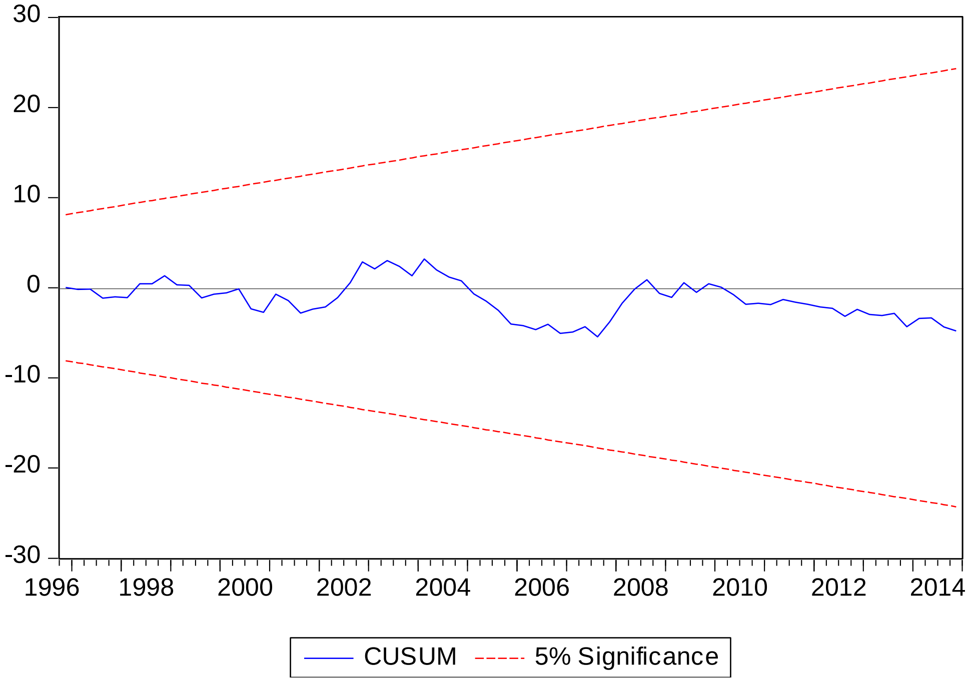
F-statistic	0.842435	Prob. F(9,71)	0.5799
Obs*R-squared	7.815223	Prob. Chi-Square(9)	0.5529
Scaled explained SS	6.360591	Prob. Chi-Square(9)	0.7034

Test Equation:
Dependent Variable: LRESID2
Method: Least Squares
Date: 08/01/16 Time: 11:47
Sample: 1994Q4 2014Q4
Included observations: 81

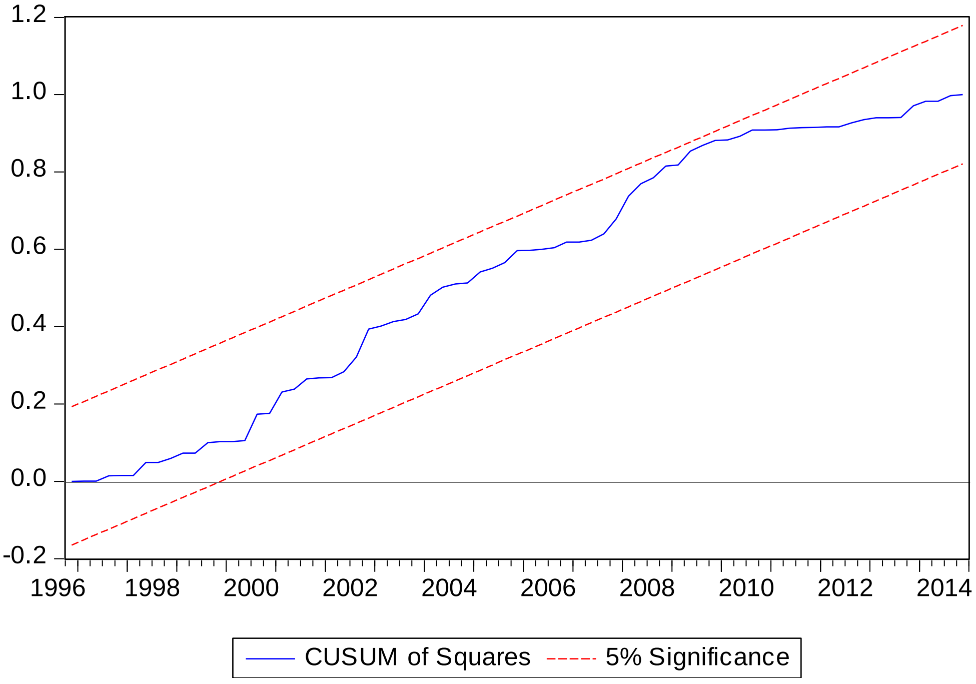
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-4.095898	3.105285	-1.319009	0.1914
IF(-1)	0.208930	0.212304	0.984108	0.3284
EX(-1)	-0.204111	0.438443	-0.465535	0.6430
UN(-1)	-0.227428	0.199679	-1.138967	0.2585
IF(-2)	-0.184589	0.325622	-0.566880	0.5726
IF(-3)	0.193739	0.205011	0.945018	0.3479
EX(-2)	0.244646	0.685199	0.357043	0.7221
EX(-3)	0.097744	0.467789	0.208948	0.8351
UN(-2)	0.252886	0.252427	1.001820	0.3198
UN(-3)	-0.009974	0.192733	-0.051749	0.9589

R-squared	0.096484	Mean dependent var	-1.415159
Adjusted R-squared	-0.018046	S.D. dependent var	2.016557
S.E. of regression	2.034671	Akaike info criterion	4.373689
Sum squared resid	293.9318	Schwarz criterion	4.669300
Log likelihood	-167.1344	Hannan-Quinn criter.	4.492292
F-statistic	0.842435	Durbin-Watson stat	1.812968
Prob(F-statistic)	0.579894		

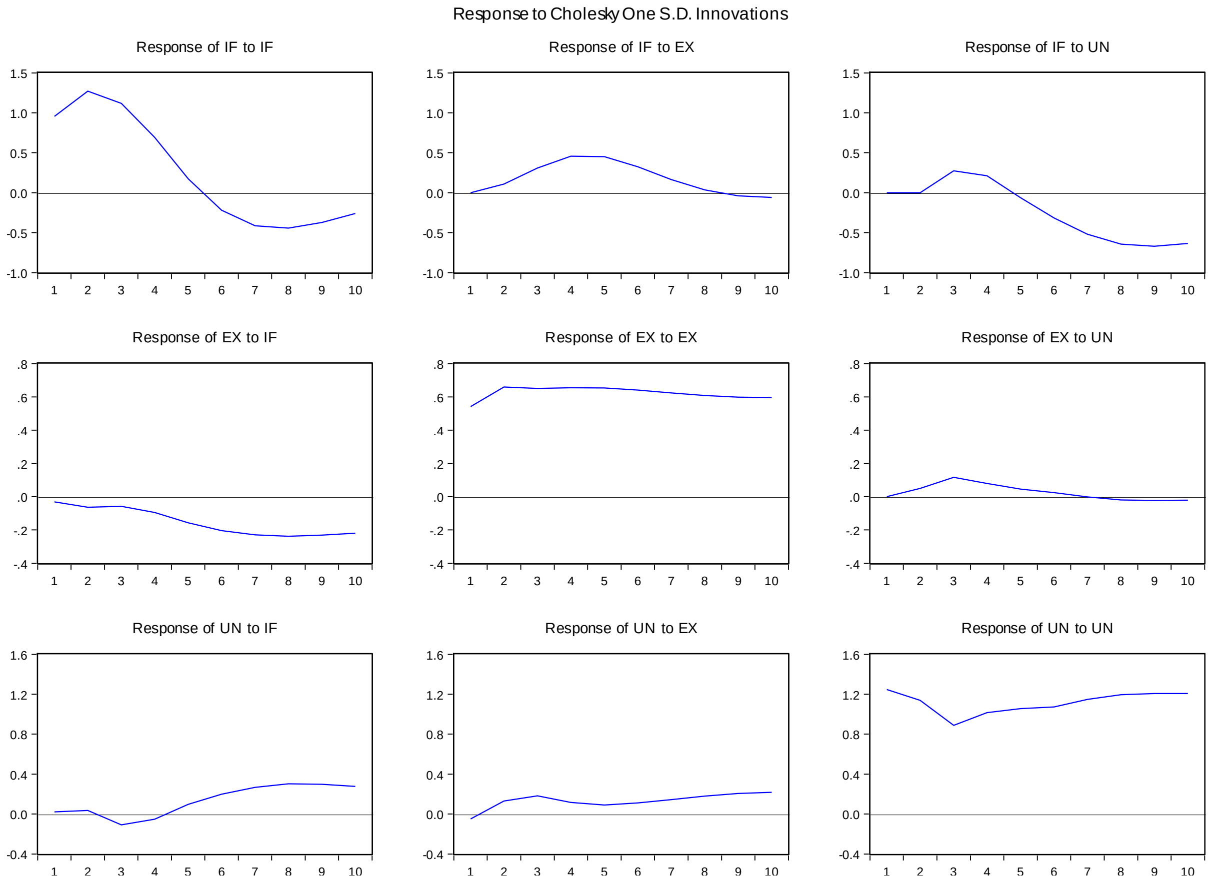
Appendix 2F: Stability test (Cusum Test)



Appendix 2G: Stability test (Cusum Squares)



Appendix 2H: The impulse response function (Vector Error Correction Model)



Appendix 2I: The impulse response function (Vector Autoregressive model)