INFLATION DYNAMICS IN NIGERIA: OPEN ECONOMY HYBRID–NEW KEYNESIAN PHILIPS CURVE APPROACH (1986 - 2010)

BY

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DECLARATION

I hereby declare that this study titled: **Inflation Dynamics in Nigeria: Open Economy Hybrid–New Keynesian Philips Curve Approach** was conducted by me under the supervision of Dr. Aliyu Rafindadi Sanusi and Dr. Peter P. Njiforti in the Department of Economics, Faculty of Social Sciences, Ahmadu Bello University, Zaria. The information derived from the literature has been duly acknowledged in text and a list of references is provided. No part of this thesis has been previously presented for the award of another diploma or degree at any institution.

_____ **_____**

ABDURRAHMAN AHMAD **DATE**

CERTIFICATION

This thesis titled: **Inflation Dynamics in Nigeria: Open Economy Hybrid–New Keynesian Philips Curve Approach** meets the requirement for the award of Masters of Sciences in Economics of the Ahmadu Bello University, Zaria and is approved for its contribution to knowledge.

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DEDICATION

This research work is dedicated to my father, Alh. Ahmadu Umaru Dantireda, who could not leave to see its completion, may his soul rest in perfect peace.

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Firstly, I wish to thank Allah (SWA) for all His blessings in my life, particularly for the successful completion of my study at this level.

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ABSTRACT

The formal adoption of the inflation targeting policy framework by the CBN requires a good understanding of the inflationary process in Nigeria. Central banks that adopt inflation targeting across the world use some variants of the New Keynesian Policy Model (NKPM) which in turn rely on the correct empirical specification of the New Keynesian Philips Curve (NKPC) because it is microfounded, hence immune to Lucas critique. This study used the Generalized Method of Moments (GMM) statistical techniques to estimate the open-economy NKPC for Nigeria in order to determine if it fits the Nigeria's data well and identify the empirical price-setting behaviour of the Nigerian firms. It also seeks to assess the relative role of external factors on the inflation dynamics in Nigeria and determine the forecasting potential of the NKPC model for Nigeria's inflationary process. The estimate shows that the open-economy hybrid NKPC model fit Nigeria's data very well. It also indicates that, although most firms are backward-looking, a significant proportion of firms in Nigeria are forward-looking, hence the CBN communication could be used to influence their price-setting behaviour and by implication inflation dynamics. The estimate also reveals that exchange rate depreciation and relatively labour market dynamics have significant impact on inflation dynamics in Nigeria. Finally it is observed that the open-economy hybrid NKPC model could be used to set target inflation in Nigeria.

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CHAPTER ONE

GENERAL INTRODUCTION

1.0 BACKGROUND TO THE STUDY

The short-run dynamics of inflation accompanied by cyclical interactions with real economic variables is a central issue of debate in macroeconomics and most especially in the analysis of monetary policy. Initially these dynamics were explained by Philips (1958) who established a negative relationship between nominal wage and unemployment using United Kingdom (UK) as a case study. The work of Philips gained support from Samuelson and Solow (1960s) who equally established an explicit link between unemployment and price inflation in the United States (US), hence the emergence of the term Philips curve. According to Hornstein, (2008), the relevance of this curve stems from the fact that proponents of the Philips curve maintained that, the curve could better serve as a menu for monetary policy makers, since it gives them the opportunity to either choose between high inflation and low unemployment or between low unemployment and high inflation.

The dilemma of choosing between inflation and unemployment broke in the 1970s leading to a situation known as "*stagflation*", where both inflation and unemployment were found to rise simultaneously thus, casting doubts on the validity of the traditional Philips curve. Korkmaz (2010) noted that the traditional Phillips curve is a standard model of expectations which is backward-looking, such that expected inflation is assumed to equal lagged inflation (or an average of several lags) hence explaining inflation from a macro perspective. It therefore implies that the traditional Philips curve lacks a microeconomic foundation (Montoya and Björn, 2011). Although backward-looking behaviour helps to explain inflation inertia, it however contradicts the general economic assumption of having rational individuals.

In response to this challenge, the New Keynesian Philips Curve (NKPC) was developed from the work of Fischer (1997), Taylor (1980) and Calvo (1983) that emphasized staggered nominal wage and price setting by forward-looking firms. The price setting decision was situated within an explicit individual optimization problem. Aggregating the individuals behaviour leads to establishing a relationship between inflation in the short run and some measure of overall real economic activity, such as real marginal cost and expected inflation called pure forward-looking NKPC (henceforth, baseline NKPC) (Gali and Gertler, 1999). The NKPC reflect a pragmatic compromise between theoretical rigor and the need for empirical tractability (Gertler and Leahy, 2008). However, reality has shown that economic agents consider both forward as well as backward looking behaviours in their price optimisation decisions. Hence, Gali and Gertler (1999), incorporate lagged inflation into the baseline NKPC to arrive at the hybrid NKPC model. Furthermore, recent works by Gali and Lopez-Salido (2001), Rumler (2005) and Binyamini (2006) integrate external sector into the NKPC model to determine the impact of openness on inflation.

Theoretically, changes in inflation depend on the movements of money supply, interest rates and exchange rates, suggesting that an increase in the money supply, interest rates and exchange rates raises the general level of prices. Therefore, to keep inflation low, interest rates and exchange rates in terms of cost and money supply in terms of demand should be kept low (Korkmaz, 2010).

Data evidently shows that inflation rates have been persistently high with almost double digits over the years in Nigeria, thus exposing the economy to high vulnerability. For instance in 1986, the inflation rate was 13.67%, and rose to 61.21% and 44.47% in 1988 and 1989 respectively. In 1993 and 1994 the inflation rate stood at 61.26% and 76.76% respectively. In 2002, a 12.7% percent inflation rate was recorded which later rose to 23.81% in 2003. However, a single digit inflation rate was recorded in 2006 and 2007 at 8.55% and 6.56%

respectively. This rate surged, assuming a double digit of 15.06%, 13.93% and 11.8% in 2008, 2009 and 2010 respectively (CBN, 2010).

Thus, inflation has become a major macroeconomic problem in Nigeria over the years. The sources that are said to have fed inflationary pressures in Nigeria range from both external to internal shocks. A major external factor is the rising price of fuel in the world market which usually translates into price hikes. Inflation imported into the country in the form of foreign goods and services also contributes significantly to price hikes in Nigeria. Internally, a good number of factors among others, huge budget deficits, continuously rising inflation expectation, substitution of the Naira into foreign currency, the volatility of the monetary policy rate (MPR) etc, have continuously raised the price of goods and services.

The persistent high inflation rates depict the presence of inflation inertia in Nigeria. This inflation inertia might as well provide the reason for CBN's move towards Inflation Targeting (IT) policy framework which takes into cognisance the impact of inflationary expectations.

1.1 STATEMENT OF PROBLEM

The efforts of the Central Bank of Nigeria (CBN) in introducing IT as the new monetary policy framework in Nigeria posed additional challenges to both the policy makers and the academia. For instance, because IT requires a good understanding of the processes that generate inflation, most central banks rely on some variant of the Dynamic Stochastic General Equilibrium (DSGE) models, the so called New Keynesian Policy Model (NKPM) for policy analysis. The NKPM, in turn, relies on the correct empirical specification of the NKPC to describe the inflation dynamics. Because the empirical specification of the NKPC varies with economies, and potentially over policy regimes, the dearth of knowledge of the empirical specification of the NKPC that fits the Nigeria's inflation data is an additional

challenge that the monetary authority has to address before the formal adoption of the IT framework.

Since the emergence of the NKPC in the last two decades, many scholars used it to model inflation dynamics for different countries, both developed and developing countries. Gali and Gertler (1999), and Rudd and Whelan (2001) for the US, Gali et al (2000) for the Euro area, Abbas and Sgro (2011) for Australia and Catik et al (2008) for Turkey among other studies estimated the NKPC. The major attractive feature of the NKPC is that it derives from a theoretical model that is based on microeconomic principles. It therefore serves to estimate the models structural parameters that capture the price-setting behaviour of firms in the economy. In addition, the NKPC allows the estimation of inflation dynamics that is potentially immune to the Lucas' critique, and without the theoretical inconsistencies that characterized the old Phillips curves and the other approaches to the estimation of inflation dynamics. The near-consensus among modern monetary economists is that the NKPC describes the inflationary process better, and because of its theoretical motivation in the micro-foundations, as well as its flexibility to suite different economic environments, it has become increasingly popular with central banks as well as the academia.

In Nigeria, despite several efforts of individual scholars and institutions to understand and manage the problems of inflation using the traditional Philips curve, solution has eluded us, as it has persisted in double digits. This calls for search of an alternative model that can address the problem. In this context, the NKPC provides a potential alternative model, for a number of reasons. First, a variant of the NKPC allows the inclusion of not only the backward and forward-looking behaviour of price setters; it also allows the inclusion of the important causes of inflation that are unique to the economy in questions. For instance, the open economy version allows the inclusion of open economy variables, such as the exchange rate and openness. Its estimation therefore allows the determination of the relative importance

of the various factors generating the inflationary process in Nigeria. This work is therefore aimed at estimating the baseline, hybrid, and the open-economy NKPC for Nigeria, based on the model developed by Gali and Gertler (1999) and others. Specifically, the study seeks to answer the following research questions:

- Does the open economy NKPC fit Nigeria's data?
- How do Nigerian firms set prices for their products?
- What is the relative rate of external factors in the inflationary process in Nigeria?
- Can the NKPC be used to forecast inflation in Nigeria?

1.2 OBJECTIVES OF STUDY

The major objective of this research is to estimate the NKPC for Nigeria and specifically;

i. To find out how well the open economy NKPC fit the Nigeria's data.
ii. To understand the empirical price-setting behaviour of Nigerian firms.
iii. To examine the relative role of external factors in the inflationary process in Nigeria.
iv. To determine the potential of the NKPC in forecasting future inflation in Nigeria.

1.3 JUSTIFICATION OF THE STUDY

The Philips curve is in the heart of the new macroeconomic models that have helped developed some emerging economies to adopt Inflation Targeting regime (Garcia, 2010). As Nigeria is planning to adopt Inflation Targeting, this work will contribute by providing an understanding of the inflationary process in Nigeria. Thus, it would provide valuable information for effective monetary policy formulation in the country.

In similar direction, Mordi et al (2007), undertook a study which aimed at understanding inflation dynamics in Nigeria using among other models, expectation-augmented Philips curve observed that "the greatest weakness of the (traditional) Philips curve is its lack of theoretical underpinning". Consequently, the NKPC was developed to address this

shortcoming. Therefore, this study is important as it would determine if NKPC would enable us understand inflation better than the traditional Philips curve in Nigeria.

Specifically, the study would enable us understand if inflation in Nigeria is caused by real economic activity, forward or backward-looking decision of firms or external factors in the country. That is, it would enable policy makers to understand better the nature and role of expectations in determining inflation in Nigeria.

1.4 SCOPE OF THE STUDY

Many issues surround inflation in Nigeria. For instance studies have been done on the nexus between inflation and economic growth, money supply and unemployment. However, this study shall concentrate on the understanding of inflation dynamics in Nigeria using the New-Keynesian Philips Curve approach. Since 1986 marks the beginning of trade liberalization in Nigeria, the study shall employ quarterly data spanning 1986 to 2010

1.5 ORGANIZATION OF THE STUDY

The study is organized as follows: Immediately after the general introduction in chapter one, chapter two reviews the relevant theoretical and empirical literature while chapter three presents the research methodology that will be used to attain the objectives of the study. Results presentation and interpretation is contained in chapter four while summary, conclusion and recommendation is presented in chapter five.

CHAPTER TWO

LITERATURE REVIEW

2.0 INTRODUCTION

Theoretically and empirically, inflation dynamics and inflation have been a topical issue most especially for policy makers. With the recent resurgence of the New-Keynesian Philips curve, it shows that there are contentions both theoretically and empirically. Some empirical findings tend to diverge away from the old traditional Philips curve while some still concur with the existing theoretical underpinnings of the relationship between inflation dynamics and unemployment. This section provides some insight into the theoretical background of Philips curve relative to inflation dynamics as well as some empirical evidence from some researches which either lend credence or discordance to the theoretical considerations.

2.1 THEORETICAL LITERATURE

2.1.1 TRADITIONAL PHILIPS CURVE

Philips (1958) identified an inverse relationship between money wage changes and rate of unemployment in the United Kingdom between 1861 and 1957. He did not have a macroeconomic model as a justification for establishing the relationship. Rather he made the statistical analysis with some theoretical thoughts which he called the wage-price spiral. This was summarized by Mankiw and Reis (2002) as:

- Low unemployment leads firms to bid up wages
- Higher wages make firms increase their prices
- Higher prices lead employees to bargain for higher wages

It is worth noting that this statistical relationship had already been found by Irving Fisher in 1926. Samuelson and Solow (1960) established an explicit link between unemployment and

price inflation in the United States (US), since wages are closely connected to price settled by company (Blanchard, 2006).

However, an economy is not that simple. The original Philips curve broke down in the US in the 1970s because it failed to incorporate correctly the economic behaviour of human beings. Two things demonstrated this fact in the 1970s: First, the world was hit by two oil shocks. Secondly, as inflation became a permanent phenomenon, people began to expect inflation, leading them to account for inflation in wage negotiations. This period coincides with the period of Stagflation. To be able to analyze theses influences, the Philips curve has been expanded to include expectations as well as price shocks (Blanchard, 2006).

According to Rudd and Whelan (2001), the incorporation of expectation into Philips Curve is contained in the *triangular model* developed by Gordon and Barro (1983), they argued that the standard Philips curve can be explained by three components:

- Demand-pull inflation: if unemployment is below its natural rate (u_n), inflation tends to increase because of a higher aggregate demand.
- Cost-push inflation: This refers to supply shocks (ν). A supply shock leads firms to increase prices, which implies a higher inflation.
- Expectation: People form expectations (π^e) about inflation and take them into account when negotiating wages.

Put formally:

$$\pi_t = \pi^e - \alpha(u_t - u_n) + \nu \qquad (2.1)$$

This equation is called *expectation-augmented Philips curve.*

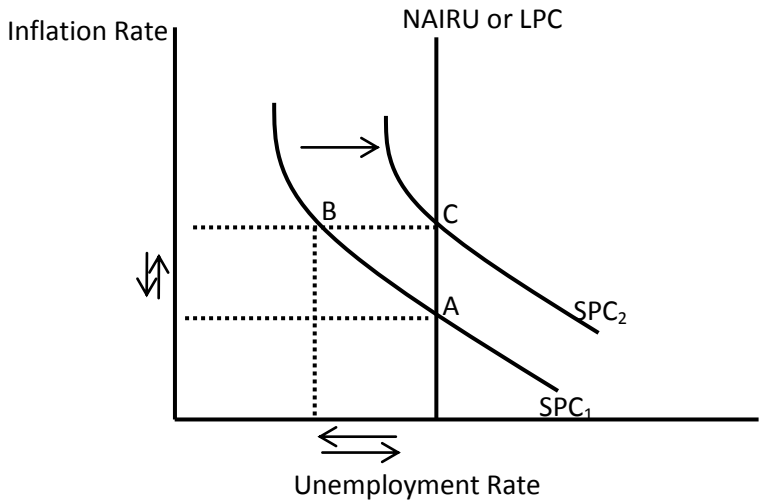
The critique that led to the changes in the original Philips curve was spear headed by Milton Friedman in the 1960s. Friedman (1968) criticized the absence of rational expectations and also pointed out that keeping output above its "potential" level (e.g. under demand

management policy) would lead to the moment, when well informed, rational employers and workers paying attention only to real wages would require higher growth of nominal wage. The consequence of this would be the growth of unemployment rate. This means, in a nutshell, that there is no permanent trade-off between inflation and unemployment rather there exist temporary trade-off that comes from a rising rate of inflation.

The works of Phelps (1967) and Friedman (1968) provide a distinction between the short-term and the long-term Philips curve, which is based on the hypothesis of the "natural rate of unemployment" later exerted as NAIRU (non-accelerating inflation rate of unemployment). They assume that NAIRU is the unique rate of unemployment succeeded by stable inflation. That is as soon as inflation rate changes, after a period of adjustment the rate of unemployment will return to the NAIRU regardless of the height of the inflation rate (Blanchard 2006).

In Figure 2.1, the long-run Phillips curve (LPC) is the vertical **A**-**C** line. The NAIRU theory says that when unemployment is at the rate defined by this line, inflation will be stable. However, in the short-run policymakers will face an inflation-unemployment rate trade-off marked by the "Initial Short-Run Phillips Curve (SPC_1)" in the graph. Policymakers can therefore reduce the unemployment rate temporarily, moving from point **A** to point **B** through expansionary policy. However, according to the NAIRU, exploiting this short-run trade-off will raise inflation expectations, shifting the short-run curve rightward to the "New Short-Run Phillips Curve (SPC_2)" and moving the point of equilibrium from **B** to **C**. Thus the reduction in unemployment below the "Natural Rate" will be temporary, and lead only to higher inflation in the long run.

Figure 2.1: Short-Run Phillips Curve before and after Expansionary Policy, with Long-Run Phillips Curve (NAIRU)



Source: Blanchard (2006)

2.2 STAGFLATION AND THE NEW KEYNESIAN MACROECONOMICS

The critique of the Philips curve by Phelps (1967) and Friedman (1968) was substantiated in the 1970s, when the period of high inflation and high unemployment rate was observed. This became known as *stagflation*. Sergent (1971) and Lucas (1972) criticize the concept of adaptive expectation of Phelp and Friedman. They argued that rational expectation provides *optimal* expectations.

Recent criticism came from Barro (1993), who argued that the Philips curve even if it exists has got the "wrong" direction (positive correlation between unemployment and inflation) in the UK from 1949 to 1990 and also does not exist in the long run in an international comparison. Concerning the short term influences he states that it might be that it is not money that affects the economy, but the economy that affects money: The quantity of money is determined by economic forces and not set exogenously. In summary, the traditional

Philips curve was criticized for lack of microeconomic foundation and its underlying assumptions.

The principal response of the Keynesian economists to these theoretical critics has been an attempt to build models that incorporate rational expectations. They analyzed the whole basis for Keynesian economics, relied more on microeconomics foundations and incorporated them into the macroeconomics models. This combination of rational expectation and micro foundations is known as *New-Keynesian macroeconomics* which relies crucially on the term *sticky prices* or the so called *price rigidities.*

Without price rigidities, it is difficult to explain, that there can be a time during which factors of production, such as labour, are under-utilized and consequently output is under its "potential level". Sticky prices allows money stock increase to cause a short run increase in real spending and thus support real output. Therefore, fiscal and monetary policies have no effect if prices are fully flexible.

2.3 THE NEW KEYNESIAN PHILIPS CURVE

The previous section shows that the Phillips curve was found as an empirical observation and later on was enhanced by a macroeconomic theory that was derived from psychological insights about the economic actors. In this form the Phillips curve offered a wide area for attacks: Firstly, although expectations were incorporated, they were backward-looking expectations which contradict the general economic assumption of having rational individuals. Secondly, the Phillips curve was criticized for not having micro foundations: Many building blocks of its theory were based on psychological insights about the aggregate behaviour of the economic actors and on the interplay between aggregate variables. Research parried these attacks and incorporated new ideas that finally cumulated in the formulation of the new Keynesian Phillips curve (NKPC).

2.3.1 NEW KEYNESIAN ECONOMICS

The classical economic framework with perfect competition and complete information does not allow for non-neutrality of money. According to classical economists, nominal variables can only affect nominal variables, and real variables can only affect real variables. This classical dichotomy was attacked on a large scale by John Maynard Keynes, whose book "The General Theory of Employment, Interest, and Money" is considered to be the foundation of modern macroeconomics. Keynes argued that previous classical economics were a particular case of the economy, valid only for the prevalence of perfect markets that are in equilibrium. He claimed that his economic theory had more explanatory power for the more general case, when not all resources are utilized and demand falls below its full-employment level. However, his reasoning was derived mainly from psychological insights about the behaviour of economic actors. His theory allowed space for criticism, for example by monetarists or advocates of the importance of rational expectations.

Economists that stood in the Keynesian tradition like Taylor (1980), Calvo (1983), Gali and Getler (1999), Mankiw (2001), Woodford (2003) or Blanchard (2006) responded to these critics by incorporating some of their valid arguments and by providing microeconomic foundations for Keynesian theories, or actually, reasoning derived from microeconomic theory. These works build the basis for new Keynesian economics, which includes the central ideas of Keynesian economics (like rigidities, imperfect markets, and the non-neutrality of money) and provides micro foundations for them.

The ideas of new Keynesian economics offer the basis for the new Keynesian Phillips curve. Important starting point was the works of Gordon and Taylor (1980) which incorporated

monetarist and rational expectations insights. Taylor (1980) developed a model with staggered wage setting which was consistent with rational expectations: The rigidity comes from the assumption that wages were fixed for some periods, and each period some new contracts were made (so the contracts are revised in a staggered way). The work of Taylor (1980) had several implications; most importantly he highlighted a new monetary policy trade-off between output and inflation. However, critique was raised that in the USA only a small fraction of the labour contracts are made for multiple periods, and the microeconomic foundations were sketchy (Goodfriend and King, 1997).

The next wave of research on the new Keynesian Phillips curve shifted the focus from wages to prices. Besides being easier to model, there is a theoretical explanation for this shift as well: The mere observation of wage rigidities does itself not prove any allocative consequences of this rigidity. Employment is an ongoing relationship, the effective cost of increased employment does not need to equal the wage paid, and wages might be smoother than the effective costs of labour. Employees benefit because they have a preference for a smoother income stream. On the other hand, the observed rigidity in prices is more likely to have allocative consequences, as the relationship between consumers and producers more resembles a market than the one between producers and employees (Woodford, 2003).

In order to rationalize rigidities in the price setting, the following assumptions are needed that contradict classical assumptions about the market, but that are compatible with observations about the economy: There is imperfect competition, thus firms are modelled as monopolistic competitors. This assumption rationalizes the observation that there are not very large changes in sales in response to small changes in market conditions. For example, in the framework of perfect competition and identical goods, in the case of a decrease in the price, the firm that fails to change its price would suddenly lose its entire sale (Woodford, 2003).

Another important implication is that firms are price setters and can charge a mark-up over marginal costs. In a classical framework, all actors are price takers, the market sets the price. Furthermore, as the price equals the marginal cost of the firm, in fact, a firm would not be able to adjust its production if demand rises: An increase in output means an increase in the marginal costs, as the market price equals the marginal costs, it would be a loss transaction. If however the price is already higher than the marginal cost, then a firm has got an incentive to increase output if the demand rises. In the case of an economic expansion, marginal costs increase because the firm needs to pay higher wages in order to produce the additional output. Therefore there is a procyclical movement of real wages and marginal costs.

The imperfect competition framework also is an explanation why the level of employment and output is too low on average. Imperfect competition itself however does not explain the stickiness of prices. The stickiness of prices can be explained by the prevalence of menu costs. Furthermore, sticky prices are a simple feature of the economic environment. Sticky prices can be better explained by transaction costs: The main benefit of less frequent price changes is not lower menu costs, but lower information gathering and bargaining costs (Goodfriend and King, 1997).

The common methodology to include sticky prices comes from Calvo (1983) that extended the work of Taylor (1980) who developed a model of staggered contracts. The important feature of the Calvo (1983) model is that the pricing decision comes directly from the firm's profit maximization, under the constraint of time-dependent price adjustment (Galí & Gertler, 1999). Optimal price setting is important because it highlights the importance of expectations. Calvo (1983) assumes that in any period, only a fixed random fraction of the firms is able to adjust prices. This may not be a particular realistic assumption; however its purpose is to reflect the empirical fact that firms do not typically adjust prices each period (Woodford, 2003).

To summarize, the following insights of new Keynesian economics combined with classical assumptions provide the synthesis for the new Keynesian Phillips curve:

- Rigidities: Because of transaction costs and imperfect information there is some kind of rigidity, whether it is in the labour market (sticky wages) or in the goods market (sticky prices).
- Imperfect competition: Firms produce a differentiated good and therefore have got some market power, which allows them to charge a markup over marginal costs.
- Rational expectations: Economic actors use all available information in order to form expectations and therefore do not have expectations that are systematically wrong.
- Microeconomic assumptions: Firms maximize their profits and individuals maximize their utilities.

2.4 EMPIRICAL LITERATURE REVIEW

The NKPC has recently become an important part of monetary policy models. The recent literature on the NKPC is mainly built on the work of Fischer (1977), Taylor (1980) and Calvo (1983). It is based on the concept of sticky prices and price setting decision of forward-looking and backward-looking firms in the market. Since new settled prices depend also on some measure of real activity, aggregating leads to the relation which is in the spirit of traditional Philips curve. In the subsequent paragraphs, we would review some empirical works on the NKPC.

We would start with the work of Gali and Gertler (1999) upon which this work is based. Their results from the estimation of the reduced form of the NKPC for the US support the presence of forward-looking behaviour and use of real unit labour costs as proxy for the real marginal cost. Though the backward-looking behaviour is statistically significant, but with limited quantitative importance. They found the real unit labour cost to be the best measure of

real activity and important determinant of inflation. On the other hand, the output gap as a measure of real activity fails, yielding a negative sign or exerting not significant effect. On the other hand, the estimate of the structural parameters shows that the average time prices remain fixed or rigid is between one to two years.

In a similar study for the Euro area, Gali et al. (2001) provide evidence on the fit of the NKPC over the period 1970 to 1998. They relaxed the assumption that firms face identical constant marginal costs and they compared the characteristics of European inflation dynamics with those observed in the US. The NKPC seems to fit Euro area possibly better and has stronger forward-looking behaviour component than the US.

There have been a number of criticisms to the NKPC: Nason and Smith (2005) using Generalized Method of Moments (GMM) found that there was lack of persistence in either exogenous variables or shocks. Therefore, they found lack of evidence for the forward-looking. Other papers such as Rudd and Whelan (2005), and Linde (2005) have criticized the model for having specification bias and are not robust.

Gali et al (2005) argued against most of these claims, they show that their estimates are robust to a variety of different econometrics procedures, including the GMM of the closed form as suggested by Rudd and Whelan (2005) and non linear instrumental variables as proposed by Linde (2005). These are supported by other works with other econometric techniques and data. Ireland (2001) used post war US data, Smets and Wouters (2003) used Bayesian Maximum Likelihood techniques, Sbordone (2005) used two-step minimum distance estimation procedure and obtained results that confirm the existence of forward-looking behaviour.

Neiss and Nelson (2002) estimate NKPC for the US, UK and Australia using theory-based estimates of output gap and found little support for the notion that labour costs explain

inflation dynamics better than the output gap.

Gwin and VanHoose (2008), searches for alternative and more appropriate measures of marginal cost and inflation for the NKPC. They replicate Gali and Gertler (1999) results using the wage share and output gap and compare it to alternative measures of the marginal cost and inflation. In particular, they found the results of marginal cost based measure on actual industry costs are not particularly altered against Gali and Gertler (1999) results. They are in fact sensitive to using a producer price index (PPI) inflation measure and they argue is more appropriate for testing the theory of firm pricing. This measure takes into account structural shifts in both real unit labour costs and industry-level average variable cost measure and this imply that price adjustments are flexible.

Sgro and Abbas (2011), investigating the validity of NKPC for Australia in comparison with Gali and Gertler (1999, 2001) found that neither the output gap nor marginal cost appears to be a key driving force variables using different set of instruments and estimators (GMM and 2SLS) over the sample period: 1959 to 2009. The reduced form estimate suggests that price-setting behaviour of firms is forward-looking while backward-looking is also statistically important only after 1980. They concluded that the forward-looking baseline NKPC contrary to the hybrid NKPC is stable and better explains inflation dynamics for the Australian Economy. According to the deep parameters estimate, average time for price adjustment was observed to be 14 months, but it increased overtime.

As an extension of the closed form NKPC model, Gali and Lopez Salido (2000) estimated the open economy NKPC model for Spain for the period: 1980 -1998. They observed the relative import price coefficient to be positive and very significant. The expected inflation as well as the forcing variable is also reported to be significant.

Similarly, Binyamini (2006), study inflation dynamics in Israel under inflation targeting regime from 1995:Q1 to 2006:Q2. His test of an open economy hybrid-NKPC indicates that real exchange rate influences inflation directly and indirectly through the other forcing variables in the model. It also shows that the level of influence is positively determined by the degree of openness of the economy.

2.4.1 EMPIRICAL LITERATURE ON INFLATION IN NIGERIA

In Nigeria, there have been several studies for various time periods on inflation dynamics. For instance Omoke (2010) examined the relationship between inflation and economic growth in Nigeria. Using cointegration and Granger causality tests for data covering the period 1970 to 2005, he observed that there was no long-run relationship between economic growth and inflation but however, a unidirectional causality was seen running from Inflation to economic growth. This result contradicts that Asogu (1991) who considered factors such as money supply, its lagged values, domestic credit, real output, net exports, and net government expenditure in a single equation model. He established that money supply variable and its lag were not significant at least when annual data were used in the estimation. In addition, changes in real income were significant and had an inverse relationship with the rate of inflation. Further, domestic credit was not significant, while government expenditure even though statistically significant had the wrong sign.

The primary objective of inflation targeting is the attainment of low level of inflation which in turns leads to macroeconomic stability. Mishkin and Posen (1997) evaluated the success of countries implementing IT and discovered that IT has successfully helped countries maintain low inflation rates and that there is no evidence undesirable effect on the real economy in the long run has been recorded; instead it has likely had the effect of improving the climate for economic growth. Recent evidences have shown that the negative effect of high and variable inflation on macroeconomic stability, economic growth and income distribution largely

outweigh the potential benefits derived from financing fiscal deficits through monetization. This is re-affirmed by Bamidele (2007) who showed that most of the countries on IT framework have been able to simultaneously achieve a reduction in inflation as well as increase in output.

Shehu and Abwaku (2009) evaluated the preparedness of Nigeria adopting inflation targeting (IT). Employing the Vector autoregressive (VAR) model on selected monetary policy and other macroeconomic they established that inflation in Nigeria is impassive to monetary transmission variables in the model. Remarkably, they observed a weak link between prices and credit and interest rate channels and strong inverse link between exchange rate and prices was found in the model.

Adeyeye and Fakiyesi (1980) explored the factors responsible for instability of prices and inflationary tendencies in Nigeria. Using annual time-series data, spanning 1960 -1977, they tested the hypothesis that the rate of inflation in Nigeria is linearly related to growth rates of money stock, government expenditure, especially deficits, and growth of government revenue, especially monetization of foreign exchange from oil exports. They established a significant positive relationship between inflation rate and growth in bank credit, growth of money supply and growth in government expenditure, while the relationship with growth of government revenue was uncertain.

In another related study, Ariyo and Raheem (1991) investigated the impact of fiscal deficit on the level and direction of economic growth. Their findings confirmed a direct relationship between fiscal deficit and inflation. In line with Ariyo and Raheem Ating (1996) empirically confirmed that although fiscal deficit caused inflation, there was no feedback between inflation and fiscal deficit. However, feedback existed between inflation and fiscal deficit deflated by the GDP.

Two distinguished studies have attempted to estimate the NKPC as an alternative model of inflation dynamics in Nigeria. The first of such model is that of Mordi et al (2007). In their study they examined the dynamics of inflation using quarterly data from 1981 to 2005. Using time series analysis, basically the ARIMA model, they reported that past effects of inflation are prevalent and persistent in Nigeria. In other words, agents are backward looking in setting prices.

In a related study, Garcia (2010) modified an expected-augmented Phillips curve which incorporates future expectations of economic agents (NKPC model) and the real business cycle approaches, in order to assess the relevance of the Phillips curve as a tool for conducting monetary policy (for countries wishing to adopt IT). Due to paucity of data, he used the Bayesian econometric technique. He found out the central bank can control inflation rates using the Philips curve, through Taylor Rule that includes exchange rates and the sterilization of oil exports.

Barnichon and Peiris (2007) studied the sources of inflation in Sub-Saharan Africa using the expectation-augmented Philips curve. In their country specific analysis, they identified backward-looking (lagged) inflation and real money gap as significant, but found no evidence that output gap has any predictive power for future inflation in Nigeria.

2.5 LITERATURE GAP

The literature survey shows the different techniques adopted to explain inflation dynamics in Nigeria. However different conclusions have been arrived at. But evidently, inflation still remains a challenging issue which suggests that proper technique that leads to a better understanding of inflation dynamics in Nigeria is needed, most especially with the move by the Central Bank towards IT in Nigeria. Thus, this work seeks to add to the existing literature

by assessing the effects of real economic activity, role of external factors and backward as well as forward looking behaviour of agents on inflation dynamics in Nigeria.

2.6 MONETARY POLICY IN NIGERIA

The Central Bank of Nigeria is mandated by the CBN act of 1958 to formulate and implement monetary policies in Nigeria with main objective of maintaining price stability and achieving a sustainable level of economic growth. During the pre-liberalization era the CBN relied on administrative measures such as fixing and controlling interest rates and exchange rates, selective sectoral credit allocation etc. During the era of indirect control, the CBN has been using the open market operations as the main instrument, with the minimum rediscount rate (MRR) as the key policy rate. In 2006, the MRR was changed to monetary policy rate (MPR). In 2007, CBN gained broader independence which included the provision of a transparent and credible framework to lock-in inflationary expectations through the adoption of inflation target as a nominal anchor for monetary policy.

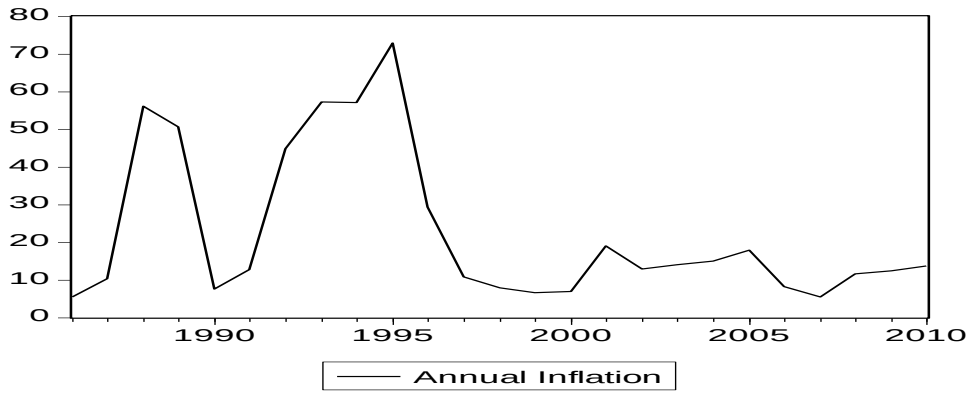
2.7 INFLATION TREND IN NIGERIA

Inflation is derived from consumer's price index (CPI) in Nigeria. The computation of this index which is reported monthly is done by the National Bureau of Statistics (NBS). The average level of retail prices of goods and services consumed by all households in the country is measured by the composite CPI.

Prior to 1986 inflation was relatively stable, but after the introduction of the Structural Adjustment Programme (SAP) which led to the liberalization of the Nigerian economy in 1986, inflation began to increase. In 1988 fuel prices were adjusted while the Naira depreciated significantly. Although government expenditure was relatively stable, long and short term interest rates rose sharply and affected financial markets. Thus headline inflation was recorded at 56% in 1988. Despite the strategies put in place, curbing inflation still

remained a major problem. In the early 1990s, persistent rise in inflation inertia was inevitable due to the increase in world oil prices, monetization of proceeds of the gulf war. In 1993, there was excess money supply in the economy, with scarcity of foreign exchange, shortage in commodity supply, as well as continual labour unrest. Consequently, inflation witnessed an increase with respect to the above events. Inflation rate continued to rise until it reached a peak of about 72.8% in 1995. However, in 1998 it declined to a single digit of about 7.9%. This was attributed to the favourable fiscal balance between 1995 and 1997. However, with a tight monetary policy, inflation rate was a bit stable with a single digit till 1999. By mid-1999, there was policy reversal and inconsistency, with a surge in wages, banking sector distress with inflation rate rising to 18.9%. In 2003, the macroeconomic economic environment was again restored with inflation rates almost stabilizing at a moderate rate though with a double digit. Between 2006 and 2007, inflation rate averaged a single digit value of 6.8%. Within this period government promoted food programmes which increased crop production and exports as well as the development of small and medium scale size enterprises which promoted wealth creation and output. Exchange rate was relatively stable thus curbing inflation inertia which posed little problems. However, inflation assumed an upward trend; averaging 12.6% in between 2008 and 2010 (Mordi et al 2007).

Figure 2.2: Inflation Trend in Nigeria



Source: CBN 2010

2.7.1 ACTUAL VERSUS TARGETED INFLATION RATES IN NIGERIA

Remarkable about the period under study is the fact that inflation targets have widely been missed as a wide margin between the targeted inflation and the actual inflation was recorded. For instance, from table 2.1, we can observe that with the exception of 2006 and 2007, the targeted inflation was not achieved and inflation has persistently remained in double digit. Although on the average it displays a downward trend. This implies that the CBN either lacks or has inadequate understanding of the inflationary process in Nigeria, because not only that the inflation targets are not been achieved, but there always exist wide gaps between the target and the actual inflation. This outcome may influence price-setting behaviour of firms to be backward-looking which would make inflation difficult to manage.

Table 2.1: Actual and Targeted Inflation in Nigeria

Inflation	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Actual	14.53	16.49	12.17	23.81	10.01	11.57	8.55	6.56	15.06	13.93	11.80
Target	9.00	7.00	9.30	9.00	10.00	10.00	9.00	9.00	9.00	9.00	11.20

Source: CBN 2010

CHAPTER THREE

RESEARCH METHODOLOGY

3.0 INTRODUCTION

This section discusses the research method applied, the type of data used in this study and the justifications for using them.

3.1 THEORETICAL FRAMEWORK

This work as earlier stated is based on Gali and Gertler (1999) and their methodology shall be adapted with the extension of the model to include foreign sector as in Gali and Lopez-Salido (2000). Therefore, both the closed and open economy models of the NKPC shall be estimated.

Baseline New Keynesian Philips Curve

As proposed by Gali´ and Gertler (1999), the starting point for the derivation of the NKPC is by assuming that monopolistically competitive firms choose their prices at time *t* to maximize their expected discounted profit. They face price adjustment constraint in term of time as introduced by Calvo (1983): In the Calvo (1983) setup, each firm has a fixed probability $1 - \theta$ that it may change its price during the period. When changing its price, a firm takes into account the expected future path of nominal marginal costs. θ is then the probability that the price of a firm will remain unadjusted. This probability is independent of the time elapsed since the last price revision. Thus, the resulting equation (3.1) is the baseline NKPC model where inflation π_t depends on real marginal cost, or rather on deviation of real marginal cost from its steady state value, mc_t^r and expected future inflation $E_t\{\pi_{t+1}\}$.

$$\pi_t = \lambda\, mc_t^r + \beta E_t\{\pi_{t+1}\} \qquad (3.1)$$

The parameter β represents the firm's subjective discount factor and λ is a function of

structural parameters $\lambda = ((1-\theta)(1-\beta\theta))/\theta$. It can be noticed that λ depends negatively on θ and β. Then, the higher θ is, the less sensitive inflation is according to the value of the real marginal cost. And if $\theta = 1$ that means absolute price rigidities, then $\lambda = 0$.

Hybrid New Keynesian Philips Curve

It is obvious that the baseline NKPC (3.1) is a purely forward-looking model. Inflation would be a function of sum of discounted expected real marginal costs. But empirical evidence has suggested the presence of inflation persistence in the data. Therefore, Gali and Gertler (1999) have introduced a fraction of firms that are backward-looking, that is follow the rule of thumb to capture the inflation inertia. This reformulation of the model divides the set of firms into two subsets.

The fraction $1 - \omega$ of the firms remains forward-looking. These firms still set their prices optimally with respect to the constraints of Calvo (1983) pricing as described above. The remaining fraction ω of the firms is the part of firms that follow the backward-looking rule of thumb. When setting prices, these firms use information about lagged inflation and the average price set in the most recent round of price adjustments (Gali and Gertler, 1999).

The model derived from this setup takes the following form

$$\pi_t = \lambda\, mc_t^r + \gamma_f\, \mathrm{E}_t\{\pi_{t+1}\} + \gamma_b\, \pi_{t-1} \tag{3.2}$$

where:

$$\lambda = (1-\omega)(1-\theta)\,(1-\beta\theta)\phi^{-1}$$

$$\gamma_f = \beta\theta\phi^{-1} \tag{3.3}$$

$$\gamma_b = \omega\phi^{-1}$$

and $\phi = \theta + \omega[1 - \theta(1-\beta)]$.

All the coefficients are explicit functions of three model parameters: θ, which measures the degree of price stickiness; ω, the degree of backwardness in price setting, and the discount factor β.

The equation (3.2) version of Philips curve is called hybrid NKPC. The term *hybrid* refers to the fact that the equation combines the *original,* baseline NKPC (3.1) and the traditional, so-called *expectation-augmented Philips curve* (2.5) derived above. The traditional Philips curve is the model of Friedman (1968) and Phelps (1967) where inflation depends on a real variable (unemployment rate) and adaptively formed expectation, i.e. past inflation.

By setting some of the structural parameters from (3.3) equal to certain values we can obtain special cases of the Philips curve. If we set $\omega = 0$, that means if we set all the firms as forward-looking, it is logical that we would get the baseline (only forward-looking) NKPC (3.1). If the subjective discount factor $\beta = 1$, then $\gamma_f + \gamma_b = 1$. This means that firms would not discount the future values of variables.

Open Economy New Keynesian Philips Curve

Activities in the external sector may affect inflation dynamics in an economy; because changes in the exchange rate can stimulate domestic inflation behaviour through imports (exports) prices. Gali and Lopez-Salido (2000) derived the open economy model of the NKPC by relaxing the assumption of a constant elasticity of output with respect to labour. Provided some intermediate inputs are imported, exchange rate would have an additional or independent effect on the marginal cost as well as inflation dynamics. Gali and Lopez-Salido (2000), specified the baseline open economy NKPC model as follows:

$$\pi_t = \lambda mc_t^r + \delta m_t + \beta E_t\{\pi_{t+1}\} \qquad (3.4)$$

Where, m_t import price of intermediate inputs

In their specification of the open economy NKPC model, Kara and Nelson (2003) view the real marginal cost as measure of domestic inflation and real effective exchange rate or real import price as measure of external inflation. Henceforth, we shall adopt their conceptualization when discussing open economy model. Following the derivation of equation (3.2) from equation (3.1), by adding lagged inflation to equation (3.4) we obtained the open economy hybrid NKPC model:

$$\pi_t = \lambda mc_t^r + \delta m_t + \gamma_f \, \mathrm{E_t}\{\pi_{t+1}\} + \gamma_b \, \pi_{t-1} \qquad (3.5)$$

The terms in the equation (3.5) are as defined in equations (3.1) to (3.4).

The degree of openness of the economy determines the extent to which domestic inflation is influenced by inflation abroad and the nominal exchange rate. The effect of the openness is not only observed by the appearance of the real exchange rate in the equation (3.5), but also indirectly through all other forcing variables: past and expected inflation and the marginal cost (Binyamini, 2006).

3.2 APPROXIMATION OF THE REAL MARGINAL COST

Both baseline and hybrid NKPC require proxy variable to be estimated, because there are no data on the real marginal cost from the available statistics. The literature provides two ways by which it could be approximated: by output gap and by labour income share (Gali and Gertler, 1999).

Approximation by the Output Gap

The real marginal cost is generally known to be cyclical variable like prices. When output is higher than its potential level, there is more competition for available factors of intermediate consumption and consequently the real marginal cost increases. This can be written in algebraic form:

$$mc_t^r = \kappa x_t \quad (3.6)$$

where output elasticity κ is a positive constant and x_t is the output gap defined as the difference between the log of real output y_t and the log of the natural or potential level of output y_t*:

$$x_t = y_t - y_t^*$$

Then the closed economy NKPC (henceforth, closed economy) (3.2) can be rewritten as

$$\pi_t = \alpha\kappa x_t + \gamma_f E_t\{\pi_{t+1}\} + \gamma_b \pi_{t-1} \quad (3.7)$$

Several empirical works on the Philips Curve used output gap as a measure of real economic activity. But the problem with this approach lies in the possible systematic bias of the error arising during the computation of the potential level of output. Moreover, using quarterly data, it is sometimes difficult to obtain a statistically significant effect of real activity on inflation using the structural formulation implied by theory, when the measure of real activity is output gap (Gali and Gertler, 1999).

In contrast, Neiss and Nelson (2002), argued that once the output gap is computed in a manner consistent with dynamic general equilibrium models, estimate based on output gap have fit that is at least as good as estimate based on labour income share.

Approximation by the Labour Income Share

The second approach used to measure the real marginal cost is labour income share in the Gross Domestic Product (GDP) which is based on the Cobb-Douglass production function. If A_t denote technology, K_t capital and N_t labour. Then output is:

$$Y_t = A_t K_t^{\alpha\kappa} N_t^{\alpha n} \quad (3.8)$$

Real marginal cost can be obtained from the ratio of the wage rate to the marginal product of labour: $MC_t^r = (W_t/P_t)/(\delta Y_t/\delta Nt)$. Thus, from equation (3.8) we have:

$$MC^{r}_{t} = S_t/\alpha_n \quad (3.9)$$

Where $S_t \equiv W_tN_t/P_tY_t$ is the labour income share which is equivalent to real unit labour cost. If the lower case letters denote deviations of the logged real marginal cost from its steady state, thus:

$$mc_t^{r} = s_t \quad (3.10)$$

Substituting equation (3.10) into the closed economy (3.2), we have:

$$\pi_t = \lambda s_t + \gamma_f E_t\{\pi_{t+1}\} + \gamma_b \pi_{t-1} \quad (3.11)$$

Also, substituting equation (3.10) into the open economy (3.5), we arrived at:

$$\pi_t = \lambda s_t + \delta m_t + \gamma_f E_t\{\pi_{t+1}\} + \gamma_b \pi_{t-1} \quad (3.12)$$

Gali and Gertler (1999) assert the importance of labour income share as a measure of real economic activity because it takes into account the effect of productivity gains on inflation which is not often captured by the simple output gap measures. Besides, Gulyas and Starz (2006), reported that other researchers such as Woodford (2003), Balakrishnan and Lopez-Salido (2002), Batini et al (2005) and favoured the use of labour income share as a measure of real activity.

Nevertheless, using unemployment as in the original Philips curve in addition to output gap as proxies for the driving force of the models, Gulyas and Starz (2006) argued that there exist a trade-off between inflation and real economic activity.

Moreover, for closed economy, output gap could be a substitute for marginal cost, but for an economy that is both open to trade and capital flow the marginal cost cannot be substituted with output gap (Binyamini, 2006).

3.3 APPROXIMATION OF THE EXTERNAL FACTOR

According to Kara and Nelson (2003), if there is complete pass-through of exchange rate movements to import price, real import price changes can be a good substitute for exchange rate in measuring external inflation. While if pass-through is slow and incomplete, then real import price may capture external influences better than the real exchange rate. Moreover, if import price is highly insensitive to external factors as well as to exchange rate, the estimated coefficients cannot be interpreted as capturing openness or external factors on inflation dynamics. Thus, using real exchange rate to measure external inflation, equation (3.12) becomes:

$$\pi_t = \lambda\, s_t + \phi\, q_t + \gamma_f\, E_t\{\pi_{t+1}\} + \gamma_b\, \pi_{t-1} \qquad (3.13)$$

Where q_t is nominal effective exchange rate.

3.4 MODEL SPECIFICATION

The NKPC models above violate the basic assumption of orthogonality between the error term and the regressors because the expected inflation term (π_{t+1}) is unobservable, thus it must be proxied, hence referred to as endogenous variable and the real marginal cost may not be perfectly measured, therefore, the models cannot be estimated using the traditional Ordinary Least Square (OLS) estimator. In order to address the problem, we need to employ a method that correct for the endogeneity bias and the likely measurement error. Since there is no sufficient data on the expected future inflation for Nigeria, we resort to the alternative obtained from the literature. According to our literature search, either instrumental variable approach: Generalized Method of Moments (GMM) and Two-Stage Least Square (TSLS) or Maximum Likelihood Estimation (MLE) can be used to estimate the NKPC.

According to Gali et al (2005), the choice of statistical technique for the estimation of NKPC is debatable. Wooldridge (2001) argued that GMM has become one of the main statistical

tools for the analysis of economic and financial data. It is a robust estimator in that, unlike maximum likelihood estimation, it does not require information of the exact distribution of the disturbances; it allows estimation under the restrictions implied by the theory. Abbas and Sgro (2011) opined that optimal GMM estimator is asymptotically efficient as two-stage least square under homoskedasticity, and generally better under hetroskedasticity.

Gali et al (2005), claim that even though GMM may be sensitive to the choice of instruments, however, they have convincingly demonstrated that the GMM estimates of the hybrid NKPC as used by Gali and Gertler (1999) are appropriate to a variety of different estimation procedures. Other studies that employed GMM to estimate NKPC include Batini et al (2005) for thr UK, Abbas and Sgro (2011) for Australia and Du Plessis and Burger (2006) for South Africa. Therefore, GMM shall be used as the econometrics technique for the estimation of the closed economy and open economy models under orthogonal condition, because using suitable instruments set GMM estimator gives a relatively small finite sample bias and reliable parameter estimate of the NKPC and the choice of single equation is aimed at avoiding taking a stand on the structure of the entire economy (Rumbler, 2005).

According to Wooldridge, (2001), GMM model estimated under rational expectations, using time series, the dependent as well as the independent variable at earlier time periods is uncorrelated with the error term in the model even though the error term does not appear in the model.

If z_{t-1} is a vector of instrumental variables dated t – 1 and earlier, given rational expectations and the assumption that the error term ε_t is not correlated with the lagged values of the dependent and independent variables. Thus, we can specify the baseline closed economy NKPC model for estimation as follows:

$$E_{t-1}\{(\pi_t - \lambda s_t + \gamma_f \pi_{t+1}) z_{t-1}\} = 0 \qquad (3.14)$$

The hybrid closed economy model which includes both expected and lagged inflation is specified thus:

$$E_{t-1}\{(\pi_t - \lambda s_t + \gamma_f \pi_{t+1} + \gamma_b \pi_{t-1}) z_{t-1}\} = 0 \quad (3.15)$$

The open economy hybrid NKPC model with real import price of intermediate inputs as measure of external inflation is:

$$E_{t-1}\{(\pi_t - \lambda s_t + \delta m_t + \gamma_f \pi_{t+1} + \gamma_b \pi_{t-1}) z_{t-1}\} = 0 \quad (3.16)$$

But when nominal effective exchange rate is used as proxy for external inflation the model becomes:

$$E_{t-1}\{(\pi_t - \lambda s_t + \phi q_t + \gamma_f \pi_{t+1} + \gamma_b \pi_{t-1}) z_{t-1}\} = 0 \quad (3.17)$$

All variables are as earlier defined.

The orthogonal condition in equations (3.14) to (3.17) provides the basis for estimating the models using GMM. It can be noted that equations (3.14) and (3.15) are closed economy version of the NKPC while (3.16) and (3.17) are the open economy version of the NKPC.

In order to achieve the set out objective, each of the reduced form equations (3.14) to (3.17) above would be estimated in four specifications: (i) in terms of the two alternative measure of inflation – GDP deflator inflation and CPI inflation and; (ii) in terms of the alternative proxy for real marginal cost - output gap and unit labour cost. Therefore, each of the equations would have four different specifications and a total of 16 specifications for the whole work.

The equations for estimation can clearly be stated in the conventional foam as follows:

Closed Economy Baseline NKPC Equations

$$c_inf = a + \lambda\, ygap + \gamma_f E(\pi t_{+1}) \quad (3.18)$$

$$c_inf = a + \alpha\, ulc + \gamma_f E(\pi t_{+1}) \quad (3.19)$$

$$d_inf = a + \lambda\, ygap + \gamma_f E(\pi t_{+1}) \quad (3.20)$$

$$d_inf = a + \alpha\ ulc + \gamma_f E(\pi t_{+1}) \quad (3.21)$$

where: c_inf - CPI Inflation

ygap – Output Gap

$E(\pi_{t+1})$ – Expected future Inflation (Forward-Looking)

d_inf – GDP Deflator Inflation

ulc – Real Unit Labour Cost

a - constant

Closed Economy Hybrid NKPC Equations

$$c_inf = a + \lambda\ ygap + \gamma_f E(\pi_{t+1}) + \gamma_b \pi_{t-1} \quad (3.22)$$

$$c_inf = a + \alpha\ ulc + \gamma_f E(\pi_{t+1}) + \gamma_b \pi_{t-1} \quad (3.23)$$

$$d_inf = a + \alpha\ ygap + \gamma_f E(\pi_{t+1}) + \gamma_b \pi_{t-1} \quad (3.24)$$

$$d_inf = a + \alpha\ ulc + \gamma_f E(\pi_{t+1}) + \gamma_b \pi_{t-1} \quad (3.25)$$

where: π_{t-1} – Past Inflation (Backward-Looking)

All other variables are as earlier defined.

Open Economy Hybrid NKPC Equations with Import Price as Measure of External Factors/Openness

$$c_inf = a + \delta\ p_imp + \lambda\ ygap + \gamma_f E(\pi_{t+1}) + \gamma_b \pi_{t-1} \quad (3.26)$$

$$c_inf = a + \delta\ p_imp + \alpha\ ulc + \gamma_f E(\pi_{t+1}) + \gamma_b \pi_{t-1} \quad (3.27)$$

$$d_inf = a + \delta\ p_imp + \lambda\ ygap + \gamma_f E(\pi_{t+1}) + \gamma_b \pi_{t-1} \quad (3.28)$$

$$d_inf = a + \delta\ p_imp + \alpha\ ulc + \gamma_f E(\pi_{t+1}) + \gamma_b \pi_{t-1} \quad (3.29)$$

where: p_imp – Percentage Change in Import Price

All other variables are as earlier defined.

Open Economy Hybrid NKPC Equations with Nominal Effective Exchange Rate as Measure of External Factors/Openness.

$$c_inf = a + \phi \text{ ner} + \lambda\, ygap + \gamma_f E(\pi_{t+1}) + \gamma_b \pi_{t-1} \quad (3.30)$$

$$c_inf = a + \phi \text{ ner} + \alpha\, ulc + \gamma_f E(\pi_{t+1}) + \gamma_b \pi_{t-1} \quad (3.31)$$

$$d_inf = a + \phi \text{ ner} + \lambda\, ygap + \gamma_f E(\pi_{t+1}) + \gamma_b \pi_{t-1} \quad (3.32)$$

$$d_inf = a + \phi \text{ ner} + \alpha\, ulc + \gamma_f E(\pi_{t+1}) + \gamma_b \pi_{t-1} \quad (3.33)$$

where: p_imp – Percentage Change in import price.

All other variables are as earlier defined.

3.5 INSTRUMENTAL VARIABLES

We use the instruments (z_{t-1}) at period $t-1$ or earlier because it is possible to have significant error in measuring marginal cost. Given that the error term is uncorrelated with past information, it becomes easy to use lagged instruments. In addition, the public may not have access to all available information at the time they form expectations (Gali and Lopez-Salido, 2000 and Gali et al, 2001). The vector of instruments has been chosen based on the criteria that they are correlated with the regressors and they satisfy the overidentifying restrictions of Hansen's *J*-test.

Adapting the vector of instruments Z_{t-1} to suit Nigerian economy from Gali and Gertler (1999), for the closed economy we have four lags each of GDP deflator inflation (d_inf), CPI inflation (d_inf), unit labour cost (ulc), output gap (ygap), monetary policy rate (mpr) and wage inflation (w_inf). We used mpr instead of interest rate spreads in Gali and Gertler (1999) because mpr is more influential in monetary policy process than spreads and the

instruments correlates with inflation theoretically. For the open economy, equal lags each of percentage change in import price (p_imp) and percentage change in nominal effective exchange rate (ner) were added to the set of instruments for the closed economy when they are included in a given equation. The length of lags up to four is based on the use of quarterly data (Abbas and Sgro, 2011).

3.6 ANALYTICAL TECHNIQUE

Based on the justification in the previous section, the GMM shall be employed as the econometric method to estimate the value of λ, α, γ_f, and γ_b coefficients in the closed economy equations (3.18) to (3.25) to determine the effects of real economic activity in the form of output gap (ygap) and unit labour cost (ulc); expected future inflation ($E(\pi_{t+1})$,) and; past inflation (π_{t-1}) respectively on inflation dynamics. In addition to the coefficients in the closed economy equations, the value of δ and ϕ coefficients in the open economy equations (3.26) to (3.33) would also be estimated to determine the influence of import price (p_imp) and nominal effective exchange rate (ner) on inflation dynamics in Nigeria.

But as earlier stated, the major problem with GMM is choosing the right instruments in the estimation process. Thus, we adapt the set of instruments used by Gali and Gertler, (1999). Our instruments are expected to be correlated with the expected future inflation ($E(\pi_{t+1})$) in order to address its problem of endogeneity. Hansen's (1982), *J*-statistics is employed to test the validity of the instrumental variables based on the null hypothesis that the overidentifying restrictions hold and the parameter estimates are consistent with the different set of instruments. Newey-west corrected standard errors which are robust to hetroskedasticity and autocorrelation of unknown form would also be used in the coefficients' significance tests.

3.7 A PRIORI EXPECTATIONS

We expect that λ, α, δ, γ_f, $\gamma_b > 0$; $0 < \phi$

3.8 DATA AND SOURCES

The data for this study was obtained from the publications of the Central Bank of Nigeria (CBN), the National Bureau of Statistics (NBS) and the International Financial Statistics (IFS). It runs from 1986Q1 to 2009Q4 for some variables and 2010Q4 for others. Inflation is measured as annualized percentage change in GDP deflator as in Gali and Gertler, (1999) and annualized percentage change in consumer price index (CPI) which is commonly used in Nigeria (Mordi et el, 2007). Output gap is the deviations of log of real GDP from its Hodrick Prescott (HP) trend and unit of labour cost is computed as the deviations of the log of labour income share from its sample means. The labour income share is calculated as the ratio of the compensation of employees to GDP. Real import price of intermediate goods is computed as the log of difference between total import and export while Nominal effective exchange rate is obtained from the IFS. The quarterly data on compensation of employees, real GDP, total import and export are disaggregates from their annual values.

With the exception of output gap that is HP filtered, all other variables are in percentage change or in deviations from their steady state in order to induce stationarity see for example Rumbler,(2005). According to Paloviita (2008), when GMM technique is used, inflation is commonly assumed to be stationary in the NKPC analysis. Though she acknowledged that possible non-stationary invalidates GMM estimation results, but she argued that Engle and Granger (1987) have proved that a linear combination of non-stationary time series may be stationary. Therefore, we would make the traditional assumption of stationary and rely on GMM for its features that fit the scenario.

CHAPTER FOUR

RESULTS PRESENTATION AND INTERPRETATION

4.0 INTRODUCTION

In this chapter, trend analysis shall be conducted on the variables included in our models to determine if the data behave as expected by capturing at least major events in the economy. This would enable us find out if our data set is a good representation of the Nigerian economy. Since alternative data sets are used for estimation, the trend analysis would also allow us to observe the level of co-movement between the alternating data sets to determine their substitutability.

This chapter also contains result of the empirical estimates of the two versions of the NKPC: closed economy NKPC (3.18) to (3.25) and open economy NKPC (3.26) to (3.33). The closed economy version is sub-divided into baseline NKPC (3.18) to (3.21) and hybrid NKPC (3.22) to (3.25), while the open economy version is estimated using two different measure of external inflation: real import price (3.26) to (3.29) and nominal effective exchange rate (3.30) to (3.33). Each version of the NKPC: (i) closed economy baseline NKPC; (ii) closed economy hybrid NKPC; (iii) open economy hybrid NKPC with real import price and; (iv) open economy hybrid NKPC with nominal effective exchange rate are estimated using both GDP deflator inflation and CPI inflation and; output gap and unit labour cost as measure of real marginal cost.

The different measures of inflation are applied because GDP deflator inflation is the most widely used in the NKPC literature whereas CPI inflation is the most commonly used in Nigeria even by the CBN. Thus, using GDP deflator would provide fair ground for comparing our results with results from other countries, while using CPI inflation would enable us determine its effectiveness and compare it with the Deflator Inflation. The ongoing

debate on which of the measures of real marginal cost better captures real economic activity, output gap or unit labour cost and; which variable is the most appropriate to use to capture the impact of openness on inflation, import price or exchange rate prompted us to apply both of them in this study in order to identify which of them are more suitable for Nigeria's NKPC models and by extension contribute to the ongoing discourse.

The tests results will be interpreted and analyzed for relevant implications on the Nigerian economy. Finally, we will evaluate the forecasting power of the model with the best fit.

4.1 TREND ANALYSIS

This section contains analysis of trend, substitutability of the alternative measure of inflation, real marginal cost and external inflation. The expected relationship between inflation (dependent variable) and output gap, unit labour cost, change in import price and change in nominal effective exchange rate (forcing independent variables) is also analyzed using graphs and pairwise correlation.

4.1.1 ALTERNATIVE MEASURES OF INFLATION, REAL MARGINAL COST AND EXTERNAL FACTORS

In order to test the robustness of our models, we applied the different measures of the variables that are found in the literatures of NKPC. Moreover, the choice of measures of the variables is becoming a contentious issue recently. Therefore, it is imperative to apply the different measures so as to determine those that better fit Nigerian data.

Figure 4.1: Inflation, Real Marginal Cost and External Inflation

Figure 1A: Inflation

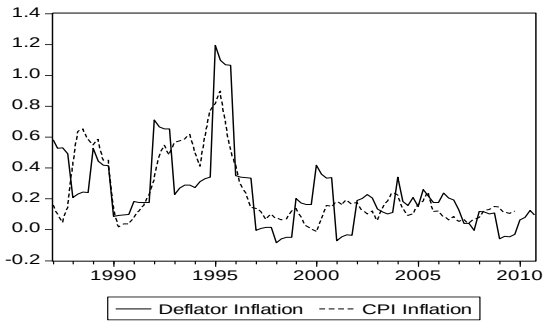


Figure 1B: Real Marginal Cost

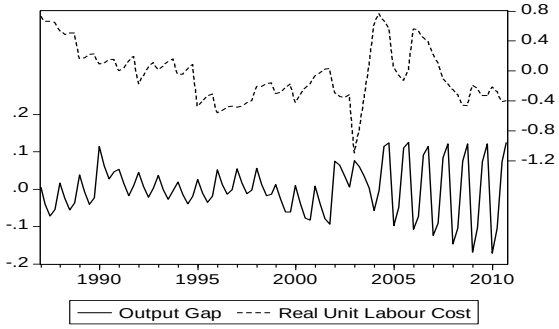


Figure 1C: External Inflation

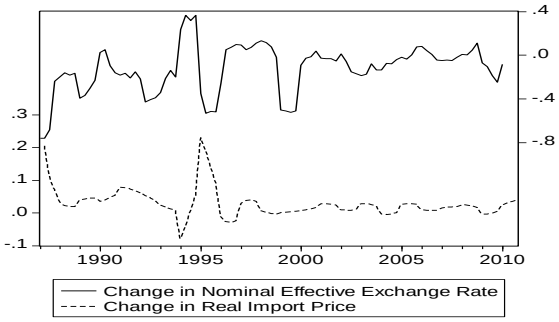


Figure 1D: Nominal Effective Exchange Rate

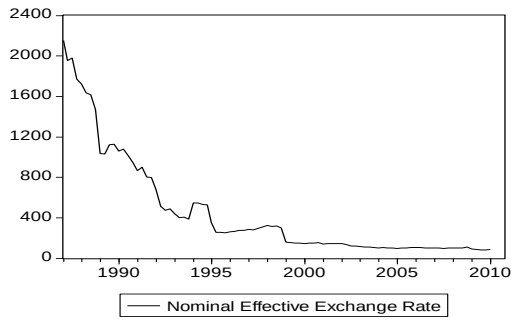


Figure 1A shows the alternative measures of inflation, deflator and CPI inflation. Visual inspection indicates that deflator inflation and CPI inflation co-varied within the sample period. This means that they could be good substitutes as measure of inflation in Nigeria. Inflation displays volatile trend from the beginning of our sample period (1986) to 2002 with a little break between 1996 and 1998. The genesis of the volatility could be attributed to the aftermath of the Structural Adjustment Programme (SAP) introduced in 1986. From 2003 to 2010, inflation seems to be fairly stable. This could be the result of the deliberate decision of the CBN to concentrate mainly on achieving price stability which prompted its adoption of inflation targeting policy framework.

The output gap and unit labour cost trend are averagely the same as shown in figure 1A, thus, could be said to be good alternative measures of real marginal cost. They also tend to be stable from 1986 to 2003 except that the unit labour cost displays a gentle downward trend

which could be attributed to the consistent GDP growth without a commensurate increase in wages. The high fluctuation in output gap and unit labour cost observed at the last part of the sample, 2003 to 2010 could be because of the erratic growth in GDP and different wage increases respectively in the period.

The trend of the measures of external inflation: change in import price and change in nominal effective exchange rate shown in figure 1C are fairly similar. There were high fluctuations in the variables from the beginning of the sample period to 2000. This could also be the consequence of SAP which brought persistent depreciation of the exchange rate and increase in import price. The exchange rate depreciation continues from 1986 to 1999 as depicted in figure 1D above.

After establishing co-movement between the alternative measures of inflation, real marginal cost and external inflation, we then proceed to investigate the existence of NKPC in the Nigerian data before the formal test. That is we would determine if the expected relationship between the dependent variable and the forcing independent variables exist.

4.1.1 RELATIONSHIP BETWEEN INFLATION AND OUTPUT GAP, UNIT LABOUR COST, CHANGE IN IMPORT PRICE AND CHANGE IN NOMINAL EFFECTIVE EXCHANGE RATE

The theoretical structure of the open economy NKPC established a positive relationship between inflation and unit labour cost, output gap, and percentage change in real import price and a negative relationship with the percentage change in nominal effective exchange rate.

Figure 4.2: Relationship between Inflation and the Forcing Independent Variables

Figure 2A: Inflation and Output Gap

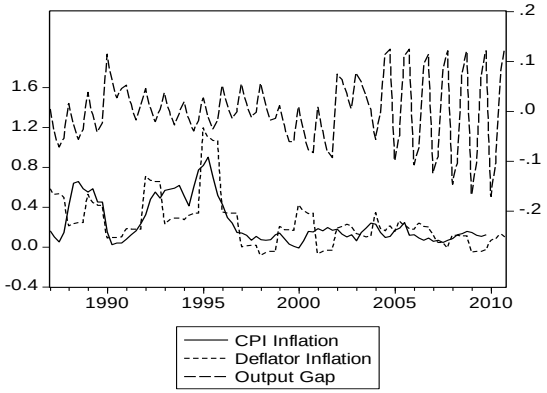


Figure 2B: Inflation and unit Labour Cost

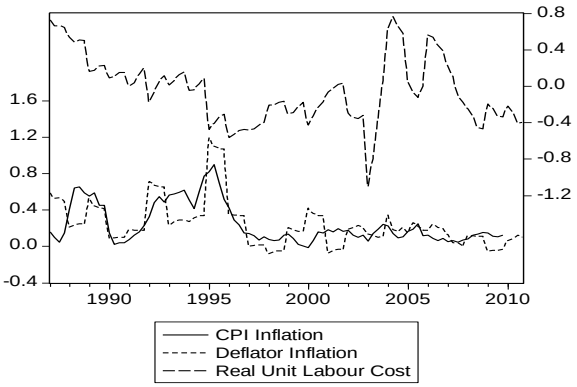


Figure 2C: Inflation and Import price

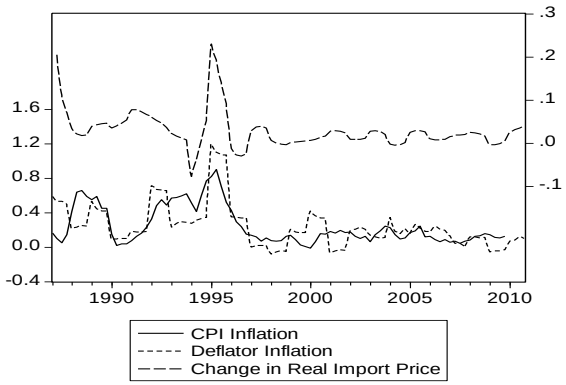
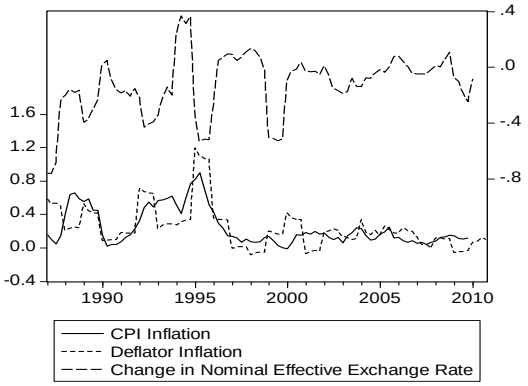


Figure 2D: inflation and Exchange Rate



A critical inspection of the relationship between both deflator inflation and CPI inflation and output gap in figure 2A reveals that they are inversely related. Boom period is characterized by inflationary pressure but between 1990 and 1992 the output gap indicates boom in the economy, on the contrary, inflation appeared to be low. In 1995 when inflation seems to be at its peak, output gap shows the economy to be declining and reverse is the case in the subsequent sample period. The negative relationship between inflation and output gap is confirmed by the negative pairwise correlation coefficients in table 4.1 between CPI inflation and output gap (-0.084) and; deflator inflation and output gap (-.056). Therefore, output gap may likely violate the theoretical structure of the NKPC model in the formal test to be conducted using GMM.

Real unit labour cost is the substitute to output gap as a measure of real marginal cost. Unlike the output gap, real unit labour cost tends to be directly related with inflation though with lag(s) and infinitesimal proportion, thus, conform to the theoretical expectation of the NKPC. The pairwise correlation coefficients in table 4.1 between CPI inflation and real unit labour cost (0.088) and; deflator inflation and real unit labour cost (0.081) in table 4.1 attests to the positive relationship between inflation and real unit labour cost.

Table 4.1: Pairwise Correlation between Inflation and Forcing Independent Variables.

	Output Gap	Unit Labour Cost	Change in Import Price	Change in Nominal Effective Exchange Rate
CPI Inflation	-0.084	0.088	0.317	-0.193
Deflator Inflation	-0.056	0.081	0.604	-0.532

Figure 2c depicts a high relationship between change in import price and inflation. There was volatile fluctuation in the two variables in the late 1980s and 1990s. Change in import prices and inflation reached their peak in the sample period. This could be due to the sanction impose on Nigeria during that period. From 2000 to 2010 both variables tend to be relatively stable. Therefore we can conclude that change in import price and inflation are directly related, hence agree with our theoretical expectation as evidenced by the correlation coefficients between CPI inflation and change in import price (0.317) and deflator inflation and change in import price (0.604).

The open economy NKPC demands that inflation be inversely related with change in nominal effective exchange rate. This appear to hold, because prior to 1999 the changes in nominal effective exchange rate appear to be negative which implies depreciation in the real naira value, while inflation continued to be positive and high, until 2000 when both variable seem to be relatively stable. This is further ascertain by the negative value of the correlation coefficients of change in nominal effective exchange rate and CPI inflation (-0.193) and deflator inflation (-0.532).

4.2 ESTIMATE OF THE MODELS

The estimates of models (4.1) to (4.16) are summarized in tables 4.2 to 4.5 respectively. Each table contains four specifications of a particular version of NKPC: (i) closed economy baseline NKPC; (ii) closed economy hybrid NKPC; (iii) open economy hybrid NKPC with import price as measure of inflation and; (vi) open economy hybrid NKPC with nominal effective exchange rate as a measure of external inflation. The difference among the four specifications of a given version is in terms of the different measures of inflation (GDP deflator and CPI) and real marginal cost (output gap and unit labour cost) used.

4.2.1 CLOSED ECONOMY BASELINE NKPC

The baseline closed economy NKPC as the name implies is the basis of NKPC. It seeks to determine the effect of real economic activity through unit labour cost (*ulc*) or output gap (*ygap*) and expected future inflation ($E(\pi_{t+1})$) on the current inflation level. In other words the price setting component in the model ($E(\pi_{t+1})$) measures the proportion of firms that set their prices based on the expectation of future prices. That set of firms are said to be forward-looking or they optimised price. The closed economy NKPC is the direct opposite of the traditional or expectation-augmented Philips Curve which assesses the impact of real economic activity and past inflation on current inflation. Those firms that set their prices based on past prices are said to have applied the rule of thumb. The four different specifications of the closed economy NKPC model are as follows:

$$c_inf = -.002 - 0.014ygap + 1.061E(\pi_{t+1}) \quad (4.1)$$

$$c_inf = -0.007 - 0.013ulc + 1.079E(\pi_{t+1}) \quad (4.2)$$

$$d_inf = 0.006 - 0.020ygap + 1.046E(\pi_{t+1}) \quad (4.3)$$

$$d_inf = 0.004 + 0.031ulc + 1.003E(\pi_{t+1}) \quad (4.4)$$

Table 4.2: Results of the Estimation of the Closed Economy Baseline NKPC

Specifications	Parameters			J-Statistics (P-Value)
	Measure of Real Marginal cost		Price Setting	
Measure of Inflation	Unit Labour Cost λ	Output Gap α	Pure Forward-Looking γ_f	
CPI		-0.014 (0.714)	1.061* (0.000)	0.131
	-0.013 (0.327)		1.079* (0.000)	0.128
Deflator		-0.020 (0.555)	1.046* (0.000)	0.148
	0.031* (0.000)		1.003* (0.000)	0.148

** Correct sign and significant at 5%*

- *Instrumental variables include four lags each of deflator inflation, CPI inflation, unit labour cost, output gap and wage inflation.*
- *All specifications are prewhitened and standard error corrected with Bartlett kernel and fixed (4) bandwidth.*

The estimated coefficients of the closed economy baseline NKPC models (4.1) to (4.4) are summarized in table 4.2.

When CPI is used as measure of inflation (4.1) and (4.2), both output gap and unit labour cost appear to be wrongly signed, and insignificant. Their price setting components appeared to be significant but difficult to interpret because they tend to be greater than one. On the other hand, when deflator inflation, models (4.8) and (4.4), is used output gap remain negative and insignificant but unit labour cost turned positive and significant at 5% as expected, although expected future inflation still remains greater than one. The test for overidentifying restrictions in table 4.2 shows that we accept the null hypothesis that the overidentifying restrictions hold. That is the parameter estimates are consistent with different instruments.

We therefore conclude that the best fit for a closed economy NKPC model is the model with deflator inflation and unit labour cost (4.4). Since the measure of real economic activity (unit labour cost) valued 0.03 is significant, hence our model is different from other pure autoregressive models of inflation analysis. Our selected model shows that change in wages or labour market dynamics contributes about 3.1% to inflation dynamics in Nigeria. Though our model also indicates that expected future inflation or forward – looking behaviour of economic agents influence inflation in Nigeria but we cannot ascertain to what extent, because the value 1.003 cannot be meaningfully interpreted. As we are unable to say 100% or more of Nigerian firms are pure forward-looking or set their prices based on expectation only.

We can therefore proceed to test another version of the NKPC, the closed economy hybrid NKPC which allows us to determine the influence of both expected future inflation and past inflation on current inflation in addition to the effect of real economic activity (real marginal cost).

4.2.2 CLOSED ECONOMY HYBRID NKPC

This model assess the impact of output gap (*ygap*) or unit labour cost (*ulc*), expected future inflation ($E(\pi_{t+1})$) and past inflation (π_{t-1}) on current inflation. In other words, it determines the effects of output gap or unit labour cost and the influence of price-setting behaviour of firms: forward-looking and backward-looking. That is, it enables us to know the proportion of firms that optimised price or set price based on expectation of future prices (forward-looking) and those that set price based past prices or apply the rule of thumb (backward-looking). The four differently specified closed economy NKPC models are as follows:

$$c_inf = -0.004 - 0.043ygap + 0.550E(\pi_{t+1}) + 0.455\pi_{t-1} \quad (4.5)$$

$$c_inf = -0.005 - 0.008ulc + 0.576E(\pi_{t+1}) + 0.433\pi_{t-1} \quad (4.6)$$

$$d_inf = 0.006 - 0.041ygap + 0.537E(\pi_{t+1}) + 0.406\pi_{t-1} \quad (4.7)$$

$$d_inf = 0.009 + 0.033ulc + 0.432E(\pi_{t+1}) + 0.503\pi_{t-1} \quad (4.8)$$

Table 4.3: Results of the Estimation of the Closed Economy Hybrid NKPC

Specifications	Parameters				J-Statistics (P-Value)
	Measure of Real Marginal cost		Price Setting		
Measure of Inflation	Unit Labour Cost **λ**	Output Gap **α**	Forward-Looking **γf**	Backward-Looking **γb**	
CPI		-0.043 (0.090)	0.550* (0.000)	0.455* (0.000)	0.130
	-0.008 (0.000)		0.576* (0.000)	0.433* (0.000)	0.130
Deflator		-0.041 (0.268)	0.537* (0.000)	0.406* (0.000)	0.118
	0.033* (0.000)		0.432* (0.000)	0.503* (0.000)	0.120

** Correct sign and significant at 5%*

- *Instrumental variables include four lags each of deflator inflation, CPI inflation, unit labour cost, output gap and wage inflation.*
- *All specifications are prewhitened and standard error corrected with Bartlett kernel and fixed (4) bandwidth.*

Models (4.5) to (4.8) as summarized in table 4.3 shows the estimated coefficients of the closed economy hybrid NKPC.

There is little improvement in this model compared to the closed economy baseline NKPC model. In the model with CPI inflation (4.5) and (4.6), both output gap and unit labour cost turned significant at 10% and 1% respectively, but they have the wrong sign-negative. The price setting components of the models are all significant and interpretable. Proportion of forward-looking and backward-looking firms ranges between (0.549 to 0.576) and (0.433 to

0.455) respectively. This means firms that optimised price are more than those that apply the rule of thumb when inflation is measured using CPI.

On the other hand, in the deflator inflation models (4.7) and (4.8) output gap is insignificant and wrongly signed. However, unit labour cost is significant at 1% with the correct sign. The coefficient of the unit labour cost (0.033) remained consistent in significance and magnitude in the both closed economy baseline NKPC and closed economy hybrid NKPC models. The coefficients of both the expected future inflation and past inflation are significant at 1%. For model 4.7, the coefficient for forward-looking is 0.537 and backward-looking is 0.406 while for model 4.8, the forward-looking is 0.432 and backward-looking is 0.503. But unlike the specification with CPI inflation, models 4.5 and 4.6 which all appeared to be more forward-looking, model 4.8 indicate that persistence plays greater role among firms than expectation when setting prices. The J. Statistics in table 4.3 indicates that we accept the null hypothesis of overidentifying restrictions.

Model 4.8 appears to have the best fit among the closed economy hybrid NKPC models because in contrast to the measures of real marginal cost in the other specifications, unit labour cost is significant with the right sign-positive. This implies that 3.3% of inflation in Nigeria is caused by labour market dynamics or changes in the labour market. It also shows that about 43% of inflation is based on expectation or 43% of firms set their prices based on their expectation of future prices and 50% of inflation is based on persistence or inflation inertia or said differently that 50% of firms apply the rule of thumb when setting prices. In summary, the model indicates that inflation persistence or inertia dominates inflation in Nigeria than expectation.

But Nigerian economy has been liberalized since 1986 and international trade has influenced domestic prices. Therefore, closed economy model may not be its good representation. Thus,

we are prompted to test the open economy hybrid NKPC model, so as to capture the external factors that might have impact on inflation dynamics in Nigeria.

4.2.3 OPEN ECONOMY HYBRID NKPC WITH IMPORT PRICE AS MEASURE OF OPENNESS/ EXTERNAL FACTOR

The open economy hybrid NKPC model is aimed at investigating the effects of external factors or openness, in this case measured as change in import prices (*p_imp*) in addition to all the variables in the closed economy hybrid NKPC: output gap (*ygap*); real unit labour cost (*ulc*) and; forward-looking ((π_{t+1})) and backward-looking (π_{t-1}) price-setting behaviour. The four different specifications of the model are as follow:

$$c_inf = -0.003 - 0.165p_imp - 0.057ygap + 0.624E(\pi_{t+1}) + 0.403\pi_{t-1} \quad (4.9)$$

$$c_inf = -0.004 - 0.152p_imp - 0.005ulc + 0.647E(\pi_{t+1}) + 0.384\pi_{t-1} \quad (4.10)$$

$$d_inf = 0.012 - 0.346p_imp - 0.037ygap + 0.568E(\pi_{t+1}) + 0.396\pi_{t-1} \quad (4.11)$$

$$d_inf = 0.030 + 0.592p_imp + 0.111ulc + 0.044E(\pi_{t+1}) + 0.786\pi_{t-1} \quad (4.12)$$

Table 4.4: Results for the Estimation of the Open Economy Hybrid NKPC with Change in Import Price as Measure of External Factor

Specifications	Parameters					J-Statistics (P-Value)
	Measure of External Factor	Measure of Real Marginal cost		Price Setting		
Measure of Inflation	Real Import Price **δ**	Unit Labour Cost **λ**	Output Gap **α**	Forward-Looking **γf**	Backward-Looking **γb**	
CPI	-0.165 (0.001)		-0.057 (0.053)	0.624* (0.000)	0.403* (0.000)	0.142
	-0.152 (0.002)	-0.005 (0.039)		0.647* (0.000)	0.384* (0.000)	0.147
Deflator	-0.346 (0.002)		-0.037 (0.314)	0.568* (0.000)	0.396* (0.000)	0.135
	0.592* (0.000)	0.111* (0.000)		0.044 (0.113)	0.786* (0.000)	0.142

** Correct sign and significant at 5%*

- *Instrumental variables include four lags each of deflator inflation, CPI inflation, unit labour cost, output gap wage inflation and change in import price.*
- *All specifications are prewhitened and standard error corrected with Bartlett kernel and fixed (4) bandwidth.*

Models (4.9) to (4.12) as tabulated in table 4.4 contain estimated coefficients of the open economy hybrid NKPC with change in import price as a measure of external factors.

The coefficients of real import prices in models, with CPI inflation (4.9) and (4.10) are significant at 1% and 5% respectively but have incorrect sign. Similarly, their measure of real marginal cost: Output gap and unit labour cost are also significant at 5% and 1% respectively, though with the wrong sign. The price-setting behaviours of firms are all significant at 1%. Model 4.9 is characterized with 0.624 forward-looking firms and 0.403 backward-looking firms while model 4.10 shows that 0.647 firms in Nigeria are forward-looking whereas 0.384 of firms are backward looking. Therefore, the models with CPI inflation appear to be autoregressive with only inflation lead and lag as the determinants of inflation. They also imply that inflation expectation play greater role in determining prices in Nigeria than persistence as obtained in the closed economy hybrid NKPC when CPI is used to measure inflation.

The models with deflator inflation (4.11) and (4.12) show that real import price with estimated coefficients –0.346 and 0.592 are significant at 5% and 1% respectively, but with an incorrect sign in model 4.11. Output gap appear to be insignificant and negative in model 4.11, but the coefficient of unit labour cost (0.111) is correctly signed and significant in model 4.12. Both coefficients of forward-looking (0.568) and backward-looking (0.396) components of model 4.11 are significant at 1% and correctly signed, but in model 4.12 coefficient of forward-looking is not significant, though backward-looking (0.786) is significant at 1%.

Therefore, our analysis reveals that the two models with CPI inflation and one with deflator inflation and output gap (4.9), (4.10) and (4.11) respectively turned to pure autoregressive models with forward-looking behaviour of firms in price-setting as the dominant cause of inflation at a range between 56% and 64%. This is because import price, output gap and unit labour cost, although significant; appear with the wrong sign which made it difficult to interpret. We thus conclude that model that has the best fit among the open economy hybrid NKPC with import price as the measure of external factors is that in which deflator inflation and real unit labour cost were used (4.12).

According to our selected model 59% of inflation dynamics in Nigeria is caused by external factors or openness and about 11% by labour market dynamics. It also implies that 78% of inflation is attributable to persistence or backward-looking behaviour of firms. It can be observed that our selected model turned to an "open economy traditional or expectation-augmented Philips curve," Since it shows that forward-looking behaviour is not significant in determining inflation in Nigeria.

But the open economy hybrid NKPC model or "open economy traditional Philips curve" that it turned to does not seem to be a true reflection of the Nigerian economy. The closed economy hybrid NKPC model we estimated earlier indicates that backward-looking or persistence is significant in determining current inflation in Nigeria at reasonable percentage – 43%. Thus, we have to explore the next available option which is to estimate the open economy hybrid NKPC model with percentage change in nominal effective exchange rate as the measure of external factors.

4.2.4 OPEN ECONOMY HYBRID NKPC WITH NOMINAL EFFECTIVE EXCHANGE RATE AS MEASURE OF EXTERNAL FACTOR

In this model of the open economy hybrid NKPC, percentage change nominal effective exchange rate (exchange rate depreciation) (*ner*) is used as measure of external factors or

openness in addition to all the variables in the closed economy hybrid NKPC: output gap (*ygap*); real unit labour cost (*ulc*) and; forward-looking ((π_{t+1})) and backward-looking (π_{t-1}) price-setting behaviour. The four different specifications of the model are as follow:

$$c_inf = -0.001 + 0.003\text{ner} - 0.014ygap + 0.595E(\pi_{t+1}) + 0.410\pi_{t-1} \quad (4.13)$$

$$c_inf = -0.002 - 0.010\text{ner} - 0.007ulc + 0.583E(\pi_{t+1}) + 0.410\pi_{t-1} \quad (4.14)$$

$$d_inf = 0.006 - 0.109\text{ner} - 0.067ygap + 0.402E(\pi_{t+1}) + 0.479\pi_{t-1} \quad (4.15)$$

$$d_inf = 0.005 - 0.143\text{ner} + 0.034ulc + 0.344E(\pi_{t+1}) + 0.507\pi_{t-1} \quad (4.16)$$

Table 4.5: Open Economy Hybrid NKPC with Change in Nominal Effective Exchange Rate as Measure of External Factors.

Specifications	Parameters					J-Statistics (P-Value)
	Measure of External Factor	Measure of Real Marginal cost		Price Setting		
Measure of Inflation	Nominal Effective Exchange Rate **ϕ**	Unit Labour Cost **λ**	Output Gap **α**	Forward-Looking **γf**	Backward -Looking **γb**	
CPI	0.003 (0.766)		-0.014 (0.537)	0.595* (0.000)	0.410* (0.000)	0.153
	-0.010 (0.405)	-0.007 (0.000)		0.583* (0.000)	0.410* (0.000)	0.149
Deflator	-0.109* (0.000)		-0.067 (0.117)	0.402* (0.000)	0.479* (0.000)	0.130
	-0.143* (0.000)	0.034* (0.000)		0.344* (0.000)	0.507* (0.000)	0.129

** Correct sign and significant at 5%*

- *Instrumental variables include four lags each of deflator inflation, CPI inflation, unit labour cost, output gap, wage inflation and change in nominal effective exchange rate.*
- *All specifications are prewhitened and standard error corrected with Bartlett kernel and fixed (4) bandwidth.*

Models (4.13) to (4.16) as summarized in table 4.2 it shows the estimates of the open economy NKPC with percentage change in nominal effective exchange rate as the proxy for external factor.

The estimated coefficients of nominal effective exchange rate in models (4.13) and (4.14), when CPI inflation is used appear to be insignificant. The output gap is also insignificant in model 4.13, but real unit labour cost is significant, though with the wrong sign. All the price setting components in the two models appeared significant with expectation exerting dominance at 0.59 and 0.58 in models (4.13) and (4.14) respectively. Thus, these models turned pure autoregressive. This result coincides with all the models in the last two versions of NKPC: Closed economy hybrid NKPC with import price, except our selected "best" models (4.8) and (4.12). Apart from the two selected models (4.8) and (4.12), all other models in the last two versions of NKPC turned autoregressive with only leads and lags as the determinants of current inflation in Nigeria. This is because the other components of the models either appear with the incorrect sign or insignificant or both.

When deflator inflation is used as a measure of inflation, models (4.15) and (4.16), the estimated coefficients of nominal effective exchange rate, -0.109 and -0.143 respectively are shown to be significant with right sign in both models. Output gap in model (4.15) appeared insignificant with the wrong sign as in all the models tested earlier. This has confirm the result of our pre-formal test conducted using graphs and pair wise correlation coefficients which indicate an inverse relationship between output gap and both CPI and deflator inflation against our a priori expectation. It also shows that output gap is not a good measure of real economic activity or real marginal cost in the NKPC model for Nigeria which is consistent with the findings of Gali and Gertler (1999) for the USA. The real unit labour cost (0.034) in model (4.16) is significant at 1% and rightly signed. All the price setting components emerged significant at 1% and correctly signed with the rule of thumb dominating price setting behaviour. The coefficients of the forward-looking appear to be 0.402 and 0.344 and backward-looking is observed to be 0.479 and 0.507 for models (4.15) and (4.16)

respectively. In all the models, the J-statistics in table 4.5 shows that we accept the null hypothesis of overidentifying restrictions.

Overall, model (4.15) reveals that inflation in Nigeria is influenced by external factors measured as percentage change nominal effective exchange rate (exchange rate depreciation) at 10.9%. It also shows that 47.9% of inflation is caused by expectation while 50.7% by persistence. But external factors alone cannot be the only factor that affect inflation in Nigeria because price of commodities may change due to some domestic activities such as labour market dynamics. Thus, model (4.15) cannot be said to have the best fit in this version of the NKPC model.

On the other hand, model (4.16) shows that both exchange rate depreciation and unit of labour income significantly affect inflation by 14.3% and 3.4% respectively. This shows that both openness and domestic activities in the form of labour market dynamics influence inflation in Nigeria. The price setting behaviour shows that 34% of firms in Nigeria are backward-looking while 50.7% are forward-looking. This means, that persistence plays a greater role in inflationary process in Nigeria.

Therefore, because it is only in model (4.16) that all the coefficients have the expected signs and are statistically significant, the model is selected as the overall estimate of inflation dynamics for Nigeria. It is the best estimate of the open-economy NKPC model which appears to reflect the true picture of the Nigerian inflationary process.

Even though the good fit of our selected model (4.16) for the Nigerian economy is useful for policy making, it would be more useful if it can be used to forecast future inflation. That would guide the CBN in policy formulation within its new policy framework of inflation targeting. Therefore, we proceed to evaluate the forecasting power of model (4.16).

4.3 INFLATION FORECAST WITH THE OPEN-ECONOMY NKPC

We have conducted a static forecast which calculates a sequence of one-step ahead forecasts using the actual value of variable.

The evaluation of the strength of forecast of our best fit open economy hybrid NKPC model shall be conducted using graphs and statistics. We shall examine three graphs: The first contains residual actual and fitted graphs; the second which is similar to the upper part of the first one contains actual inflation and forecasted inflation and; the third shows the forecasted inflation lying in between plus and minus two standard error bands. The band indicates 95% confidence interval.

Evaluation of the graphs shall be done by visual inspection. The actual and fitted graphs as well as the inflation and the forecasted inflation are expected to show similar trend for a good forecast. The forecasted inflation is expected to lie in-between the upper and lower limits at 95% confidence level.

We shall employ Theil inequality coefficient and the bias, variance and covariance proportions statistics to also evaluate the model. Theil inequality coefficient lies between zero and one. It shows the level of fitness of the model for forecast, where zero indicates a perfect fit. The bias, variance and covariance proportions add-up to one. The bias and variance proportions show how far the mean and variance of the forecast series are from the mean and variance of the actual series respectively. The covariance proportion measures the unsystematic forecasting errors.

A good forecast should have small bias and variance proportions, so that most of the bias should be concentrated on the covariance proportion.

Figure 4.3: Forecast Evaluation of the Open Economy Hybrid NKPC Model

Figure 3A: Actual, Fitted and Residual Inflation

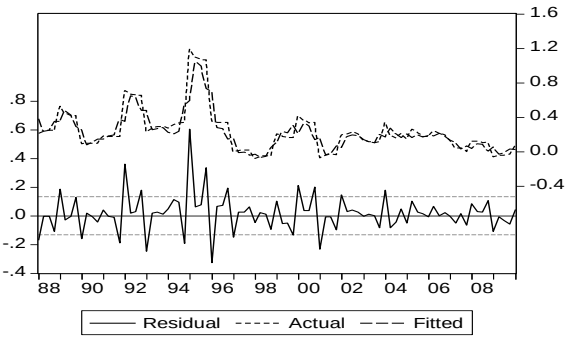


Figure 3B: Deflator and Forecast Inflation

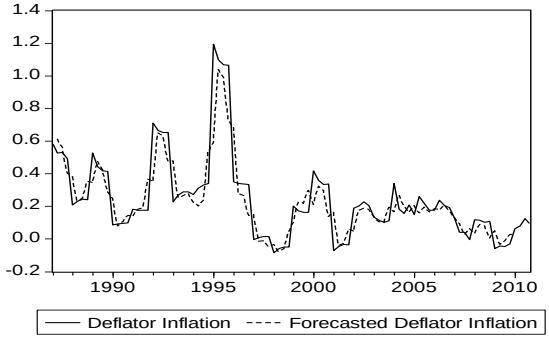


Figure 3C: Forecasted Inflation and Standard Error

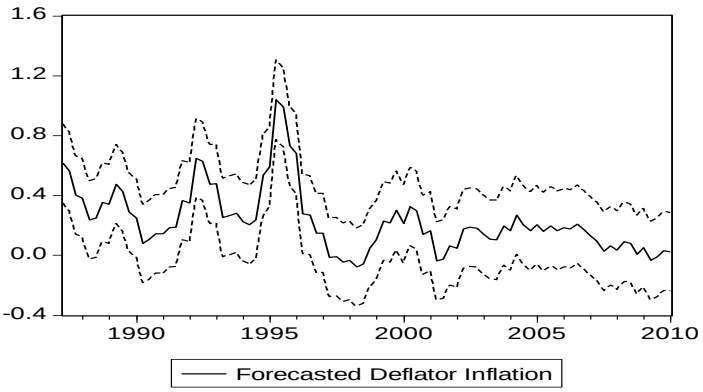


Table 4.6 Forecast Evaluation

Forecast: D_INFF	
Actual: D_INF	
Forecast sample: 1987Q1 2010Q4	
Adjusted sample: 1987Q2 2010Q1	
Included observations: 92	
Root Mean Squared Error	0.126051
Mean Absolute Error	0.082517
Mean Abs. Percent Error	105.7367
Theil Inequality Coefficient	0.190162
Bias Proportion	0.011362
Variance Proportion	0.112271
Covariance Proportion	0.876367

The figures and the table above show graphs and statistics from the static forecast of deflator inflation using our best fit open economy NKPC model. The upper part of figure 3A which is the graphs of actual and fitted values together with figure 3B which also shows graphs of deflator inflation and forecasted deflator inflation indicates what a feature of a good forecast is. This is also confirmed by figure 3C as the forecasted deflator inflation lies within the 95% confidence interval as expected.

Furthermore, table 4.6 contains the statistics we need to evaluate our model for forecast. The Theil inequality coefficient (0.190) shows a good fit up of the model as the coefficient is close to zero as expected. In addition the bias proportion (0.011) and variance proportion (0.112) are very low as required by theory for a good forecast compared to the covariance proportion (0.876) which is large accordingly.

Therefore, we can conclude that the estimated open-economy NKPC model (4.16) is good for forecasting inflation, since it has passed the entire tests of good forecast

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.0 INTRODUCTION

This chapter contains the summary of results interpretation and analysis, conclusion which shall be drawn from the summary and recommendations implied by our conclusion.

5.1 SUMMARY

This study sought to estimate open economy NKPC model for Nigeria, determine the empirical price-setting behaviour of Nigerian firms and assess the relative role of external factors on the inflation dynamics for Nigeria. In addition, it aimed at determining the forecasting potential of the NKPC model for Nigeria's inflationary process. The NKPC model unlike other macroeconomic models of inflation is micro-founded, hence immune to Lucas critique.

We used instrumental variable statistical technique, the Generalized Method of Movements (GMM) to estimate the NKPC model. This is because unlike maximum likelihood estimation technique, the GMM does not require information of the exact distribution of the disturbances and it is better than two stage least square under hetroskedasticity.

The closed and open economy NKPC models were estimated using CPI and deflator measures of inflation and; output gap and real unit labour cost as measure of real marginal cost. But none of the models with CPI inflation or output gap as proxy for real marginal cost is found to have good fit. In other words, all models that have best fit have deflator inflation and unit labour cost as measure of real marginal cost.

We started the estimation with the two versions of the closed economy NKPC baseline and hybrid. The baseline closed economy is the basic NKPC model and the hybrid was a build up upon it.

Applying the traditional diagnostics, the model that appears to fit the Nigerian inflation dynamics is the open-economy hybrid that uses GDP Deflator as the measure of inflation with real unit labour cost, instead of output gap, and nominal effective exchange rate as against the real import prices. Therefore, NKPC appears to fit Nigerian data very well.

According to the estimate, inflation in Nigeria is explained by both external and domestic factors, and that firms are on aggregate both forward and backward-looking in their price-setting behaviour. Specifically, although, more firms (50%) appear to be backward-looking, a significant proportion of firms (34%) tend to incorporate currently available information to form their expectation of future inflation when setting their prices. This suggests that a large number of firms in Nigeria seek for information about the future direction of inflation when setting prices for their products. One implication of this finding is that the Central Bank of Nigeria is in a good position to influence price setting, hence current inflation, by supplying information and data that can influence firms expectations about future path of inflation. Central Bank communication is therefore a potentially important policy tool. The other proportion of firms makes use of past information to set their prices, thus, implies that achieving single digit inflation might take some time.

The model also suggests that external factors which affect domestic prices through the nominal exchange rate have potentially important role in the inflationary process in Nigeria. Nominal depreciation of Naira appears to be inflationary, consistent with a number of previous studies in Nigeria such as Imimole and Enoma (2011). One implication of this

finding is that price stability in Nigeria would require exchange rate stability. Unstable exchange rate will raise inflation variability.

The third major finding is that real unit labour cost is positive and significant, suggesting that labour market dynamics is an important determinant of inflation in Nigeria. Increase in real wages appears to raise the real marginal cost for the firms, which in turn pushes up the prices of their products in an attempt to keep profit margin intact.

5.2 CONCLUSION

We conclude, therefore, that the selected open-economy NKPC model provides the needed empirical specification of inflation dynamics for Nigeria which could be used for the implementation of the new CBN policy framework of inflation targeting.

The open-economy NKPC model can serve as a good monetary policy tool for inflation dynamics analysis, because it shows that though most firms use past information to set their prices, a significant proportion of firms in Nigeria utilize all currently available information to set their prices, hence the CBN communication can be used to influence their price-setting behaviour and thus, achieve the targeted inflation.

The model also indicates that external factors, particularly, exchange rate depreciation significantly affects inflationary process in Nigeria. In addition, labour market dynamics is also observed to be relatively important in determining inflation dynamics in Nigeria.

Finally, the open-economy NKPC model can be used by the CBN to set target inflation, because it can be used as effective tool for forecasting inflation in Nigeria, because since it is microfounded, it is robust to different sample periods and policy regimes.

5.3 RECOMMENDATION

From our findings, we therefore, recommend as follows:

- The CBN communication can be used as a monetary policy intervention tool, at least to augment its real intervention in order to achieve price stability in Nigeria. This is because a reasonable percentage of firms use currently available information to set their prices.
- Stability in the inflationary process in Nigeria could be attained by ensuring stability in the foreign exchange, because exchange rate depreciation significantly affects inflation dynamics in Nigeria.
- The CBN should consider using the open-economy NKPC model to set its inflation target, for our findings revealed that it is good for forecast and theoretically it is robust to different sample periods and policy regimes.

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APPENDIX I

EVIEWS RESULTS OUTPUT FOR THE ESTIMATION OF CLOSED AND OPEN ECONOMY NKPC MODELS

Dependent Variable: C_INF
Method: Generalized Method of Moments
Date: 10/02/12 Time: 07:59
Sample(adjusted): 1988Q1 2009Q3
Included observations: 87 after adjusting endpoints
Kernel: Bartlett, Bandwidth: Fixed (4), Prewhitening
Simultaneous weighting matrix & coefficient iteration
Convergence achieved after: 19 weight matrices, 20 total coef iterations
Instrument list: D_INF(-1) D_INF(-2) D_INF(-3) D_INF(-4) C_INF(-1) C_INF(-2) C_INF(-3) C_INF(-4) ULC(-1) ULC(-2) ULC(-3) ULC(-4) YGAP(-1) YGAP(-2) YGAP(-3) YGAP(-4) MPR(-1) MPR(-2) MPR(-3) MPR(-4) W_INF(-1) W_INF(-2) W_INF(-3) W_INF(-4)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.002337	0.007532	-0.310286	0.7571
C_INF(1)	1.061030	0.030060	35.29734	0.0000
YGAP	-0.014340	0.038975	-0.367929	0.7139
R-squared	0.858400	Mean dependent var		0.246428
Adjusted R-squared	0.855029	S.D. dependent var		0.221351
S.E. of regression	0.084280	Sum squared resid		0.596657
Durbin-Watson stat	1.243705	J-statistic		0.131124

Dependent Variable: C_INF
Method: Generalized Method of Moments
Date: 10/02/12 Time: 23:30
Sample(adjusted): 1988Q1 2009Q3
Included observations: 87 after adjusting endpoints
Kernel: Bartlett, Bandwidth: Fixed (4), Prewhitening
Simultaneous weighting matrix & coefficient iteration
Convergence achieved after: 26 weight matrices, 27 total coef iterations
Instrument list: D_INF(-1) D_INF(-2) D_INF(-3) D_INF(-4) C_INF(-1) C_INF(-2) C_INF(-3) C_INF(-4) ULC(-1) ULC(-2) ULC(-3) ULC(-4) YGAP(-1) YGAP(-2) YGAP(-3) YGAP(-4) MPR(-1) MPR(-2) MPR(-3) MPR(-4) W_INF(-1) W_INF(-2) W_INF(-3) W_INF(-4)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.006679	0.007251	-0.921198	0.3596
C_INF(1)	1.078943	0.031001	34.80310	0.0000
ULC	-0.012736	0.012923	-0.985565	0.3272
R-squared	0.853615	Mean dependent var		0.246428
Adjusted R-squared	0.850130	S.D. dependent var		0.221351
S.E. of regression	0.085692	Sum squared resid		0.616818
Durbin-Watson stat	1.239528	J-statistic		0.128067

Dependent Variable: D_INF
Method: Generalized Method of Moments
Date: 10/01/12 Time: 22:21
Sample(adjusted): 1988Q1 2010Q1
Included observations: 89 after adjusting endpoints
Kernel: Bartlett, Bandwidth: Fixed (4), Prewhitening
Simultaneous weighting matrix & coefficient iteration
Convergence achieved after: 60 weight matrices, 61 total coef iterations
Instrument list: D_INF(-1) D_INF(-2) D_INF(-3) D_INF(-4) C_INF(-1) C_INF(-2) C_INF(-3) C_INF(-4) ULC(-1) ULC(-2) ULC(-3) ULC(-4) YGAP(-1) YGAP(-2) YGAP(-3) YGAP(-4) MPR(-1) MPR(-2) MPR(-3) MPR(-4) W_INF(-1) W_INF(-2) W_INF(-3) W_INF(-4)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.005605	0.005677	0.987336	0.3262
D_INF(1)	1.045922	0.013319	78.52600	0.0000
YGAP	-0.020413	0.034466	-0.592275	0.5552

R-squared	0.527199	Mean dependent var	0.231385
Adjusted R-squared	0.516204	S.D. dependent var	0.256260
S.E. of regression	0.178243	Sum squared resid	2.732263
Durbin-Watson stat	2.131233	J-statistic	0.148054

Dependent Variable: D_INF
Method: Generalized Method of Moments
Date: 10/01/12 Time: 22:16
Sample(adjusted): 1988Q1 2010Q1
Included observations: 89 after adjusting endpoints
Kernel: Bartlett, Bandwidth: Fixed (4), Prewhitening
Simultaneous weighting matrix & coefficient iteration
Convergence achieved after: 41 weight matrices, 42 total coef iterations
Instrument list: D_INF(-1) D_INF(-2) D_INF(-3) D_INF(-4) C_INF(-1) C_INF(-2) C_INF(-3) C_INF(-4) ULC(-1) ULC(-2) ULC(-3) ULC(-4) YGAP(-1) YGAP(-2) YGAP(-3) YGAP(-4) MPR(-1) MPR(-2) MPR(-3) MPR(-4) W_INF(-1) W_INF(-2) W_INF(-3) W_INF(-4)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.003835	0.004490	0.854154	0.3954
D_INF(1)	1.003302	0.010690	93.85867	0.0000
ULC	0.031362	0.008102	3.870848	0.0002

R-squared	0.543035	Mean dependent var	0.231385
Adjusted R-squared	0.532408	S.D. dependent var	0.256260
S.E. of regression	0.175232	Sum squared resid	2.640746
Durbin-Watson stat	2.132809	J-statistic	0.148264

Dependent Variable: C_INF
Method: Generalized Method of Moments
Date: 10/02/12 Time: 08:00
Sample(adjusted): 1988Q1 2009Q3
Included observations: 87 after adjusting endpoints
Kernel: Bartlett, Bandwidth: Fixed (4), Prewhitening
Simultaneous weighting matrix & coefficient iteration
Convergence achieved after: 39 weight matrices, 40 total coef iterations
Instrument list: D_INF(-1) D_INF(-2) D_INF(-3) D_INF(-4) C_INF(-1) C_INF(-2) C_INF(-3) C_INF(-4) ULC(-1) ULC(-2) ULC(-3) ULC(-4) YGAP(-1) YGAP(-2) YGAP(-3) YGAP(-4) MPR(-1) MPR(-2) MPR(-3) MPR(-4) W_INF(-1) W_INF(-2) W_INF(-3) W_INF(-4)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.003595	0.001843	-1.950115	0.0545
C_INF(-1)	0.455306	0.012890	35.32162	0.0000
C_INF(1)	0.549765	0.018513	29.69644	0.0000
YGAP	-0.043212	0.025220	-1.713374	0.0904

R-squared	0.958708	Mean dependent var	0.246428
Adjusted R-squared	0.957216	S.D. dependent var	0.221351
S.E. of regression	0.045785	Sum squared resid	0.173990
Durbin-Watson stat	2.660871	J-statistic	0.129614

Dependent Variable: C_INF
Method: Generalized Method of Moments
Date: 10/02/12 Time: 08:10
Sample(adjusted): 1988Q1 2009Q3
Included observations: 87 after adjusting endpoints
Kernel: Bartlett, Bandwidth: Fixed (4), Prewhitening
Simultaneous weighting matrix & coefficient iteration
Convergence achieved after: 28 weight matrices, 29 total coef iterations
Instrument list: D_INF(-1) D_INF(-2) D_INF(-3) D_INF(-4) C_INF(-1) C_INF(-2) C_INF(-3) C_INF(-4) ULC(-1) ULC(-2) ULC(-3) ULC(-4) YGAP(-1) YGAP(-2) YGAP(-3) YGAP(-4) MPR(-1) MPR(-2) MPR(-3) MPR(-4) W_INF(-1) W_INF(-2) W_INF(-3) W_INF(-4)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.004800	0.001644	-2.919238	0.0045
C_INF(-1)	0.432938	0.013727	31.53951	0.0000
C_INF(1)	0.575918	0.018104	31.81131	0.0000
ULC	-0.007675	0.001958	-3.920533	0.0002

R-squared	0.957196	Mean dependent var	0.246428
Adjusted R-squared	0.955649	S.D. dependent var	0.221351
S.E. of regression	0.046616	Sum squared resid	0.180361
Durbin-Watson stat	2.624928	J-statistic	0.129533

Dependent Variable: D_INF
Method: Generalized Method of Moments
Date: 10/01/12 Time: 22:22
Sample(adjusted): 1988Q1 2010Q1
Included observations: 89 after adjusting endpoints
Kernel: Bartlett, Bandwidth: Fixed (4), Prewhitening
Simultaneous weighting matrix & coefficient iteration
Convergence achieved after: 42 weight matrices, 43 total coef iterations
Instrument list: D_INF(-1) D_INF(-2) D_INF(-3) D_INF(-4) C_INF(-1) C_INF(-2) C_INF(-3) C_INF(-4) ULC(-1) ULC(-2) ULC(-3) ULC(-4) YGAP(-1) YGAP(-2) YGAP(-3) YGAP(-4) MPR(-1) MPR(-2) MPR(-3) MPR(-4) W_INF(-1) W_INF(-2) W_INF(-3) W_INF(-4)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.005804	0.003072	1.889302	0.0623
D_INF(-1)	0.406237	0.026918	15.09176	0.0000
D_INF(1)	0.537465	0.033686	15.95530	0.0000
YGAP	-0.040669	0.036466	-1.115245	0.2679

R-squared	0.752020	Mean dependent var	0.231385
Adjusted R-squared	0.743267	S.D. dependent var	0.256260
S.E. of regression	0.129844	Sum squared resid	1.433051
Durbin-Watson stat	2.892898	J-statistic	0.118049

Dependent Variable: D_INF
Method: Generalized Method of Moments
Date: 10/03/12 Time: 02:22
Sample(adjusted): 1988Q1 2010Q1
Included observations: 89 after adjusting endpoints
Kernel: Bartlett, Bandwidth: Fixed (4), Prewhitening
Simultaneous weighting matrix & coefficient iteration
Convergence achieved after: 53 weight matrices, 54 total coef iterations
Instrument list: D_INF(-1) D_INF(-2) D_INF(-3) D_INF(-4) C_INF(-1) C_INF(-2) C_INF(-3) C_INF(-4) ULC(-1) ULC(-2) ULC(-3) ULC(-4) YGAP(-1) YGAP(-2) YGAP(-3) YGAP(-4) MPR(-1) MPR(-2) MPR(-3) MPR(-4) W_INF(-1) W_INF(-2) W_INF(-3) W_INF(-4)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.008817	0.003660	2.408917	0.0182
D_INF(-1)	0.502708	0.027392	18.35258	0.0000
D_INF(1)	0.431667	0.033172	13.01294	0.0000
ULC	0.033284	0.007318	4.548470	0.0000

R-squared	0.746131	Mean dependent var	0.231385
Adjusted R-squared	0.737171	S.D. dependent var	0.256260
S.E. of regression	0.131376	Sum squared resid	1.467079
Durbin-Watson stat	2.838608	J-statistic	0.119756

Dependent Variable: C_INF
Method: Generalized Method of Moments
Date: 10/03/12 Time: 03:11
Sample(adjusted): 1988Q2 2009Q3
Included observations: 86 after adjusting endpoints
Kernel: Bartlett, Bandwidth: Fixed (4), Prewhitening
Simultaneous weighting matrix & coefficient iteration
Convergence achieved after: 42 weight matrices, 43 total coef iterations
Instrument list: D_INF(-1) D_INF(-2) D_INF(-3) D_INF(-4) C_INF(-1) C_INF(-2) C_INF(-3) C_INF(-4) ULC(-1) ULC(-2) ULC(-3) ULC(-4) YGAP(-1) YGAP(-2) YGAP(-3) YGAP(-4) MPR(-1) MPR(-2) MPR(-3) MPR(-4) W_INF(-1) W_INF(-2) W_INF(-3) W_INF(-4) P_IMP(-1) P_IMP(-2) P_IMP(-3) P_IMP(-4)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.003022	0.002010	-1.503324	0.1366
C_INF(-1)	0.403039	0.016435	24.52353	0.0000
C_INF(1)	0.624400	0.018248	34.21722	0.0000
YGAP	-0.056708	0.028845	-1.965979	0.0527
P_IMP	-0.164940	0.050506	-3.265771	0.0016

R-squared	0.954400	Mean dependent var	0.244536
Adjusted R-squared	0.952148	S.D. dependent var	0.221941
S.E. of regression	0.048550	Sum squared resid	0.190924
Durbin-Watson stat	2.434912	J-statistic	0.142405

Dependent Variable: C_INF
Method: Generalized Method of Moments
Date: 10/03/12 Time: 03:06
Sample(adjusted): 1988Q2 2009Q3
Included observations: 86 after adjusting endpoints
Kernel: Bartlett, Bandwidth: Fixed (4), Prewhitening
Simultaneous weighting matrix & coefficient iteration
Convergence achieved after: 48 weight matrices, 49 total coef iterations
Instrument list: D_INF(-1) D_INF(-2) D_INF(-3) D_INF(-4) C_INF(-1) C_INF(-2) C_INF(-3) C_INF(-4) ULC(-1) ULC(-2) ULC(-3) ULC(-4) YGAP(-1) YGAP(-2) YGAP(-3) YGAP(-4) MPR(-1) MPR(-2) MPR(-3) MPR(-4) W_INF(-1) W_INF(-2) W_INF(-3) W_INF(-4) P_IMP(-1) P_IMP(-2) P_IMP(-3) P_IMP(-4)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.003874	0.001986	-1.949984	0.0546
C_INF(-1)	0.384259	0.017780	21.61175	0.0000
C_INF(1)	0.646560	0.018692	34.59008	0.0000
ULC	-0.004958	0.002360	-2.100574	0.0388
P_IMP	-0.152007	0.047421	-3.205459	0.0019

R-squared	0.952836	Mean dependent var	0.244536
Adjusted R-squared	0.950507	S.D. dependent var	0.221941
S.E. of regression	0.049375	Sum squared resid	0.197472
Durbin-Watson stat	2.402071	J-statistic	0.146731

Dependent Variable: D_INF
Method: Generalized Method of Moments
Date: 10/03/12 Time: 02:49
Sample(adjusted): 1988Q2 2010Q1
Included observations: 88 after adjusting endpoints
Kernel: Bartlett, Bandwidth: Fixed (4), Prewhitening
Simultaneous weighting matrix & coefficient iteration
Convergence achieved after: 59 weight matrices, 60 total coef iterations
Instrument list: D_INF(-1) D_INF(-2) D_INF(-3) D_INF(-4) C_INF(-1) C_INF(-2) C_INF(-3) C_INF(-4) ULC(-1) ULC(-2) ULC(-3) ULC(-4) YGAP(-1) YGAP(-2) YGAP(-3) YGAP(-4) MPR(-1) MPR(-2) MPR(-3) MPR(-4) W_INF(-1) W_INF(-2) W_INF(-3) W_INF(-4) P_IMP(-1) P_IMP(-2) P_IMP(-3) P_IMP(-4)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.012153	0.003421	3.552933	0.0006
D_INF(-1)	0.395728	0.024091	16.42608	0.0000
D_INF(1)	0.567599	0.035730	15.88593	0.0000
YGAP	-0.036747	0.036300	-1.012335	0.3143
P_IMP	-0.346207	0.111850	-3.095278	0.0027

R-squared	0.736469	Mean dependent var	0.231656
Adjusted R-squared	0.723769	S.D. dependent var	0.257716
S.E. of regression	0.135449	Sum squared resid	1.522763
Durbin-Watson stat	2.854915	J-statistic	0.135340

Dependent Variable: D_INF
Method: Generalized Method of Moments
Date: 10/03/12 Time: 02:43
Sample(adjusted): 1988Q2 2010Q1
Included observations: 88 after adjusting endpoints
Kernel: Bartlett, Bandwidth: Fixed (4), Prewhitening
Simultaneous weighting matrix & coefficient iteration
Convergence achieved after: 202 weight matrices, 203 total coef Iterations
Instrument list: D_INF(-1) D_INF(-2) D_INF(-3) D_INF(-4) C_INF(-1) C_INF(-2) C_INF(-3) C_INF(-4) ULC(-1) ULC(-2) ULC(-3) ULC(-4) YGAP(-1) YGAP(-2) YGAP(-3) YGAP(-4) MPR(-1) MPR(-2) MPR(-3) MPR(-4) W_INF(-1) W_INF(-2) W_INF(-3) W_INF(-4) P_IMP(-1) P_IMP(-2) P_IMP(-3) P_IMP(-4)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.029836	0.009475	3.148881	0.0023
D_INF(-1)	0.785768	0.029688	26.46756	0.0000
D_INF(1)	0.044192	0.027616	1.600250	0.1133
ULC	0.110514	0.018453	5.989071	0.0000
P_IMP	0.592240	0.157613	3.757555	0.0003

R-squared	0.650119	Mean dependent var	0.231656
Adjusted R-squared	0.633257	S.D. dependent var	0.257716
S.E. of regression	0.156071	Sum squared resid	2.021720
Durbin-Watson stat	2.189416	J-statistic	0.141899

Dependent Variable: C_INF
Method: Generalized Method of Moments
Date: 10/03/12 Time: 03:00
Sample(adjusted): 1988Q1 2009Q3
Included observations: 87 after adjusting endpoints
Kernel: Bartlett, Bandwidth: Fixed (4), Prewhitening
Simultaneous weighting matrix & coefficient iteration
Convergence achieved after: 71 weight matrices, 72 total coef iterations
Instrument list: D_INF(-1) D_INF(-2) D_INF(-3) D_INF(-4) C_INF(-1) C_INF(-2) C_INF(-3) C_INF(-4) ULC(-1) ULC(-2) ULC(-3) ULC(-4) YGAP(-1) YGAP(-2) YGAP(-3) YGAP(-4) MPR(-1) MPR(-2) MPR(-3) MPR(-4) W_INF(-1) W_INF(-2) W_INF(-3) W_INF(-4) NER(-1) NER(-2) NER(-3) NER(-4)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.001240	0.001607	-0.771685	0.4425
C_INF(-1)	0.409877	0.015254	26.87093	0.0000
C_INF(1)	0.594777	0.016224	36.66076	0.0000
YGAP	-0.014452	0.023310	-0.619992	0.5370
NER	0.003391	0.011366	0.298344	0.7662

R-squared	0.956642	Mean dependent var	0.246428
Adjusted R-squared	0.954527	S.D. dependent var	0.221351
S.E. of regression	0.047202	Sum squared resid	0.182697
Durbin-Watson stat	2.582268	J-statistic	0.153302

Dependent Variable: C_INF
Method: Generalized Method of Moments
Date: 10/03/12 Time: 02:54
Sample(adjusted): 1988Q1 2009Q3
Included observations: 87 after adjusting endpoints
Kernel: Bartlett, Bandwidth: Fixed (4), Prewhitening
Simultaneous weighting matrix & coefficient iteration
Convergence achieved after: 44 weight matrices, 45 total coef iterations
Instrument list: D_INF(-1) D_INF(-2) D_INF(-3) D_INF(-4) C_INF(-1) C_INF(-2) C_INF(-3) C_INF(-4) ULC(-1) ULC(-2) ULC(-3) ULC(-4) YGAP(-1) YGAP(-2) YGAP(-3) YGAP(-4) MPR(-1) MPR(-2) MPR(-3) MPR(-4) W_INF(-1) W_INF(-2) W_INF(-3) W_INF(-4) NER(-1) NER(-2) NER(-3) NER(-4)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.002058	0.001444	-1.424872	0.1580
C_INF(-1)	0.409924	0.014142	28.98586	0.0000
C_INF(1)	0.583060	0.015706	37.12366	0.0000
ULC	-0.007391	0.002079	-3.554852	0.0006
NER	-0.010372	0.012395	-0.836750	0.4052

R-squared	0.956551	Mean dependent var	0.246428
Adjusted R-squared	0.954432	S.D. dependent var	0.221351
S.E. of regression	0.047251	Sum squared resid	0.183080
Durbin-Watson stat	2.562803	J-statistic	0.148542

Dependent Variable: D_INF
Method: Generalized Method of Moments
Date: 10/03/12 Time: 02:46
Sample(adjusted): 1988Q1 2010Q1
Included observations: 89 after adjusting endpoints
Kernel: Bartlett, Bandwidth: Fixed (4), Prewhitening
Simultaneous weighting matrix & coefficient iteration
Convergence achieved after: 80 weight matrices, 81 total coef iterations
Instrument list: D_INF(-1) D_INF(-2) D_INF(-3) D_INF(-4) C_INF(-1) C_INF(-2) C_INF(-3) C_INF(-4) ULC(-1) ULC(-2) ULC(-3) ULC(-4) YGAP(-1) YGAP(-2) YGAP(-3) YGAP(-4) MPR(-1) MPR(-2) MPR(-3) MPR(-4) W_INF(-1) W_INF(-2) W_INF(-3) W_INF(-4) NER(-1) NER(-2) NER(-3) NER(-4)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.005689	0.003776	1.506875	0.1356
D_INF(-1)	0.478704	0.026707	17.92413	0.0000
D_INF(1)	0.401776	0.026852	14.96261	0.0000
YGAP	-0.066545	0.042024	-1.583480	0.1171
NER	-0.109480	0.028733	-3.810286	0.0003

R-squared	0.763742	Mean dependent var	0.231385
Adjusted R-squared	0.752492	S.D. dependent var	0.256260
S.E. of regression	0.127490	Sum squared resid	1.365307
Durbin-Watson stat	2.804026	J-statistic	0.130097

Dependent Variable: D_INF
Method: Generalized Method of Moments
Date: 10/03/12 Time: 02:38
Sample(adjusted): 1988Q1 2010Q1
Included observations: 89 after adjusting endpoints
Kernel: Bartlett, Bandwidth: Fixed (4), Prewhitening
Simultaneous weighting matrix & coefficient iteration
Convergence achieved after: 119 weight matrices, 120 total coef Iterations
Instrument list: D_INF(-1) D_INF(-2) D_INF(-3) D_INF(-4) C_INF(-1) C_INF(-2) C_INF(-3) C_INF(-4) ULC(-1) ULC(-2) ULC(-3) ULC(-4) YGAP(-1) YGAP(-2) YGAP(-3) YGAP(-4) MPR(-1) MPR(-2) MPR(-3) MPR(-4) W_INF(-1) W_INF(-2) W_INF(-3) W_INF(-4) NER(-1) NER(-2) NER(-3) NER(-4)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.005274	0.004604	1.145541	0.2552
D_INF(-1)	0.507038	0.030851	16.43530	0.0000
D_INF(1)	0.344143	0.030862	11.15099	0.0000
ULC	0.033701	0.007839	4.299284	0.0000
NER	-0.142640	0.029565	-4.824566	0.0000

R-squared	0.750008	Mean dependent var	0.231385
Adjusted R-squared	0.738104	S.D. dependent var	0.256260
S.E. of regression	0.131143	Sum squared resid	1.444676
Durbin-Watson stat	2.633259	J-statistic	0.128832