# An Estimated New Keynesian Phillips Curve for Nigeria

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**Abstract:** This paper estimates a New Keynesian Phillips curve (NKPC) model for the Nigerian economy. This is to identify the structural parameters determining inflation dynamics in Nigeria. Previous studies that examined the dynamics of inflation in Nigeria have largely estimated the traditional Phillips curve. This study employs quarterly time series data on six macroeconomic variables from 1990:1 to 2012:4. The study adopts the Generalized Method of Moments (GMM) technique to analyse the data. The findings indicate that both backward-looking and forward-looking behaviour are significant determinants of inflation dynamics in Nigeria. The results, however, suggest that backward-looking behaviour seems to be more quantitatively important in inflation dynamics. Moreover, the findings indicate that price of foreign input, money supply and the lending rate are the main drivers of inflation in Nigeria.

**Keywords:** Inflation; NKPC; GMM; Backward-looking; forward-looking

**JEL Classification:** E31

## 1. Introduction

Recent theoretical studies on the dynamics of inflation have shown the quantitative significance of both the backward looking (lagged) and forward looking (lead) behaviour in the determinants of current inflation. This is termed the hybrid New Keynesian Phillips curve (NKPC hereafter). This is a mark departure from the traditional Phillips curve where inflation depends only on the backward looking behaviour. Moreover, studies have also shown the relative importance of real marginal cost in the short run inflation dynamics[2]. However, empirical findings on the relative significance of the backward and forward looking components in explaining current inflation have been quite divergent. For example, Gali and Gertler (1999) show that current inflation largely depends on the forward looking behaviour and the real marginal cost. In contrast, Rudd and Whelan (2005) find that the forward-looking component plays a limited role in inflation dynamics

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[2] see (Petrella & Santoro, 2012).

Using the NKPC framework, this study estimates the dynamics of inflation for the Nigerian economy. This is to highlight the key structural parameters driving short-run inflation dynamics in Nigeria. Most empirical works on NKPC have largely focused on the developed and emerging economies[1]. Nigeria has some features which differentiate it from the developed and emerging economies. For example, Nigeria largely depends on imported intermediate inputs for its domestic production. This implies that foreign input price shocks and exchange rate shocks may influence the cost of production and hence inflation. The paper is motivated by the distortionary and harmful effects of high and unstable inflation on the economy. High and unstable inflation makes it difficult for households and firms to plan their savings and investment decisions. Moreover, high inflation aggravates inequity across members of the society[2].

The gap that this study seeks to fill is to empirically estimate the hybrid NKPC that incorporates the backward and forward looking components of inflation for the Nigerian economy. Previous studies on the determinants of inflation in Nigeria have largely estimated the traditional Phillips curve. For example, Odusanya and Atanda (2010) estimate the traditional Phillips curve model for Nigeria using the error correction model. Similarly, Omotosho and Doguwa (2013) employ the GARCH model to estimate a traditional Philips curve for the Nigerian economy. Maku and Adelowokan (2013) also examine a traditional Phillips curve for Nigeria using autoregressive model.

A number of studies have shown that inflation significantly distorts investments, lowers economic growth[3]. Hence, understanding the dynamics of inflation in Nigeria is of central concern to macroeconomists and policy makers. Like other developing countries, the leading monetary policy objective in Nigeria is price stability. However, empirical evidence on the sources of inflation in Nigeria has been quite divergent. A strand of literature argues external factors are the main determinants of inflation in Nigeria. In contrast, other studies argue that internal factors especially monetary and fiscal policies are the sources of inflation in Nigeria[4]. Hence, this study will assist the monetary authority to understand the main drivers of inflation in Nigeria and to formulate appropriate policies to maintain price stability.

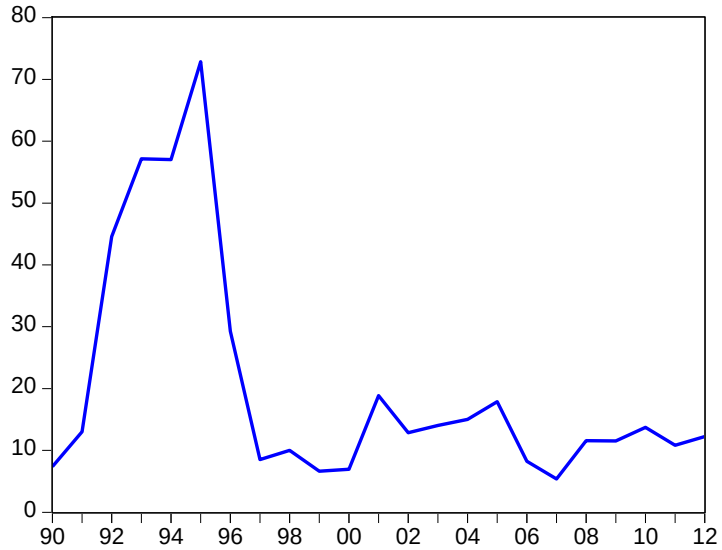
The contributions of this paper are in three-fold. First, building on the works of Gali and Gertler (1999) and Gali et al. (2005), we estimate a hybrid NKPC for the Nigerian economy using the components of real marginal cost rather than the output gap. Second, similar to Agenor and Bayraktar (2005), we incorporate features that are peculiar to the Nigerian economy in the NKPC model. Given the influence of oil

[1] See for example, (Gali et al., 2005; Ramos-Fracia & Torres, 2008; Malikane & Mokoka, 2014).
[2] See (Sill, 2011).
[3] See, for example, (Guerrero, 2006; Barro, 2013).
[4] See, for example, (Maku & Adelowokan, 2013; Oseni & Sanni, 2016).

price on the Nigerian economy, we incorporate oil price shocks in our estimates. Since Nigeria largely depends on foreign intermediate inputs for its domestic production, we incorporate the price of foreign inputs in our estimates. Based on the influence of exchange rate, we also include the real exchange rate in the estimates. Lastly, we estimate the model using the General Methods of Moment (GMM) technique.

Inflation trend in Nigeria has been characterised by rising and declining inflation rate (see figure 1). The early 90s were characterised by rising double-digit inflation rate. This peaked in the mid-1990s. The rising and high rate of inflation in the early 90s was attributed to the exchange rate devaluation, chronic budget deficit, and expansionary monetary policy. The late 90s, however, witnessed a declining inflation. This decrease in the inflation rate was attributed to the declining budget deficit and improved exchange rate management. The beginning of year 2000 witnessed very low inflation rate. Generally, inflation rate in Nigeria has been hovering around two-digit figures.

Figure 1. Inflation Rate in Nigeria



## 2. Review of Related Literature

Empirical estimates of the NKPC have shown inconclusive results on the relative significance of the backward-looking component, the forward-looking components and the real marginal costs in the determinant of inflation. While a number of studies have shown the relative significance of forward looking behaviour in the determinant of inflation, other studies have identified the backward-looking components as the significant driver of inflation. For example, Gali and Gertler (1999) estimate a hybrid NKPC for the US using the GMM technique. The findings indicate that the forward looking behaviour is significant and quantitatively more important than the backward-looking behaviour. The results also suggest that the real marginal cost is an important driver of inflation in the US. Similarly, Gali et al. (2005) examine inflation dynamics in the Euro area. The results show that the forward-looking model behaviour is more important than the backward-looking behaviour in inflation dynamics.

Moreover, Yazgan and Yilmazkuday (2005) examine inflation dynamics for Turkey. The results suggest that forward looking component is statistically significant while the backward looking component is insignificant. Holmberg (2006) estimates the NKPC for Sweden using GMM and the full information maximum likelihood (FIML). The results indicate that the real marginal costs explain inflation dynamics. Maturu et al. (2006) estimate the NKPC for Kenya. The findings show that the forward looking component is an important determinant of inflation in Kenya. Cogley and Sbordone (2008) investigate inflation persistence in the US. The results suggest that forward looking component is more important in the determinant of inflation. Petrella and Santoro (2012) examine inflation dynamics and real marginal costs in the US manufacturing industries using GMM estimation technique. The findings indicate that expected value of intermediate inputs is the main driving force of inflation in the US manufacturing industries.

In contrast, other studies have found that the backward looking component is more important than the forward looking component in the dynamics of inflation. For instance, Mohanty and Klau (2001) examine inflation dynamics for a number of developing countries and emerging economies. The results, among others, show that the backward looking component play more significant role in the determinant of inflation in those countries. The results also suggest that output gap is the main determinant of inflation in these countries. Rudd and Whelan (2005) examine inflation dynamics in the US. Using the GMM estimation technique, they conclude that the forward looking component plays a limited role in inflation dynamics. The backward looking component determines inflation dynamics for the US.

A number of studies have shown that both backward and forward looking components explain inflation dynamics. For example, Linde (2005) estimates NKPC for the US employing the GMM and FIML. The findings suggest that both the

backward and forward looking components determine inflation dynamics in the US. Ramos-Fracia and Torres (2008) estimate short run inflation dynamics in Mexico. The results suggest that both backward looking and forward looking components explain short run inflation dynamics in Mexico. Dua and Upasna (2009) investigate the determinants of inflation in eight Asian countries. The authors conclude that both the forward and backward looking components account for the dynamics of inflation in Asian countries. The study also suggests that output gap is a significant determinant of inflation. Malikane and Mokoka (2014) examine inflation dynamics in number of developed and emerging economies using GMM. The findings indicate that both backward looking and forward looking components significantly determine inflation dynamics.

## 3. Empirical Specification

This study adopts the hybrid NKPC to examine the relative quantitative importance of the backward looking and forward looking components in determinants of inflation in Nigeria. We estimate the model with Generalized Method of Moments (GMM).

Our empirical specification is similar to Agenor and Bayraktar (2010) who estimate contrasting models of NKPC for a number of developing countries. The model incorporates a number of variables that can influence the real marginal cost in Nigeria. Given the vulnerability of Nigerian economy to external shocks[1] and the dependence of the domestic firms on imported intermediate inputs, we specify a set of basic variables that include the real exchange rate, foreign input prices, and oil prices. To account for the impact of interest rate, we also include the lending rate. Since monetary authority in Nigeria (Central Bank of Nigeria) targets monetary aggregates, we include real money balances in the model.

Let $\widehat{Z_t}$ denote a vector of variables consisting of the deviation of the foreign input price, $\widehat{p_t^f}$, deviation in the price of oil, $\widehat{p_t^c}$, deviations of the real exchange rate, $\hat{s}_t$, the cyclical components of the lending rate, $\widehat{r_t}$, and the deviation of the monetary aggregates, $\widehat{m}_t$.

$$\widehat{Z_t} = \left(\widehat{p_t^f}, \widehat{p_t^c}, \widehat{rer}_t, \widehat{r_t}, \widehat{m}_t\right)$$

We estimate an extended version of the hybrid NKPC proposed by Gali and Gertler (1999). This model features backward-looking and forward-looking behaviour and is specified as:

[1] See (Rasaki & Malikane, 2015).

$$\hat{\pi}_t = \gamma_b \hat{\pi}_{t-1} + \gamma_f E_t \pi_{t+1} + \alpha_a \widehat{p_t^c} + \alpha_b \widehat{rer}_t + \alpha_c \hat{m}_t + \alpha_d \widehat{p_t^f} + \alpha_e \hat{r}_t$$

Where $\gamma_b$ is the backward looking component of inflation, $\gamma_f$ is the forward looking component of inflation.

## 4. Estimation Result and Discussion

Table 1 shows the estimated results for the study. The results suggest that backward looking and forward looking behaviour are highly statistically significant determinants of inflation in Nigeria. As expected, the lagged and lead inflation variables have positive impacts on current inflation. The coefficient on lagged inflation is larger than the coefficient on the lead inflation indicating that backward looking behaviour is a more important component in inflation dynamics in Nigeria. This is similar to the findings by Mohanty and Klau (2001). The importance of backward looking component in the determinant of inflation may be due to the low credibility regarding inflation goals by the monetary authority in Nigeria, the Central Bank of Nigeria.

Moreover, the results indicate that oil price shocks have no statistically significant effects on inflation in Nigeria. Oil price shocks have little impact on inflation dynamics in Nigeria. This is in line with the conclusion by Olomola and Adejumo (2006) and Iwayemi and Fowowe (2012). The results show a negative sign between the real exchange rate and inflation. This implies that real exchange rate depreciation reduces the price level. The negative relation may be due to the balance sheet effect where depreciation deteriorates the country's net worth, reduces the aggregate demand and hence leads to a fall in the price level.

Expectedly, the results show a positive sign between monetary aggregate and inflation dynamics in Nigeria. This implies that an expansionary monetary policy leads to a rise in the inflation rate and vice versa. This is similar to the findings by Akinbobola (2012) for Nigeria. Moreover, there is a positive sign between foreign input price and the inflation dynamics in Nigeria. This suggests that a rise in foreign input price increases the cost of production and thus increases the inflation rate. Furthermore, the results indicate positive relation between the lending rate and inflation dynamics. The positive sign indicates that a hike in the lending rate increases the cost of borrowing, increases the cost of production and thereby increases the general price level. The significance of the foreign input price and the lending rate suggests the importance of cost channel in inflation dynamics in Nigeria.

**Table 1. GMM results**

| Parameters | **GMM** |
|---|---|
| $\gamma_b$ | 0.55<br>(0.00) |
| $\gamma_f$ | 0.48<br>(0.00) |
| $\alpha_a$ | 0.00<br>(0.17) |
| $\alpha_b$ | -0.04<br>(0.00) |
| $\alpha_c$ | 0.06<br>(0.00) |
| $\alpha_d$ | 0.03<br>(0.00) |
| $\alpha_e$ | 0.11<br>(0.00) |
| $R^2$ | 0.96 |
| $DW$ | 2.04 |
| $LM$ | 1.8 |
| $JB$ | 0.25 |

## 5. Conclusion and Recommendations

Using GMM, this study estimates a hybrid New Keynesian Phillips curve (NKPC) for the Nigerian economy. This is to determine the structural parameters influencing inflation dynamics in Nigeria. Using the GMM estimation technique, our results tend to support the hybrid NKPC. The findings suggest that both backward looking and forward looking components influence the current inflation in Nigeria. The backward looking component, however, seems to be more important in explaining inflation dynamics in Nigeria. Oil price seems to have limited influence on inflation in Nigeria. The results suggest that money supply, foreign input prices and the lending rate significantly influence inflation dynamics in Nigeria.

Given the dominance of the backward looking behaviour, it is important for the monetary authority in Nigeria to make monetary policies more credible. Moreover, since the cost channel effect is important in the dynamics of inflation, the monetary authority should reduce the lending rate so as to reduce this impact. Similarly, the government should also promote the use of domestic inputs or local content in the production process; this will lessen the cost channel effect of inflation dynamics.

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