A NEW KEYNESIAN PHILLIPS CURVE FOR KENYA

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Abstract

The objective of the paper is to establish whether the new Keynesian Philips curve function is applicable to Kenyan data under different assumptions of technology. The main finding in the paper using the Generalized Method of Moments estimator is that the hybrid New Keynesian Philips Curve fits Kenyan data relatively well. An interesting aspect of the paper contrary to expectations is that it establishes that forward looking expectations are an important component of the inflationary process in Kenya. The estimated forward-looking coefficient is approximately 0.6. The degree of price rigidity ranges from between 0.7 to 0.8 which implies that prices are fixed for roughly 3 to 5 months. Our results also indicate that the estimated NKPC has been relatively stable over time.

JEL Classification Numbers: EXX, FXX.
Keywords: New Phillips curve, marginal costs, inflation, GMM

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1. Introduction

A clear understanding of the inflationary process among central bankers is indispensable in effective planned price stabilization. Research endeavours aimed at understanding the inflationary process among countries have witnessed major advancements in modelling short-term inflation dynamics. Concomitantly, literature on the Phillips Curve, which is the modern view of the inflationary process, continues to increase.

A Phillips Curve is an embodiment of the idea that the level of economic activity causes the general level of prices. Espoused by Phillips (1958), analysis of this relationship tended to focus on the measurement of the level of economic activity and how that influenced the general level of prices. In his seminal work, Phillips (1958) analysed this relationship in terms of the level of unemployment and nominal wages in the United Kingdom and reported existence of an inverse relationship. This implied that a country that chose to reduce unemployment equally chose to live with higher inflation. For this reason, and for quite sometimes, price stability and real output growth have been considered to be mutually exclusive policy objectives.

The shift in emphasis from the traditional to the New Keynesian Phillips Curve (NKPC) is explained by the inability of the traditional Phillips curve to explain developments in inflation among several countries. It would be expected that high levels of economic activity are accompanied with correspondingly high levels of inflation as the economy's operations approach the full employment level of income. That most countries report high levels of real economic activity while experiencing low inflation does not vindicate the traditional Phillips Curve. Apart from being an had hoc inflation model, the traditional Phillips Curve is weak in the sense that it is susceptible to the Lucas critique whereby coefficient estimates are rendered irrelevant following policy regime changes.

In contrast, the NKPC is a structural model and once established structurally yields coefficients that are robust to any policy regime changes. These models assume monopolistic price setting and price rigidity. Monopolistic price setting rationalizes a firm putting a mark-up over marginal costs, whereas price stickiness is rationalized against the fact

that firms face adjustment costs when changing nominal prices (see Calvo, 1983). To the extent that firms are constrained by price adjustment costs such as litigation against breach of existing contracts, short run inflation dynamics depend on the firm's past as opposed to future marginal costs alone. Thus, while optimisation among firms explains the forward-looking component in the NKPC model, price rigidities explain the backward-looking component.

In view of the far reaching policy ramifications deriving from establishment of an inflation process that is consistent with the NKPC framework, many countries, in particular central banks of developed economies, have strived to estimate NKPC models[1]. This has not however been done within the Kenyan context, and this study seeks to bridge that knowledge gap. The study findings will also be useful in establishing the monetary policy transmission mechanism linkage between real output and inflation. This is because monetary policy initially and temporarily affects real output and thereafter inflation (Taylor, 1998).

In this context, we estimate a NKPC for the Kenyan economy using monthly data for the period 1997 to 2005. Our analysis uses the framework of the basic Calvo (1983) price setting model whereby firms adjust prices optimally to the expected evolution of marginal costs. In particular we estimate a hybrid version of the NKPC model that allows for backward looking behaviour. In addition we consider three measures of marginal costs corresponding to three alternative specifications of the production function. The technology is applicable to all firms given the fact that capital is freely mobile across firms.

As shown in Gagnon and Khan (2005) alternative specifications of the production technology imply important modifications to the NKPC which influence the link between real marginal costs and inflation. If the production technology alters the elasticity of the firms marginal cost relative to its own output, changes will also take place in the complementarity factors. The relevance of considering different production technologies can be appreciated by considering the influence the aggregation factors have on the structural estimates of the NKPC and particularly on the degree of price rigidity. The structural estimations in this study are conditional only on alternative measures of marginal costs and not on strategic complementarity factor. In the case where the production structure is represented by cobb douglas production function and the cobb douglas production with overhead labour, ignoring

[1] These include the US, Canada

the aggregation factor will not yield different conclusions since it has been shown that under both technologies the strategic complementarity factors are identical. In this study capital is assumed to be freely mobile across firms.

In the analysis the overall annual Consumer Price Index (CPI) is used as the measure of inflation, and it has been relatively volatile. The evidence analysed suggests that the NKPC can be a useful tool for analysing inflationary dynamics. The NKPC has well founded micro foundations that allow for the identification of structural parameters under the assumption of monopolistic competition and wage rigidity. The estimated hybrid NKPC provides a good description of the evolution of inflation in Kenya during the period under analysis. However, results based on the Constant Elasticity of Substitution (CES) Production Function in an open economy seem to capture the data in a more consistent manner particularly with respect to the degree of inflation persistence.

One interesting aspect of the results using the Generalized Method of Moments (GMM) is in the similarity of the estimated coefficients with results for developed economies, with respect to the coefficient on marginal costs, and the predominance of forward looking behaviour in the inflationary process. The evidence shows that the forward-looking coefficient in the NKPC ranges between 0.58 and 0.6 for all the alternative specifications.

The results suggest that prices remain unchanged for roughly between 3 and 5 months, which is contrary to inflation persistence observed particularly in the developed countries which is around three to four quarters. The high frequency in price adjustments is not surprising particularly for developing countries. In Kenya, the overall CPI is quite volatile given the fact that it is influenced by movements in the food index which is subject to weather patterns in the country. Similarly, the energy, and transport and communications index plays a significant role in the patterns of the overall CPI, and is subject to developments in crude oil prices. The results also indicate that only 40 percent of firms in the economy are backward looking setters and this is consistent with the relatively important role that forward looking expectations play in the price setting mechanism. As a robustness check, we estimate the NKPC under the alternative specifications of technology for different samples. The stability of the coefficients implies that the NKPC is relatively stable.

One important aspect to note is that the predominance of forward looking behaviour doesn't necessarily translate to full credibility of monetary policy but could be an indication that the Central Bank has performed relatively well in anchoring inflation expectations. It has been shown that if a model which has both forward-and backward-looking components well approximates the behaviour of inflation, any disinflation will involve some output loss. Chadha *et al* (1992) find evidence of a critical value for the relative importance of the forward-looking element above which, a disinflation path need not translate into output losses. This finding has implications for the way in which monetary policy is conducted. In particular, disinflation costs are smaller if policy is announced in advance to permit gradual decelerations thereby enhancing policy credibility, which then accords greater importance of the forward-looking component in price adjustment.

Disinflation costs are smaller if policy is announced in advance since the more gradual the decelerations are phased out, the more credible monetary policy is and the greater the importance of the forward-looking component in price adjustments. The policy implication from this finding is that the CBK needs to enhance its credibility. Recent steps in this direction such as the press release highlighting key features of the monetary policy statement and the creation of the Monetary Policy Advisory Committee are likely to change the nature of expectations formation in a manner that we can attribute the predominance of the forward looking behaviour to forward looking nature of monetary policy. The desired policy outcome is that it will be possible to have periods of disinflation without significant loss of real output.

The paper is organised as follows. In section 2 and 3 we review the theoretical framework underlying the Phillips Curve. The section also covers model specification, estimation, as well as data measurement issues. The results are presented and discussed in section 4. The study concludes in section 5.

2. Theoretical framework

2.1 Price setting

Derivation of any form of the NKPC typically starts with the assumption of monopolistically competitive firms which face a constraint on the frequency of price adjustments that can be

made in response to shocks. Price rigidity and staggered pricing strategy across firms arise from this constraint, and are captured in the Calvo (1983) framework. Under the Calvo model, there is a probability of firms changing prices (1-θ) and a probability of prices remaining fixed (θ), whereas the average period during which a price is fixed equals [1/(1-θ)]. Following Galí and Gertler (1999), the aggregate price level p_t specified in (2.1) is a convex combination of the lagged price level p_{t-1} (the price implemented by firms which do not adjust prices) and the optimal price p^*, i.e., the level arrived at by firms which are able to adjust their prices.

$$p_t = \theta p_{t-1} + (1-\theta) p_t^* . \tag{2.1}$$

For those firms that seek to maximise expected discounted profits, the optimal price p^* depends on the subjective discount factor β and the expected path of nominal marginal costs mc_{t+k}^n given the probability of prices remaining fixed for a number of periods.

$$p^* = (1-\beta\theta) \sum_{k=0}^{\infty} (\beta\theta)^k \mathrm{E}\left\{ mc_{t+k}^n \right\}. \tag{2.2}$$

The firm level marginal cost terms mc_{t+k}^n given in (2.2) are not directly observable but can proxied by some average aggregate marginal cost measures that are observed such as real unit labour costs or labour income shares.

2.1.1 The New Keynesian Phillips Curve

To facilitate empirical implementation, it is necessary to specify the NKPC in terms of observed marginal cost measures. This is achieved through the Calvo formulation which yields a Phillips curve with the desired properties of staggered price formulation. The combination of equations (2.1) and (2.2) gives an inflation equation of the following form

$$\pi_t = \lambda mc_t + \beta \mathrm{E}\left\{ \pi_{t+1} \right\}, \tag{2.3}$$

where $\lambda \equiv (1-\theta)(1-\beta\theta)/\theta$ depends on the frequency of price adjustment and the subjective discount factor. The inflationary process is the result of the optimisation process among firms and consumers whereby optimisation is assumed to occur under a monopolistic competition market structure with sticky wages and commodity prices.

2.1.2 Hybrid Model

The pure forward-looking basic NKPC model specified in (2.3) is usually not data coherent because of the failure to fully account for price rigidities. The basic NKPC model is therefore extended to incorporate a backward-looking component. Inclusion of the inertial component is an appendage to the solution of the optimisation problem among firms and consumers in the interest of arriving at a realistic specification of the inflation equation. It is therefore assumed that a proportion of the firms that adjust their prices upon receipt of a random signal, (1-θ), actually adjust their prices using a backward-looking price adjustment rule while the remainder use a forward-looking rule.

A typical hybrid NKPC model therefore has two terms, namely, a backward-looking expectations component reflecting the inertial effect in prices and a forward-looking component capturing optimal price adjustment. Assuming away the inertial effects in price adjustment means that the backward-looking component in the specification of the inflation equation drops out. However, the weight of the evidence in the empirical studies is that the backward-looking component is significant in spite of the predominance of the forward-looking component.

The amendment to the pure expectations Phillips curve was advanced by, among others, Galí and Gertler (1999) and Galí, Gertler and López-Salido (2001). Inclusion of the backward-looking term in the inflation equation is for practical expediency. Though not forming part of the solution to the optimisation problem in price adjustment, it explains empirical regularity often escaping capture by the pure forward-looking inflation model.

The closed economy hybrid NKPC model nests the basic pure optimisation NKPC model specified in (2.3) as a special case and provides a good framework for verifying the inertial

effects in the evolution of inflation. Following Galí and Gertler (1999), the hybrid NKPC may be specified as follows.

$$\pi_t = \lambda mc_t + \gamma_f \mathrm{E}_t \pi_{t+1} + \gamma_b \pi_{t+1}, \qquad (2.4)$$

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

$\gamma_f = \theta\beta\phi^{-1}$, $\gamma_b = \omega\phi^{-1}$, $\phi = \theta + \omega[1-\theta(1-\beta)]$, ξ is a function of the elasticity of demand ε and elasticity of substitution between factor inputs α (Galí et.al, 1999), and, ω is the proportion of firms using the backward-looking rule in price adjustment. ξ is somewhat similar to the strategic complementarity factor *h* derived in Gagnon and Khan (2005) which is a function of the elasticity of demand ε and elasticity of a firms' marginal cost with respect to its own output, *g*.

The reduced form parameters γ_b, γ_f and λ represent the degree of backward-looking, forward-looking ness and the coefficient of marginal costs respectively. The reduced form coefficient λ depends on θ, β and ξ. As alluded to, capital is assumed to be freely mobile across firms and hence ξ=1. Following from the results in Galí and Gertler (1999) and Galí, Gertler and López-Salido (2003) for the USA and the Euro area, respectively, the expected results on the coefficients are: $\lambda>0$, $0<\gamma_b<1$, $0<\gamma_f<1$, $\gamma_f + \gamma_b = 1$ and to capture the fact that the forward-looking component is predominant in developing countries so that $\gamma_f > \gamma_b$.

2.2 Real Marginal Costs

One of the practical problems of explaining inflation in terms of the level of economic activity is the measurement of the level of economic activity. Under the traditional Phillips Curve, the level of economic activity was measured in terms of the level of unemployment or the real output gap. Such models are however ad hoc since they lack any microeconomic foundations.

The substitution of real output or the real output gap for marginal costs reflects the emphasis on microeconomic foundations of the inflationary process. The argument is that for instance, if marginal costs are characterised by unit labour costs, then this could be a potential source of inflation inertia. Since wages are usually contracted and since the contracts among workers across firms are not synchronized, then they will be subject to staggered changes. It

is these staggered adjustments in wages that underpin inertial changes in marginal costs and by extension commodity prices.

To the extent that marginal cost is a major determinant in the New Keynesian Phillips curve, some form of production function will need to be invoked in analysing the inflationary process. Original works consider the Cobb-Douglas production function, which is a realistic assumption within the context of a closed economy. It is however difficult to explicitly capture the role of intermediate imported goods' prices and the exchange rate in the inflationary process once the closed economy assumption is relaxed. Galí and López-Salido (2001) compute alternative measures of marginal costs under different assumptions of technology for Canada, the US and the Euro area, and find that measures based on the open economy assumption yield better estimates of the NKPC.

Balakrishnan and López-Salido (2002) have shown that under such circumstances the constant elasticity of substitution (CES) production function is preferred. Gagnon and Khan (2005), compute the Phillips curve under alternative production technologies. Most importantly, there are two modifications that are implicit in the NKPC (i) a specific strategic complementarity parameter that influences the link between real marginal cost and inflation and (ii) a specific modification to the labour share measure of real marginal cost.

2.2.1 Measures of marginal costs

2.2.1.1 Benchmark specification

In the simplest of the approaches, a constant-returns-to–scale Cobb-Douglass production function is adopted so that effectively, the real marginal cost is estimated as the labour income share in gross domestic product or gross national product if the external sector factors feature in the inflation equation.

Formally, the constant-returns-to–scale Cobb-Douglas (CD) production function is stated in (2.5) and the logarithm of the real marginal cost (mc) corresponding to CD technology is stated in (2.7).

$$Y_t = K_t^{\alpha} (AL)_t^{(1-\alpha)} \quad , \qquad (2.5)$$

$$MC_t = \frac{1}{1-\alpha}\frac{W_t L_t}{Y_t}\ , \tag{2.6}$$

$$mc_{t+i} = s_{t+i} - s\,, \tag{2.7}$$

whereby lower case variables denote log transformed variables and are deviations from steady state and: Y is real output; K the capital stock; L corresponds to labor; A the labour productivity augmenting factors; α the factor substitution coefficient; MC *i*s marginal cost; and W is the nominal wage rate per hour.

2.2.1.2 Alternative specifications

Following Gagnon and Khan (2005) and Céspedes, Ochoa and Soto (2005) we consider two alternative specifications of the production function that imply different measures of marginal costs.

Overhead labor

We consider the case of CD technology while allowing for overhead labour costs (CDOL). The production function which includes overhead labour costs can be expressed as

$$Y_t = K_t^{\alpha}(A_t(L-\bar{L})_t))^{(1-\alpha)}, \tag{2.8}$$

where $\bar{L}_t$ corresponds to quantity of labour that a firm hires independent of the output it produces. The nominal marginal cost corresponding to this type of technology is given in (2.9)

$$MC_t = \frac{1}{1-\alpha}\frac{W_t L_t}{Y_t}\frac{\left(L_t - \bar{L}\right)}{L_t}, \tag{2.9}$$

while the linearized version of real marginal cost is given by

$$\hat{mc}_{t+i} = s_{t+i} - s + \frac{\bar{L}}{L-\bar{L}}\hat{l}_{t+i}. \tag{2.10}$$

Marginal costs depend on deviations of unit labor costs from steady state as well as deviations of employment from steady state.

Constant Elasticity of Substitution

Once the closed economy assumption is relaxed, the CES production function is preferred (CES Open Economy). The CES production function allows for non unitary substitution between the inputs and may be expressed as follows

$$Y_t = \left[K_t^{\frac{\sigma-1}{\sigma}} + (A_t L_t)^{\frac{\sigma}{\sigma-1}} \right]^{\frac{\sigma}{\sigma-1}} \tag{2.11}$$

the corresponding marginal costs are given by

$$MC_t = \frac{W_t L_t}{Y_t \vartheta_t}, \tag{2.12}$$

$$\hat{mc}_{t+i} = s_{t+i} - s + \varphi\varpi(\rho_{m,t+i} - \varpi_{t+i}) \tag{2.13}$$

Expression (2.13) represents log linearized marginal costs. $\rho_{m,t} - \varpi_t$ represents the log deviations of the relative price of foreign inputs with respect to nominal wages.

Galí and López-Salido (2001), Balakrishnan and López-Salido (2002) for the US, Leith and Malley (2002) in G7 countries, Genberb and Pauwels (2003) for Hong-Kong, incorporate the price of imported intermediate goods in the inflationary process to account for the openness of the economy.

3. Estimation of the NKPC

3.1 Methodology

We estimate the NKPC under three alternative specifications of the production function using the Generalized Method of Moments (GMM). For purposes of identification of the structural parameters such as the speed of price adjustment and the proportion of firms adjusting prices according to a forward-looking rule, the hybrid open economy NKPC model is estimated structurally. In view of the many parameters and lack of adequate degrees of freedom

because of the short sample, some of the parameters will be calibrated. Accordingly, the discount factor is set to 0.99. The basic reduced form NKPC estimated is stated in (3.0).

$$\pi_t = \lambda mc_t + \gamma_f \mathrm{E}_t \pi_{t+1} + \gamma_b \pi_{t+1} \,, \tag{3.0}$$

where $\lambda = \theta^{-1}(1-\omega)(1-\theta)(1-\beta\theta)\xi$.

The corresponding orthogonality conditions in (3.1) and (3.2).

$$\mathrm{E}_t\left\{\left(\phi\pi_t - \phi\varpi\pi_{t-1} - \phi\beta\theta\pi_{t+1} - (1-\varpi)(1-\theta)(1-\beta\theta)\xi mc_t\right) z_t\right\} = 0 \tag{3.1}$$

$$\mathrm{E}_t\left\{\left(\pi_t - \varpi\pi_{t-1} - \beta\theta\pi_{t+1} - \phi^{-1}(1-\varpi)(1-\theta)(1-\beta\theta)\xi mc_t\right) z_t\right\} = 0 \tag{3.2}$$

Vector z_t is a vector of instruments. When ϖ =0, the hybrid NKPC expressed in (3.0), is the same as the pure forward looking NKPC in (2.3). The set of instruments include inflation (lags from *t-1 to t-6*), the sixth lag of detrended output, nominal exchange rate (lags from *t-1 to t-3*) and oil prices (lags from *t-1 to t-6*). Galí and Gertler (1999) use four lags each of inflation, labour income share, the output gap, the short term-long term interest rate spread, wage inflation, and commodity price inflation. Galí, Gertler and López-Salido (2003) use four lags of inflation, and two lags each of the output gap[2], wage inflation, and the labour income share. It should be noted that these studies use quarterly data..

3.2 The Data

Estimation of the NKPC model is based on monthly data spanning the period 1997 to 2005. The sample period represents the period for which new GDP data expressed in 2001 prices is available. We use the monthly change in the natural logarithm of the overall consumer price index as a measure of our inflation.

[2] Guay and Pelgrin (2004) contend that estimation of the output gap is "… obtained by applying the Hodrick-Prescott filter or by fitting a quadratic trend to the entire sample."

Figure 1: Overall inflation

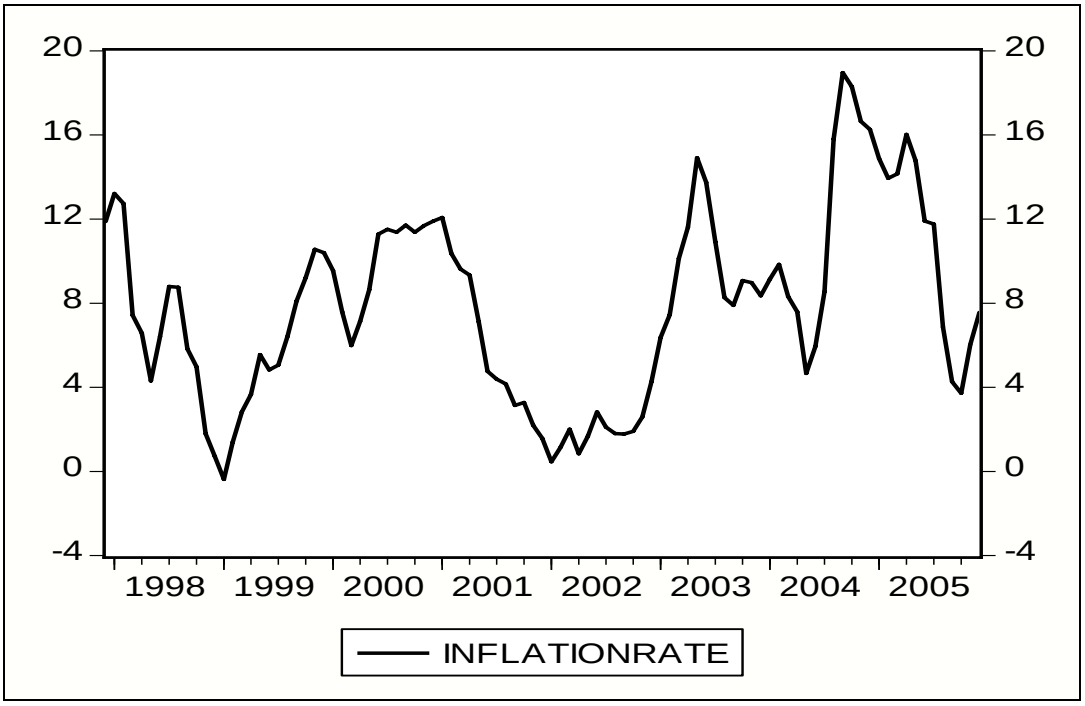


Figure 1 shows the trend in the month on month overall inflation over the period 1997 to 2005, and depicts periods of relatively high inflation followed by episodes of disinflation. For instance in 2000 inflation averaged 9.8 percent whereas in 2001 and 2002 inflation was below 5 percent. From end 2004 to mid 2005 however, inflation peaked to an average of 14.8 percent and this corresponds to a time when lack of adequate rainfall led to food shortages thereby causing a substantial rise in the food index.

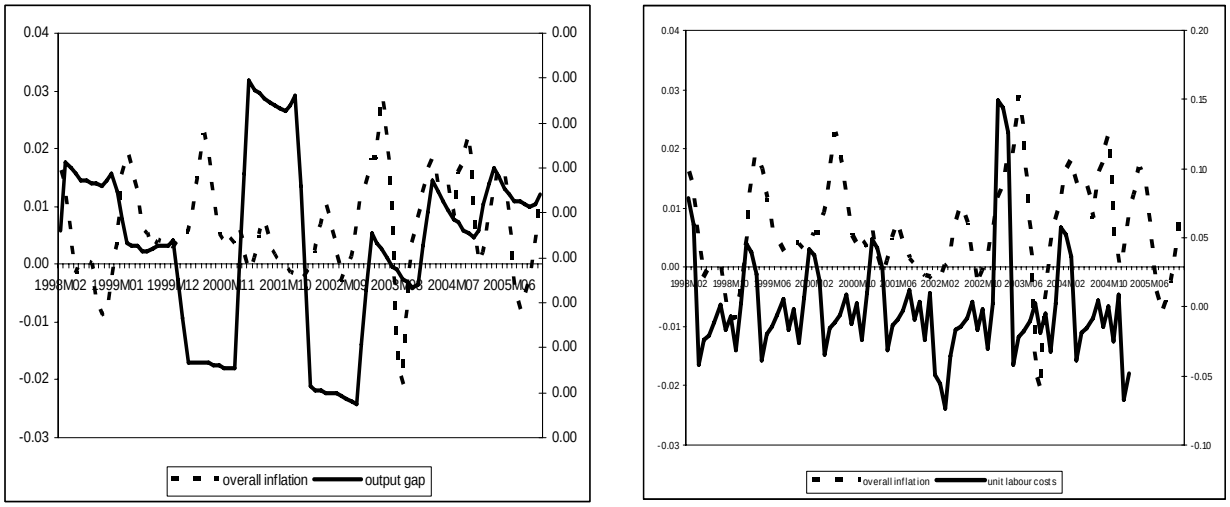
As indicated the measure of economic activity in this study is real marginal costs which are defined as unit labour costs of the public and private sector. This variable was derived only for employment in the formal sector. The unit labour costs were derived as the total monthly earnings of the employees in the public and private sector divided by the number of employees in the two sectors. The derivation of this variable was limited by lack of monthly data on the number of employees and total earnings of employees in the two sectors.

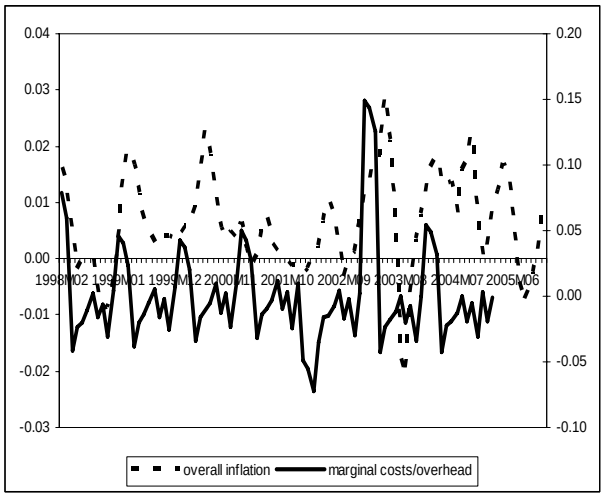
The limitation was overcome by using seasonal indices derived from the monthly salaries and wages in the public sector, which are published by the Ministry of Finance in the monthly budget outturn. Furthermore, on average, annual public sector earnings account for more than

40 percent of the total annual earnings in the public and private sectors. Similarly, there are no monthly observations for total number of employees in the public and private sectors. This limitation was overcome by assuming a linear and proportionate growth in the number of employees in the two sectors within the year.

In addition we also considered two alternative measures of marginal costs corresponding to alternative specifications of the production function. The first is overhead labour and in this case we adjust unit labour costs by adding the log-deviation of employment from a deterministic linear trend as in Céspedes, Ochoa and Soto (2005). In the case where the economy is open and characterised by a CES production structure, the unit labour costs are adjusted to include the prices of imported inputs. The evolution of marginal costs under the different production technologies are presented in Figure 2. With the exception of the output gap measure, it is evident that our marginal cost measures move contemporaneously with overall inflation.

Figure 2: Different measures of marginal costs and log deviation of inflation





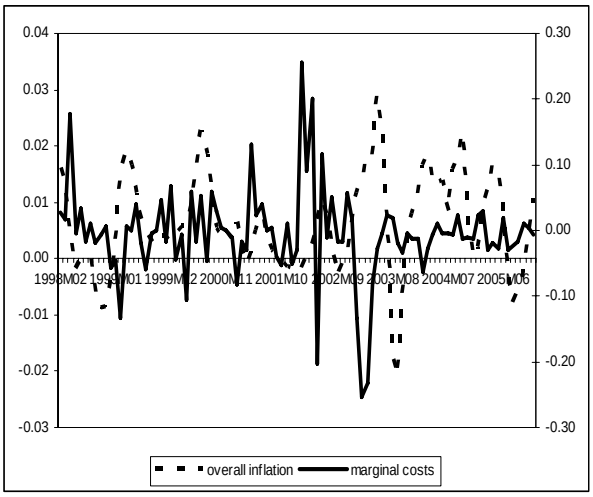
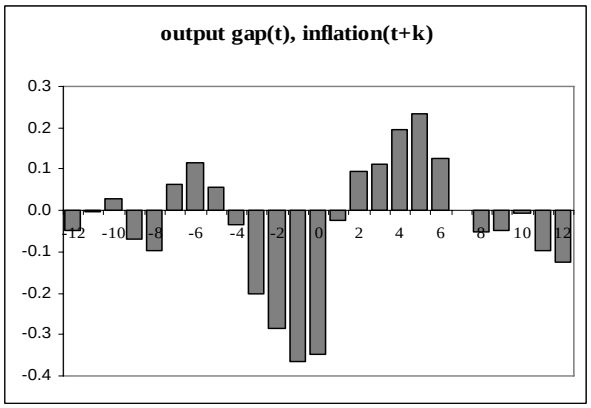
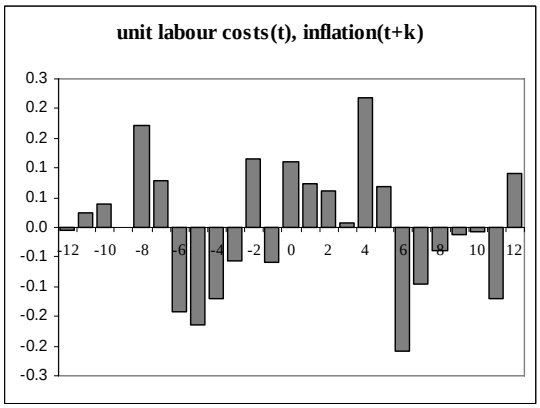
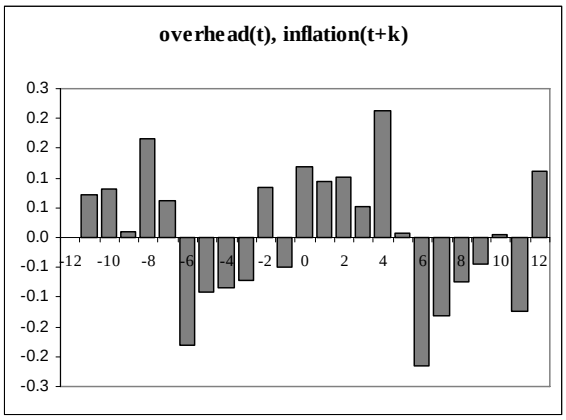


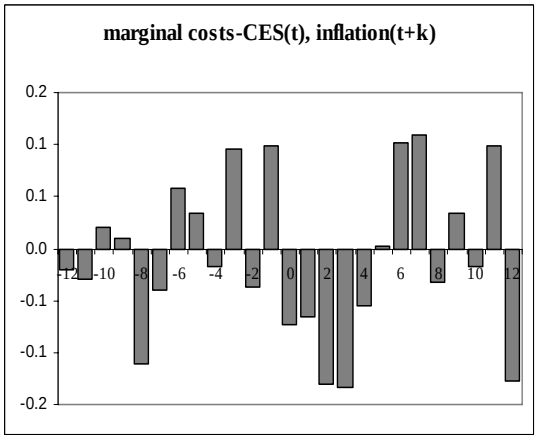
Figure 3 presents evidence that movements in inflation lead those in unit labour costs under different assumptions of technology. Under the benchmark New Keynesian Phillips curve, inflation should lead output gap over the cycle. As can be seen there is a positive correlation between inflation and unit labour costs and movements in inflation lead those in the unit labour costs. There is also a strong negative co movement between the current output gap and past inflation and a positive co movement between the current output gap and future inflation. This contradicts the New Keynesian Phillips Curve.

Figure 3: Dynamic cross-correlations









3.2 NKPC Model Estimation Issues

The two-stage generalized method of moments (2S-GMM) is commonly applied and its preference derives from the estimator's capacity to provide robust results regardless of the nature of distribution of the fitted residuals. It is applied in various studies for instance in Galí and Gertler (1999) as well as in Galí, Gertler and López-Salido (2003).

The 2S-GMM estimator has however come under criticism recently in for instance Guay, Luger, and Zhu (2004), Newey and Smith (2004) and Guay and Pelgrin (2004). A major criticism of the 2S-GMM estimator is that it does not yield unique solutions to an NKPC model since the results depend on the kind of normalisation of the identifying restrictions used. The results shown in Galí and Gertler (1999) and Galí, Gertler, and López-Salido (2003) attest to this.

Besides that, the solution to an NKPC model also varies with the number of identifying restrictions and hence the number of instrumental variables used. This is shown to be the case in Guay, Luger, and Zhu (2004) using Canadian data. Newey and Smith (2004) and Guay and Pelgrin (2004) demonstrate that estimation bias increases with the number of moment conditions. Since the number of moment conditions are equal to the number of instruments used, and the number is decided on subjectively the solution to an NKPC model is not unique for reasons that arbitrary choice of instruments yield different results. It has also been argued that the number of lags used in computing the optimal weighting matrix determines the small sample properties of the GMM. Therefore, the power of the over-identifying restrictions

depends on the weighting matrix and as such the NKPC may be accepted under the J-test statistic in spite of inherent misspecification in the NKPC model.

In order to circumvent the estimation limitations of small sample bias under the 2S-GMM, Guay and Pelgrin (2004) follow Hansen, Heaton, and Yaron (1996) to apply the continuously updated GMM (CU-GMM) estimator. They also follow Bonnal and Renault (2003) to apply the 3S-GMM estimator. The CUE-GMM is robust to normalisation of the orthogonality condition. Using the automatic lag selection criteria proposed by Newey and West (1994), Guay and Pelgrin (2004) avoid arbitrarily fixing the lag structure in the analysis unlike the case in Galí and Gertler (1999) and Galí, Gertler and López-Salido (2003). Another innovation applied in Guay and Pelgrin (2004) is following Hall (2000) using variable measurement in deviations from mean to improve the power of the J-test statistic. The J-test statistic is used to test over-identifying restrictions in the NKPC model and therefore test whether or not the NKPC model is misspecified to the extent that it includes redundant instrumental variables which as we have seen would bias the estimation results.

However, for instance in Galí and Gertler (1999) the important conclusions do not change according to the method of normalization used, which is the main criticism of the 2S-GMM.

4. Empirical Results

The results are derived based on the hybrid NKPC under alternative production structures. The hybrid model allows for a subset of firms that use a backward looking rule of thumb while setting the prices. The model allows for the estimation of the reduced form equation and the structural equation. The advantage of the estimating the structural equation is that it enables us estimate the structural parameters namely (a) the frequency of price adjustment and (b) the fraction of firms that are backward looking.

4.1 Estimates under alternative production structures

Table 1 presents the estimated values of ω, θ, γ_f, γ_b, λ, *and* β under the orthogonality condition that normalizes the coefficient on inflation to unity and the case when capital is freely mobile across firms that is ξ=1 as in (3.1). As indicated in Galí et.al (2001) nonlinear estimation using GMM may sometimes be sensitive to the way the orthogonality conditions are imposed. However, in an earlier study, Galí and Gertler (1999) show that, conclusions drawn from the estimations are not influenced by the normalization used. We also consider the case where the output gap is included and excluded in the instrument list and the solution to the NKPC model does not seem to vary which can be taken as evidence of robustness with regard to the marginal cost parameter. The implied duration of price stickiness is reported in months. In addition the *J-statistic* which tests the validity of over identifying restrictions is also reported.

Table 1: Structural estimates of the hybrid NKPC

Production technology										
	CD		CD[1]		CDOL		CDOL[1]		CES Open Economy	
Reduced form parameters										
ω	0.4670	*0.0000*	0.4680	*0.0000*	0.4650	*0.0000*	0.4700	*0.0000*	0.4280	*0.0000*
θ	0.7030	*0.0000*	0.7030	*0.0000*	0.6970	*0.0000*	0.6970	*0.0000*	0.7890	*0.0000*
γ_f	0.5840	*0.0000*	0.5820	*0.0000*	0.5830	*0.0000*	0.5790	*0.0000*	0.6140	*0.0000*
γ_b	0.3910	*0.0000*	0.3920	*0.0000*	0.3930	*0.0000*	0.3950	*0.0000*	0.3360	*0.0000*
λ	0.0400	*0.0590*	0.0390	*0.0480*	0.0420	*0.0670*	0.0410	*0.0550*	0.0210	*0.0875*
β	0.999		0.999		0.999		0.999			
Duration of price stickiness										
D (months)	3.4		3.4		3.3		3.3		4.8	

This table reports GMM estimates based on monthly data using the specification of the orthogonality condition that normalizes inflation to unity. The set of instruments include six lags of inflation, and the sixth lag of detrended output. Probabilites are in italics.

1/detrended output included in the instrument list

The estimates of the NKPC are consistent with the theory. The slope coefficient λ is positive and statistically significant in all specifications, implying that marginal costs play a role in explaining inflationary dynamics. The estimated value of the coefficient of marginal cost lies between 0.2 and 0.4 across the specifications implying that marginal costs as defined by unit

labour costs do have a consistent impact on inflation for the Kenyan economy. The importance of wage stickiness in inflationary inertia is therefore considerable.

The estimate on the coefficient on expected inflation is positive and statistically significant. The estimates for the reduced form coefficient γ_b on lagged inflation ranges between 0.34 and 0.4, and 0.58 and 0.6 for future inflation, γ_f. This finding implies that forward looking behaviour is more predominant. A larger proportion of firms that update their prices using a forward looking rule results in a greater weight for expected inflation in the inflationary process. The importance of forward looking behaviour is greater in the case where a CES production function in an open economy is considered. As shown in Table 2, results for the U.S. and Euro respectively show a coefficient of between 0.3 and 0.5 for lagged inflation, and 0.7 and for expected inflation.

Table 2: Structural estimates: An international comparison

Hybrid Model	US*	Euro Area*	Singapore**	Israel***
Reduced form parameters				
ω	0.27	0.25	0.46	0.6-0.8
θ	0.8-0.87	0.50	0.74	0.77
γ_f	0.68	0.58	0.60	0.59
γ_b	0.25	0.35	0.40	0.56
λ	0.04	0.29	0.03	0.07
Duration of price stickiness				
D (quarters)	5-8	2.0	4	4.3

* Galí, Gertler and López-Salido (2001)
** Parrado (2004)
***Ribon (2004)

The degree of price rigidity θ is estimated at between 0.7 and 0.8. Prices are fixed for roughly between three and five months or just over one quarter. This seems somewhat on the higher side but not unreasonable. For instance Lach and Tsiddon (1996) in a study on Israel find that prices were updated every 2.2-2.6 months. Galí and Gertler (1999) find that prices are adjusted after every five quarters. Most of the studies surveyed indicate a period of between three to four quarters, and Taylor (1998) concludes that the average frequency of price changes for the U.S. is one year. A robust conclusion from the Taylor survey is that the average frequency of price changes depends on the average rate of inflation. For the Kenyan

economy therefore, frequent price adjustments are not unusual given the inflationary environment relative to that of developed economies.

Among the firms that can update their prices, the proportion of firms that use a backward looking rule of thumb, ω, is roughly two fifth. This means that some firms update their prices using a backward-looking rule and hence this finding seems to reject the purely forward-looking specification. About 60 percent of the firms apply the optimal forward-looking rule. The policy implication is that there is some limited scope for disinflation without lost real output. As shown in Table 2, Ribon (2004) for Israel finds an estimate of 0.4-0.5 while Galí and Gertler (1999) find that roughly a quarter of price setters are backward looking for the U.S economy.

One important finding is that the structural estimates across the CD and CD technology with overhead labour do not change much. As in Gagnon and Khan (2005), the presence of overhead labour under the CD technology does not alter the elasticity of the firms' real marginal costs with respect to its own output implying identical strategic complementarity parameters. However, there is a change in the estimated parameters under the CES technology in an open economy implying that elasticity of marginal costs changes with respect to its own output. Following Gagnon and Khan (2005), this would imply some modifications need to be made with respect to the strategic complementarity factor and labour share measures relative to CD technology. The longer duration of price stickiness observed in the CES open economy technology may therefore be a reflection of the fact that the aggregation factors have been ignored.

4.2 Robustness Analysis

As a robustness exercise, we consider sub-sample stability. Table 3 reports estimates of both the reduced form and structural parameters over various sub-samples. For the CD and CDOL technology, the magnitudes of the marginal cost parameter are largely unchanged but decrease slightly for the case of CES open economy. As alluded to, this may be an indication of the fact that the strategic complementarity factor has not been taken into account and so

the reason for additional inertia observed in the production structure which represents the CES open economy as opposed to the CD technology.

Overall, marginal costs do have a significant influence on inflationary dynamics in the short run. Forward looking behaviour dominates the inflationary process and interestingly increases when the production structure is assumed to be that of CES in an open economy. Another interesting aspect is that from 1997:12 to 2005:12, the coefficients on the backward looking behaviour increases while that of forward looking behaviour and marginal costs declines, compared with the entire sample. However, no conclusion can be drawn from this observation given that the changes are marginal.

Table 3: Robustness analysis: subsample stability

Model	ω	θ	γ_f	γ_b	λ
Cobb Douglas					
With no output gap in the instrument list					
1997:07-2005:11	0.467	0.703	0.584	0.391	0.040
	0.000	*0.000*	*0.000*	*0.000*	*0.059*
1997:07-2004:12	0.417	0.706	0.604	0.361	0.044
	0.000	*0.000*	*0.000*	*0.000*	*0.076*
1997:12-2005:12	*0.550*	*0.687*	0.520	0.420	0.034
	0.000	0.000	*0.000*	*0.000*	*0.069*
Cobb Douglas					
With output gap in the instrument list					
1997:07-2005:11	0.468	0.703	0.582	0.392	0.039
	0.000	*0.000*	*0.000*	*0.000*	*0.048*
1997:07-2004:12	0.439	0.702	0.587	0.371	0.042
	0.000	*0.000*	*0.000*	*0.000*	*0.078*
1997:12-2005:12	0.522	0.691	0.536	0.410	0.036
	0.000	*0.000*	*0.000*	*0.000*	*0.045*
Overhead labour					
With no output gap in the instrument list					
1997:07-2005:11	0.465	0.697	0.583	0.393	0.042
	0.000	*0.000*	*0.000*	*0.000*	*0.067*
1997:07-2004:12	0.418	0.707	0.606	0.362	0.044
	0.000	*0.000*	*0.000*	*0.000*	*0.072*
1997:12-2005:12	0.547	0.671	0.515	0.424	0.038
	0.000	*0.000*	*0.000*	*0.000*	*0.050*
Overhead labour					
With output gap in the instrument list					
1997:07-2005:11	0.470	0.697	0.579	0.395	0.041
	0.000	*0.000*	*0.000*	*0.000*	*0.055*
1997:07-2004:12	0.441	0.703	0.588	0.373	0.042
	0.000	*0.000*	*0.000*	*0.000*	*0.074*
1997:12-2005:12	*0.517*	*0.677*	0.536	0.412	0.041
	0.000	*0.000*	*0.000*	*0.000*	*0.031*
CES for Open Economy					
With output gap in the instrument list					
1997:07-2005:11	0.428	0.789	0.614	0.336	0.021
	0.000	*0.000*	*0.000*	*0.000*	*0.087*
1997:07-2004:12	0.376	0.842	0.694	0.313	0.013
	0.000	*0.000*	*0.000*	*0.000*	*0.159*

This table reports GMM estimates of parameters for alternative sample periods. β is restricted to 0.99 as in the previous exercise.

5. Conclusions and further work

This study presents the New Keynesian Phillips Curve for the Kenyan economy. The evidence analysed suggests that the NKPC may be a useful tool for analysing inflationary dynamics. The NKPC has well founded micro foundations that allow for the identification of structural parameters under the assumption of monopolistic competition and wage rigidity. The estimated hybrid NKPC based on marginal costs, forward looking and backward looking behaviour provides a good description of the evolution of inflation in Kenya during the period under analysis.

Surprisingly, the forward looking component is also more predominant which is consistent with the price setting behaviour of firms. The proportion of firms that use 'rule of thumb' when setting prices is a reasonable estimate, given observed inflation persistence for the Kenyan economy. We are able to identify two sources of inertia in the inflationary process (a) existence of backward looking expectations and (b) wage stickiness.

As alluded to, the predominance of forward looking behaviour doesn't necessarily translate to full credibility of monetary policy. More needs to be done by the Central Bank with respect to anchoring inflation expectations. As a start, the introduction of the Central Bank rate which to be announced by the recently created Monetary Policy Advisory Committee on a regular basis is likely to influence the nature of expectations formation perhaps giving a bigger role to forward looking behaviour.

There are important issues that need to be analysed. First there is a need to consider explicitly the strategic complementarity factor as it has implications for monetary policy analysis. Theoretically, in the case where there is no realloacation of capital so as to equalize a firms marginal cost with respect to the average marginal cost, the strategic complementarity in firms pricing decisions allows for prolonged effects of aggregate demand shocks in models for monetary policy analysis (Woodford, 2005). Therefore, the complementarity factor is a

source of inertia in the adjustment of prices it is necessary to relax the assumption on the mobility of capital.

Second, as alluded to the high frequency in price adjustments is not surprising since the overall CPI is quite volatile and is influenced by movements in the food index which is subject to weather patterns in the country, and the energy, and transport and communications index which is subject to developments in crude oil prices. The current consumer price index is based on the 1993/94 urban household survey. The survey was conducted in a period during which economic activity may not be considered as normal following significant monetary expansion in 1993/94. The ongoing urban household survey is appropriate as it is likely to give reasonable weights on the baskets. Efforts to derive a separate basket for underlying inflation will also enhance the analysis of monetary policy on prices.

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