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Estimation of Sacrifice Ratio for the Nigerian Economy using a Time Varying Autoregressive Distributed Lag Approach

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Abstract

Monetary policy in the last few decades had focused on creating the enabling conditions for sustainable economic growth, using the level of inflation as the pivotal tool, complemented with central banks' independence and monetary policy transparency. However, attaining the delicate balance of achieving low inflation and optimal output, with minimal tradeoffs has been a cause for concern for policy makers. Thus, the measurement of the output loss, arising from the inflation-output tradeoff, forms the fulcrum of this study. This study estimates the sacrifice ratio using a state space methodology in an aggregate supply framework to adjust for real business cycle rigidities. The results from the ARDL model analysis suggest that when average inflation was lower, the sacrifice ratio was higher. On the balance of risks, an average sacrifice ratio of 0.69 shows that the achievement of price stability will come at a cost of a high output trade-off. In that case, the monetary authority will be relatively more aggressive with its policy mix, especially adjusting interest rate, to achieve a radical influence on non-structural factors that drive inflation.

Keywords: Sacrifice Ratio, Output Loss, Inflation, Time-varying ARDL, Gibbs Sampling

JEL Classification: *E10, E31, C22, C55*

I. Introduction

Maintaining price stability and fostering economic growth and development remain the mandate of central banks as enshrined in the enabling statutes. However, the inflationary pressures of the 1970s and 1980s instituted price stability as the overarching objective of monetary policy in most economies in the 1990s. According to the European Central Bank (2004), the mandate prioritisation aided price transparency, lowered risk premium on inflation and prevented arbitrariness in wealth and income distribution. Other derived benefits of inflation stabilisation were the achievement of key economic indicators, such as stable exchange rate and interest rates. Consequently,

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variants of inflation targeting frameworks were introduced with a view to reining in inflationary pressures.

Concomitantly, monetary policy in the last two decades had also focused on creating the enabling environment for sustainable economic growth. This called for more independence of central banks and monetary policy transparency to boost the credibility of monetary policy. The need, therefore, to attain the delicate balance of achieving low inflation and optimal output, with minimal tradeoffs, became a serious concern for policy makers. On the one hand, while inflation rate at some level is desirable to achieving some long-term goals, the conduct of monetary policy to deliberately keep inflation at low ebb has not been without some short-term loss of output (Barro, 1996 and Feldstein, 1999). It is this loss of output, arising from the inflation-output tradeoff, that is generally referred to as the sacrifice. Sacrifice ratio is, therefore, defined as the cumulative output loss resulting from a permanent one percentage reduction in inflation. According to Cecchetti and Rich (2001), achieving optimal output-inflation level depends on balancing the benefits and costs of moving to the new levels of inflation, which requires a re-estimation of the size of inflation and output levels.

The concept of sacrifice ratio is underpinned in several theoretical arguments on wage stickiness and rational expectation, resulting from wage setting mechanism that reflects the degree of labour market flexibility (Gordon, 1982), and the non-neutrality of money hypothesis, which the new Keynesians associated with producer price rather than wages (Mankiw, 1990). In other words, the concept focuses on wage and price adjustments, inflation expectations, labour market conditions, among others. It is generally employed to measure the relative success of policy regimes benchmarked against designed policy objectives. These theoretical perceptions have fueled the debate that was triggered by the Great Depression, propelled by the Philips curve of the 1950s, and has attracted several empirical studies for various countries, using different methods.

The objective of this study is to measure the sacrifice ratio for Nigeria, a developing economy characterised by unstable inflation and growth rate trajectories. In doing this, some terms require modification since it is difficult to obtain a permanently downward sloping inflation trend or disinflation in a developing economy; more so, the determinants of sacrifice ratio in developed economies cannot be appropriate for emerging economies.

Previous estimates of the sacrifice ratio, such as Mordi and Adebiyi (2010), applied the DSGE approach, which although had backward-looking features in the specification of the output gap and Phillips curve, nevertheless reported the posterior sacrifice ratio. This could mean the sacrifice ratio would be constant overtime. In addition, their approach did not take cognisance of recent global and domestic shocks, such as the financial crisis, oil price shocks, which could have impacted on the shape of the Phillips Curve, hence, the sacrifice ratio. The third factor is that the sacrifice ratio was estimated within a model framework that was overtly over interdependent on the aggregate demand and the Phillip curves in a DSGE framework.

Thus, following Filardo (1998), which questioned the linear approximation assumption inherent in the Phillips curve in DSGE models, the paper suggested it would make the shape of the curve shift and hence the sacrifice ratio. Changes in the regime can, therefore, be an important factor in influencing the time varying dimension of the sacrifice ratio. To resolve the above, this study fits a time varying ARDL model, with transition in parameter and stochastic volatility component, using Gibbs sampling.

This paper attempts to answer the following questions: what is the sacrifice ratio for Nigeria over time? Have the sacrifice ratio estimates at different episodes been identified in the policy orientation? Is the change in the sacrifice ratio qualitatively intuitive?

To achieve the objectives of this paper, we derive the sacrifice ratio from an autoregressive distributed lag (ARDL) model with parameter transition and stochastic volatility, as applied in Mitra, et al. (2015), using the short-run aggregate supply curve framework. From these, the output loss arising from the reduced inflation vis-à-vis its historical average is evaluated and plotted. Quarterly data, spanning 1991Q1 to 2016Q1, were used for the estimation, and sourced from the CBN Statistical Bulletin.

The rest of the paper is structured as follows: Section 2 reviews relevant literature while the data, methodological approach and ARDL model are presented in Section 3. Section 4 presents the sacrifice ratio estimates, and Section 5 concludes the paper.

II. Review of Literature

II.1 Theoretical Literature

Policy makers interested in managing high levels of inflation in an economy are also poised to ensuring that the gains of maintaining low inflation outweighs the loss in economic output or increased unemployment. The estimation of sacrifice ratio is an essential assessment for the monetary authorities, to ensure effective monetary policy management.

Theoretically, the Sacrifice ratio is perceived as the real cost of disinflation, or an aggregate potential output loss due to reduction in the long-run equilibrium inflation rate. A significantly high sacrifice ratio translates to a huge loss in gross domestic product (GDP) or employment, at a given level of inflation. The decision to adopt a disinflationary policy to manage actual and expected inflation is typically accompanied by some level of sacrifice in output and employment, as explained by macroeconomic theory. Hence, a measure of sacrifice ratio aggregates such losses in output over certain periods of time, relative to the decline in inflation rate.

Mankiw (2001) defined the concept of sacrifice ratio as the percentage of potential output sacrificed to obtain one percentage point reduction in the inflation rate. Thus, obtaining an optimum sacrifice ratio requires a deliberate attempt by the monetary authorities to achieve a decline in inflation over time. This implies that decline in inflation rate, occasioned by other economic influences like fiscal tightening, positive supply shocks or exogenously determined appreciation in currency, are not considered in the estimation of sacrifice ratios. Also, the decline in inflation rate is deemed permanent without hyperinflation episodes, and output losses are cumulative over a period of time, that the inflation rate declines.

The magnitude of sacrifice ratio in an economy is subject to:

i. inflation persistence: the tougher it is for disinflation, the higher the associated costs;
ii. the hysteresis hypothesis: short-term monetary shocks or changes in aggregate demand might impact on long-run output;
iii. the speed of disinflation: fast disinflation results in a reduced sacrifice ratio, as the adjustment of inflationary expectations is faster;
iv. the independence of central banks could result in a decline in sacrifice ratio, owing to a credibility bonus.

II.2 Review of Empirical Studies

Evidences from the literature show that estimates of sacrifice ratio vary, based on the estimation method chosen, as well as, the estimation method of the prospective output. Also, it has been argued that high frequency data results in a high sacrifice ratio estimate, and vice versa. These studies have adopted three alternative approaches of estimation, including the Phillips curve estimates (Okun, 1978; Gordon and King, 1982); analysis of single disinflation episodes (Ball, 1994) to measure output losses; and structural estimation and structural vector autoregression (SVAR) methodology, which describes the dynamic effects of disinflation (Cecchetti, 1994).

The pioneer empirical study on estimation of sacrifice ratios was by Lucas (1973), who also developed the model that provided a theoretical basis for other empirical studies. The study adopted the standard IS-LM framework to build aggregate demand, while aggregate supply was based on the assumption of full labour market clearance. The study concluded that the trade-off was inversely related to the volatility of inflation in a particular economy. Following Lucas (1973), Okun (1978) specified that inflation had severe consequences on the real economy, through distortions in information, prediction, and transactions institutions. The study used six different versions of the Phillips curve, available at the time, to quantify the trade-off, which was averaged at 6-18 percentage points with a 10-percentage point loss in output, based on a percentage point decline in inflation for the US economy.

In more recent studies, Coffinet et al., (2007) estimated the sacrifice ratio for the Euro Area from 1985Q1 to 2004Q4, using three methods that corresponded with output loss (short-term cost of disinflation). Adopting a SVAR approach and a general equilibrium model, they concluded that the sacrifice ratio was between 1.2 and 1.4 per cent. That is, a 1 percentage point decline in inflation would result in a more than 1 per cent reduction in GDP in the Euro Area.

Serju (2009) estimated the sacrifice ratio in Jamaica and Trinidad & Tobago, adopting nonparametric and parametric models from 1981Q1 to 2008Q2. Using SVAR and episode-specific models, the study concluded that the sacrifice ratio for Jamaica and Trinidad & Tobago were low. In disinflation periods, the sacrifice ratio for Jamaica averaged 0.029 percentage points loss in output with 1 percentage point fall in inflation; it was, however, an average of 0.113 for Trinidad & Tobago. The study concluded that policies targeted at managing inflation could be implemented without the fear of a significant contraction in economic output.

Durai and Ramachandran (2013) measured the sacrifice ratios for the farm and non-farm sectors in India, as a disinflation policy was perceived to have different impacts on different sectors. The study adopted the non-parametric approach, as used by Ball (1994), and identified five disinflation episodes due to contractionary policies implemented by the Reserve Bank of India between

1950 and 1951, and 2009 and 2010. The sacrifice ratio estimates indicated that disinflationary monetary policy had a greater negative effect on output growth in the non-farm sector. However, the negative sacrifice ratio in the farm sector offsets the positive ratio in the non-farm sector, which implied a small aggregate ratio for the economy. Although this study considered only short-run aggregate supply functions, it concluded that output gains during disinflationary periods were driven largely by self-determining factors immune to monetary shocks.

Belke and Böing (2014) estimated the sacrifice ratio of the euro area countries between 1999Q1 and 2012Q3, adopting a structural vector autoregressive technique and a procedure based on historical disinflationary episodes. The results indicated that most countries within the region had sacrifice ratios ranging from –1.0 to 2.0 per cent.

Mitra et al., (2015) adopted a time varying approach in the estimation of sacrifice ratio in India, by providing for transition in parameters and stochastic volatility in residual. This was done to effectively capture time dynamics and track movements in growth-inflation tradeoff, over time. They observed that the sacrifice ratio estimate was higher during the periods of expansionary monetary policy (2.8 per cent) but reduced during the adoption of a contractionary monetary policy (2.3 per cent). The highest sacrifice ratio was recorded from 2003: Q3 - 2004 to 2004: Q1-2005 and in 2010: Q1-2011 with the movements depicting the contribution of inflation and output in the sacrifice curve.

Dholakia and Virinchi (2015) estimated the sacrifice ratio, focusing on aggregate demand and supply side assumptions. The study considered the adjustment path for short run equilibrium to derive a sacrifice ratio that was hypothetically adequate. Using quarterly data from 1996: Q1-1997 to 2013: Q4-2014 in India, the study adopted direct methods and regression (time-varying parameters) to estimate the ratio. The study perceived the sacrifice ratio as a qualitative concept rather than quantitative and derived a sacrifice curve. They concluded that the ratio ranged from 1.7 to 3.8, depending on the measure of inflation and method used.

The review of extant literature that addressed country specific peculiarities in the determination of the sacrifice ratio underscore the ratio to having time-variant characteristics, such as inflation persistence; unemployment hysteresis; speed of disinflation; and, the real business cycle. Hence, we apply a time-varying methodology to estimate sacrifice ratio for Nigeria.

III. Methodology

III.1 Data Selection

The variables used in this study included domestic inflation, output gap and supply shocks. The World Price index (WPI) headline inflation was used as the domestic price indicator, while the supply shocks comprised of domestic dynamics, which impact on the domestic price (such as broad money growth, changes in exchange rate and prime lending rate) as well as variables representative of international prices (international crude oil price and global food prices).

The data for this study (that is, exchange rate, prime lending rate, broad money, GDP and inflation) were sourced from the Statistical bulletin of the Central Bank of Nigeria, while others (international crude oil prices and global food prices) were sourced from the IMF Database. The study covered the period 1991Q1 to 2016Q1. The output gap was estimated as the difference between the natural logarithm of actual output less the natural logarithm of potential output. There are several approaches to the determination of the trend output. For the current estimation, we derive the potential output by fitting a Hodrick-Prescott (HP) filter on the natural logarithm of real GDP.

III.2 Model Specification

The study adopts a time-varying autoregressive distributed lag (ARDL) model, with a stochastic volatility component and parameter transition in an aggregate supply framework, as applied in Mitra, et al., (2015).

Mitra, et al. (2015) adopted an expectation augmented Philips curve to show the short-term trade-off between inflation and output. This is specified as:

$$\pi_t = \pi^e + \alpha(y_t - y_t^*) \tag{1}$$

Where: π^e is the inflation expectation and $(y_t - y_t^*)$ is the output gap. The observable output gap is included at a lag value to avoid endogeneity in the equation. Given that it is theoretically consistent from Calvo of inflation inertia, and the several studies on Nigeria which reveal backward-looking expectations, it is intuitive to reflect nominal rigidity in the inflation process or aggregate supply curve. Hence, we adopt inflation expectation as $\pi^e = \pi_{t-1}$ in order to tract the long-term nominal neutrality.

Thus, Equation (1) is re-specified as:

$$\pi_t = \alpha\pi_{t-1} + \beta ygap_{t-1} + u_t \qquad (2a)$$

which transforms into:

$$\pi_t = \alpha\pi_{t-1} + \beta ygap_{t-1} + \alpha(L)S_t + u_t \qquad (2b)$$

Where, α represents inflation persistence and β is the output gap impact on inflation when output gap changes - the "acceleration limit" effect and also interpreted by Hutchison and Walsh (1998) as a "correction for cyclical conditions". Equation (2.a) includes a stochastic volatility variable (**S_t**) to capture supply shocks, so that the sacrifice ratio is modeled to remain constant despite the underlying volatility in external supply shocks, such as the global financial crisis. These estimates are used to calculate the sacrifice ratio at each point as $(\boldsymbol{SR_t} = \frac{\boldsymbol{1-\hat{\alpha}_t}}{\boldsymbol{\hat{\beta}_t}})$

Where: SR_t = sacrifice ratio; $\hat{\alpha}_t$ = inflation persistence and $\hat{\beta}_t$ = output gap impact. Following Turner and Seghezza (1999) and the extensive proof of a unit root in inflation; Equation (2.b) is expressed as:

$$\Delta\pi_t = \alpha\Delta\pi_{t-1} + \beta ygap_t + \alpha(L)S_t + u_t \qquad (3)$$

This implies that there is no long-run trade-off between inflation and output. Thus, a rise in the output gap in the short-run would result in a permanent rise in the level of inflation. Equation (3) would make comparison between time varying and time invariant estimates possible (Patra and Kapur, 2003).

Equations (2a), (2b) and (3) assume a constant inflationary persistence and output gap impact, which implies that the sacrifice ratio is constant. The validity of this assumption is questioned when you apply models that do not tract the underlying volatility or supply side shocks associated with global crisis and the resultant economic recessions. However, augmenting the supply side model with stochastic volatility tracts the intrinsic volatility inherent in factors that drive the business cycle. The sacrifice ratio, which shows the scale of economic growth that needs to be forgone to achieve a unit decline in inflation, relies significantly on some factors, including the initial level of inflation, independence of the monetary authority and trade openness, among others (Ball, 1994).

Given that the inflation persistence parameter and output gap impact could vary over the estimation period, the aggregate supply curve is augmented with stochastic volatility, so that the underlying volatility is controlled to revert to its long-term state value and the variance of the volatility process as well. In that regard, the impact of inflationary persistence and output gap, on the sacrifice ratio, remain constant. This eliminates the headwinds associated with factors affecting the business cycle such as the recent global financial crisis. This is expressed as:

$$\Delta\pi_t = \alpha_t \Delta\pi_{t-1} + \beta_t ygap_{t-1} + \alpha(L)_t S_t + u_t \quad (4)$$

With the state space representation given as:

$$\Delta\pi_t = \theta_t X_t + u_t \; where \; u_t \sim N(0, \sigma_t^2) \quad (5)$$

Where θ_t is the transition equation for the time varying parameters and X_t is a vector of other variables and the transition equation is shown below:

$$\theta_t = \theta_{t-1} + \epsilon_t \; where \; \epsilon_t \sim N(0, \Sigma) \quad (6a)$$

$$\sigma_t^2 = \delta exp(h_t) \quad (6b)$$

$$h_t = \emptyset h_{t-1} + \varepsilon_t \; where \; \varepsilon_t \sim N(0, \Sigma^1) \quad (6c)$$

The residual variance is assumed to be heteroscedastic, so as to track time varying dynamics of economic instabilities.

Based on the proven time varying feature of sacrifice ratio estimates (Parta and Kapoor, 2003), the estimation approach follows the time-varying methodology, as suggested by Nakajima (2011) and performed, using Gibbs Sampling Algorithm. The maximum likelihood parameter estimation method was used within this algorithm; and the convergence diagnostics and auto-correlation evaluations were determined to assess the statistical significance of the estimates.

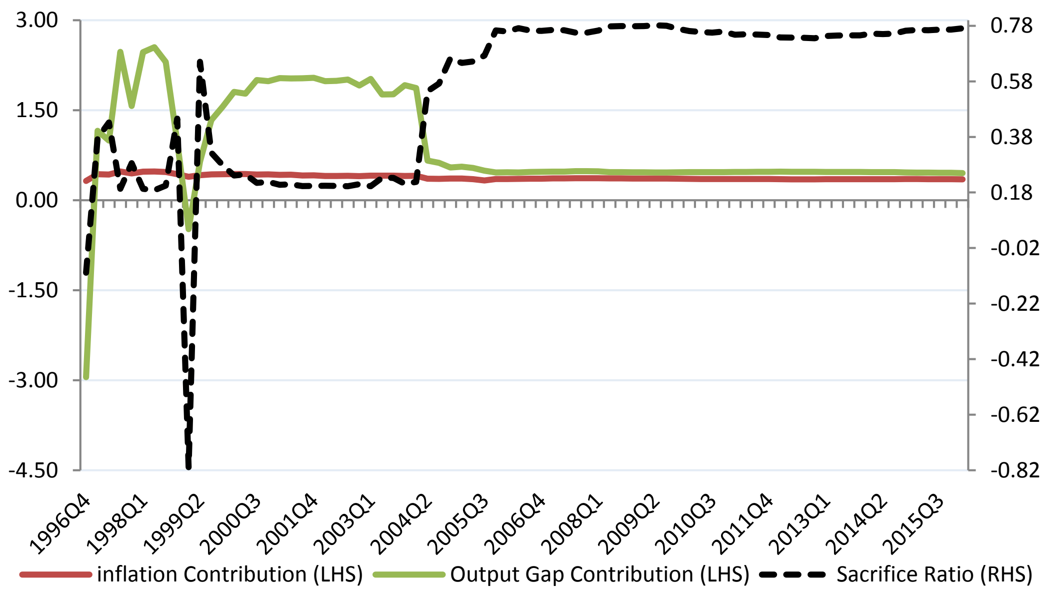
IV. Estimation Results

The estimation of the aggregate supply curve model was carried out, using various indicators.

Model 1 estimated the time varying aggregate supply curve model, using the change in oil price, prime lending rate, change in global food price, and growth in broad money from 1999Q1 to 2016Q1. The results presented an inflation persistence of 0.65 and output gap of 0.45. Using this to estimate the sacrifice ratio, at the end-point, gives a ratio of 0.77. By plotting all the estimates obtained over the sample period against time, the sacrifice ratio curve is attained as shown in Figure 1.

All through the sample period, the inflation persistence was steadily maintained within an average. Hence, a major part of the changes in the sacrifice ratio is dependent largely on the value of output gap over the period. The sacrifice ratio, which on average was low in the early 1990's, fell significantly in 1999Q1, as output gap dipped sharply and became negative. However, in 2004Q2, it rose sharply, due to the significant decline in output gap. However it has since maintained a steady rise, as output gap declined. The sacrifice ratio reached its peak between 2008Q2 to 2009Q3, at which point average inflation rate was lower. From 2005Q4 to 2016Q1, the sacrifice ratio was maintained at an average of 0.76, despite the global financial crisis, which had minimal impact on the Nigerian economy.

Figure 1: Sacrifice Ratio for Model 1



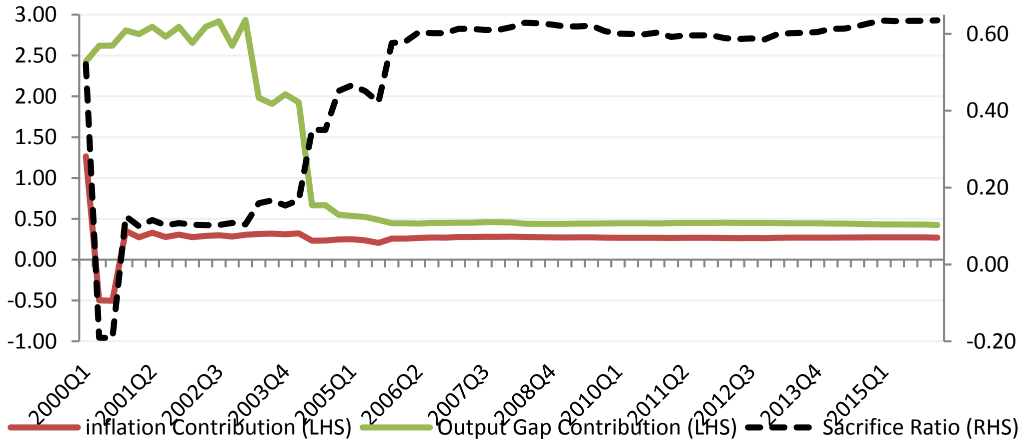
Also, the relationship between sacrifice ratio, average output gap and average inflation, as shown in Figure 1, indicates that the time varying impact of inflation over the review period remained at a steady non-significantly different level, while the time varying impact of output gap fluctuates in line with economic shocks. The sacrifice ratio of 0.77 at the end of the sample period shows that the economy is tightening, as inflation is targeted at the expense of output. The movements in the sacrifice ratio curve, in the period as shown in Figure 1, depict the contribution of inflation and output.

Table 1: Estimation Results for Model 1

Method: Maximum likelihood (Marquardt)				
Sample: 1991Q1 2016Q1				
	Coefficient	**Std. Error**	**z-Statistic**	**Prob.**
Change in Oil Price	-0.030	0.002	-15.774	0.0
Prime lending rate	0.145	0.005	31.570	0.0
Change in global food prices	0.024	0.002	13.546	0.0
Broad money growth	0.051	0.003	18.837	0.0
	Final State	**Root MSE**	**z-Statistic**	**Prob.**
Inflation Persistence	**0.651**	0.006	100.592	0.0
Output gap Impact	**0.453**	0.033	13.538	0.0
Log likelihood	-669.9494	Akaike info criterion		16.8
Parameters	4	Schwarz criterion		17.0
Diffuse priors	2	Hannan-Quinn criter.		16.9

Model 2 estimated the time-varying aggregate supply curve model, using the change in oil price, prime lending rate, and change in global food price. We also interact the effect of exchange rate depreciation with growth in broad money (that is, exchange rate depreciation multiplied by growth in broad money). Model 2 presented an inflation persistence state of 0.73 and output gap impact of 0.42. Using this to estimate, the sacrifice ratio at the end point, gives a ratio of 0.64. An overview of the relationship between the sacrifice ratio, inflation persistence and output gap impact is presented in Figure 2.

Figure 2: Sacrifice Ratio for Model 2



The inflation persistence in Model 2 showed a significant dip in the early 2000s. Similarly, output gap contribution, which was unstable from the beginning of the same period fell significantly in 2003Q1- 2005Q4 but maintained a relatively stable level all through the sample period. This significantly impacted on the performance of the sacrifice ratio, which grew significantly from 0.10 in 2003Q1 to 0.64 as at 2016Q1.

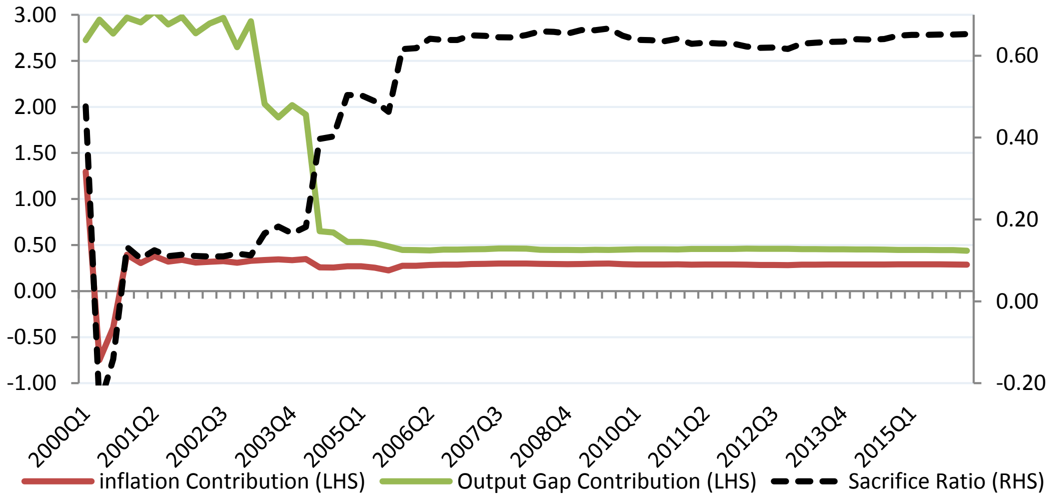
The estimation results for Model 2 are presented in Table 2.

Table 2: Estimation Results for Model 2

Method: Maximum likelihood (Marquardt)				
Sample: 2000Q1 2016Q1				
	Coefficient	**Std. Error**	**z-Statistic**	**Prob.**
Change in oil price	-0.015	0.00	-986.20	0.0
prime lending rate	0.134	0.00	5225.40	0.0
exchange rate dep*broad money growth	0.041	0.00	2453.01	0.0
change in global food prices	-0.001	0.00	-34.26	0.0
	Final State	**Root MSE**	**z-Statistic**	**Prob.**
Inflation Persistence	**0.727088**	0.000635	1144.566	0.0
Output gap Impact	**0.424194**	0.002795	151.7616	0.0
Log likelihood	-68889.92	Akaike info criterion		2119.8
Parameters	4	Schwarz criterion		2119.9
Diffuse priors	2	Hannan-Quinn criter.		2119.9

Model 3 used the same set of variables as in Model 1 but a different sample period of 2000Q1 to 2016Q1. The results of the estimation showed an inflation persistence state of 0.71 and output gap impact of 0.44, which resulted in a sacrifice ratio at the end-point of 0.65. Figure 3 shows the relationship between inflation persistence, output gap and sacrifice ratio over the estimation period for model 3.

Figure 3: Sacrifice Ratio for Model 3



The estimation results for Model 3 are presented in Table 3, and Table 4 shows the comparison of model results

Table 3: Estimation Results for Model 3

Method: Maximum likelihood (Marquardt)				
Sample: 2000Q1 2016Q1				
	Coefficient	**Std. Error**	**z-Statistic**	**Prob.**
Change in oil price	-0.001	0.002	-0.563	0.6
prime lending rate	0.119	0.004	28.530	0.0
change in global food prices	-0.005	0.003	-1.752	0.1
broad money growth	0.059	0.003	21.519	0.0
	Final State	**Root MSE**	**z-Statistic**	**Prob.**
Inflation Persistence	**0.713**	0.008	92.182	0.0
Output gap Impact	**0.439**	0.034	12.890	0.0
Log likelihood	-518.03	Akaike info criterion		16.1
Parameters	4	Schwarz criterion		16.2
Diffuse priors	2	Hannan-Quinn criter.		16.1

In summary, results from the three models do not significantly differ from one another in spite of the different control variables and estimation periods used in the determination of the sacrifice ratio. The contribution of the inflation persistence and output gap in the sacrifice ratio fundamentally cluster around an average of 0.70 and 0.43, respectively. What is obvious is that inflation persistence coincides with the level of period-to-period inflation rates, which has lingered, ensuring that quite a number of the economic agents were showing backward-looking expectations. Of course, as the output gap lowers, given the relationship between the output gap and inflation in the Phillips curve, higher levels of inflation are expected.

The direct policy implication could, therefore, be that on the average, the sacrifice ratio preference for output stabilisation is estimated at approximately 0.69. Maintaining a delicate balance between output and inflation stabilisation is, therefore, important, except for a hawkish central bank where price stability is paramount. In that case, the monetary authority will be relatively more aggressive with its interest rate policy in order to achieve a radical influence on non-structural factors that drive inflation.

Table 4: Comparison of Model Results

	Model 1	**Model 2**	**Model 3**
Inflation Persistence	0.65	0.73	0.71
Output Gap	0.45	0.42	0.44
Sacrifice Ratio	0.77	0.64	0.65

V. Conclusion and Policy Implication

The study estimates the sacrifice ratio from 1991Q1 to 2016Q1 in the Nigerian economy. It also examines the relationship between the sacrifice ratio, inflation and output gap. Estimating the sacrifice ratio is a vital assessment for a monetary authority, to evaluate short-term losses that might emanate from some level of inflation in the economy. This paper presents the estimates for three models, with sacrifice ratio levels of 0.77, 0.64 and 0.65 for Model 1, 2 and 3, respectively. The results suggest that when average inflation was lower, the sacrifice ratio was higher. On the balance of risks, an average sacrifice ratio of 0.69 shows for a hawkish central bank that achieving price stability will come at a high cost of output trade-off. In that case, the monetary authority will be relatively more aggressive with its policy mix, especially interest rate, in order to achieve a radical influence on non-structural factors that drive inflation.

References

Adebiyi, M. A. & Mordi, C. N. O. (2010). Estimating Small Scale Macroeconometric Model (SSMM) for Nigeria: A Dynamic Stochastic General Equilibrium (DSGE) Approach. *Central Bank of Nigeria Occasional Paper*, No 39, pp 1- 65.

Ball, L. M. (1994). What Determines the Sacrifice Ratio? In Monetary Policy, ed. N. G. Mankiw, Chicago: University of Chicago Press, pp. 155-188.

Barro, R. (1996). Inflation and Growth. *Federal Reserve Bank of St. Louis Review*, May/June.

Belke, A. H. & Boing, T. (2014). Sacrifice Ratios for Euro Area Countries – New Evidence on the Costs of Price Stability. *Ruhr Economic Paper No. 520*, Available at SSRN: http://ssrn.com/abstract=2565729.

Cecchetti, S. G., & Rich, R. W. (2001). Structural Estimates of the U.S. Sacrifice Ratio. *Journal of Business & Economic Statistics*, Vol. 19, No. 4 (Oct.), pp. 416-42.

Cecchetti, S. G. (1994). Comment in Monetary Policy, ed. N. G. Mankiw, Chicago: University of Chicago Press, pp. 188-193.

Coffinet, G., Matheron J., & Poilly, C. (2007). Estimating the Sacrifice Ratio for the Euro Area. *Quarterly Selection of Articles* - Bulletin de la Banque de France, Banque de France, Issue 08, pp. 5-34, Summer.

Dholakia, R. H. (2014). Sacrifice Ratio and Cost of Inflation for the Indian Economy. Indian Institute of Management, Ahmedabad. *M-A Working Paper* No. 2014-02-04,

Dholakia, R. H. & Virinchi, K. S. (2015). How Costly is the Deliberate Disinflation in India? Estimating the Sacrifice Ratio. Indian Institute of Management. *Working Paper* No. 08-01.

Durai, S. & Ramachandran, M. (2013). Sectoral Effects of Disinflation: Evidence from India. *Macroeconomics and Finance in Emerging Market Economies*, 6(1), 77-87.

European Central Bank (2004). *Convergence Report*.

Feldstein, M. (1999). Tax Avoidance and the Deadweight Loss of the Income Tax. *The Review of Economics and Statistics*, Vol. 81, No. 4 (Nov.,), pp. 674-680.

Filardo, A. J. (1998). New Evidence on the Output Cost of Fighting Inflation. *Economic Review*. Third Quarter, Federal Reserve Bank of Kansas City.

Gordon, R. J. & King, S. (1982). The Output Cost of Disinflation in Traditional and Vector Autoregressive Models. *Brookings Pap. Econ. Activity*, 1: 205-242.

Gordon, R. J. (1982). Wages and Prices Are Not Always Sticky: A Century of Evidence for the United States, United Kingdom, and Japan. National Bureau of Economic Research, Inc. *NBER Working Papers 0847*.

Hutchison, M. M. & Walsh, C. E. (1998). The Output-inflation Trade-off and Central Bank Reform: Evidence from New Zealand. *Economic Journal*, pp. 703-25.

Kapur, M., & Patra, M. D. (2003). The Price of Low Inflation. *RBI Occasional Papers*, Vol. 21, Nos. 2 and 3, Monsoon and Winter, 191-233.

Lucas, R. E. (1973). Some International Evidence on Output-Inflation Trade-offs. *American Economic Review* 63 (June), 326-34.

Mankiw, N. G. (2001). The Inexorable and Mysterious Tradeoff between Inflation and Unemployment. *The Economic Journal, 111(471), 45-61*.

Mitra, P., Biswas, D. & Sanyal, A. (2015). Estimating Sacrifice Ratio for Indian Economy: A Time Varying Perspective. *RBI Working Paper Series* WPS (DEPR). 01, June.

Nakajima, J. (2011). Time-Varying Parameter VAR Model with Stochastic Volatility: An Overview of Methodology and Empirical Applications. Institute for Monetary and Economic Studies, Bank of Japan. *Discussion Paper Series 11-E-09*

Okun, A. M. (1978). Efficient Disinflationary Policies. *American Economic Review*, 68, 348-352.

Serju, P. (2009). Estimating the Output Cost of Disinflation: An Application to Jamaica and Trinidad & Tobago. *Journal of Business, Finance and Economics in Emerging Economies*, 4(1)117-148.