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Structural Vector Autoregressive-Based Estimates ofthe Sacrifice Ratio forthe Nigeria Economy

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Abstract:*The roots of the economic crisis in Nigeria that led to economic recession especially in2016 is still to some extent open to question. Attribute of such recession are high rate of inflation, unemployment and negative growth rate of the economy and the Federal government has put in place various monetary policies towards disinflation. The objective of this paper is to estimate the sacrifice ratio of Nigeria economy. A high sacrifice ratio means a large loss of gross domestic product (GDP) or employment for a given reduction in inflation. In order to estimate the cost of adjustments in inflation rates by the sacrifice ratio, we apply, firstly, a structural vector autoregressive technique following Cecchetti and Rich (2001) and secondly the Impulse Response Function. Quarterly data on real GDP and inflation rate (measured by the first difference of CPI as stipulated by Cecchetti Model), for the period 1981:Q1-2015:Q4, were used. Our findings indicate that on a quarterly estimate, Nigeria has sacrifice ratios that relatively vary as the horizon grows. It shows a clear upward trend, with higher output loss at longer horizons. A high sacrifice ratio between 0.8 and 8.4 per cent of real GDP for a reduction in inflation of one percentage point within 30 quarters (about seven and half) years was recorded.There is a highest positive effect at every fourth quarter intervals, lowest positive effect also at intervals. It rises to peaks at every 4 quarters. That is at the 4^{th},8^{th}, 12^{th}, 16^{th} and 20^{th} quarters respectively. That means at interval of about four quarters, the Nigeria economy witnesses a loss in GDP that is an increase in unemployment rate. The study recommends rapid disinflationary monetary policies to move the country quickly out of the current recession combined with an expansionary fiscal policy to encourage economic growth.*

Keywords: *Structural VAR, Sacrifice Ratio, Real GDP, Inflation rate.*
JEL Classification: Z

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I. Introduction

The fundamental concern of any government is the growth of its economy. A number of monetary and fiscal policies are always put in place to achieve stated economic goals of price stability, low level unemployment, output growth, etc. Nigeria as an economy is not exempted from these set objectives. Many policies were put in place in Nigeria but without achieving desired results. For the first time in 29 years, the report by the Nigeria Bureau of Statistics (NBS) figures showed that in the gross domestic product (GDP) for the second quarter of 2016, Nigeria's economy contracted by 2.06 percentReal quarterly GDP growth rate fell from -0.36% in Q1 2016 to -2.06 in Q2 2016.The NBS figure further showed that in the first quarter of 2016, the country's economy performance shrank by 0.36 percent to hit its lowest point in 25 years. The second quarter report makes the country's economy the worst in three decades.

There are a number of explanations for inflation's slow adjustment and the absence of costless disinflation. Fuhrer (1995) provided a review of recent discussions and focused on three possibilities. First, inflation persistence may arise from the overlap and non-synchronization of wage and price contracts in the economy. Because wages and prices adjust at different times, as well as to each other, slowing the process takes time. Second, people's inflation expectations may adjust slowly over time, being based on a sort of adaptive mechanism. Because decisions about wages and prices depend on expectations of future changes, slow adaptation is self- fulfilling, creating inertia. And third, if people do not believe that the monetary authority is truly committed to reducing inflation, then inflation will not fall as rapidly. That is, the credibility of the policy

The concept of the sacrifice ratio literally assumes that a reduction in prices, or the inflation rate, is associated with costs in terms of output or unemployment. A high sacrifice ratio means a large loss of gross domestic product (GDP) or employment for a given reduction in inflation. To be more precise, the sacrifice ratio is a concept that describes the cumulative loss of output when the inflation rate declines by one percentage point (Cecchetti and Rich 2001). A high sacrifice ratio indicates high costs in structural adjustments that relate to the changes in price levels. The objective of this paper is to estimate the sacrifice ratio for Nigeria and based on the

estimates calculate the costs associated with disinflation monetary policies if Nigeria should adopt this as a way out of recession. Hence, the contribution of tis paper is to gain empirical evidence of the magnitude of the sacrifice ratio in Nigeria based on a sample of quarterly data ranging from 1981to 2015.Thus, it is the view of this paper that the measurement of the sacrifice ratio is a prerequisite to any study attempting to evaluate its key determinants or the impact of alternative policies on the costs of disinflation.

II. Brief Review Of Literature

The view that reductions in inflation are accompanied by a period of decreased output (relative to trend) has generated considerable debate among economists on how to lessen the costs of disinflation. Some discussions, including those of Okun (1978), Gordon and King (1982), Taylor (1983), Sargent (1983), Schelde-Andersen (1992), and Ball (1994), have focused on the speed of disinflation and whether the monetary authority should adopt a gradualist approach or subject the economy to a "cold turkey" remedy.

A number of authors have estimated sacrifice ratios for different countries using a variety of techniques. Okun (1978) examined a family of Phillips curve models and derived estimates that range from 6% to 18% of a year's gross national product, with a mean of 10%. Gordon and King (1982) used traditional and VAR models to obtain estimates of the sacrifice ratio that range from 0 to 8. Mankiw (1991) examined the 1982-1985 Volcker disinflation and used Okun's law to arrive at a "back-of-the-envelope" estimate of 2.8. Ball (1994) examined movements in trend output and trend inflation over various disinflation episodes and obtained estimates that vary from 1.8 to 3.3.

Bowdler (2009) calculated the sacrifice ratio through the Phillips curve method in the article "openness, exchange rate regime and the Phillips curve" and considered the slope of the Phillips curve from 1998 to 1981 for most countries. Regressions based on the new measures indicate that the Phillips curve slope increases with trade openness amongst countries maintaining flexible and semi-flexible exchange rate regimes, but is unrelated to openness amongst countries maintaining fixed exchange rate regimes.

Daniel and Van Hoose (2013) in an article "exchange rate pass through, openness and sacrifice ratio", assessed the effect of exchange rate pass through, its condition and the effect of openness on the sacrifice ratio for 20 OECD members during the years 2004-1975 using panel data model. The results show that the large exchange rate increases the sacrifice ratio while there is a significant interaction among exchange rates and openness. Openness exerts an empirically ambiguous effect on the sacrifice ratio.

In an article titled "Sacrifice Ratio and Cost of Inflation for the Indian Economy", Dholakia (2014) suggests that traditional concept of the Sacrifice Ratio measures the loss of potential output sustained by the society in the medium term to achieve reduction in the long-run inflation by one percentage point. This concept is critically examined and generalized to include episodes increasing the long-run inflation rate to gain higher growth of output and employment and hence reduction in the poverty proportion in the medium term. His results show that Sacrifice Ratio turns out to be in a narrow range of 1.8 to 2.1 for deliberate deflation and 2.8 for inflation in India.

III. The Model And Empirical Results

Our strategy for deriving an estimate of the sacrifice ratio can be illustrated within a relatively simple system that only includes output and inflation. Following Cecchetti (1994), we consider the following structural VAR model:

$$\Delta y_t = \sum_{i=1}^{n} b_{11}^{i} \Delta y_{t-1} + b_{12}^{0} \Delta \pi_t + \sum_{i=1}^{n} b_{12}^{i} \Delta \pi_{t-i} + \varepsilon_t^{y}$$

$$\Delta \pi_t = b_{21}^{0} \Delta y_t + \sum_{i=1}^{n} b_{21}^{i} \Delta y_{t-i} + \sum b_{22}^{i} \Delta \pi_{t-i} + \varepsilon_t^{\pi} \quad \text{....3.0}$$

where

yt = log of RGDP at time t,

π = inflation rate between time t - 1 and t,

Δ = the difference operator (1 - L), B(L) - [Bij(L)] for i, j = 1, 2 is a (2 x 2) matrix of polynomial lags, and

ε [ε_t^{y} , ε_t^{π}] = a vector innovation process that contains the shocks to aggregate supply (ε_t^{y}) and aggregate demand (ε_t^{π}).

Shocks to aggregate supply in Nigeria were identified as high cost of production brought about by costly raw material arising from banning of importation of raw materials that are not available within in the country. Also shocks to aggregate demand in Nigeria may be a fiscal or a monetary shock, like the recent monetary policies that lead to high exchange rate in the country.

We construct sacrifice-ratio estimates from the two structural VAR models in equation 3.0 using quarterly data over the sample period 1981:Q1-2015:Q4. Output is measured by real GDP and inflation is measured by the change in CPI. The sacrifice-ratio estimates are based on a different transformation of the data for output and prices.

Table 1: Stationarity Properties of Variables

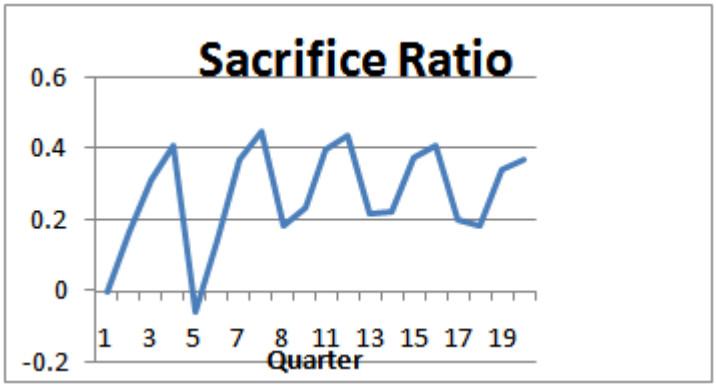
	AT LEVEL			*FIRST DIFFERENCE*		
Variable	**ADF Stat.**	**Critical Value**	**Prob.**	**ADF Stat.**	**Critical Value**	**Prob.**
RGDP	-2.07568	-2.8829	0.2549	-5.23343	-2.8829	0.0000
INF	-1.62078	-2.8823	0.4693	-11.2495	-2.8824	0.0000

It is worth noting that preliminary analysis of the data supports the specification of the models. In particular, we examined the stationarity properties of the various series to determine their degree of integration and the presence of cointegrating relationships. Table 1 shows that RGDP and INF have unit root and therefore stationary at their first difference. This confirms that each is integrated of order one, I(1), and therefore cointegrate. This condition supports the specification of our Structural VAR model. The findings that both output and inflation contain a unit root are particularly important for the identification schemes and the concept of a sacrifice ratio. The evidence of a unit root in the output process allows the long-run restriction on the effects of aggregate demand shocks to be well defined and meaningful, while the evidence of a unit root in the inflation process allows for permanent shifts in its level. The lag length of the reduced-form VAR was set equal to 8 for the Cecchetti model.

Estimation of the sacrifice ratio also requires the selection of a horizon for the long-run restriction on aggregate demand shocks. Following Cecchetti (1994), we assume that aggregate demand shocks completely die out after 20 years and truncate the structural Vector Moving Average(VMA) representations at 80 quarters.

The Structural VAR result is presented in the Appendix. The Impulse Response Function and the estimation of Sacrifice Ratio is reported in the next sub-section. The short run quarterly Sacrifice ratio for 20 quarters is shown in Figure 1 and the cumulative point estimate at 4, 8, 12, 20, 30 and 80 quarters are presented in Table 2.

Figure1 : Short-run trend in Quarterly Sacrifice Ratio



The quarterly sacrifice ratio in Figure 1 shows that the sacrifice ratio is unstable for the 20 quarters (5 years).There is a highest positive effect at every fourth quarter intervals, lowest positive effect also at intervals. It rises to peaks at every 4 quarters. That is at the 4^{th},8^{th}, 12^{th}, 16^{th} and 20^{th} quarters respectively. That means at interval of about four quarters, the Nigeria economy witnesses a loss in GDP that is an increase in unemployment rate. The sacrifice ratio witnessed a negative value at the 5^{th} quarter which contrasts with the assumption of a positive sacrifice ratio.

Table 2: Sacrifice-Ratio Point Estimates for Nigeria, 1981:Q1- 2015:Q4; Cumulative Output Loss as a Percentage of Real GDP

	$\tau = 4$	$\tau = 8$	$\tau = 12$	$\tau = 20$	$\tau = 30$	$\tau = 80$
Cecchetti	0.8308	1.9748	3.2589	5.5222	8.4051	3.0589
Mean	0.2077	0.24685	0.271575	0.27611	0.28017	0.038236

The estimated sacrifice ratios based on the SVAR method are given in Table 2, which includes the empirical realizations of sacrifice ratios based on 5 years ($\tau = 20$), as suggested by Cecchetti model and extended to 20 years ($\tau = 80$) for analysis. Table 2 presents the point estimates of the sacrifice ratio at horizons

of one to 20 years, and the point estimates are interpreted as the cumulative output loss corresponding to a permanent one-percentage-point decline in the rate of inflation measured on an annual basis. The Cecchetti model yields sacrifice-ratios estimates that relatively vary as the horizon grow. It shows a clear upward trend, with higher output loss at longer horizons. A high sacrifice ratio means a large loss of gross domestic product (GDP) or employment for a given reduction in inflation. By implication, Inflation increases and displays a permanent upward surge in response to the monetary-policy shock. Interestingly, the 30-quarter horizon mean estimates from the Cecchetti are relatively constant around 0.2

Figure 2 displays the (median) bias-adjusted estimated responses of output and inflation to a one-unit monetary policy shock in the Cecchetti models, together with 90% confidence bands. An examination of the bias-adjusted impulse response functions in Figure 2 reveals a pattern that is qualitatively similar across A, B, C and D and accords with the predicted effects of a monetary tightening. Noted of the similarities is that output declines in response to a monetary-policy shock arising from dis-inflation policies.

Figure 2: Impulse Response Function of the Cecchetti Model

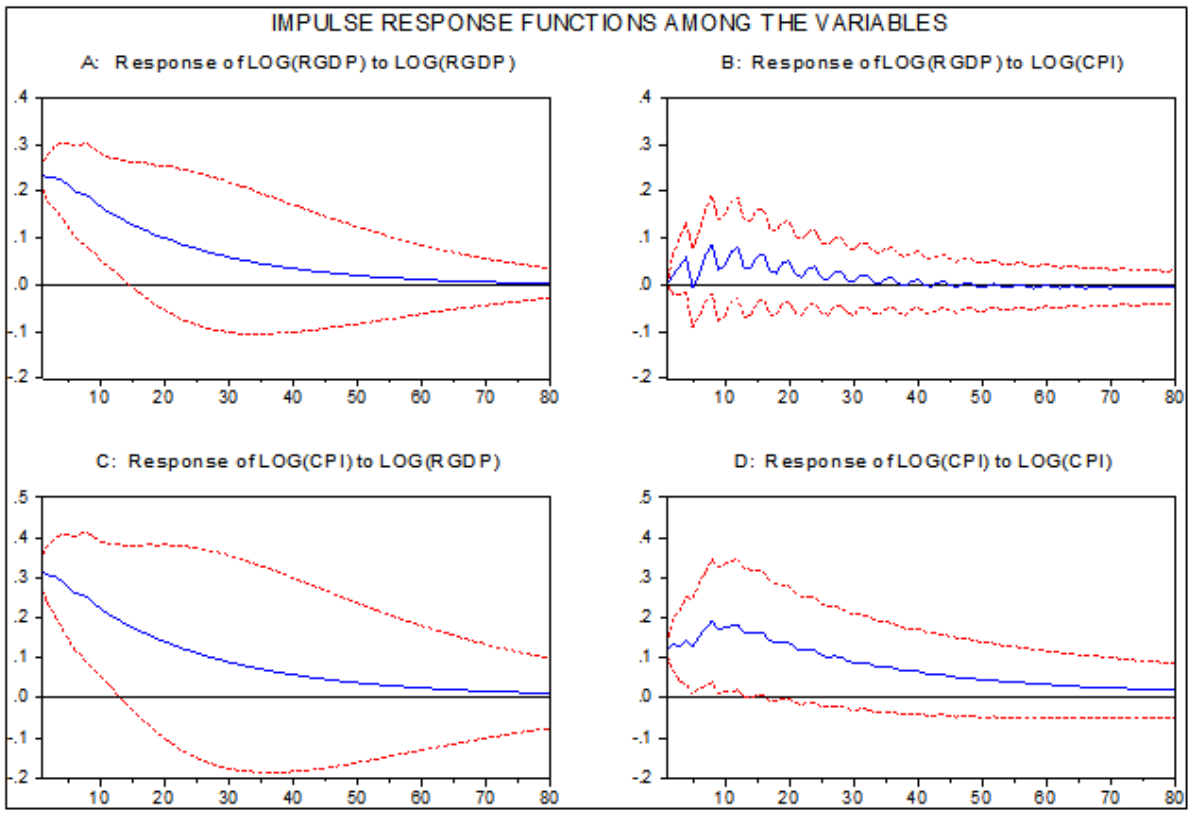


Figure 2A is the response of real GDP growth to a real shock. Any policy towards dis-inflation is a demand or real shock. Economic growth rate respond to it by falling as shown in Figure 2A.

The implication of a falling economic growth is a recession with its attending growing unemployment if it falls below equilibrium. In Figure 2B, the response of real GDP growth to a shock to inflation rate, another demand shock, has an obvious fluctuation and falling towards zero. It shows the tendency to fall below zero, which is a recession. Figure 2C is the response of inflation rate (measured by log difference of CPI) to A standard deviation shock to RGDP growth. When the impulse is real shock, the response of inflation rate growth has an obvious down trending. Inflation rate responds to real shock by gradually falling towards zero but never zero. The response of inflation rate to its own shock (like the monetary policies that tend to withdraw money in circulation to curb excess demand inflation) is fluctuating and convergent. Inflation decreases and displays a permanent decline in response to the monetary-policy shock.

IV. Conclusion

To reduce inflation in medium run, monetary authority must reduce money growth rate. In the Short run reduction in money growth causes reduction in output growth and rise in unemployment. As unemployment rises, inflation falls. Over time expected inflation is reduced. Unemployment falls and output growth increases. In the Medium- run return to natural rate of unemployment, normal rate of output growth and lower inflation. A

major finding here is that if an economy want to engineer a disinflation through contractionary it can lead the economy into a recession which is a temporary reduction in output growth and temporary rise in unemployment. The timing of the short-run and medium run vary across economies. Our findingssuggest thatpolicy can change timing but not costs of disinflation, which is the recession the Nigeria economy is currently witnessing. If Nigeria desires a rapid disinflation, monetary policies towards this will generate a very short but deep recession. On the other hand if a less severe inflation is desirable, monetary policies toward this will generate slow disinflation but more prolonged recession. The sacrifice ratio shows a clear upward trend, with higher output loss at longer horizons. A high sacrifice ratio means a large loss of gross domestic product (GDP) or employment for a given reduction in inflation. This study therefore recommends rapid disinflationary monetary policies to move the country quickly out of the current recession. Such as contractionary monetary policies like reduction in government spending. Also to reduce the impact of such policy, an expansionary fiscal policy to encourage economic growth can accompany the contractionary policy.

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