

Daboh, Foday; Abraham Jackson, Emerson; Tamuke, Edmund

Article

A Bayesian estimation of monetary policy effects on macroeconomic dynamics in Sierra Leone: A new Keynesian DSGE approach

West African Journal of Monetary and Economic Integration

Provided in Cooperation with:

West African Monetary Institute (WAMI), Accra

Suggested Citation: Daboh, Foday; Abraham Jackson, Emerson; Tamuke, Edmund (2025) : A Bayesian estimation of monetary policy effects on macroeconomic dynamics in Sierra Leone: A new Keynesian DSGE approach, West African Journal of Monetary and Economic Integration, ISSN 0855-594X, West African Monetary Institute, Accra, Ghana, Vol. 24, Iss. 1, pp. 1-37, <https://www.wami-imao.org/sites/default/files/2026-02/MONETARY%20POLICY%20EFFECTS%20ON%20MACROECONOMIC%20DYNAMICS%20IN%20SIERRA%20LEONE.pdf>

This Version is available at:

<https://hdl.handle.net/10419/336824>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.

A BAYESIAN ESTIMATION OF MONETARY POLICY EFFECTS ON MACROECONOMIC DYNAMICS IN SIERRA LEONE: A NEW KEYNESIAN DSGE APPROACH

Foday Daboh¹, Emerson Abraham Jackson² and Edmund Tamuke³

Abstract

This paper conducts a Bayesian assessment of a New Keynesian Dynamic Stochastic General Equilibrium (DSGE) model in the context of Sierra Leone's economy by utilising quarterly data from 2011 to 2022. It examines how monetary policy, demand shocks, and cost-push shocks affect selected macroeconomic variables, including production, inflation, and the policy interest rate. The analysis highlights the crucial role of monetary policy in managing demand-induced inflation; however, it is comparatively less successful in mitigating inflation resulting from cost-push shocks, such as commodity price volatility. The research found that demand shocks result in a temporary rise in output and inflation, followed by policy tightening. Conversely, cost-push shocks induce persistent inflationary pressures, pushing the economy into recession, characterised by declines in output. The results highlight the importance of macroeconomic policy coordination that amalgamates effective monetary policies with structural changes, particularly given Sierra Leone's vulnerability to exogenous shocks. This paper enhances the comprehension of DSGE models relevant to low-income countries, providing the Bank of Sierra Leone and similar institutions with significant insights into complex economic dynamics. Policy recommendations include enhancing fiscal-monetary coordination, investing in supply-side diversification, and strengthening institutional credibility to build resilience against macroeconomic shocks.

Keywords: DSGE Model, Monetary Policy, Bayesian Estimation, Structural Shocks, Macroeconomic Stability, Sierra Leone.

JEL Classification: E52, E32, C11, O55

¹ Faculty of Economic Science, Higher School of Economics, Moscow, Russia. Email: fdabo@edu.hse.ru

² Special Economic Assistant, Governor's Office, Bank of Sierra Leone. Email: ejackson1@bsl.gov.sl

³ Economic Assistant, Governor's Office, Bank of Sierra Leone. Email: etamuke@bsl.gov.sl

1. INTRODUCTION

Since the 1980s, Dynamic Stochastic General Equilibrium (DSGE) models have become a crucial component in the analysis of the interrelationships among macroeconomic variables under uncertainty as well as for conducting policy analysis. Initiated with the pioneering work of Kydland and Prescott (1982) on Real Business Cycles (RBC), and further developed by Rotemberg and Woodford (1997), Smets and Wouters (2003), and Christiano, Eichenbaum, and Evans (2005) to deal with nominal frictions and monetary policy rules, DSGE models represent a logically consistent approach to economic modeling in which the optimising behaviour of agents and market clearing condition is incorporated. This micro-founded approach aids in the understanding of both the transitory random fluctuations caused by frictions like sticky prices and wages, as well as the permanent random fluctuations causing long-run trends driven by agents' intertemporal choices.

In this paper, we construct and estimate a New Keynesian DSGE model that focuses on the implications of three major economic shocks: demand shocks, monetary policy shocks, and cost-push (or supply-side) shocks. Demand shocks, which arise from changes in consumer behaviour, investment choices, and government spending, affect output and inflation in the short run (Blanchard & Perotti, 2002). Unlike demand shocks, monetary policy shocks are unexpected changes in short-term interest rates by the central bank that are not accounted for in the systematic component of the policy rule (Clarida, Galí, and Gertler, 1999; Tamuke & Barrie, 2021). Such deviations from the policy could change the perception of the agents, leading to changes in the current or future economic situation. Cost-push shocks are supply-side shocks that arise, for example, from changes in energy or commodity prices that can drive inflation irrespective of the demand side outcomes (Galí, 2015).

In our model, firms and households face price and wage setting constraints that introduce some degree of nominal rigidities and ensure the real variables can be impacted by monetary policy in the short term. In the model, households are depicted as rational agents who seek to optimise their consumption and leisure times, and the producers who face convex adjustment costs on prices are assumed to follow a Calvo (1983) model of pricing behaviour.

By embedding price and wage stickiness in nominal parameters, we maintain that policy can be impactful in short time horizons. It is assumed that households derive utility from consumption or leisure, and firms can select prices but are subjected to certain convex adjustment

costs, according to Calvo (1983) models. The Central Bank establishes the nominal interest rate based on whether the economy's inflation and output level deviates from its stable policy target. As such, deviations from the monetary authority's policy objectives would determine the interest rate (Taylor, 1993). The existing institutional setup and the level of financial sector development influence how shocks propagate and impact the overall economy.

The global DSGE literature still lacks a comprehensive understanding of Sierra Leone's policy transmission mechanism. Existing studies on the New-Keynesian framework focus on upper-middle-income and advanced economies with deep financial markets, long data histories, and stable institutional frameworks. In sharp contrast, Sierra Leone has three novel features that make policy design particularly difficult—and analytically attractive: (i) deep exposure to commodity price and terms of trade shocks, (ii) shallow domestic financial markets that exacerbate real sector problems unlike financial sectors are seldom volatile but often vulnerable to shocks, and (iii) a monetary framework in which the central bank is trying to move towards an explicit interest-rate corridor but lacking a formal framework for inflation targeting. These features pose a different set of primary concerns for New-Keynesians relying on interest-rate smoothing and inflation control techniques in weakly anchored economies dominated by cost-push shocks. Not only does this help inform domestic policy formulation, but it also supports multilateral institutions that increasingly depend on model-based evaluations when designing programmes for least developed and frontier economies.

Three contributions in this study address this gap. First, it constructs a Bayesian New-Keynesian DSGE model tailored to Sierra Leone's structural features, capturing demand shocks, monetary policy surprises, and commodity-driven cost-push shocks. Second, the paper provides a comprehensive set of posterior distributions (rather than point estimates) for the structural parameters, impulse responses, and forecast error variance decompositions, thereby diminishing the bounded volatility that intuitively accompanies short macro datasets. Third, the analysis explains normative consequences where we derive an empirically based policy-reaction function that minimises quadratic loss in output and inflation, demonstrating the limited traction of monetary policy experts on supply-side shocks. Together, these contributions advance the sparse literature on DSGE models for low-income countries, while also providing practical insights for

the Bank of Sierra Leone and other similar monetary institutions that deal with extreme external shocks.

The main findings of the study shows that monetary policy can effectively mitigate demand-driven and policy-induced inflation but has limited influence on cost-push inflation. In addition, demand shocks result in temporary booms in output and price pressures, which are subsequently followed by policy tightening. Moreover, cost-push shocks from global commodity price surges and health crises tend to drive the most significant and most persistent inflationary effects with contractionary output. These results are consistent with Sierra Leone's recent major economic episodes coupled with the need for coordinated macroeconomic policies, which combine active monetary strategies, institutional and supply-side structural reforms to achieve stability and sustained growth.

This study is structured as follows: Section 2 provides the theoretical background of the study and a comprehensive literature review. Section 3 provides the methodological framework and the core behavioural equations, data sources and estimation strategies. Section 4 presents and discusses the empirical results, including impulse response functions, Variance Decomposition of Structural Shocks, and Posterior Parameter Estimates. Finally, Section 5 offers conclusions and key policy recommendations.

2. LITERATURE REVIEW

2.1. New Keynesian DSGE Framework for Monetary Policy Transmission

Dynamic Stochastic General Equilibrium (DSGE) models provide a coherent, micro-founded approach to studying the relationship between monetary policy and macroeconomic variables. The New Keynesian (NK) DSGE model builds on the classical real business cycle framework (Kydland & Prescott, 1982) by incorporating nominal rigidities, which enable monetary policy to affect the real economy, at least in the short term. Clarida, Galí, and Gertler (1999) showed that when prices are set by sticky monopolistic competition, systematic monetary policy (e.g., Taylor-type interest rate rules) becomes critical for macroeconomic stability. The NK model provides an inflation targeting framework where the three core equations – a Taylor-type interest rate rules, an intertemporal IS equation, and a forward-looking New Keynesian Phillips Curve – describe the rational expectation equilibrium between output, inflation and interest rates.

Calvo's (1983) staggered price-setting models provide a rough nominal price (and sometimes wage) stickiness, describing a gradual response of inflation to shocks. The existence of such costs gives rise to the cost-push inflation phenomenon in which inflation is driven independently of the demand conditions, creating a trade-off situation for controlling inflation and stabilising output.

For example, a surge in commodity not input prices does not characterise a cost push but demand-pull inflation and compel the central bank to determine how aggressively to raise its short term interest rates at the expense of output. This dynamic has been thoroughly analysed in the New Keynesian literature (Clarida et al., 1999; Galí, 2015). By incorporating such nominal frictions and shocks, New Keynesian DSGE models can convey the monetary transmission mechanism or the way in which a policy-induced interest rate change affects aggregate demand and prices in a controlled fashion (Christiano, Eichenbaum, & Evans, 2005). A DSGE model with sticky prices and wages could replicate the observed persistence and hump-shaped responses of output and inflation following a monetary policy shock, as shown by Christiano et al. (2005). This provides a theoretical justification for the use of New Keynesian DSGE models by central banks for policy analysis.

Importantly, the DSGE modelling technique also allows researchers the latitude to introduce multiple stylised structural shocks into NK DSGE models and study their propagation. Since it may be impossible to completely model the dynamic relationship between macroeconomic variables in an economy, the introduction of structural shocks into the DSGE infrastructure helps capture those unexpected disturbances that usually produce cyclical dynamics in the economy. For real-world application. Smets and Wouters (2003) famously estimated a medium-scale DSGE model for the Euro Area with a rich menu of shocks, including technology, demand, cost-push (price markup), and monetary policy shocks, and found that such a model can fit macroeconomic data remarkably well. Their results showed, for example, that price markup (cost-push) shocks, while not the largest source of variance, were significant drivers of short-run inflation volatility, necessitating appropriate monetary responses. Moreover, Bayesian estimation techniques were crucial in that and subsequent studies: incorporating prior information together with the likelihood of the data, Bayesian methods facilitate making estimations of DSGE models even in data scarce environments (Smets & Wouters, 2003; An & Schorfheide, 2007). The Bayesian approach provides posteriors of parameters as well as systematic comparison of models, which increases the

reliability and credibility of policy recommendations from the DSGE family of models. For a detailed exploration of NK DSGE models' theoretical underpinnings and their usage for policy analysis, refer to (Clarida et al., 1999; Smets & Wouters, 2003)

2.2. Empirical Applications in Low and Emerging-Market Economies

The use of NK DSGE models for policy analysis has been embraced by institutions in other regions, including those found in Africa. Initially meant for developed countries, these models are now used in least developed economies and emerging markets to assess macroeconomic activities and the impact of monetary policy. In this section, we explicitly review studies from Sub-Saharan African countries, paying attention to economies with varying degrees of commodity dependency and diverse monetary policy frameworks, showcasing how NK DSGE models offer a greater analytical approach for policy implications.

In West Africa, such efforts are made, for instance, in Nigeria, a major oil exporter, where researchers have tried to adapt these models for policy impact analyses. For example, Oye and Alege (2022) construct a New Keynesian Dynamic Stochastic General Equilibrium (NK DSGE) model for Nigeria to study the interaction of fiscal and monetary policy and conclude that the two policies tend to be supportive of stabilising output and inflation. Their findings emphasise the importance of a rules-based monetary policy even in a developing context, which asserts that having some inflationary control targets tends to yield better developmental results in the long run. Other studies have focused on fiscal policy rather than examining it in conjunction with monetary policy. Researchers in Nigeria used to rely on reduced-form or Vector Autoregression (VAR) models for their policy analyses, which became more sophisticated through the application of micro-founded DSGE models and estimation. Rasaki and Malikane (2015) estimate a monetary DSGE model for a group of African countries, including Nigeria and claim that both domestic and foreign shocks are fundamental to the business cycles in these countries.

For other West African countries, such as Côte d'Ivoire, Jidoud (2022) uses a DSGE model to determine the fundamental causes of macroeconomic variability in what is considered a typical West African economy. The analysis concludes that Ivorian business cycles are driven by a combination of endogenous (such as productivity and demand) and exogenous (especially terms-of-trade and other external) shocks. This illustrates that some cost-push factors, such as import prices and commodity pricing, coupled with domestic demand, are also important. The range of

inflationary pressures faced by these economies requires that the monetary transmission mechanism take into account the supply-side origin of many inflationary processes that are, at least for the time being, not controllable domestically. A new Keynesian DSGE model captures this as it allows for the incorporation of import price shocks into the Phillips Curve and models the responsiveness of the central bank's interest rate policy to these shocks. Akosah (2020) applied the NK DSGE model for Ghana, a country that has transitioned from the traditional monetary targeting to an inflationary targeting framework and is a key exporter of commodities such as cocoa, gold and oil. Findings from their study revealed that external cost push shocks remain the core driver of inflation volatility, and that the Dynamic Stochastic General Equilibrium approach provides a more active tool for assessing and evaluating different monetary policy rules in a major commodity exporting economies.

Moving to East Africa, Shobande et al. (2019) developed an NK DSGE model for Kenya, a non-commodity exporter with a more diversified economy, to study the impact of monetary policy. Their findings suggested that monetary policy, particularly through interest rate channels, is effective in managing demand-side inflation, but less so for inflation stemming from supply shocks, offering nuanced insights that reduced-form models might miss. Similarly, Mkai and Aikaeli (2020) conducted a study on Kenya, Tanzania, and Uganda and concluded that the interest rate and credit channel are robust in absorbing demand shocks, while supply side shocks on the other hand significantly weaken the transmission channels. In Uganda, Karingi and Wabomba (2015) applied a DSGE model and demonstrated that supply side shocks, such as commodity price fluctuations, significantly weaken the efficiency of the traditional monetary policy channels.

In the context of a more advanced African economy, NK DSGE models have previously been applied to study the monetary policy impact and structural changes in the South African economy. A small open economy NK DSGE model for South Africa was developed by Steinbach, Mathuloe, and Smit (2009) featuring a credible inflation targeting central bank. Their model indicates that the South African economy is mostly shielded from foreign demand shocks, with domestic shocks (such as policy and supply shocks) dominating the fluctuations. This aligns with South Africa's relatively sophisticated financial markets and less volatile terms of trade compared to other smaller African economies. Liu and Molis (2020) further developed a South African DSGE model by adding segmentation in the labour market (for instance, between skilled and

unskilled, or formal and informal sectors) and differentiating between tradable and non-tradable goods sectors. With this enhanced model, Liu and Molis (2020) assess the effects of structural reforms and public investment policies, which illustrates the considerable ease with which country-specific issues can be addressed using DSGE frameworks. Similarly, (Baldini et al., 2014) develop an NK DSGE model and incorporate the banking sectors and the effect of the global economic crisis on the Zambian economy. They conclude that external macroeconomic shocks such as deteriorating terms of trade, complex risk premiums, and condensed bank risk appetite can significantly affect output and inflation.

A shared characteristic across these African studies is the application of Bayesian estimation and calibration approaches to fit the models to local data. In many African contexts, which are data-scarce (short time spans for sampling and structural breaks), Bayesian approaches are particularly useful (An & Schorfheide, 2007). They allow for the incorporation of reasonable estimation bounds based on advanced economies or microeconomic data, especially for crucial parameters related to price stickiness, coefficients of the interest rate rule, or the persistence of shocks. This methodological framework effectively improves the accuracy and robustness of the estimation of parameters and model inference, making dynamic stochastic general equilibrium models more viable and effective tools even in data-driven constrained economies where the traditional estimation method fails.

2.3. Relevance of NK DSGE Approach to Sierra Leone

Sierra Leone's fragile post-conflict economy presents itself as a small, open, and frontier economy that is heavily reliant on the exports and imports of commodities, making it highly susceptible to volatile growth and inflation episodes because of supply-side composite shocks and routine demand and policy shocks. The New Keynesian DSGE (NK DSGE) model framework is highly advantageous because it allows for the explicit treatment of demand shocks, monetary-policy shocks and cost-push shocks; incorporates expectation formations; and includes an interest rate rule. Specifically, the food and import price volatility are treated as cost-push inflation in the NK Phillips Curve, resulting in an increase in inflation that triggers monetary contraction and a decline in output. The impact of expectations on the NK DSGE model, through forward-looking terms in the IS and Phillips equations, captures the role of credibility and systematic policy on macroeconomic outcomes. Cost-push shocks can have a less inflationary effect if a credible

Taylor-type rule is in place as inflation expectations being are anchored. Sierra Leone already has a monetary policy rate to which the interest rate corridor system will be aligned. A Taylor-type rule that supports this arrangement will enhance monetary policy transmission and better anchor expectations.

Until recently, the use of the DSGE framework for policy analysis in Sierra Leone remained scanty. The available studies (see Barrie & Bah, 2022; Barrie & Jackson, 2023) focused on the impact of fiscal shocks and technological shocks on macroeconomic stability as well as the effect of financial frictions on monetary policy. Therefore, the use of the NK DSGE to study the impact of demand, cost-push and monetary policy shocks as proposed in this paper is relevant and timely for monetary policymakers in Sierra Leone.

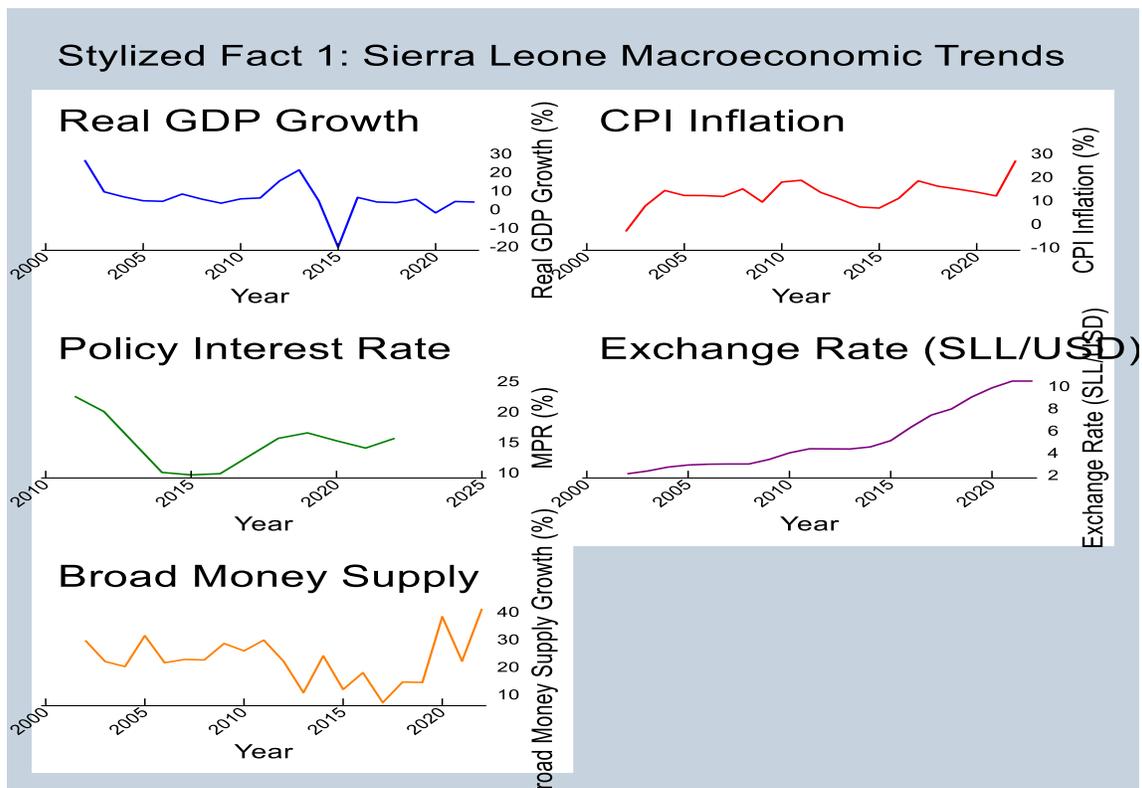
Conclusively, there is a sound theoretical and empirical rationale for applying of the NK DSGE model to Sierra Leone. It disentangles the relative contributions of demand, supply, and policy shocks, imposes intertemporal budget constraints and rational expectations, and enhances country-level insights through Bayesian estimation. The NK DSGE framework emerges as a critical tool for evaluating and shaping the monetary policy transmission in Sierra Leone owing to its combination of global best practices and local benchmarks.

2.4 Sierra Leone Economic and Banking Sector Indicators

The Sierra Leone economy has experienced an extremely volatile real GDP growth rate, with periods of robust economic development, particularly in the early 2000s and also around 2010. This economic boom was interspersed with a rapid economic contraction around 2014 to 2015 due to the twin shock (i.e., during the Ebola crisis and commodity price volatility). Economic recovery is still observed in the country, but growth continues to fluctuate, which demonstrates the country's vulnerability to shocks. Inflationary pressure continues to be a persistent challenge in Sierra Leone, regularly posting double digits, indicating a volatile price-setting environment that challenges the Bank of Sierra Leone's stability objective. The monetary policy rate has also been volatile, drastically falling abruptly around 2015-2016 to stabilise the economy from the post-Ebola crisis period before increasing again in response to the inflationary pressures and external macroeconomic shocks, consistent with the study conducted by Daboh and Jackson (2023) concluded that changes in the policy rate can have substantial impacts on the demand for money and economic growth stabilisation. Broad money supply growth has been volatile over time, and

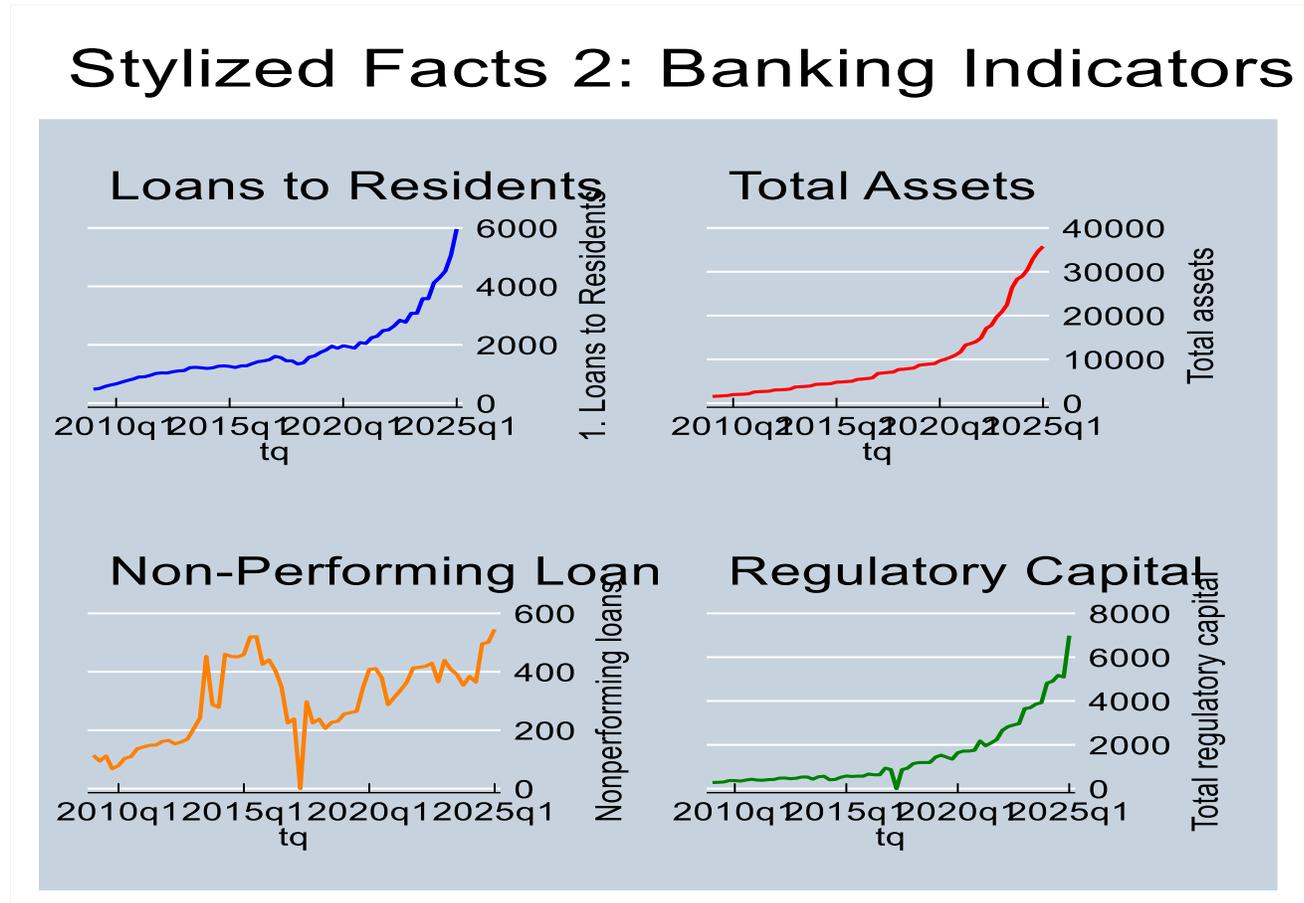
periods of unrestrained growth in money supply have coincided the episodes of rising inflationary pressure in the domestic economy. Empirical evidence from Daboh, Duramany-Lakkoh, and Knox-Goba (2023) reveals a bidirectional interconnection between money supply and inflation, with a negative long-term impact of money supply shocks on GDP, indicating the desire for prudent monetary supervision. Finally, from the Exchange Rate trend analysis (SLL/USD), the domestic currency (SL Leone) has consistently depreciated against the US dollar over time, intensifying import-induced inflation. This is consistent with the study conducted by Daboh, Kur, and Knox-Goba (2025), which related this trend to currency substitution and regime-dependent shocks, with the results indicating that an increase in the policy rates stabilises the domestic currency in a normal period, and destabilises the economy during a crisis period.

Figure 1: Sierra Leone Macroeconomic Trends



Source: BSL Annual and Macroeconomic and Financial Stability Indicators, 2023

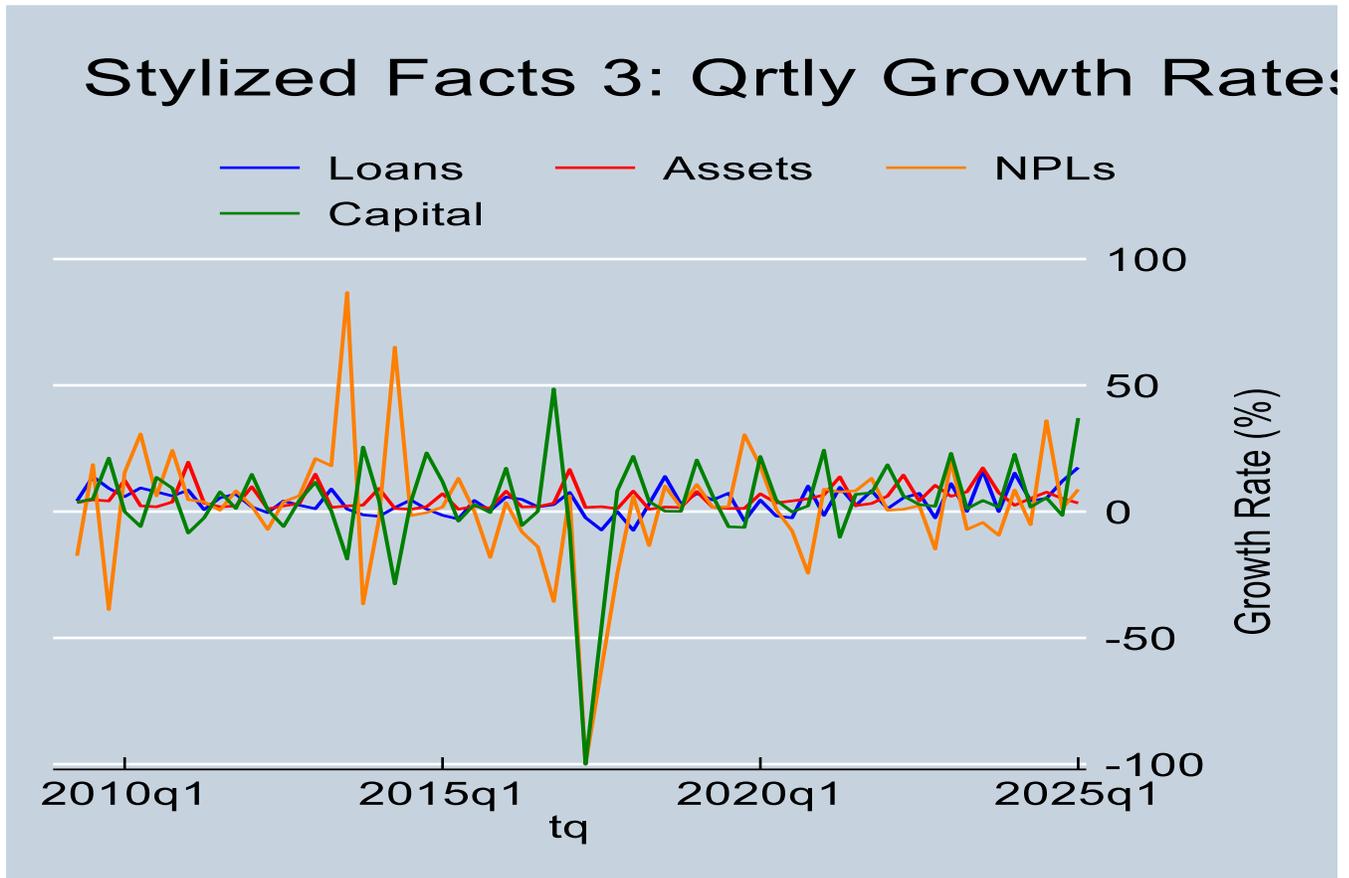
Figure 2: Banking Indicators in Sierra Leone



Source: BSL Annual and Macroeconomic and Financial Stability Indicators, 2023

The trend analysis from the banking indicators revealed that between 2010 and 2025, the banking sector in Sierra Leone recorded a significant growth and increase in financial deepening, as mirrored in the sustained growth in total loans to residents and sectoral assets. Non-performing loans exhibited periods of extreme volatility, primarily around 2015-2016, which corresponded to a major macroeconomic recession, while regulatory capital has increased consistently over time, signifying robust resilience and risk management. According to Daboh and Duramany-Lakkoh (2024), the constant volatility in non-performing loans and regulatory capital around 2014-2015 is due to global macroeconomic shocks, the Ebola crisis and decline in commodity prices.

Figure 3: Quarterly Growth Rates of Banking Indicators



Source: BSL Annual and Macroeconomic and Financial Stability Indicators, 2023

The trend analysis from the quarterly growth rate of banking indicators for the period 2010q1-2025q1 shows significant quarterly growth fluctuations, indicating the active nature of financial time series and the need for continuous and prudent monitoring. Non-performing loans were particularly volatile, with a quarter-on-quarter volatility that signals rapid changes in the quality of assets tied to the economic environment. Around 2017-2018, capital and assets growth rates exhibited a negative trend, demonstrating a systemic shock.

3. METHODOLOGY

In this section, we outline the basis of the New Keynesian DSGE model used in this study. We derive the main NK DSGE model, which encompasses household actions, the firm’s markup policies, equilibrium in the goods market, and the aggregate behaviour of the economy. These

derivations ensure that the empirical investigation is grounded in a sound micro-founded architecture that embodies expectations, nominal stickiness, and the channels through which monetary policy impacts the economy. We test our model through macroeconomic time series data, utilising Bayesian estimation techniques. This method enables the joint estimation of structural parameters and structural shocks by weighing prior information with the observed data set (An & Schorfheide, 2007). The model is evaluated using several techniques, including the impulse response functions (IRFs), parameter estimation, historical and smooth estimates, and shock decomposition analyses.

3.1. Structural Framework

This study's DSGE model is based on the New Keynesian view, which is considered a benchmark for monetary policy analysis owing to its micro-founded nature and ability to model forward-looking and nominal rigidities behaviour (Clarida, Galí, & Gertler, 1999; Galí, 2015). It has three building blocks representing households, firms, the central bank and structural shocks. The representative household derives maximum utility over its lifetime through an optimal saving method and an intertemporal consumption trade-off that is calculated through the Euler equation, which states that today's consumption decision is made taking into account the future's expected interest rate. Firms operate in a monopolistically competitive environment with Calvo price-setting behaviour, which leads to staggered price adjustment and hence contributes to the New Keynesian Phillips Curve, where inflation is based on expected future inflation and an output gap formed during the period of price stickiness. Monetary policy is described within a Taylor-type rule where the central bank modifies the policy interest rate in response to inflation and the output gap distance from its steady state, suggesting a structured approach towards stabilisation of the economy.

The model incorporates three types of exogenous shocks within it, each of which is modelled as an AR (1) process. These include: demand shocks, cost-push shocks, and monetary policy shocks. These represent structural disturbances that drive fluctuations in the economy in the short-run. This theory lays down a framework in which relevant short-run policy interactions with macroeconomic variables can be efficiently analysed and examined.

3.2 Model Equations and their Economic Interpretations

It can be noted in this study that the derived equations are log-linearised around the steady state. The Euler equation is obtained as a result of the consumer's maximisation problem. The Phillips curve is derived as a result of the maximisation problem of the firms. The monetary policy reaction (equation) is simply a modification of the Taylor Rule. The DSGE model comprises three core equations, stemming from the dynamic interrelationships between the key economic indicators. The DSGE model comprises the following core equations:

i. Output Gap Dynamics:

$$\check{y}_t = E_t[\check{y}_{t+1}] - \frac{1}{\theta} (i_t - E_t[\pi_{t+1}] - r_t^n) + \mu_t^y \quad (1)$$

The output gap \check{y}_t depends on the expected future output gap $E_t[\check{y}_{t+1}]$, the real interest rate $i_t - E_t[\pi_{t+1}]$, where i_t is the nominal interest rate (set by the central bank) and $E_t[\pi_{t+1}]$ is expected inflation, and a demand shock μ_t^y . θ is the elasticity of intertemporal substitution (how willing agents are to substitute consumption across time). This relationship reflects intertemporal consumption choices influenced by interest rates, aligning with the Euler equation for consumption.

ii. Inflation Dynamics (New Keynesian Phillips Curve):

$$\pi_t = \beta E_t[\pi_{t+1}] + \kappa \check{y}_t + \mu_t^p \quad (2)$$

The current inflation rate π_t is influenced by the predicted inflation rate $E_t[\pi_{t+1}]$ and the output gap \check{y}_t . The amount of inflation that results from changes in output is known as the slope of the Phillips curve and its value is represented by κ . The cost-push shock, which includes supply-side shocks, is denoted as μ_t^p (Clarida et al., 2000).

iii. Monetary Policy Rule (Taylor Rule):

$$i_t = \phi_\pi \pi_t + \phi_y \check{y}_t + \mu_t^i \quad (3)$$

Nominal interest rate i_t as set by the central bank is based on inflation and output target parameters. The central bank targets output and inflation, hence the model presented follows the

Taylor rule. The parameters $\phi_\pi \pi_t$ and $\phi_y \tilde{y}_t$ also set how sensitive policies are to changes in the two variables. The other part of the model describes a monetary policy shock μ_t^i .

3.3. Data and Estimation Strategy

We build a small New Keynesian DSGE model with data spanning from 2011 Q1 to 2022 Q4. Before proceeding with the estimation strategy, we conducted some data transformations on the following macroeconomic indicator of interest. Since the output gap is unobserved, it must be computed as the deviation of real output from potential output. Given the absence of trustworthy quarterly data on capital stock and labour input essential for the production function, the Hodrick-Prescott (HP) filter was used. Although endpoint bias, as discussed in (Hamilton, 2018), is one of the famous restrictions of the HP filter, it is still a widely accepted practice in the literature for similar small-open economy models where data is scarce. Output is measured as real gross domestic product (real GDP). Though real GDP data is available at the Bureau of Statistics, it is compiled on an annual basis. As a result, to obtain a quarterly series, the real GDP figures were interpolated using the Linear Interpolation method. The output gap is included to account for the response of domestic economic activity to the exogenous shocks in the model (monetary policy shock, demand shock, and cost-push shock).

The quarterly data balances the dynamic fluctuations while avoiding excessive noise. We conducted preliminary diagnostics, unit root tests, and outlier detection to check for stationary trend and quality shifts. The filtered series \tilde{y}_t , π_t , and i_t are then used in the Bayesian estimation.

3.4. Calibration Strategy

Table 1(a) shows the distribution of the priors, their mean values and the expected range, as well as their standard deviation. Prior expectations and inflation are based on assessment of available empirical and theoretical literature. The persistence and discount factor's parameters are assigned Beta distributions (support $[0,1]$); and the coefficients on the responses to inflation and output employ Gamma distributions (positive support). Standard deviations are established from the estimators' sense of prior uncertainty. Estimation is executed in Dynare using the Metropolis Hastings algorithm with 20,000 draws, Brooks Gelman diagnostics evaluate convergence. The estimation relied on 20,000 draws from the Metropolis-Hastings algorithm. This amount was chosen because we achieved the best trade-off between stability of the posterior distributions and

the efficiency of computation for a small-scale DSGE model. Convergence was formally assessed by Brooks-Gelman diagnostics and certified that the Markov chains attained a stationary distribution.

Table 1 (a): Calibration Strategy

Parameter	Distribution	Prior Mean	Std. Dev.	Support
Elasticity of Substitution θ	Beta	0.55	0.05	[0.1, 0.9]
Discount factor β	Beta	0.95	0.05	[0.8, 0.999]
Phillips curve slope κ	Beta	0.5	0.05	[0.1, 0.9]
Inflation response ϕ_π	Gamma	1.5	0.5	[0.01, 3]
Output response ϕ_y	Gamma	0.5	0.15	[0.01, 3]
Persistence of cost-push shock μ_p	Beta	0.9	0.01	[0.8, 0.999]
Persistence of policy shock μ_i	Beta	0.91	0.01	[0.8, 0.999]

Source: Author Computation, 2024

Table 1 (b): Key Impulse Response Function (IRF) Values and Associated Economic Episodes in Sierra Leone

Shock Type	Variable	Impact	4 Qtrs	8 Qtrs	Long-Run	Peak	Direction	Typical Episode in Sierra Leone
Policy (<i>epsr</i>)	Output (<i>y</i>)	-0.39	-0.343	-0.301	-0.07	-0.39	Negative	2016–2017 monetary tightening
	Inflation (<i>p</i>)	-2.194	-1.93	-1.698	-0.41	-2.194	Negative	2016–2017 monetary tightening
Policy (<i>epsr</i>)	Policy Rate (<i>i</i>)	0.012	0.01	0.009	0.002	0.012	Positive	2016–2017 monetary tightening
Demand (<i>epsy</i>)	Output (<i>y</i>)	0.266	0.246	0.228	0.099	0.266	Positive	Post-Ebola stimulus, donor aid
	Inflation (<i>p</i>)	1.79	1.659	1.538	0.667	1.79	Positive	Post-Ebola stimulus, donor aid
	Policy Rate (<i>i</i>)	0.711	0.659	0.61	0.265	0.711	Positive	Post-Ebola stimulus, donor aid
Cost-Push (<i>epsps</i>)	Output (<i>y</i>)	-0.332	-0.235	-0.166	-0	-0.332	Negative	2014-2015 Ebola, 2021-2022 price shocks
	Inflation (<i>p</i>)	5.123	3.626	2.567	0.058	5.123	Positive	2014-2015 Ebola, 2021-2022 price shocks
	Policy Rate (<i>i</i>)	0.026	0.018	0.013	0	0.026	Positive	2014-2015 Ebola, 2021-2022 price shocks

Note: *epsr* = Monetary policy Shocks, *epsy* = Demand Shocks, and *epsps* = Cost Push Shocks. Key Impulse Response Function (IRF) Values and Associated Economic Episodes in Sierra Leone

Table (1b) provides an overview of the key macroeconomic indicators of Sierra Leone and their responses to various types of economic shocks, showing their impact as well as how it

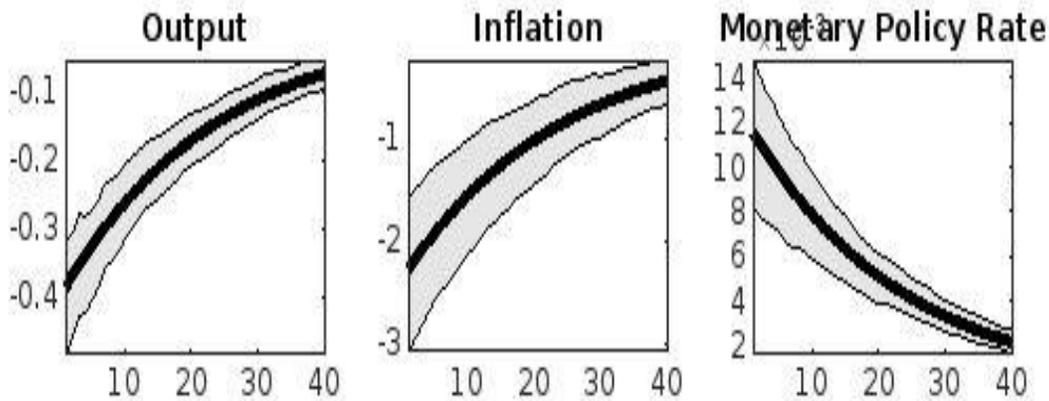
evolves. Exogenous monetary policy shocks (policy tightening) reduce output and inflation in the short run, which, although gradually evolving, persists for some time, capturing episodes like the 2016–2017 tightening. Demand shocks are associated with higher output, inflation, and policy rates, which also counterbalance supply and reinforce expansion. This corresponds to the post-Ebola stimulus period, during which donor aid supported recovery, which led to economic expansion. Cost-push shocks, especially stemming from supply disruptions, ignite sharp and short-lived increases in inflation and moderate policy rate increases, as seen during the Ebola outbreak and more recent surge in global commodity prices.

4. Results and Analysis

In this section, we present the empirical results obtained from the Bayesian-estimated New Keynesian DSGE model for Sierra Leone with emphasis on the impulse response functions (IRFs) of output, inflation, and the monetary policy rate to structural shocks. These results are framed not only in view of theoretical expectations but also in line with Sierra Leone's macroeconomic developments during the sample period (2011Q1–2022Q4), which is marked by persistent external shocks, changes in monetary policy, and high volatility in real and nominal variables. We report all changes in the output gap and inflation in percentage points deviation from their non-stochastic steady state, and changes in the central monetary policy rate were also reported in percentage points.

4.1. Impulse Response Functions (IRFs)

This section of the study explains the impact of structural shocks, including monetary policy shocks, cost-push shocks, and demand shocks, on output, inflation, and the monetary policy rate. The IRFs, which were generated from the Bayesian estimation of the DSGE model for Sierra Leone, are shown in Figure 4 with their confidence bands.

Figure 4: Response to an exogenous monetary policy shock

Source: Author Computation

The impulse response functions (IRFs) shown in Figure 4 are the responses of the output gap (\check{y}_t), inflation (p) and the policy interest rate (i) to an exogenous monetary policy shock.

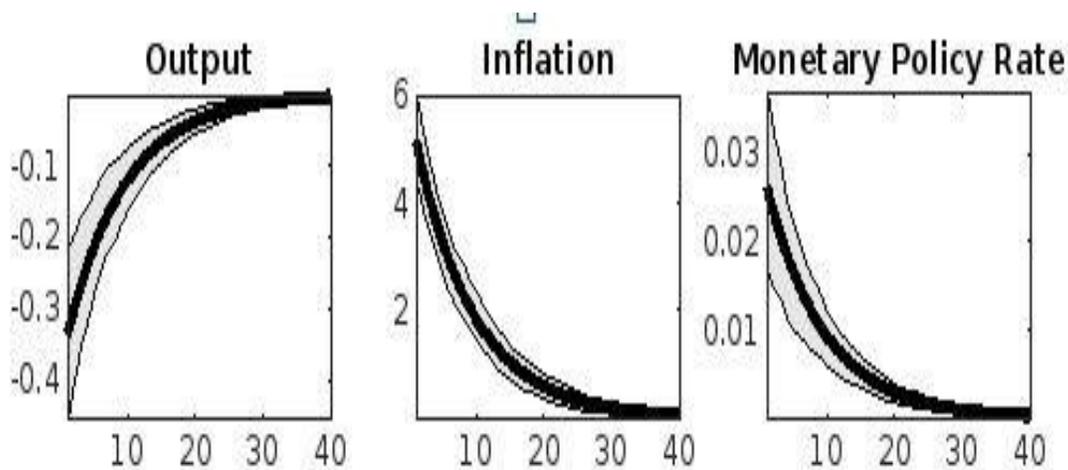
Policy Rate (i_t): following the shock, the policy rate increases by about 0.012 percentage points immediately, as dictated by the model's policy rule, before reverting slowly toward its steady state. This gradual adjustment reflects the real-world inertia observed in the Bank of Sierra Leone's operational framework, where policy changes are typically implemented cautiously and remain in effect for several quarters to anchor expectations.

Output Gap (\check{y}_t): In response to the monetary policy shock shows an impact of one-standard-deviation contractionary hike of the policy rate and the responsive dynamics. The output gap contracts sharply immediately with an output decline of approximately 0.39 percentage points. This is followed by a persistent and gradually diminishing negative impact over several quarters, which is consistent with the traditional transmission mechanism where borrowing costs restrain consumption and investment.

Inflation (π_t): On the other hand, inflation responds even more immediately by falling over 2.19 percentage points of the trend value instantly after the monetary tightening and remaining below its trend level for several years while declining in magnitude. This indicates the effectiveness of contractionary monetary policy in controlling demand-driven inflationary pressures.

These results strongly validate the significant empirical experiences and evolving New Keynesian model theories, in particular, the analytical work conducted on Sierra Leone during periods of policy tightening. For example, in 2016-2017 and later in 2020, the Bank of Sierra Leone faced rising inflation and currency pressures and thus decided to increase the policy rates, thus leading to a drastic reduction in the GDP growth rate and restraining inflationary control (IMF, 2017). Following both monetary policy contractions, official data showed slowdowns in real GDP growth, which were followed, for some time, by inflation moderation. The model underlying estimates of the real shock suggests that, although shallow in nature, the financial intermediation structure enables the efficient transmission of monetary policy beyond inflation and real activity in Sierra Leone's economy. According to Johnson (2022); Barrie and Jackson (2022), monetary policy shocks account for a substantial share of output adjustment, and the transmission mechanism occurs through economic activities and inflation.

Figure 5: Response to an exogenous Cost-Push Shock



Source: Author Computation

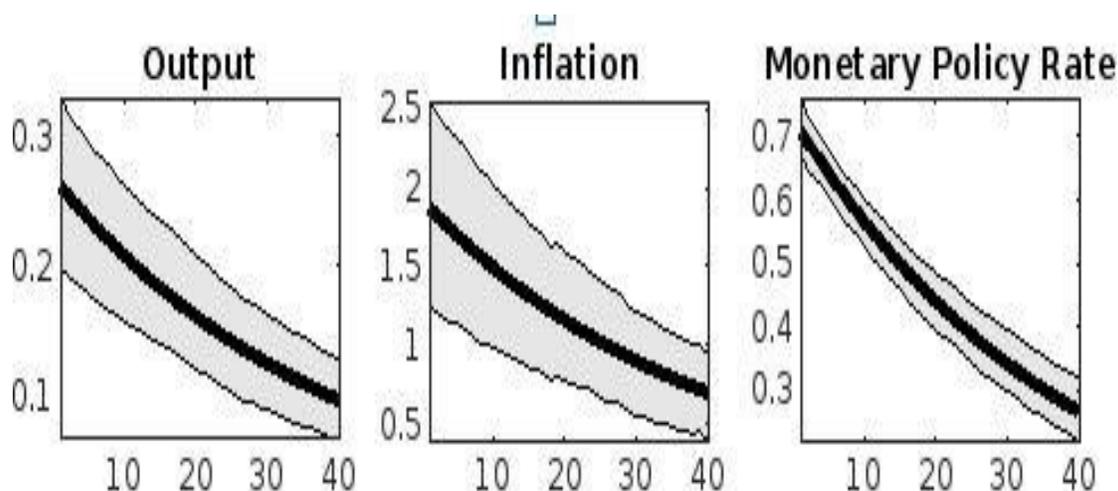
The impulse response functions presented in Figure 5 portray the aftermath of a cost-push shock (ϵ_{psp}) on the output gap (\check{y}_t), inflation (p) and the monetary policy rate (i). A cost-push shock has a positive impact on inflation in that it causes a large and significant increase in the overall price level, which, over time, tightens monetary policy and is accompanied by output declines (recession). The high prices tend to adversely impact aggregate demand initially; hence, output drops off.

Inflation (p): The most extreme reactions occur with cost-push (supply-side) shocks. The model shows that a one-standard-deviation increase in the cost-push shock results in inflation jumping by +5.12 percentage points above its normal level. This increase is noteworthy and mirrors the direct effect of supply-side pressures on prices. The effect of the inflationary pressure persists over several periods and then dissipates over time.

Output (\check{y}_t): output simultaneously contracts by -0.33 percentage points below its normal steady state trend value. This negative impact is a standard feature of adverse supply-side shocks, where an increase in the input costs constrains production and results in a reduction in aggregate supply. The negative response output persists over several quarters and then diminishes over time.

Policy Rate (i): In response to the high upsurge in inflation, the monetary policy rate increases slightly by 0.026 percentage points, but this response is relatively modest considering how much inflation is expected to rise. This suggests that the monetary policy rate has a limited ability to offset significant supply-side shocks.

This describes exactly Sierra Leone's historical vulnerability to external supply shocks, including the Ebola crisis in 2014-2015, the commodity price increase in 2015, and the fuel and food price shocks in 2021-2022. Despite the cost-push shock pushing inflation to increase more than five (5) percentage points at impact, the monetary policy response was inadequate (0.03%). Moreover, as shown in Figure 4, the results indicate that a monetary policy shock, which increased the monetary policy rate by 12%, led to inflation declining by more than 2% (indicating the effectiveness of monetary policy in fighting inflation in SL). These findings are consistent with the findings of Barrie and Jackson (2022), who confirm that cost-push shocks are the primary forces driving inflationary pressure in Sierra Leone.

Figure 6: Response to an exogenous Demand Shock

Source: Author Computation

The impulse response functions (IRFs) displayed in Figure 6 describe the consequences of a positive demand shock (ϵ_{psy}) to the output gap (\check{y}_t), inflation rate (p), and the monetary policy rate (i). After the demand shock, the output gap (\check{y}_t) initially experiences an upward and transitory movement before settling back to the steady-state level. Demand shock leads to a positive output gap, inflation increases, and the central bank responds by increasing the policy rate to control inflation.

Output gap (\check{y}_t): In response to the positive demand shock, the output gap experiences an abrupt and temporary upward trend, increasing by approximately 0.27 percentage points above its normal steady state level. This initial increase persists over several quarters and gradually decays over time as the economy adjusts.

Inflation (p): An increase in government expenditure or an unexpected upsurge in exports would cause a demand shock, which would cause inflation to rise simultaneously. In this scenario, inflation would be expected to rise by 1.79 percentage points above its trend level. This positive inflationary shock persists over several periods and gradually diminishes in response to the central bank's actions.

Policy Rate (i): In response to the upward inflationary pressure and increasing output, the policy rate was increased by the central bank to approximately 0.71 percentage points. An increase in the policy rate reflects the central bank's response in controlling demand-induced inflation with

the primary aim of stabilising the economy. Overtime, the central bank gradually reduces the policy rate gradually to its steady state level as the inflationary pressure declines to its steady state value.

The above-mentioned patterns effectively capture Sierra Leone’s macroeconomic trends in the aftermath of the Ebola outbreak (2016-2017). The country experienced a temporary boom in output coupled with rapid inflation resulting from massive fiscal spending and increased donor aid. Expansionary periods are often observed in Sierra Leone, typically following a rise in commodity exports or an inflow of external aid, and are often accompanied by tighter policies. The impulse response function (IRFs) illustrates the crucial need for fiscal authorities to work together collaboratively to avoid overheating the economy and excessive inflation while sustaining real growth. Similarly, our findings with studies conducted in similar Sub-Saharan African countries, where the inflows of foreign aid and the use of expansionary fiscal policy produce transitory growth risk stickiness in the economy, Houssa & Henderson (2010).

Table 2: Posterior Parameter Estimates

Parameter	Prior Mean	Posterior Mean	Std. Dev.	90% HPD Interval
θ	0.55	0.7152	0.027	[0.672, 0.759]
β	0.95	0.9426	0.024	[0.905, 0.983]
κ	0.5	0.5454	0.048	[0.464, 0.622]

Source: Author Computation, 2024

Table 2 presents the posterior estimates of key structural parameters in the estimated NK DSGE model. The results indicate that the inverse elasticity of intertemporal substitution (θ), the discount factor (β), and the slope of the Phillips curve (κ) are all tightly estimated, with posterior means of 0.7152, 0.9426, and 0.5454, respectively. The 90% highest posterior density (HPD) intervals for these parameters are relatively narrow, reflecting high statistical precision and strong identification given the data. Notably, the posterior mean of the discount factor (β) remains close to the prior mean, implying agents exhibit a high degree of patience consistent with standard macroeconomic theory. The slope (κ) of the estimated Phillips curve suggests moderate nominal rigidity in price adjustment. Overall, these parameter estimates provide a credible empirical foundation for the subsequent impulse response and forecast analysis, ensuring that the model’s dynamic properties are consistent with both theoretical expectations and the realities of Sierra Leone’s macroeconomy.

Table 3: Variance Decomposition of Structural Shocks

Variable	Demand (μy)	Cos push (μp)	Policy (μr)
Output	37.48%	13.99%	48.53%
Inflation	25.84%	50.77%	23.39%
Interest Rate	99.95%	0.03%	0.02%

Notes: (μy) denoted demand shock, (μp) represents cost push shock, and (μr) denotes the policy rate. Source: Author Computation

Table 3 reports the asymptotic (long-run) variance decomposition, which measures the relative contribution of each structural shock to the total unconditional variance of the variables. Results for the structural shocks in the estimated DSGE model, highlighting the relative importance of demand, cost-push, and policy shocks in driving macroeconomic fluctuations in Sierra Leone. The findings reveal that policy shocks account for the largest share of output variance (48.53%), followed by demand shocks (37.48%), while cost-push shocks play a more limited role in output dynamics (13.99%). In contrast, cost-push shocks emerge as the dominant source of inflation variability (50.77%), consistent with the country's exposure to external supply disturbances such as commodity price swings and import dependency. Demand and policy shocks also contribute to inflation variance, but to a lesser extent. Strikingly, the interest rate is almost entirely explained by demand shocks (99.95%), with negligible contributions from cost-push and policy shocks. These results underscore the central role of monetary policy and aggregate demand in shaping real activity, while also emphasising the need to address structural vulnerabilities that expose inflation to supply-side disturbances.

5. CONCLUSIONS AND POLICY RECOMMENDATIONS

5.1. Conclusions

This study employed a Bayesian-estimated New Keynesian DSGE model to assess the impact of nominal shocks, including monetary policy, demand, and cost-push shocks, on Sierra Leone's macroeconomic variables. The analysis showed, through empirical testing, that higher monetary policy rates reduced inflation and output, which confirms the role of monetary policy in economic stabilisation, especially in controlling demand-induced fluctuations in inflation. It was also established that demand shocks lead to a temporary increase in output and inflation, followed by a gradual dissipation as the economy reverts to its steady state. Furthermore, the interaction

between cost-push shocks and inflation was found to be dominant: supply shocks (attributable to external inflationary pressures) tend to fuel domestic inflation, which then results in contractionary monetary policy and reduced output. The accuracy with which the model's predicted trajectories aligned with historical data attests to its empirical adequacy and practical relevance for macroeconomic policy evaluation.

The study findings confirm the theoretical views of the New Keynesian framework in a small, open developing economy that is commodity dependent. Findings from the study further confirm that the Bank of Sierra Leone has practical monetary tools to manage demand-driven fluctuations and manage inflation expectations. However, the model also demonstrates the limited effectiveness of monetary policy concerning persistent cost-push (supply-side) shocks. These types of shocks are often dominated by external developments in commodity prices or domestic supply constraints, which, as the variance decomposition results show, continue to be the dominant factors of inflation volatility in Sierra Leone. The impulse response analysis showcases the impacts of shocks, thereby highlighting the need for additional comprehensive policies to support the monetary policy stance in the fight against inflation and macroeconomic instability.

5.2. Policy Recommendations

The macroeconomic management policies of Sierra Leone can be informed by the empirical findings highlighted in this study. The proposed recommendations aimed to strengthen macroeconomic policy, advance policy credibility, and develop responsive fiscal measures, including flexible exchange rates and structural supply-side reforms designed to mitigate systemic vulnerabilities, thus deepening the empirical rationale for a potent multi-layered stabilisation framework in Sierra Leone. The building of fiscal and foreign exchange buffers would also strategically improve resilience to future shocks, alongside bolstering revised macroscale institutional frameworks. Focusing on increasing policy credibility would help mitigate Sierra Leone's rising inflation. Ultimately, the research expands the frontiers of macroeconomic modelling in West Africa while also providing policymakers in Sierra Leone's with sustainable development and growth policy alternatives to policymakers in Sierra Leone. We propose the following policy recommendations to help improve macroeconomic stability in Sierra Leone:

- **Strengthen Monetary Policy Responsiveness to Demand Shocks:** We recommend that the Bank of Sierra Leone should continue to reinforce its monetary instruments,

particularly the policy rate, to efficiently counter demand and policy-induced inflationary pressures to control output volatility. As aggregate demand increases, for example, through fiscal spending, donor funds, or export booms, increases in the policy rate help reduce output volatility and ensure inflation remains within the central Bank's desired level. This aligns with Sierra Leone's historical experiences, especially during the post-Ebola recovery period, where expectational monetary tightening during stimulus spending would strengthen price stability.

- **Invest in Supply-Side Resilience and Economic Diversification:** findings from the study suggest that global food and fuel price inflation, supply chain disruptions, or external cost push shocks are the leading forces driving inflationary pressure in Sierra Leone. Since the effect of the policy rate changes is limited due to Sierra Leone's dependence on imported commodities and the shallow structure of the domestic financial market. The study therefore recommends that the central bank should prioritise supply-side interventions, with a key focus on economic diversification, improvement of the agriculture and energy sectors, as well as strengthening the logistical infrastructure to withstand external shocks.
- **Enhance Monetary-Fiscal Policy Coordination and Real-Time Responsiveness:** The model's impulse response functions demonstrate that the policy rate reacts strongly and almost instantaneously not only to demand shocks, but also to cost-push inflation. This highlights the need for Sierra Leone's central bank to employ a more proactive, policy risk-assessment approach that relies on accurate forecasting and swift policy adaptation to emerging risks in real-time. This study further recommends that the central bank must coordinate closely with the fiscal authorities to smooth the economy by subsidising essential goods, commanding targeted social safety net programs, or directly financing inflation in times of price surge. Such coordination will ensure that stabilisation efforts are efficient and timely.
- **Strengthen Macroeconomic Institutions and Build Policy Credibility:** The persistent effects of both demand and supply shocks, as documented by the model, further reinforce the need to strengthen Sierra Leone's macroeconomic institutions. The slow return of output and inflation to trend after-shocks reflects the presence of structural rigidities, limited policy credibility, and challenges in information dissemination. The study recommends that the central bank prioritise building credible and transparent

communication strategies, reinforcing the independence and capacity of the central bank, and accumulating fiscal and foreign exchange buffers during periods of stability. Such buffers are vital for enabling counter-cyclical interventions and for safeguarding macroeconomic stability during future shocks.

REFERENCES

- An, S., & Schorfheide, F. (2007). Bayesian analysis of DSGE models. *Econometric Reviews*, 26(2–4), 113–172.
- Akosah, N. K. (2020). Estimated DSGE model for macroeconomic analysis in a small-open economy: A Ghanaian perspective (SSRN Scholarly Paper No. 3709360). Social Science Research Network.
- Baldini, G., Camilleri, M., Ercolani, V., & Vlcek, J. (2014). Monetary policy and the banking sector in Zambia: A DSGE approach (IMF Working Paper No. 14/195). International Monetary Fund.
- Barrie, M. S., & Jackson, E. A. (2022). Impact of technological shock on the Sierra Leone economy: A dynamic stochastic general equilibrium (DSGE) approach. Munich Personal RePEc Archive. <https://mpra.ub.uni-muenchen.de/113636/>
- Barrie, M. S., & Jackson, E. A. (2023). Financial frictions and monetary policy reaction in Sierra Leone: A Bayesian DSGE approach (working paper). Retrieved from https://www.researchgate.net/publication/388750519_Financial_Frictions_and_Monetary_Policy_Reaction_in_Sierra_Leone_A_Bayesian_DSGE_Approach.
- Barrie, M. S., & Bah, M. A. (2022). Simulating tax effects on economic activities in Sierra Leone: A DSGE framework. *Economic Insights – Trends and Challenges*, 11(4), 107–124. <https://doi.org/10.51865/EITC.2022.04.07>.
- Blanchard, O. J., & Perotti, R. (2002). An empirical characterization of the dynamic effects of changes in government spending and taxes on output. *The Quarterly Journal of Economics*, 117(4), 1329–1368.
- Calvo, G. A. (1983). Staggered prices in a utility-maximizing framework. *Journal of Monetary Economics*, 12(3), 383–398.
- Christiano, L. J., Eichenbaum, M., & Evans, C. L. (2005). Nominal rigidities and the dynamic effects of a shock to monetary policy. *Journal of Political Economy*, 113(1), 1–45.
- Clarida, R., Galí, J., & Gertler, M. (1999). The science of monetary policy: A new Keynesian perspective. *Journal of Economic Literature*, 37(4), 1661–1707.
- Clarida, R., Galí, J., & Gertler, M. (2015). Monetary policy rules and macroeconomic stability: Evidence and some theory. *The Quarterly Journal of Economics*, 115(1), 147–180.
- Daboh, F., & Duramany-Lakkoh, E.K (2023): “Performance Evaluation of The Sierra Leone Banking Sector Using Camel Rating Framework”. This paper evaluates the performance of the Sierra Leone banking sector using the CAMEL rating framework.
- Daboh, F., & Jackson, E. A (2023): “Effects of Interest Rates Volatility on Money Demand in Sierra Leone: An ARDL and Bounds Testing Model”. This study examines the structural relationship between money supply, inflation, and economic growth in Sierra Leone using the Vector Autoregressive (VAR) model.
- Daboh, F., Duramany-Lakkoh, E. K., & Knox-Goba, T. L. (2024). Analysing the Structural Relationship between Money Supply, Inflation, and Economic Growth in Sierra Leone: A VAR Model Approach.

- Daboh, F., Kur, K.K. & Knox-Goba, T.L. Exchange rate volatility and macroeconomic stability in Sierra Leone: using EGARCH and Markov switching regression. *SN Bus Econ* 5, 111 (2025). <https://doi.org/10.1007/s43546-025-00882-z>.
- Galí, J. (2015). *Monetary policy, inflation, and the business cycle: An introduction to the New Keynesian framework and its applications* (2nd ed.). Princeton University Press.
- IMF. (2017). *Sierra Leone: Staff report for the 2017 Article IV consultation*. International Monetary Fund.
- Houssa, R., Badunenko, O., & Henderson, D. J. (2010). *Explaining African Growth Performance: A Production-Frontier Approach*.
- Jidou, A. (2022). *Business cycles in Côte d'Ivoire: A DSGE approach* (IMF Working Paper No. 22/105). International Monetary Fund.
- Johnson, L. N. (2022). Financial frictions and monetary policy shocks in Sierra Leone: Dynamic stochastic general equilibrium model. *Ilorin Journal of Economic Policy*, 9(2), 78–96. <https://www.econstor.eu/handle/10419/310037>.
- Karingi, S. N., & Wabomba, M. N. (2015). *Monetary policy effectiveness in Uganda: A DSGE approach* (Working Paper No. 2015/007). Bank of Uganda.
- Kydland, F. E., & Prescott, E. C. (1982). Time to build and aggregate fluctuations. *Econometrica*, 50(6), 1345–1370. <https://www.jstor.org/stable/1913386>.
- Liu, Z., & Molis, B. (2020). *A DSGE model for South Africa with a segmented labour market and tradable/nontradable sectors* (IMF Working Paper No. 20/21). International Monetary Fund.
- Mkai, A., & Aikaeli, J. (2020). Monetary policy transmission in East African Community countries: A DSGE approach. *Journal of Economic Integration*, 35(2), 269–295.
- Oye, M. A., & Alege, P. O. (2022). Fiscal-monetary policy interaction in Nigeria: A New Keynesian DSGE approach. *Journal of Policy Modelling*, 44(4), 779–800.
- Rasaki, Y., & Malikane, C. (2015). Monetary DSGE model for a group of African countries. *Journal of Economic Modelling*, 46, 156–174.
- Rotemberg, J. J., & Woodford, M. (1997). An optimisation-based econometric framework for the evaluation of monetary policy. In B. S. Bernanke & J. J. Rotemberg (Eds.), *NBER macroeconomics annual 1997* (Vol. 12, pp. 297–362). MIT Press.
- Shobande, O., Shodunke, A., Adejumo, O., & Owolabi, O. (2019). Monetary policy and economic growth in Kenya: A New Keynesian DSGE approach. *African Journal of Economic and Management Studies*, 10(1), 108–126.
- Smets, F., & Wouters, R. (2003). An estimated dynamic stochastic general equilibrium model of the euro area. *Journal of the European Economic Association*, 1(5), 1123–1175.
- Steinbach, R., Mathuloe, V., & Smit, B. (2009). *A small open economy DSGE model for South Africa* (Working Paper No. WP/09/200). South African Reserve Bank.

Tamuke, E. C. E., & Barrie, A. S. I. (2021). Analysing monetary policy and productivity shocks on output, inflation, and monetary policy rate in Sierra Leone: A DSGE approach. *West African Economic and Financial Review (WAFER)*, 21(2), 141–148.

Taylor, J. B. (1993). Discretion versus Policy Rules in Practice. *Carnegie-Rochester Conference Series on Public Policy*, 39, 195-214. [https://doi.org/10.1016/0167-2231\(93\)90009-L](https://doi.org/10.1016/0167-2231(93)90009-L).

APPENDICES

3 Model Derivations and Foundations

In this section, we outline the basis of the New Keynesian DSGE model used in this study. We derive the main NK DSGE model, which encompasses household actions, the firm's markup policies, equilibrium in the goods market, and the aggregates behavior of the economy. These derivations guarantee that the empirical investigation is grounded on a sound micro-founded architecture that embodies expectations, nominal stickiness, and the channels of monetary policy impact on the economy. CRRA is chosen because it persuasively captures wealth-dependent risk aversion, enables intertemporal investigation, and makes parallel with typical macroeconomic and DSGE frameworks, unlike CARA, CES, or Cobb-Douglas, which also distort risk behaviour.

3.1 Household Problem

3.1.1. Preferences and Budget Constraint

We start with the representative household that decides on consumption and labour to maximise the expected lifetime utility. Utility is given as:

$$U = E_0 \sum_{t=0}^{\infty} \beta^t \left[\frac{C_t^{1-\sigma}}{1-\sigma} - \frac{N_t^{1+\varphi}}{1+\varphi} \right] \quad 1$$

Where $\beta \in (0,1)$ is the discount factor, $\sigma > 0$ determines the risk aversion to consumption fluctuations, and $\varphi > 0$ governs labour supply elasticity.

As a representative household, Consumption is aggregated over a continuum of differentiated goods:

$$C_t = \left(\int_0^1 C_t(i)^{1-\frac{1}{\varepsilon}} di \right)^{\frac{\varepsilon}{\varepsilon-1}} \quad 2$$

with elasticity of substitution $\varepsilon > 1$.

The per-period budget constraint is:

$$\int_0^1 P_t(i) C_t(i) di + Q_t B_t \leq B_{t-1} + W_t N_t + T_t \quad 3$$

Where $P_t(i)$ is the price of the good i , Q_t is the bond price, B_t are bond holdings, W_t is the nominal wage, N_t is the labour supply and T_t are lump-sum transfers. A standard transversality condition ensures no Ponzi schemes.

3.2 Demand for Individual Goods

Define total consumption expenditure:

$$E_t \equiv \int_0^1 P_t(i) C_t(i) di$$

The household seeks allocation $\{C_t(i)\}$ such that expenditure is minimised while the aggregate consumption C_t is achieved. The cost minimisation problem is:

$$\min_{\{C_t(i)\}} \int_0^1 P_t(i) C_t(i) di$$

Subject to;

$$C_t = \left(\int_0^1 C_t(i)^{\frac{\varepsilon-1}{\varepsilon}} di \right)^{\frac{\varepsilon}{\varepsilon-1}}$$

Form the Lagrangian:

$$\mathcal{L} = \left(\int_0^1 C_t(i)^{\frac{\varepsilon-1}{\varepsilon}} di \right)^{\frac{\varepsilon}{\varepsilon-1}} - \lambda_t \left(\int_0^1 P_t(i) C_t(i) di - E_t \right)$$

Taking the FOC with respect to $C_t(i)$;

$$\frac{\partial \mathcal{L}}{\partial C_t(i)} = \left(\int_0^1 C_t(j)^{\frac{\varepsilon-1}{\varepsilon}} dj \right)^{\frac{1}{\varepsilon-1}} C_t(i)^{-\frac{1}{\varepsilon}} - \lambda_t P_t(i) = 0$$

Noting that

$$C_t^{\frac{1}{\varepsilon}} = \left(\int_0^1 C_t(j)^{\frac{\varepsilon-1}{\varepsilon}} dj \right)^{\frac{1}{\varepsilon-1}}$$

we solve for the individual demand function:

$$C_t(i) = \left(\frac{P_t(i)}{P_t} \right)^{-\varepsilon} C_t, \quad P_t = \left(\int_0^1 P_t(i)^{1-\varepsilon} di \right)^{\frac{1}{1-\varepsilon}} \quad 4$$

Substituting back the result yields the total expenditure $P_t C_t$ which makes the budget constraint to be simplified as:

$$P_t C_t + Q_t B_t \leq B_{t-1} + W_t N_t + T_t \quad 5$$

3.3 First-Order Conditions

3.3.1 Intertemporal Euler Equation

The Lagrangian problem for the household is thus written as;

$$\mathcal{L} = E_0 \sum_{t=0}^{\infty} \beta^t [U(C_t, N_t) - \mu_t (P_t C_t + Q_t B_t - B_{t-1} - W_t N_t - T_t)]$$

Here μ_t represent the multiplier on the budget constraint. FOC w.r.t. B_t ;

$$\frac{\partial \mathcal{L}}{\partial B_t} = -\beta^t \mu_t Q_t + \beta^{t+1} E_t [\mu_{t+1}] = 0 \Rightarrow Q_t = \beta^t E_t \left[\frac{\mu_{t+1}}{\mu_t} \right]$$

Since $\mu_t = U_C(C_t, N_t)$ and accounting for price levels P_t ,

$$Q_t = \beta E_t \left[\frac{U_C(C_{t+1}, N_{t+1})}{U_C(C_t, N_t)} \frac{P_t}{P_{t+1}} \right] \quad 6$$

3.3.2 Intertemporal Labor Supply

FOC w.r.t. N_t

$$\frac{\partial \mathcal{L}}{\partial N_t} = \beta^t [U_N(C_t, N_t) - \mu_t(-W_t)] = 0 \Rightarrow -\frac{U_N(C_t, N_t)}{U_C(C_t, N_t)} = \frac{W_t}{P_t}$$

3.3.3 Specialization to CRRA Utility

With $U_C(C_t, N_t) = C_t^{-\sigma}$ and $U_N(C_t, N_t) = -N_t^\varphi$

the Euler and labor conditions become;

$$Q_t = \beta E_t \left[\left(\frac{C_{t+1}}{C_t} \right)^{-\sigma} \frac{P_t}{P_{t+1}} \right] \quad 7$$

The intertemporal condition becomes

$$-\frac{-N_t^\varphi}{C_t^{-\sigma}} = \frac{W_t}{P_t} \Rightarrow \frac{N_t^\varphi}{C_t^{-\sigma}} = \frac{W_t}{P_t} \quad 8$$

3.4. Log-Linearization of Household Conditions

3.4.1. Log-Linearising the Intertemporal (Labour Supply) Condition

$$\frac{N_t^\varphi}{C_t^{-\sigma}} = \frac{W_t}{P_t}$$

Taking logs of both sides gives:

$$\log \left(\frac{W_t}{P_t} \right) = \log(c_t^\sigma) + \log(N_t^\varphi) = \sigma \log C_t + \varphi \log N_t$$

Now, by defining the lower-case variables as log-deviations (for example, $c_t = \log C_t - \log \bar{C}$, where \bar{C} is the steady state consumption, we can write:

$$w_t - p_t = \sigma c_t + \varphi n_t \quad 9$$

which is the log-linearised intertemporal condition.

3.4.2. Log-Linearising the Intertemporal Euler Equation

The Euler equation in levels is given by

$$Q_t = \beta E_t \left[\left(\frac{C_{t+1}}{C_t} \right)^{-\sigma} \frac{P_t}{P_{t+1}} \right]$$

Recall that the short-term nominal interest rate is defined by

$$i_t \equiv -\log Q_t$$

and the discount rate by

$$\rho \equiv -\log \beta$$

Taking logs (and using a first-order Taylor expansion around the steady state) yields an approximation of the form:

$$-\log Q_t \approx -\log \beta + \sigma E_t(\log C_{t+1} - \log C_t) - E_t(\log P_{t+1} - \log P_t)$$

Rewriting the price term as the expected inflation rate, $\pi_{t+1} \equiv P_{t+1} - P_t$, and substituting the definitions, we rearrange the equation to obtain:

$$c_t = E_t\{c_{t+1}\} - \frac{1}{\sigma}(i_t - E_t\{\pi_{t+1}\} - \rho) \quad 10$$

which is the log-linearized intertemporal condition.

3.4.3. The Log-Linear Money Demand Equation

An ad-hoc money demand relation is assumed in the log-linear form:

$$m_t - p_t = y_t - \eta i_t \quad 11$$

Where m_t is the log of the nominal money stock, p_t is the log price level, y_t is the log of output, and η is a parameter capturing the sensitivity of money demand to the nominal interest rate. This equation is introduced to close the model and is taken as given.

3.5. Firms and Calvo Pricing

3.5.1. Technology and Demand

Each firm i produces;

$$Y_t(i) = A_t N_t(i)^{1-\alpha}$$

With common technology A_t and labor $N_t(i)$. Demand is;

$$C_t(i) = \left(\frac{P_t(i)}{P_t} \right)^{-\varepsilon} C_t$$

3.5.2. Calvo Price Setting

With the Calvo (1983) pricing, a fraction of the firm $1 - \theta$ reoptimize prices in each period. The aggregate price index evolves as

$$P_t^{1-\varepsilon} = [\theta(P_{t-1})^{1-\varepsilon} + (1 - \theta)(P_t^*)^{1-\varepsilon}] \quad 12$$

Linearising around the steady state zero inflation, thus gives

$$\pi_t = (1 - \theta)(P_t^* - P_{t-1}), \quad \pi_t = P_t - P_{t-1} \quad 13$$

3.5.3. Optimal Price Reset

A firm resetting at t chooses P_t^* to maximize;

$$\max_{P_t^*} \sum_{k=0}^{\infty} \theta^k E_t \{ Q_{t,t+k} (P_t^* Y_{t+k/t}) - \Psi_{t+k}(Y_{t+k/t}) \}$$

subject to

$$Y_{t+k/t} = \left(\frac{P_t^*}{P_{t+k}} \right)^{-\varepsilon} C_{t+k}$$

FOC gives

$$\sum_{k=0}^{\infty} \theta^k E_t \{ Q_{t,t+k} Y_{t+k/t} (P_t^* - \mu mc_{t+k/t}) \} = 0 \quad 14$$

Where $\mu = \varepsilon / (\varepsilon - 1)$ and $mc_{t+k/t} = \Psi'_{t+k} Y_{t+k/t}$ is marginal cost.

3.6.4 Log-Linear Price Condition

Let $\widehat{mc}_t = mc_t - \overline{mc}$, $\gamma = \beta\theta$ Then normalising by P_{t-1} :

$$P_t^* - P_{t-1} = (1 - \gamma) \sum_{k=0}^{\infty} \gamma^k E_t \{ \widehat{mc}_{t+k} + (P_{t+k} - P_{t-1}) \}$$

3.6. Market Equilibrium and Dynamics

3.6.1. Goods Market Clearing

Market-clearing implies $Y_t(i) = C_t(i)$ for all i , so;

$$Y_t = C_t = \left(\int_0^1 Y_t(i)^{\frac{\varepsilon-1}{\varepsilon}} di \right)^{\frac{\varepsilon}{\varepsilon-1}} \quad 15$$

3.6.2. Dynamic IS Curve

Combining the Euler equation 10 with clearing yields;

$$y_t = E_t(y_{t+1}) - \frac{1}{\sigma} (i_t - E_t(\pi_{t+1}) - \rho) \quad 16$$

3.6.3 Production Relation

Log-linearizing $Y_t = A_t N_t^{1-\alpha}$ define the relationship between output, employment, and technology gives

$$y_t = a_t + (1 - \alpha)n_t \quad 17$$

3.6.4 New Keynesian Phillips Curve

Define the output gap $\tilde{y}_t = y_t - y_t^n$ and real marginal cost deviation \widehat{mc}_t . Then;

$$\pi_t = \beta E_t(\pi_{t+1}) + \lambda \tilde{y}_t + q_t \quad 18$$

Where; $\lambda = \frac{(1-\theta)(1-\beta\theta)}{\theta} \frac{1-\alpha}{1-\alpha+\alpha\varepsilon}$

3.7.5. Natural Rate and Output

Natural output and rate satisfy;

$$y_t^n = \psi_{ya}^n a_t + v_y^n,$$

where r_t^n denotes the natural interest rate and is expressed as follows:

$$r_t^n = \rho + \sigma \psi_{ya}^n E_t(\Delta a_{t+1})$$

(more inquisitive readers are referred to Galí (2008)).

3.6.6. Output Gap IS Curve

Another element of the NK DSGE model is the dynamic IS curve, which is obtained by incorporating the output gap in the expression $y_t = E_t(y_{t+1}) - \frac{1}{\sigma}(i_t - E_t(\pi_{t+1}) - \rho)$:

$$\tilde{y}_t = E_t(\pi_{t+1}) - \frac{1}{\sigma}(i_t - r_t^n) + E_t(\tilde{y}_{t+1}) \tag{19}$$

3.6.7. Monetary Policy

The central bank sets;

$$i_t = \rho_i i_{t-1} + (1 - \rho_i)(\rho + \phi_\pi \pi_t + \phi_y \tilde{y}_t) + \epsilon_t^r \tag{20}$$

The captured relationships of the New Keynesian Phillips Curve and the Dynamic IS Curve that define the model economy have been derived. These relationships, in conjunction with a monetary policy rule, provide a consistent framework that encapsulates the responsive interactions of output, inflation, and interest rates over time.

