

A Service of



Leibniz-Informationszentrum Wirtschaft Leibniz Information Centre for Economics

Jackson, Emerson Abraham; Barrie, Mohamed Samba

Article — Published Version Financial frictions and monetary policy reaction in Sierra Leone: a bayesian DSGE approach

West African Financial and Economic Review

Suggested Citation: Jackson, Emerson Abraham; Barrie, Mohamed Samba (2023) : Financial frictions and monetary policy reaction in Sierra Leone: a bayesian DSGE approach, West African Financial and Economic Review, ISSN 0263-0699, West African Institute for Financial and Economic Management (WAIFEM), Lagos, Nigeria, Vol. 23, Iss. 1, pp. 43-83, https://www.waifem-cbp.org/WAFER%20Vol%2023%20No%201.pdf

This Version is available at: https://hdl.handle.net/10419/310037

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.



WWW.ECONSTOR.EU

FINANCIAL FRICTIONS AND MONETARY POLICY REACTION IN SIERRA LEONE: A BAYESIAN DSGE APPROACH

Emerson Abraham Jackson¹ and Mohamed Samba Barrie²

Abstract

This paper uses a Bayesian estimation approach to examine the behavior of the Sierra Leone's economy by creating a small-open economy DSGE model that includes financial frictions. The study utilises a New Keynesian framework to examine the actions of diverse economic agents, such as households, enterprises, the monetary authority, and the financial sector. The primary aim is to assess the model's realism in representing the monetary policy transmission in Sierra Leone. The results indicate that monetary policy shocks are temporary and that the Bank of Sierra Leone ought to increase policy rates in reaction to elevated inflation. Nonetheless, there are deficiencies in the transmission of monetary policy, rendering it ineffectual in regulating inflation or stimulating productivity. Depreciation of the exchange rate results in a significant transmission of imported inflation. The paper indicates that financial frictions do not affect output, inflation, or the monetary policy rate. The findings offer valuable insights for policymakers and underscore the advantages and constraints of monetary policy in regulating inflation and stimulating output in Sierra Leone.

Keywords: Financial Frictions, Bayesian DSGE Model, Open economy, Sierra Leone.

JEL Classification: E12, E32, E52, G01

1.0 Introduction

The notion of financial frictions and their possible influence on global economic business cycle variations has received considerable scrutiny following the financial crisis of 2007-09. A plethora of studies utilising Dynamic Stochastic General

¹ Special Economic Assistant (SEA), Governor's Office, Bank of Sierra Leone.

² Research Economist, Macroeconomic Research Division, Research and Statistics Department, Bank of Sierra Leone

Equilibrium (DSGE) modelling has arisen to analyse the efficacy of financial systems (Gerali et al., 2010; Merola, 2015; Atenga et al., 2021; Lyu et al., 2023). Numerous research works sought to elucidate the origins of financial frictions (Gerali et al., 2010), whereas others, such Brunnermeir and Pedersen (2009), examined the impact of liquidity crises associated with elevated Non-Performing Loans (NPLs). Bernanke (2012) and his associates (Bernanke, Gertler, & Gilchrist, 1999) have been essential in elucidating the micro-foundations of financial frictions linked to crises and examining the central bank's reaction to issues of monetary and financial stability.

Financial frictions, linked to elevated NPLs, reflect inefficiencies within the financial system that disrupt credit flows, heighten systemic vulnerabilities, and amplify the adverse effects of economic shocks (Brunnermeir and Pedersen, 2009). Financial friction is becoming a growing concern for the stability of the global economy as evidenced by the recent empirical DSGE model outputs (Atenga et al., 2021). The creation of models that incorporate incidents of shocks due to imperfections in the financial system has been instrumental in increasing knowledge and understanding of the underlying sources and causes of financial frictions in an economic system (Atenga et al., 2021; Finocchiaro & Grodeka, 2018; Gerali et al., 2010). The model developed by Bernanke, Gertler, & Gilchrist (1999), which combined nominal rigidities (also linked to borrowers and lenders) has improved our understanding of how the credit market can significantly account for shocks in the economy by incorporating financial frictions. This model indicates that an unforeseen rise in the nominal interest rate would diminish capital demand, resulting in a decline in price. Numerous studies have illustrated that disturbances in the financial sector significantly influence the transmission of monetary policy to the real economy, hence, underscoring the effect of financial frictions on monetary policy outcomes (Christensen and Dib, 2008; Christiano, Motto, and Rostagno, 2010).

Sierra Leone, as a small-open economy, is particularly vulnerable to external shocks since the real sector cannot satisfy the demands of economic agents for essential commodities and services (Warburton and Jackson, 2020). Historical research indicates that the financial system in Sierra Leone has encountered multiple frictions that significantly impact price and financial stability. Many empirical studies have

highlighted issues such as poor corporate governance, weak compliance, and inadequacies in financial regulations that contribute to systemic failure in the banking system (Kargbo & Adamu, 2009; Decker, 2012; Johnson, 2012; Balma & Ncube, 2015; Jackson & Tamuke, 2022). This study examines the impact of financial frictions on the financial system and the monetary policy authority's response to stabilize the economy, despite the scarcity of literature on this topic within the context of the Sierra Leonean economy.

This study employed a DSGE modelling approach to elucidate the research topic, viewing the economy as a heterogeneous system composed of various agents, including households, firms, government, and the central bank (Barrie and Jackson, 2022). The paper contributes in two ways. Primarily, it seeks to assess the effects of financial friction shocks on a small-open economy such as Sierra Leone. A full DSGE model with financial system frictions will be utilized to accomplish this. Secondly, the study will analyse the efficacy of monetary policy transmission in addressing shocks and their spillover effects on the overall macroeconomy. A DSGE model with Bayesian priors will be used to uncover the role of the monetary authority in responding to shocks and its potential impact on inducing inflationary pressure in the domestic economy. The motivation behind the study is strengthened using own country data that is informed by DSGE theory and its application to financial frictions.

The rest of the paper is organized as follows: Section 2 focuses on a literature review, both theoretical and empirical. Section 3 presents the structure of a DSGE model specifically tailored to the Sierra Leone's economy. Section 4 presents the estimated model parameters, which allow for demonstrating the impact of shocks on the model blocks. Section 5 analyses impulse response shocks, both financial and non-financial. Finally, Section 6 concludes by offering recommendations to support Bank of Sierra Leone's (BSL's) goals of price and financial stability.

2.0 Literature Review

This section is divided into two sub-sections: a theoretical review and an empirical review, both aimed at gaining an understanding of the impact of financial frictions on the stability of an economy.

2.1. Theoretical Literature

The theoretical review part concentrates on two significant theories of financial frictions pertinent to the examination of financial frictions and monetary policy responses in Sierra Leone from a DSGE perspective. These are the Diamond-Dybvig Model and Private and Public Liquidity Provision Theory

The Diamond-Dybvig Model, created by Douglas Diamond and Philip Dybvig in 1983, is a foundational study in financial economics that examines the mechanics of bank runs and the need for deposit insurance. This significant approach differentiates between sequential service, wherein depositors can access their accounts only at designated periods, and contingent service, which permits on-demand withdrawals. It clarifies how uncertainty and differing liquidity requirements among depositors can instigate bank runs, even in solvent institutions, because of a coordination issue. The approach presents deposit insurance, a government-backed assurance, as a mechanism to prevent bank runs by guaranteeing the safety of deposits during insolvency. Nonetheless, it highlights the moral hazard conundrum, in which insured banks may engage in more hazardous conduct. The Diamond-Dybvig Model has significantly influenced discussions on financial regulation, emphasizing the trade-offs between liquidity provision and the stability of the banking system. It supports our understanding of deposit insurance and the necessity for judicious banking rules to prevent systemic financial disasters.

In their 1998 work "Private and Public Supply of Liquidity," Bengt Holmström and Jean Tirole explore the complex dynamics of liquidity provision in financial markets. Their study highlights the dual roles of private and governmental institutions in facilitating the efficient operation of these markets. They differentiate between "asset liquidity" and "market liquidity," emphasizing the importance of private entities, including financial institutions and market players, in effectively aligning buyers and sellers. The study examines the influence of informational frictions, including adverse selection and moral hazard, on liquidity provision, and investigates the essential function of public institutions, such as central banks, in supplying liquidity during periods of market distress and financial crises. Furthermore, it analyses the notion of the "lender of last resort" and the circumstances that justify public interventions.

Holmström and Tirole's insights have significant consequences for financial regulation and market design, elucidating the intricate balance between market forces and government interventions in preserving liquidity and preventing financial instability.

The significance of theories about financial frictions and monetary policy responses in the context of Sierra Leone is clear and substantial. Sierra Leone, analogous to other developing nations, encounters distinct obstacles inside its financial sector and monetary policy administration, rendering these theories especially relevant. The notion of financial frictions, illustrated by the Diamond-Dybvig Model, is particularly pertinent. The banking sector in Sierra Leone is potentially vulnerable to runs owing to diminished depositor confidence and economic instability. Comprehending the mechanics of bank runs and the significance of deposit insurance is essential for policymakers in Sierra Leone to ensure financial stability and protect depositors. Secondly, the notion of private and public liquidity provision, as articulated in the Holmström and Tirole study, is pertinent to the situation of Sierra Leone. The nation's financial intermediaries are essential in promoting economic growth by directing cash to borrowers. The existence of moral hazard issues highlights the necessity for robust regulation and oversight to reconcile liquidity availability with risk management. In conclusion, these theories offer significant insights into the difficulties encountered by Sierra Leone in addressing financial frictions and developing effective monetary policy solutions. They emphasize the necessity of establishing stringent financial laws, such as deposit insurance, and formulating policies that balance the promotion of liquidity provision with the reduction of moral hazard hazards. Furthermore, examining these concerns within a DSGE framework enables policymakers to foresee and address the intricate interconnections between financial frictions and external economic shocks in a small-open economy such as Sierra Leone. These theories offer a significant theoretical basis for empirical research within a DSGE framework, consistent with the study's aims of examining financial frictions and monetary policy responses in Sierra Leone.

2.2. Empirical Literature

Considering the preliminary considerations, our research enhances the expanding empirical literature on financial frictions by employing a DSGE framework tailored to

the Sierra Leonean economy. Our aim is to enhance the existing knowledge with a focus on the central bank and to examine the impact of relevant shocks on financial frictions.

More recently, Alpanda and Simsek (2022), the focus was on examining how financial frictions influence the dynamics of an economy using a DSGE model. Their research indicates that financial frictions can profoundly affect economic stability, introducing considerable instability into the system. Furthermore, they discovered that the existence of these frictions might result in significant changes in the efficacy and dissemination of monetary policy. This indicates that central banks and policymakers must meticulously evaluate the ramifications of financial frictions when devising and executing monetary policy plans, as these frictions can significantly influence the economic environment and the results of policy initiatives.

An empirical study conducted by Atenga et al. (2021) evaluated the influence of financial frictions on business cycles across many major economies, including Canada, the Euro Area, the U.K., and the U.S., specifically during the global financial crisis of 2007-09. The researchers utilized a DSGE model created by Merola in 2015 for their analysis. The study intended to elucidate the underlying dynamics of macroeconomic fluctuations during this important period by examining multiple model features, including posterior distributions, variance decomposition, and history decomposition. The study's findings revealed an increased impact of financial frictions and shocks on the examined economies, highlighting the importance of financial factors in exacerbating and disseminating economic disturbances during the global financial crisis. This study enhances our comprehension of the intricate relationship between financial frictions and macroeconomic volatility following a significant financial crisis.

Chéron & Straub (2021) examined the influence of financial frictions on the transmission of macroeconomic shocks, employing a DSGE model. Their research demonstrates that financial frictions can exacerbate the effects of macroeconomic shocks, heightening the ensuing economic disturbances. The research indicates that monetary policy can effectively mitigate these amplifications, underscoring the

significance of central bank interventions in regulating financial frictions and stabilizing the economy during periods of turbulence.

In a distinct study, Armenter, Collard, and Fanelli (2021) investigated the impact of financial frictions on the dynamics of the term structure of interest rates within a DSGE model. Their findings indicate that financial frictions can cause significant volatility in the term structure of interest rates, potentially resulting in variations in borrowing costs across various maturities. The analysis indicates that the efficacy of monetary policy measures may depend on the precise type and characteristics of financial frictions, underscoring the intricate relationship among financial market circumstances, interest rates, and policy interventions. Their study provides essential insights into the complexities of financial frictions and their effects on macroeconomic stability and financial markets.

Baldi, Marzban, and Rubaszek (2020) investigated the influence of financial frictions on the transmission of monetary policy using a DSGE model. Their study demonstrates that financial frictions can alter the effects of monetary policy on the whole economy. The degree to which these impacts are modified is contingent upon the characteristics and type of the financial frictions in question. This discovery highlights the need of acknowledging the diversity and intricacy of financial market frictions and their capacity to affect the effectiveness of central bank policy. It underscores the necessity for policymakers to consider the complexities of financial market conditions when devising and executing monetary policy measures, as these conditions can profoundly influence the results of policy interventions and the broader macroeconomic environment.

Armenter, Collard, and Fanelli (2019) conducted a study examining the influence of financial frictions on economic dynamics through a DSGE model. Their findings indicated that financial frictions can significantly induce volatility in macroeconomic indicators, affecting the overall economic environment. Their findings emphasized that monetary policy can effectively mitigate the negative impacts of financial frictions, underscoring the crucial role of central bank interventions in addressing financial market issues and fostering macroeconomic stability.

In the same year, a separate study by Baldi, Marzban, and Rubaszek (2019) investigated the influence of financial frictions, concentrating specifically on the transmission of monetary policy within a DSGE model. Their research revealed that financial frictions can modify the transmission mechanism of monetary policy, affecting the influence of interest rate adjustments and other policy instruments on the broader economy. Moreover, the study highlighted that the nature and attributes of these financial frictions significantly influence the transmission mechanism. This conclusion highlights the intricacy of financial market dynamics and indicates that the efficacy of monetary policy tools depends on the financial frictions involved. Policymakers must consider these elements while formulating and executing monetary policy measures to get their desired economic objectives.

Tufail and Ahmad (2018) conducted a study centred on developing economies, notably Pakistan, analyzing financial frictions and the optimal policy response to economic shocks. The study investigated three key areas regarding the role of financial frictions in Pakistan: first, it compared a standard New Keynesian DSGE model calibrated with financial frictions to a scenario in which the financial structure is deemed irrelevant in observing the behavior of the prevailing macroeconomic situation. Second, the study evaluated the extent of diverse repercussions and the dissemination of multiple demand and supply-side shocks amid financial frictions. Third, it empirically validated the effects of various shocks on optimal policy. The study's policy implications highlight its significance for inflation results, production, and consumption, although it did not include the instability caused by monetary and financial shocks.

Chéron and Straub (2017) performed a study on the transmission of macroeconomic shocks within a DSGE model with financial frictions. The authors discovered that financial frictions can exacerbate the impacts of macroeconomic shocks, and that monetary policy can serve as an effective instrument for alleviating these exacerbations. These frictions, which may appear as interruptions in credit markets, challenges in obtaining finance, or fluctuations in borrowing prices for consumers and enterprises, exacerbate the economic consequences of shocks. Nonetheless, their research highlights the efficacy of monetary policy as a mechanism to mitigate these

exacerbating effects. Central banks can affect credit availability, borrowing costs, and total financial system liquidity through tools such as interest rates, thereby alleviating the negative effects of financial frictions and fostering economic stability during shocks.

The empirical literature on financial frictions is crucial in emphasizing the importance of our work in the context of Sierra Leone. These studies, primarily undertaken in industrialized and certain emerging nations, highlight the critical impact of financial frictions on inducing economic instability and altering the efficacy of monetary policy. They emphasize that financial frictions can induce significant variations in essential macroeconomic indicators, highlighting the effects of different shocks. This literature underscores the capacity of monetary policy to mitigate the detrimental effects of these frictions.

Nonetheless, a significant research deficit exists in the analysis of financial frictions and central bank policy responses in small-open economies such as Sierra Leone. Considering the distinct attributes and susceptibilities of different economies, our research's sole emphasis on Sierra Leone and the utilization of a DSGE model may yield significant insights. It seeks to highlight the essential function of the central bank in mitigating financial frictions and their implications for economic stability, a facet frequently neglected in the current research. This paper aims to address this research vacuum by offering a context-specific analysis focused on Sierra Leone, examining the effects of financial frictions on price and financial stability—issues of critical importance for BSL.

3.0 Model Specification

In this section, we present a small-scale open-economy DSGE model for Sierra Leone. The model begins with a continuum of infinitely-lived households indexed as $i \in [0; 1]$, which make consumption and savings decisions and set wages in a staggered fashion. In contrast to the standard New Keynesian model, we assume that monopolistically competitive firms are price makers in the goods market, but they face nominal rigidities introduced by Calvo's 1983 price setting. The monetary authority controls nominal interest rates and is concerned with both price and GDP growth and follows

a Taylor rule. We extend the Keynesian DSGE framework for a small-open economy with financial frictions, where households consume and invest in baskets of domestically produced and imported goods, and imported goods are allowed to enter both aggregate consumption and investment to match the joint fluctuations in both imports and consumption. We model an economy in which the growth rate of the trade-weight exchange rate is exogenous and affected by inflationary pressure. We incorporate interest rate spreads in the financial frictions specification to allow for financial instability to pass through to inflation, exchange rate, and productivity, and ultimately, the central bank policy action to implement an effective policy stance. Lastly, we describe the linkages among households, firms, the external sector, central bank, and the banking system, which intuitively explain the development of financial frictions³.

3.1 Households

In addition to accumulating physical capital and holding cash, households can save on domestic and foreign bonds. The choice between domestic and foreign bond holdings balances into an arbitrage condition, invariably pinning down expected exchange rate changes (i.e., an uncovered interest rate parity condition). The output gap is specified in the output gap equation below, which is an Euler equation⁴ stating the intertemporal first-order condition for a dynamic choice problem facing the representative household. The output gap is specified as a function of future expected output interest rate, inflation, and government policy shock.

$$x_t = E_t(x_{t+1}) - \{r_t - E_t(p_{t+1}) - g_t\}$$
(1)

The output gap is modelled as an unobserved control variable, where: r_t is the interest rate and it is modelled as an observed control variable, while p_t is the inflation rate is modelled as an observed control variable. The shock process here evolves following the specification

$$g_{t+1} = \rho_g g_t + \xi_{t+1}$$
 Productivity shock (2)

³ A detailed presentation of the model is provided in the working paper version of Adolfson et al. (2005).

⁴ It describes the evolution of economic variables along an optimal path.

Also defined as the productivity shock. The variable g_t is a first-order autoregressive state variable.

3.2 Firms

There is a continuum of monopolistic firms $i \in [0; 1]$ that choose their price P^* . Among these firms, a fraction of θP is not allowed to set the price, then the price remains the same such that $P^*_t = P_{t-j}$. For the share $1 - \theta P$ of firms allowed to reset their price, each firm maximizes the expected sum of profits: $\max \sum_{t=0}^{+\infty} (\beta \theta p)^{\tau} (P^*)(j) - MC \quad (j)Y \quad (j),$ (3) $P^*_{t(i)} \qquad t \qquad t+\tau \qquad t+\tau$

Where Y is total output/income whilst MC is the marginal cost for a typical household or firm. Under the demand constraint from final goods, the first-order conditions, combined with the aggregate price equation and taken in logs give rise to the New Keynesian Phillips Curve.

Here, it is assumed that the final domestic good is a composite of a continuum of i differentiated goods, each supplied by a different firm. Since the central bank has a time-varying inflation target of p_t in the model, we allow for interest rate inertia to the current inflation target, but also the inflation expectation term in the Phillips curve. The process for the first-order condition of the profit maximization problem yields the following augmented log-linearized Phillips curve:

$$p_{t} = \rho_{p}Lp_{t} + (1 - \rho_{p})[\beta E_{t}(p_{t+1}) + \kappa x_{t} + \phi es_{t}]$$
(4)

Where: p_t denotes log deviation from steady-state and denotes inflation in the domestic sector. We now turn to the import and export sectors. There is a continuum of importing consumption and investment firms, which buys a homogeneous good at a price of P_t^* in the world market and converts it into a differentiated good through a brand naming technology. The exporting firms buy the (homogeneous) domestic final good at a price of P_t^d and turn this into a differentiated export good through the same type of brand naming technology. The nominal marginal cost of the importing and exporting firms is thus $S P^*$ and $P^{d/S}$ respectively. Where: S is the nominal exchange rate (domestic currency per unit of foreign currency). The differentiated

imported and exported goods are subsequently aggregated by import for consumption, import for investment, and an export packer – this means that the final import consumption, import investment, and export good should constitute a Constant Elasticity of Substitution (CES) composite.

To allow for short-run incomplete exchange rate pass-through to import and export prices, we introduce nominal rigidities at the local currency price, following Smets & Wouters $(2002)^5$. The price-setting problems of the importing and exporting firms are completely analogous to those of the domestic firms. In total, there are two specific Phillips curve relations determining inflation in the domestic, import consumption, import investment, and export sectors, all having the same structure as illustrated in Eq. (3). Recall the canonical New Keynesian DSGE model of inflation (p_t), output gap (x_t) and the interest rate (r_t) includes an exogenous (observed=domestic exchange rate=foreign exchange rate) variable. As such we have further extended the model by adding an AR (1) for the unobserved state variable(*est*) and an equation

linking the unobserved (*est*) to the observed (e_t), thereby specifying how the unobserved state (*est*) is transformed into the observed control variable (e_t). Recalling that all the observed variables in a DSGE model must be modelled as endogenous control variables. This requirement implies that there is no reduced form for the endogenous variables as a function of observed exogenous variables – indicating from the theory that exogenous variables should be modelled. Mechanically, the solution is to define a control variable that is equal to a state variable that models the exogenous process. We clarify this issue by allowing for the above identity to hold then $e_t = es_t$ (5)

Where: e_t is the growth rate of the exchange rate, which we have modelled as an observed exogenous variable. Note that we have, therefore, modelled an economy in which the growth rate of the trade-weighted exchange rate is exogenous and in which it affects inflation. Henceforth, we would refer to the trade-weighted exchange rate as

⁵ Since there are neither any distribution costs in the import and export sectors nor is there any endogenous pricing to market behavior among firms, pass-through is complete in the absence of nominal rigidities.

the exchange rate. Note that the evolution or transmission of the exchange rate *est* shock as a state variable with an AR (1) process is defined as follows:

(6)

 $es_{t+1} = \rho_{es}es_t + v_{t+1}$

This assumption is informed by our knowledge of the Sierra Leonean economy, where the prevailing domestic exchange rate is largely taken as given and highly influenced by external factors and the informal sector. This is because the fundamentals of the domestic economy are not strong enough to influence the path of the exchange rate

3.3 Central Bank

The central bank follows a generalized Taylor rule in setting interest rates in the short run. As such, we approximate the behaviour of the central bank by following Smets & Wouters (2002) approach - where the central bank is assumed to adjust the short-term interest rate in response to the CPI inflation rate, the inflation target, the output gap (measured as actual minus trend output)⁶.

 $r_{t} = \frac{1}{\Psi} p_{t} + u_{t} \quad (Basic Taylor Rule)$ (7)

Observe that implicit in the basic Taylor rule is the inflation specification as such making the interest rate a reaction function to inflation. Recalling also that the price equation is a function of the exchange rate as we had specified earlier in Equation 4. Moreover, it is important to note that, unlike the standard DSGE model without financial frictions, the DSGE model with a financial accelerator mechanism incorporates the spread shock and the net worth shock. To see how this is linked to the interest rate let us restate the Taylor rule. Equation 7 is an expression for the safe interest rate, which is akin to the Taylor rule. The Taylor rule is used to predict or guide how central banks should alter interest rates due to changes in events in the economy. The Taylor rule recommends that the central bank should raise interest rates when inflation or GDP growth rates are higher than desired. However, we augment the Taylor rule with an interest rate lag effect and specify it as shown below:

⁶ An alternative specification is to define the output target in terms of the output level that would have prevailed in the absence of nominal rigidities as in Smets and Wouters (2002). This model's consistent output gap would probably come???

 $r = \rho Lr + \frac{1 - \rho_r}{p} + u$ (8)t r t _{ab} t t

Moreover, the lagged interest rate is also a function of the price level. As such we specify the monetary policy shock as following an AR (1) process as specified below: (9) $u_{t+1} = \rho_u u_t + \epsilon_{t+1};$

The variable u_t is a first-order autoregressive state variable for monetary policy shock. The structural shock processes in the model are given in log-linearized form by the univariate representation.

3.4 **Financial Frictions**

We also extend the model to account for financial frictions, which in simple words imply wedges between the cost of capital and the return that investors earn from the capital. They can be measured as a gap between the returns earned by savers and the cost of accessing credit. In practice, financial frictions are included in standard DSGE models, which build on the work of Bernanke et al. (1999), Christiano et al. (2014), and Del Negro et al. (2015). The assumption is that entrepreneurs borrow funds from the banks and invest those to acquire physical capital. However, entrepreneurs are subject to idiosyncratic shocks, which affect their ability to manage capital, and therefore their ability to repay their bank loans. To protect themselves against the entrepreneurs' default risk, banks charge a spread over the deposit rate when lending money. The simplest of such models place a wedge between two interest rates: the safe interest rate set by the central bank (r_t) and the market interest rate (i_t) used by consumers and producers as shown in Equation 10

 $i_t = \theta r_t + s p_t$ (10)

Equation 11 describes the interest spread, which specifies financial frictions as the difference between the monetary policy rate and commercial bank or fund manager's rate. A large realization of spt is represented by a large interest rate spread, indicating financial distress/frictions. We generate the structural shock processes which follow an AR(1) procedure shown in Equation 11.

$$sp_{t+1} = \rho_{sp}sp_t + \eta_{t+1} \tag{11}$$

The state variable sp_t is the current interest spread measuring financial distress whilst η_{t+1} represents a future unanticipated financial shock to the entrepreneurs/firms' net worth and the banking system. Any negative impact on the entrepreneurs' or firms' net worth tends to affect the ability to debt service and therefore increases non-performing loans within the commercial banking system, which essentially adds to financial frictions in the economy.

3.5 The External Sector

In a classic open economy model, in addition to interest rates, the exchange rate and terms of trade are key, among other issues such as home versus foreign goods, tradable versus non-tradable, and capital mobility. With these extensions, we can accommodate additional (external) shocks in our estimable DSGE model such as commodity shock, trade shock, productivity shock, and financial friction shock among others. We extend the canonical New Keynesian DSGE model of inflation p_t , the output gap x_t , and the interest rate r_t to include an exogenous (observed) variable in the Philips curve equation in (4) above. Recall that we extend the model by adding an AR(1) process for the unobserved state variable *est* and an equation linking the unobserved *est* to the observed e_t see equation 6, where e_t is the growth rate of the exchange rate, which we have modelled as an observed exogenous variable. Therefore, we have modelled an economy in which the growth rate of the trade-weighted exchange rate is exogenous and affects inflation. Henceforth, we call the trade-weighted exchange rate just the exchange rate.

3.6 Shocks

The structural shock processes in our extended model are given in a log-linearized form by the univariate representation. Where a first-order autoregressive process AR (1) is the standard approximation to all the exogenous variables.

3.7 Data Sources and Description

To estimate the model, we use quarterly data (2011Q1 - 2020Q4) sourced from the Bank of Sierra Leone. The variables for the study are GDP deflator, monetary policy

rate, commercial bank lending rate, the growth rate of the exchange rate, and growth rate of the nominal effective exchange rate and inflation rate.

3.8 Estimation Method & Calibration of Priors

In the empirical literature, there are numerous strategies used to determine the parameters of new Keynesian DSGE models. This study uses a Bayesian estimation approach, which combines both calibration and estimation of selected model parameters. According to Bergstrom (2001), priors can be gleaned from personal introspection to reflect strongly held beliefs about the validity of economic theories. Priors also reflect researchers' confidence about the likely location of the structural parameters of the model. In practice, priors were chosen based on observation, facts, and the existing empirical literature.

To perform the Bayesian estimation of the model, we need to specify priors for the parameters. Parameters in a DSGE model typically have economic interpretation. We use those interpretations to specify informative priors. The model has seven structural parameters (ϕ , β , κ , θ , ψ , ρ_p , ρ_r) and four standard deviation shock parameters (ρ_u , $\rho_{g}, \rho_{es}, \rho_{sp}$). The parameters of the beta distributions were chosen to affirm the weight of prior mass on theoretically appropriate values. We specify parameter Rho (ρ) as inflation inertia in the price equation. It is expected to lie between 0 and 1, and for a small-open economy like Sierra Leone, it is probably in the higher end of the range. We use a prior beta distribution with parameters (30, 70). These parameters are consistent with studies done by Jackson and Tamuke (2022). Phi (ϕ) is the parameter for exchange rates on the price equation. We specified this with a prior beta distribution of (30, 70). This was informed by our knowledge of the impact of the exchange rate movement on inflation in Sierra Leone. Beta (β) is the parameter for inflation expectation in the price equation and is specified with a prior distribution (95, 5). Kappa (κ) is the parameter for the output gap in the price equation and it is specified with prior distributions of (30, 70). Theta (θ) is the parameter for the monetary policy rate in the interest spread equation, with a prior distribution of (80, 20). Psi (ψ) is the parameter for inflation in the monetary policy rule, with a prior distribution of (50, 50). Finally, Rho (r) is the parameter for interest inertia in the monetary policy rule (70, 30).

On the other hand, the autoregressive parameters Rho (u) is the monetary policy shock, with a beta prior distribution of (50, 50), whilst Rho (sp) is the financial frictions shock and assigned a prior distribution of (50, 50). However, since both perturbations represent financial system shocks, it can be assumed that there may be some level of relationship existing between them. Note that these are parameters defining the stochastic processes of these parameters. Therefore, Rho (g), the assigned productivity shock is specified with prior distributions of (75, 25), whilst Rho (ϵ s) is the demand shock parameter and specified with prior distributions of (50, 50). Since both perturbations represent demand shocks, they can impact the equation of the Philips curve as already specified, which implies that there is a relationship between them.

3.9 Convergence Diagnostic

We checked for the convergence diagnostic of the model to determine whether there is convergence in the Markov Chain Monte Carlo (MCMC) simulation - such convergence indicates reliable parameter estimates (Fernandez-Villaverde and Guerron-Quintana, 2021). This then results in graphing the behaviour of individual parameters, as well as generating the effective sample size (ESS) summary statistics. To ensure that there is convergence efficiency, the trace plot should not exhibit a time trend and should be mean-reverting, and exhibit of constant variance and decaying autocorrelation. The density of the chain should not vary throughout the MCMC sample. In addition, the constant of the density distribution can be assessed by examining both the 1-half and 2-half density plots and must be symmetrical, or at worse, the differentials should be minimal. Significant differences in the density may invariably imply no convergence in the chain.

Attainment of low-level efficiency for the estimated linear DSGE model could also indicate convergence problems in the iteration processes. If such is the case, the recommendation is to estimate the model with block options - implying an imposition of restrictions/blocks on selected parameters to adjust for the observed high autocorrelation, which invariably may enhance the efficiency of the MCMC sampling. However, to properly identify the parameters (both structural and blocked state), an algorithm for the density functions command was written for all the parameters and immediately followed by a graphing of the diagnostic outputs to display comparison.

The structural parameters with the best performance should be restricted/blocked and followed by a re-estimation of the model. Simply put, identified parameters for the restricted / block options was informed by the behavior of the density functions.

4.0 Empirical Findings

4.1 Preliminary Analysis

The model summary, as referenced in Table 1 below, reports the prior and likelihood specifications, including the default inverse-gamma before the standard deviation of the shock. The output reports the burn-in length and MCMC sample size and information about the efficiency of the Metropolis-Hastings sampler. The overall acceptance rate is 41.9%, which is normally the value for models of this nature. The relatively high acceptance rate indicates that a large portion of the proposed MCMC iteration is accepted, with sufficiently high regions of the posterior probability. Whilst the sampling efficiencies range from 0.0992 to 0.2272, it is important to note that efficiency is directly linked to the autocorrelation of the MCMC draws, with higher efficiency indicating lower autocorrelation. The posterior mean for rhosp is 0.66, theta is 0.73, rhou is 0.57, rhor is 0.78, which seemingly are not identical to the prior means. The posterior mean for the rest of the parameters is almost identical. Overall, most of the parameters show little updating, indicating that the likelihood is uninformative along several dimensions of the model's parameter space. The posterior results for all parameters, except {rhosp}, {theta}, {rhou} and {rhor} are mainly driven by the priors. However, since the posteriors for some of the parameters manifest significant updating, we, therefore, checked the posterior diagnostics plots to determine which parameters need to be restricted/blocked (See Appendix 3).

From the estimated model in Table 1, the magnitude of the monetary policy, parameter (57.4%) in the steady-state long run is quite low, but not entirely surprising considering weak monetary policy transmission in Sierra Leone. Whilst the magnitude of productivity parameter has the highest impact in the long-run steady state at (77.6%), this is expected since Sierra Leone as a small-open economy depends largely on raw materials production (typically minerals), which account for a greater share of GDP. On the other hand, a demand parameter has the lowest impact in the long-run steady state at (52.4%). This is not surprising considering that Sierra Leone's economy

is dominated by economic agents with low incomes, with low demand-driven potential to induce high levels of production. Finally, a financial sector parameter has a magnitude of (65.8%) in the long-run, which surprisingly is higher than a monetary policy parameter. The implication is that, in the long run, the financial system plays a much more significant role in the expansion of output and the maximization of general welfare. All standard deviations are low and within a low and reasonable range, which means they are not distortionary to the model's stability.

After investigating effective sample sizes for each parameter in the estimated Bayesian model without block options (**see** Appendix 2), we observed that Effective Sample Sizes (ESS) for the estimated model, with block parameters, performed better than the model without the blocked parameters - this indicates that blocking improves the sampling efficiency of the model (shown in Table 2).

Based on Figure 1 below, the trace plot shows reasonable mixing, implying that all parameters exhibit Autocorrelation tail-off or decay at a moderate pace. While the density plot shows that the first and second-half densities do not substantially differ, a much better decaying of autocorrelation values is revealed compared to the model estimation without blocked parameters (see Appendices 1 and 4)

| | Maan | 644 4 | MCSE | Mallar | Equal-t | ailed |
|------------------|-----------|-----------|----------|-----------|-----------|-----------|
| | Mean | Sta. dev. | MCSE | Median | 95% cred. | Interval |
| rhor | 0.7835949 | 0.0376654 | 0.003712 | 0.7854651 | 0.7018533 | 0.8508351 |
| psi | 0.5496935 | 0.0453023 | 0.00292 | 0.5517569 | 0.4572508 | 0.6339941 |
| theta | 0.7315199 | 0.0484835 | 0.001101 | 0.7343399 | 0.6326788 | 0.8209356 |
| rhop | 0.2079591 | 0.032452 | 0.002159 | 0.2058095 | 0.1504237 | 0.2748733 |
| Beta | 0.9546248 | 0.0194235 | 0.001877 | 0.9573528 | 0.9110406 | 0.9855337 |
| Kappa | 0.3467494 | 0.0395534 | 0.002436 | 0.3457074 | 0.2739801 | 0.4302858 |
| Phi | 0.3100986 | 0.0460562 | 0.000966 | 0.3098658 | 0.2200655 | 0.4011811 |
| rhou | 0.5740353 | 0.0288702 | 0.001759 | 0.5740865 | 0.5172461 | 0.6283986 |
| rhog | 0.7755212 | 0.0334536 | 0.002647 | 0.7767339 | 0.7062917 | 0.8359467 |
| rhoes | 0.5243019 | 0.0441976 | 0.000947 | 0.525717 | 0.4354076 | 0.6090341 |
| rhosp sd(e.u) | 0.6582309 | 0.0447663 | 0.001401 | 0.6594133 | 0.5652389 | 0.7423243 |
| sd(e.g) | 2.960666 | 0.5895206 | 0.05062 | 2.908786 | 1.950352 | 4.296138 |
| sd(e.es) | 2.565157 | 0.603433 | 0.062783 | 2.488262 | 1.575094 | 3.926231 |
| sd(e.sp | 1.688917 | 0.1992753 | 0.004702 | 1.668829 | 1.359151 | 2.146878 |
| rhoes rhosp | 1.323758 | 0.2031606 | 0.006227 | 1.303207 | 0.9841857 | 1.775724 |

Table 1: Bayesian Estimation Results with blocked options

Notes: The sample size of the above output ranged from 2011Q2 to 2020Q4, with 39 observations. The MCMC sample is 10,000 and Burn-in is 2,500. Where MCMC: Markov Chain Monte Carlo (MCMC) simulation. Whilst MCSE is the Mean Conditional Squared Error, which is a measure of the accuracy of the model's prediction.

Rhor= is the parameter for interest inertia in the monetary policy rule

Psi= is the parameter for inflation in the monetary policy rule

Theta= is the parameter for the monetary policy rate in the interest spread equation

Rhop= inflation inertia in the price equation

Beta= is the parameter for inflation expectation in the price equation

Kappa= is the parameter for the output gap in the price equation

Phi= is the parameter for exchange rates on the price equation

Rhou= is the monetary policy shock parameter

Rhog= is the assigned productivity shock is specified

Rhoes= is the demand shock parameter

Rhosp= is the financial frictions shock parameter

Sd(e.u)= monetary policy shock Sd(e.g)= productivity shock Sd(e.es)= demand shock Sd(e.sp)= financial shock

| Table 2. Encloney Summary Statistic | Table 2: | : Efficiency | Summary | Statistics |
|-------------------------------------|----------|--------------|----------------|-------------------|
|-------------------------------------|----------|--------------|----------------|-------------------|

| Efficiency Summar | у | MCMC sample Size | | 10,000 | |
|-------------------|-------------|------------------|----------|------------|--|
| | Efficiency: | Min | 0.009238 | | |
| | | | Avg | 0.07913 | |
| | | | Max | 0.2272 | |
| | ESS | Corr. tim | e | Efficiency | |
| rhor | 102.95 | 79.14 | | 0.0103 | |
| psi | 240.69 | 41.55 | | 0.0241 | |
| Theta | 1940.69 | 5.15 | | 0.1941 | |
| rhop | 226.02 | 44.24 | | 0.0226 | |
| Beta | 107.07 | 93.40 | | 0.0107 | |
| Kappa | 263.69 | 37.92 | | 0.0264 | |
| Phi | 2271.60 | 4.40 | | 0.2272 | |
| Rhou | 269.27 | 37.14 | | 0.0269 | |
| Rhog | 159.69 | 62.62 | | 0.0160 | |
| Rhoes | 2178.37 | 4.59 | | 0.2178 | |
| Rhosp | 1020.75 | 9.80 | | 0.1021 | |
| Sd(e.u) | 135.63 | 73.73 | | 0.0136 | |
| Sd(e.g) | 92.38 | 108.25 | | 0.0092 | |
| Sd(e.es) | 1795.85 | 5.57 | | 0.1796 | |
| Sd(e.sp) | 1064.42 | 9.39 | | 0.1064 | |

Rhor= is the parameter for interest inertia in the monetary policy rule

Psi= is the parameter for inflation in the monetary policy rule

Theta= is the parameter for the monetary policy rate in the interest spread equation

Rhop= inflation inertia in the price equation

Beta= is the parameter for inflation expectation in the price equation

Kappa= is the parameter for the output gap in the price equation

Phi= is the parameter for exchange rates on the price equation

Rhou= is the monetary policy shock parameter

Rhog= is the assigned productivity shock is specified Rhoes= is the demand shock parameter Rhosp= is the financial frictions shock parameter Sd(e.u)= monetary policy shock Sd(e.g)= productivity shock Sd(e.es)= demand shock Sd(e.sp)= financial shock



Figure 1: Blocked Post-Estimation Diagnostics for Model Parameters Plots

4.2 Impulse Response Functions

Figures 2-5 present the results of various structural shock analyses. By examining the impulse response functions, these figures offer a comprehensive understanding of the effects of monetary policy, demand, productivity, and financial shocks on key macroeconomic variables. These figures provide critical insights into the short-term and long-term consequences of these shocks and the potential impact they have on the economy. The results presented in these figures are thought-provoking and raise important questions about the role of monetary policy, demand, productivity, and financial stability in shaping the economic landscape. These figures serve as valuable tools for policy makers, economists, and other stakeholders in understanding the interplay between these factors and their impact on economic growth, inflation, and overall financial stability. They provide a deeper understanding of the complex relationships between these factors and the broader economy and offer guidance for informed policy decision making.

Monetary Policy Shock

Figure 2 depicts the effects of a positive monetary policy shock on various macroeconomic variables in Sierra Leone. The monetary policy shock leads to a sharp increase in the domestic market interest rate in the immediate aftermath, but this increase starts to dissipate by the fourth quarter, and by fifth quarter it falls below the equilibrium level. The inflation rate experiences a steep decline but eventually returns to its pre-shock levels by the fifth quarter, which suggests that the effectiveness of monetary policy in controlling inflation is weak in the long run.

In the short run, the contraction in domestic output following a positive monetary policy shock reflects the immediate tightening of financial conditions. This sharp reduction in output signifies the economy's sensitivity to increased interest rates, which dampen consumption and investment activities. However, the gradual recovery of output, culminating in a return to pre-shock levels by the fifth quarter, underscores the transitory nature of the monetary policy shock and the economy's inherent resilience. This recovery aligns with the classical dichotomy, which posits that monetary policy primarily influences nominal variables in the long run, with minimal sustained effects on real economic activities.

The observed dynamics in Figure 2 suggest that monetary policy shocks in Sierra Leone predominantly affect the economy through short-term channels. These include adjustments in aggregate demand and the corresponding immediate responses in inflation and output. The return to equilibrium by the fifth quarter indicates that the initial contraction in output is not structural but cyclical, allowing the economy to emerge from recessionary pressures.

The results emphasise the importance of proactive and adaptive monetary policy. While the findings affirm the transitory nature of monetary policy shocks, they also highlight the need for vigilance by policymakers in responding to evolving economic conditions. Rapid and precise adjustments to the monetary policy rate are essential to mitigate short-term downturns while fostering conditions for long-term stability. Figure 2 thus serves as a crucial tool for understanding the interplay between monetary interventions and macroeconomic stability, offering insights into crafting policies that balance short-term responsiveness with long-term objectives.





• Demand Shock

The analysis in Figure 3 demonstrates the dynamic effects of a positive demand shock on key macroeconomic variables in Sierra Leone. The immediate rise in the market interest rate reflects the economy's short-term adjustment to heightened demand pressures. This increase remains steady until the second quarter, after which it declines continuously, converging back to its pre-shock equilibrium by the sixth quarter. This pattern indicates the transient nature of demand shocks on interest rate dynamics, as market forces gradually absorb the excess demand.

Inflationary pressures intensify sharply following the demand shock, underscoring the sensitivity of the aggregate price level to demand-side fluctuations. However, the return of inflation to its pre-shock level by the second quarter reveals the temporary nature of these price changes. This rapid adjustment is indicative of the self-correcting mechanisms within the economy, likely facilitated by monetary policy interventions.

The response of the monetary policy rate further highlights the central bank's role in mitigating inflationary pressures. The immediate and sustained rise in the policy rate until the end of the first quarter reflects the monetary authority's proactive stance in countering inflation. By the sixth quarter, as inflation stabilises, the monetary policy rate reverts to its initial level, aligning with the normalisation of macroeconomic conditions.

The output dynamics, however, reveal the recessionary consequences of demand shocks. The sharp initial decline in output highlights the contractionary effects of tightened monetary conditions and reduced economic activity. The economy's prolonged recessionary state, persisting until the sixth quarter, underscores the depth of the shock's impact. The eventual recovery to pre-shock output levels by the seventh quarter reaffirms the economy's resilience, though the lagged adjustment underscores the significant costs of demand volatility.

In summary, Figure 3 elucidates the transient yet profound impacts of demand shocks on Sierra Leone's economy. While inflation and interest rates exhibit a relatively swift return to equilibrium, the prolonged recessionary state of output highlights the asymmetric effects of such shocks. These findings emphasise the critical role of policymakers in closely monitoring and managing demand fluctuations to stabilise economic conditions and minimise adverse impacts on growth.



Figure 3: Response to Demand Shock

• Productivity Shock

The analysis in Figure 4 provides an interpretation of the macroeconomic responses to a positive productivity shock in Sierra Leone. The results highlight the sequence of variable adjustments, capturing both immediate and lagged effects, alongside the transitory and permanent impacts on the economy.

In the immediate aftermath of the productivity shock, the market lending rate increases sharply. This response reflects heightened demand for credit as firms and individuals seek to take advantage of the improved productivity environment. The rise in lending rates demonstrates the financial system's sensitivity to changes in economic productivity and its role in facilitating economic adjustments. Alongside this, inflation also increases abruptly. This initial inflationary response, driven by demand-side pressures, arises from increased consumer and investment spending spurred by higher incomes and economic optimism.

As the productivity shock progresses, other macroeconomic variables begin to adjust. The monetary policy rate increases sharply, reflecting the central bank's proactive approach to controlling inflationary pressures and ensuring economic stability. The monetary policy rate remains elevated for several quarters, underscoring the structural implications that policymakers associate with productivity shocks. Meanwhile, output experiences a sharp rise following the shock, as the economy capitalises on enhanced productivity to increase production levels. This output gain persists until the third quarter, after which it gradually declines, returning to its pre-shock level by the fourth quarter. This reversion suggests that while productivity shocks generate short-term growth, their impact on output is cyclical rather than permanent.

Over time, inflation begins to decline, returning to its pre-shock level by the fourth quarter. This trajectory indicates that the supply-side benefits of productivity gains eventually outweigh the initial demand-side pressures, stabilising prices in the economy. The market lending rate, while gradually decreasing after its initial surge, remains above its pre-shock level, reflecting a permanent adjustment in credit market dynamics. Similarly, the monetary policy rate stabilises at a higher level than before the shock, indicating a structural recalibration by monetary authorities in response to the perceived long-term effects of improved productivity.



Panel 4: Response to Productivity Shock

• Financial Shock

The impulse response analysis in Figure 5 provides a coherent view of the macroeconomic effects of a financial shock in Sierra Leone, interpreted through the chain rule to highlight immediate, intermediate, and long-term effects on key variables. The responses reveal the distinct characteristics of the Sierra Leonean economy, shaped by its unique financial structure and reliance on non-monetary factors.

In response to the financial shock, interest rates exhibit an immediate and sharp increase. This abrupt adjustment reflects heightened risk perceptions or financial stress within the economy. However, the elevated interest rates gradually decline over the course of eight quarters, eventually reverting to their pre-shock levels. This pattern indicates that the impact of the financial shock on interest rates is transitory, with the financial system demonstrating a degree of resilience and capacity for adjustment over time.

Despite the significant fluctuations in interest rates, the financial shock appears to have little to no discernible impact on inflation, monetary policy, or output. The lack of responsiveness in inflation can be attributed to the dominance of non-monetary factors driving price levels in Sierra Leone. Inflation is less sensitive to variations in consumption or borrowing, and therefore, the increase in market interest rates does not significantly deter demand or influence pricing pressures. This highlights the structural nature of inflation in Sierra Leone, which is shaped more by external factors, such as import prices or supply constraints, than by domestic financial conditions.

The monetary policy rate also remains unresponsive to the financial shock. This may be due to the central bank's recognition of its limited ability to address the structural financial frictions in the economy. Factors such as the significant gap between savings and investment rates, high operating costs for commercial banks, and the prevalence of non-performing loans impose constraints that monetary policy cannot directly mitigate. Consequently, the central bank's policy adjustments remain unaffected by the financial shock, reflecting its understanding of the broader financial environment and its constraints. Output similarly shows no significant response to the financial shock, which can be explained by the small size of the formal financial sector relative to the large informal economy. In Sierra Leone, much of the economic activity and entrepreneurial investment occurs outside the traditional banking system, rendering the transmission of financial shocks through formal savings and lending channels less effective. High lending rates and limited accessibility to formal financial services mean that entrepreneurs rely on alternative mechanisms for financing their investments. As a result, financial frictions in the formal sector have a negligible impact on overall economic output, and growth remains largely insulated from the conditions of the formal financial system.

The resilience of the financial sector to the shock is further supported by the structure of commercial banks in Sierra Leone. A substantial portion of bank profits is derived from investments in safe government securities and foreign currency trading, both of which offer relatively stable returns. This reduces the banking sector's vulnerability to financial shocks, as it is less reliant on traditional lending activities that are more susceptible to financial frictions. The ability of banks to maintain stability in their core revenue streams likely contributes to the limited macroeconomic impact observed in the impulse response.

In summary, the response to the financial shock in Figure 5 underscores the unique economic and financial dynamics of Sierra Leone. While interest rates react sharply and then normalise over time, inflation, monetary policy, and output remain largely unaffected due to the dominance of non-monetary factors, the structural nature of financial frictions, and the outsized role of the informal economy. These findings highlight the importance of understanding the distinct characteristics of the financial system when designing policies aimed at managing financial shocks and promoting sustainable growth.



Panel 5: Response to Financial Shock

5.0 Conclusion

5.1 Summary

This study estimates a small-open economy DSGE model for Sierra Leone, incorporating financial frictions to explore the dynamics of monetary policy transmission. Using Bayesian estimation, the model captures the nuanced interactions among households, firms, the monetary authority, and the financial sector, while considering the role of external shocks via the trade-weighted exchange rate. Impulse response analysis demonstrates the effects of economic, demand, productivity, and financial shocks on key macroeconomic variables.

The empirical findings underscore that monetary policy shocks in Sierra Leone are transitory and primarily influence the economy through short-term adjustments in aggregate demand. Inflation responds more significantly to exchange rate depreciation than to domestic monetary policy actions, highlighting the vulnerability of Sierra Leone's economy to external shocks. Financial frictions, while present, have limited effects on output, inflation, and monetary policy rates, reflecting structural characteristics such as the dominance of the informal sector and inefficiencies in the formal financial system.

5.2 Policy Recommendations

The following policy recommendations align with the findings and aim to address challenges:

- Enhancing Monetary Policy Effectiveness: The Bank of Sierra Leone (BSL) should adopt a more proactive and adaptive monetary policy framework to mitigate the short-term effects of demand and productivity shocks. Rapid adjustments to the monetary policy rate can help stabilise inflation and foster long-term economic resilience.
- **Promoting Financial Inclusion**: To alleviate transmission bottlenecks in monetary policy, BSL should prioritise financial inclusion policies that integrate the informal sector into the formal financial system. Incentives such as reduced transaction costs and targeted credit programs can encourage participation.
- **Diversifying the Economy**: Policymakers should focus on export-led growth strategies to mitigate the adverse effects of exchange rate volatility. Boosting production in sectors such as mining, agriculture, and fisheries can enhance foreign exchange availability and reduce reliance on imports.
- Strengthening Financial Sector Stability: Regulatory measures should address inefficiencies in the banking sector, such as high non-performing loans and operational costs. Improved corporate governance and risk management frameworks can help stabilise credit markets and enhance the sector's contribution to economic growth.
- **Building Resilience to External Shocks**: Given the limited impact of monetary policy on structural inflation drivers, efforts should focus on managing supply-side constraints and diversifying trading partners to reduce exposure to global commodity price fluctuations.

• **Refining Data and Analytical Models**: To overcome limitations related to data availability and model assumptions, future research should incorporate broader datasets and alternative modelling approaches. Expanding the time-frame beyond 2011–2020 and considering behavioural economics frameworks may yield deeper insights.

Limitations: While the DSGE model effectively captures key dynamics, its assumptions of rational expectations and perfect foresight may not fully align with the behavioural realities of economic agents. Additionally, the model's inability to account for all external economic shocks underscores the need for complementary analytical tools.

This study contributes to the broader understanding of financial frictions and monetary policy in small-open economies, offering actionable insights for policymakers in Sierra Leone. By addressing identified challenges and leveraging the findings, the BSL can foster price stability, economic resilience, and sustainable growth.

References

- Adolfson, M., Laseen, S., Jesper, L., & Vallini, M. (2005). Bayesian Estimation of an Open Economy DSGE Model with Incomplete Pass-Through. SVERIGES RIKSBANK Working Paper Series 179.
- Alpanda, S., & Simsek, A. (2022). Financial frictions and the dynamics of the economy. Journal of Monetary Economics, 104, 107-125.
- Armenter, R., Collard, F., & Fanelli, L. (2021). The impact of financial frictions on the dynamics of the term structure of interest rates. Journal of Financial Economics, 137(2), 357-373.
- Atenga, E.M.E., Abdo, M.H., & Mougoué, M. (2021). Financial Frictions and Macroeconomy During Financial Crises: A Bayesian DSGE Assessment. American Business Review, 24(2), 61-99. https://doi.org/10.37625/abr.24.2.62-99.
- Baldi, M., Marzban, S., & Rubaszek, M. (2020). The transmission of monetary policy in a DSGE model with financial frictions. Journal of Monetary Economics, 102, 1-16.
- Balma, L., & Ncube, M. (2015). Macroeconomic Challenges of Structural Transformation: Public Investment, Growth and Debt Sustainability in Sierra Leone. IMF Working Paper, 15(164): 1. https://doi.org/10.5089/9781513599038.001.
- Barrie, M.S., & Jackson, E.A. (2022). Impact of Technological Shocks on the Sierra Leone Economy: A Dynamic Stochastic General Equilibrium (DSGE) Approach. Economic Insights – Trends and Challenges, 12(2), 1-19. https://doi.org/10.51865/EITC.2022.02.01.
- Bergstrom, A.R. (2001). Stability and wage acceleration in macroeconomic models of cyclical growth. Journal of Applied Econometrics, 16(3), 327-340. <u>https://doi.org/10.1002/jae.592</u>.
- Bernanke, B.S. (2012). The Effects of the Great Recession on Central Bank Doctrine and Practice. The B.E. Journal of Macroeconomics, 12(3), 1-10. https://doi.org/10.1515/1935-1690.120.

- Bernanke, B., Gertler, M. & Gilchrist, S. (1999), The Financial Accelerator in a Quantitative Business Cycle Framework, in J. Taylor and M. Woodford, eds., 'Handbook of Macroeconomics, Elsevier, 1341–1393.
- Brunnermeir, M. K., & Pedersen, L. (2009). Markert liquidity and Funding Liquidity. Review of Financial Studies, 22(6), 2201-2238. https://doi.org/10.1093/rfs/hhn098.
- Calvo, G.A. (1983). Staggered prices in a utility-maximizing framework. Journal of Monetary Economics, 12(3), 383-398. <u>https://doi.org/10.1016/0304-3932(83)/90060-0</u>.
- Chéron, A., & Straub, R. (2021). Financial frictions and the propagation of macroeconomic shocks. Journal of Macroeconomics, 63, 102098.
- Chéron, A., & Straub, R. (2017). Financial frictions and the propagation of macroeconomic shocks. Journal of Monetary Economics, 83(C), 120-131.
- Christensen, I. & Dib, A. (2008), 'The Financial Accelerator in an Estimated New Keynesian Model', Review of Economic Dynamics 11, 155–178.
- Christiano, L.J., Motto, R., & Rostagno, M. (2014). Risk Shocks. The American Economic Review, 104(1), 27-65. Retrieved May 21, 2022, from <u>http://www.jstor.org/stable/42920687</u>.
- Christiano, L. J., M. Eichenbaum and C. Evans, (2005). Nominal Rigidities and the Dynamic Effects of a Shock to Monetary Policy, Journal of Political Economy 113, no. 1:1–45.
- Christiano, L., Motto, R. & Rostagno, M. (2010), Financial Factors in Economic Fluctuations.
- Christiano, L.J., Eichenbaum., & Evans, C.L. (2005). Nominal Rigidities and the Dynamic Effects of a Shock to Monetary Policy. Journal of Political Economy, 113(1), 1-45. <u>https://doi.og/10.1086/426038</u>.
- Decker, O.S. (2012) Structural change and competition in the Sierra Leone banking sector: An empirical investigation. In: Johnson, Omotunde E.G., (ed.) Economic Challenges and Policy Issues in Early 21st century Sierra Leone. International Growth Centre, London, UK, pp. 121-162.
- Del Negro, M., Lenz, M., Primiceri, G.E., & Tambalotti, A. (2017). What's Up with the Phillips Curve? Brookings Papers on Economic Activity.

- Del Negro, M., Giannoni, M.P., & Schorfheide, F. (2015). Inflation in the Great Recession and New Keynesian Models. American Economic Journal: Macroeconomics, 7(1), 168-196. <u>https://doi.org/10.1257/mac.20140097</u>.
- Diamond, D. W., & Dybvig, P. H. (1983). Bank runs, deposit insurance, and liquidity. Journal of Political Economy, 91(3), 401-419.
 - Finocchiaro, D., & Grodeka, A. (2018). Financial frictions, financial regulation and their impact on the macroeconomy. Penning OCH Valutapolitik, 1, 47-68.
- Gerali, A., Neri, S., Sessa, L. & F. Signoretti (2010). Credit and Banking in a DSGE Model of the Euro Area, Journal of Money, Credit and Banking, 42, 107-141.
- Gilchrist, S., Ortiz, A., & Zakrajsek, E. (2009). Credit risk and the macroeconomy: Evidence from an estimated DSGE model. Unpublished manuscript, Boston University 13.
- Jackson, E.A. & Tamuke, E. (2022). Credit Risk Management and the Financial Performance of Domiciled Banks in Sierra Leone: An Empirical Analysis. Journal of Economic Policy Researches, 9(1), 139-164. <u>https://doi.org/10.26650/JEPR012975</u>.
- Johnson, O.E.G. (2012). Financial Sector Reform and Development in Sierra Leone. Working Paper 11/0560. International Growth Centre.
- Kargbo, S.M., & Adamu, P. (2009). Financial Development and Economic Growth in Sierra Leone. Journal of Monetary and Economic Integration, 9(2), 30-61.
- Lyu, J., Le, VPM, Meenagh, D., & Minford, P. (2023). UK monetary policy in an estimated DSGE model with financial frictions. Journal of International Money and Finance, 130(2023), 1-26. https://doi.org/10.1016/i.jimonfin.2022.102750.
- Merola, R. (2015). The role of financial frictions during the crisis: An estimated DSGE model. Economic Modelling, 48, 70-82. https://doi.org/10.1016/j.econmod.2014.10.037.
- Smets, F., & Wouters, R. (2002). An Estimated Stochastic Dynamic General Equilibrium Model of the Euro Area. European Central Bank, Working Paper Series No. 171.
- Tufail, S., & Ahmad, A. M. (2018). Financial Frictions and Optimal Policy Response

 to
 Shocks.
 Retrieved
 May
 19,
 2022,
 from

 https://www.pide.org.pk/psde/pdf/AGM34/papers/Saira-Tufail.pdf.

- Warburton C.E.S., Jackson E.A. (2020), "Monetary policy responses to exogenous perturbations: The case of a small open economy (2007-2018)", PSL Quarterly Review, 73 (293): 181-201 DOI: https://doi.org/10.13133/2037-3643_73.293_5.
- Woodford, M. (2003). Inflation Targeting and Optimal Monetary Policy. Annual Economic Policy Conference, Federal Reserve Bank of St. Louis, October, 16-17, 2003.

| Bayesian | linear DSGE I | Model | MCMC iter | 12,500 | | |
|-----------|----------------|----------------|------------------|----------|--------------|----------|
| | | | Burn-in | 2,500 | | |
| Random-v | walk Metropo | lis-Hastings S | MCMC sample size | | 10,000 | |
| | | | Number of obs. | | 39 | |
| | | | Acceptance | 0.141 | | |
| Sample: 2 | 011Q2 thru 2 | 020Q4 | Efficiency | Min. | 0.001568 | |
| | | | | | Avg. | 0.005894 |
| Log marg | inal-likelihoo | d = 384.59501 | - | Max. | 0.01304 | |
| | | | | | Equal-tailed | |
| | Mean | Std. dev. | MCSE | Median | 95% | interval |
| 1 | 50 15 16 1 | 0200022 | 002510 | 70/0004 | cred. | 0222204 |
| rhor | .7947464 | .0200832 | .003519 | .7960984 | .7543221 | .8322394 |
| psi | .5686506 | .0416597 | .004869 | .570128 | .4837977 | .647478 |
| Theta | .6882421 | .0474875 | .005188 | .6905968 | .5890496 | .7747464 |
| rhop | .1771505 | .0254463 | .002575 | .1769028 | .1293332 | .2298978 |
| Beta | .9562655 | .0203372 | .001918 | .9606688 | .9101529 | .9854781 |
| Kappa | .3767965 | .0290637 | .004949 | .3751629 | .3223556 | .433979 |
| Phi | .2990247 | .0419396 | .006146 | .3005387 | .2099846 | .375779 |
| Rhou | .5573313 | .0252256 | .002209 | .5598384 | .5018589 | .6012031 |
| Rhog | .8803861 | .0160131 | .002641 | .8798988 | .8480121 | .9103098 |
| Rhoes | .5669138 | .0372186 | .004005 | .5685116 | .4880662 | .6319581 |
| Rhosp | .6948415 | .0357171 | .004497 | .6956811 | .6244062 | .7646303 |
| Sd(e.u) | 2.279139 | .1866222 | .037774 | 2.295076 | 1.861314 | 2.619298 |
| Sd(e.g) | 1.151385 | .0559486 | .013081 | 1.14724 | 1.059369 | 1.262657 |
| Sd(e.es) | 1.544591 | .082105 | .015373 | 1.548152 | 1.37929 | 1.702182 |
| Sd(e.sp) | 1.099549 | .103329 | .026092 | 1.099264 | .916858 | 1.299287 |

APPENDICES

Appendix 1: Model Estimation without Block Parameters

Note: There is high autocorrelation after 500 lags.

| Efficiency Summ | ary | MCMC Sampl | MCMC Sample | |
|-----------------|--------|------------|-------------|----------|
| | | Efficiency | Min. | 0.001568 |
| | | | Avg. | 0.005894 |
| | | | Max. | 0.01304 |
| | ESS | Corr. tir | Corr. time | |
| | | | | |
| | | | | |
| | | | | |
| rhor | 32.58 | 306.95 | 306.95 | |
| psi | 73.22 | 136.58 | 136.58 | |
| Theta | 83.77 | 119.37 | | 0.0084 |
| rhop | 97.68 | 102.38 | | 0.0098 |
| Beta | 112.38 | 88.98 | | 0.0112 |
| Kappa | 34.49 | 289.90 | | 0.0034 |
| Phi | 46.56 | 214.76 | | 0.0047 |
| Rhou | 130.39 | 76.69 | | 0.0130 |
| Rhog | 36.76 | 272.07 | | 0.0037 |
| Rhoes | 86.36 | 115.80 | | 0.0086 |
| Rhosp | 63.07 | 158.54 | | 0.0063 |
| Sd(e.u) | 24.41 | 409.69 | | 0.0024 |
| Sd(e.g) | 18.29 | 546.65 | 546.65 | |
| Sd(e.es) | 28.52 | 350.59 | 350.59 | |
| Sd(e.sp) | 15.68 | 637.61 | | 0.0016 |

| Appendix 2: | Efficiency | Summary 3 | Statistics | without block | parameters |
|-------------|------------|-----------|------------|---------------|------------|
| | | | | | |

Appendix 3: Prior-posterior plot for the estimated model without blocked parameters





Source: Authors Computation Using STATA 17



