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THE IMPACT OF FISCAL DOMINANCE ON MACROECONOMIC PERFORMANCE IN SIERRA LEONE: A DSGE SIMULATION APPROACH.

Mohamed Samba Barrie¹ and Emerson Abraham Jackson²

Abstract

This study delves into the repercussions of fiscal policies, particularly those marked by high expenditure financed by monetary means, on key macroeconomic indicators in Sierra Leone. Employing a Dynamic Stochastic General Equilibrium (DSGE) model, the analysis illuminates how shocks in one variable ripple through the entire economic system over time. The analysis indicates that high levels of domestic borrowing and monetary financing in the medium-term crowd out private-sector investment hurt growth, and reduce government tax revenues, thereby reducing the government's capacity to invest in public goods and services. Furthermore, it demonstrates that this phenomenon leads to an endless "borrow-to-finance-debts-expenditures spiral" and creates more debt, worsens macro conditions, and exacerbates fiscal dominance. The paper recommends that policymakers manage Sierra Leone's fiscal trilemma, i.e., high development spending needs, high debt burden, and a low revenue base, not by taking on more debt and relying on monetary financing, but rather by expanding the economy's export capacity, harmonizing fiscal expenditures, and gradually expanding the domestic revenue base. Moreover, to prevent fiscal dominance from becoming systemic in the medium to long term, the research also recommends adhering to the Bank of Sierra Leone 2019 Act, which permits the Bank to cover temporary government deficits at no more than 5% of actual domestic revenue, excluding private receipts in the previous year. In sum, this study underscores the intricate interplay between fiscal policies and macroeconomic stability in Sierra Leone, offering a roadmap for policymakers to navigate the complexities of fiscal and monetary dynamics in the pursuit of enduring economic prosperity.

Keywords: Fiscal dominance, macroeconomic variables, Sierra Leone, DSGE framework, monetary financing

JEL Classification: E3, E5, H6, O2

Disclaimer: Views expressed in this paper are those of the authors and do not in any way reflect the institution(s) they are affiliated.

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1. Introduction

Fiscal dominance, characterized by the influence of fiscal shocks on monetary policy, presents challenges, particularly in developing and emerging economies grappling with substantial fiscal deficits (Tanner, 2002). In the case of Sierra Leone, fiscal instability has persisted for over four decades, marked by fiscal deficits exceeding 5% of GDP. Consequently, policymakers have resorted to funding increased government spending through central bank financing, primarily due to limitations in domestic revenue collection (Ekpo et al., 2015). While the notion that fiscal dominance invariably leads to inflation is a topic subject to debate and warrants a more comprehensive discussion, it is recognized that this situation can potentially result in inflationary pressures, which may, in turn, have adverse effects on the economy, including rising prices, reduced private investment, and potential harm to societal welfare (Liviatan, 2003; Kumhof et al., 2008).

Countries experiencing revenue shortfalls often resort to domestic money market borrowing due to limited fiscal space and challenges accessing external financing. In developing nations with underdeveloped financial markets and cheaper central bank financing, governments may exceed statutory borrowing limits due to constrained central bank independence. In such cases, government expenditure can become a driving force behind increases in the money supply and, subsequently, inflation and affect other key macroeconomic variables. In normal circumstances, central banks in open economies work to curtail government credit growth to control money supply, maintain monetary stability and preventing crowding out of the private sector and avoid the road to inflationary spiral. This practice is more prevalent in advanced and emerging market economies compared to developing economies. In a monetary dominant (MD) or Ricardian regime, fiscal policy is passive, with the fiscal authority adjusting the primary balance to reduce debt accumulation, while the monetary authority doesn't accommodate budget deficits. Conversely, in a fiscal dominant (FD) regime, persistent fiscal deficits lead the central bank to accommodate government financial demands, shifting its focus from price stability to debt stability. The credibility of fiscal policy also significantly impacts monetary policy effectiveness, as inflationary deficit financing can undermine macroeconomic stability and the central bank's autonomy.

Therefore, it is crucial to examine the impact of fiscal dominance on Sierra Leone's macroeconomic variables, including RGDP / Output Growth, Investment, Consumption, Government Expenditure, Capital, Labour, Wage Rate, Interest Rate, Employment, Inflation, Government Securities, Taxes, Debt and Government Transfers. To explore this, the study has therefore proposed the following research question: (a) what are the effects of fiscal dominance on

the highlighted macroeconomic indicators in Sierra Leone? The study aims to achieve the research questions by addressing the following objectives: (i) build a structural model for the economy of Sierra Leone and (ii) examine the impact of fiscal dominance on the most important macroeconomic variables in Sierra Leone. While previous studies have used macroeconomic time-series model simulations to investigate the impact of fiscal deficits and inflation on Sierra Leone's economy see Robert Dauda Korsu (2014, there is a research gap in the application of structural DSGE framework to evaluate the impact of fiscal dominance on macroeconomic indicators in the country. Therefore, this study aims to develop a DSGE model that interacts monetary and fiscal policies to stabilize prices for real GDP growth.

Dynamic Stochastic General Equilibrium (DSGE) models offer several advantages when investigating the impact of fiscal dominance on key macroeconomic variables. These models provide a solid foundation in microeconomic theory, incorporating forward-looking behavior and maintaining consistency with economic principles. They explicitly model fiscal policy rules, allowing for in-depth analysis of its effects, including interactions with monetary policy, endogenous responses of central banks, and the examination of various shocks and counterfactual scenarios. DSGE models deliver quantitative insights, aiding policymakers in evaluating the consequences of fiscal policy choices on macroeconomic variables like output, inflation, and interest rates. Their ability to integrate multiple variables enables a comprehensive analysis of complex economic interactions.

The disruptive effects of fiscal dominance on macroeconomic stability cannot be underestimated, as they pose significant challenges to the ability of the central bank to maintain macroeconomic stability. This is especially true for countries like Sierra Leone, where fiscal policy tends to exhibit a bias towards deficits and pro cyclical behavior. Such a bias in fiscal policy can directly translate into a pro-inflationary stance for the central bank (Montiel, 2013). The rest of the study is structured as follows: Section 2 provides the Literature Review that incorporates theoretical and empirical reviews. In Section 3, we present the methodology, including the estimation technique. Moving on to Section 4, we provide an analysis of the empirical results and a discussion that incorporates calibration of parameters and interpretation of the results. Finally, in Section 5, we present our recommendations for policy action by state actors such as the monetary and fiscal authorities and conclude the study.

2. Literature Review

2.1. Theoretical Literature

2.1.1. Central Bank Independence Theory

The section discusses the relationship between a nation's inflation rate and the independence of its central bank, as originally proposed by Barro in 1976. This theory suggests that a nation's inflation rate is inversely correlated with the level of central bank independence. The article further explores the concept of time inconsistency, which is used to explain why central

banks often depend on policymakers and the implications of this dependence for macroeconomic stability, especially concerning key variables such as inflation and GDP growth. According to Kydland and Prescott (1977), when policymakers establish an optimal inflation rate, and it is accepted by the private sector, it becomes the ideal rate. However, governments may be tempted to inflate beyond what was planned, as there is a belief that inflation can bring some desired benefits (Eijffinger & Haan, 2000). Such inconsistency can result in a surge in the inflation rate, ultimately requiring the central bank to act independently to maintain economic stability. Therefore, it is crucial to manage a stable and balanced price system that is sustainably managed at a low level, while also preserving the independence of the central bank as a credible institution within the system. Alesina (1993) has also pointed out that the lack of independence by central banks can potentially hinder the effective implementation of monetary policy due to the influence of fiscal dominance that results from central bank financing.

2.1.2. Fiscal Theory of Price Level

In the realm of economics, the fiscal theory of price level suggests that inflation is not just a monetary issue but can also be driven by fiscal factors. The origins of this concept can be traced back to Sargent and Wallace in 1984, who aimed to explain fluctuations in price levels resulting from changes in fiscal policy. The theory emphasizes that fiscal dominance can impact price levels and that central bank independence can only be maintained in a sound financial environment. There are two forms of fiscal theory: weak and robust. The weak form emphasizes that changes in money growth caused by fiscal deficit or insolvency drive inflationary pressure. In contrast, the robust variant asserts that fiscal policy has a significant impact on the inflation rate, even if the money supply were to remain constant. Fiscal dominance is assumed to take the weak form, as the fiscal authority is committed to primary surpluses to balance government spending. When public spending outpaces revenue, the monetary authority must use its power to maintain macroeconomic stability by utilising legal power to finance deficits through seigniorage or trading bills and bonds. The weak form contends that the fiscal authority's budgeting policies are a critical factor in achieving monetary policy objectives. The robust form incorporates considerations of heterogeneity, expectations, and feedback effects to provide a more comprehensive understanding of the relationship between fiscal policy and the price level. It recognises the importance of understanding the heterogeneity of the economy and the role of expectations in determining the effects of fiscal policy. Robust fiscal theory also includes the fiscal theory of the price level, which provides a more complete understanding of the relationship between fiscal policy and the price level. (Friedman, 1972; Sargent & Wallace, 1984; Carlstron & Furerst, 1999; Auerbach & Obstfeld, 2002; Barro, 1979; Woodford, 2003).

2.1.3. Crowding-Out Effect Theory

The theory of fiscal dominance, known as the crowding-out effect, describes the impact of government spending on private sector investment. As Barro (1979) notes, when government spending increases, it can result in a decrease in private sector investment. This is because government spending can lead to higher interest rates, greater competition for savings, and fewer funds available for private investment. Government borrowing, which typically funds an increase in spending, leads to higher interest rates, as Barro (1981) explains. These higher rates can make it more expensive for firms to borrow funds, leading to a decline in their investment. Moreover, increased government borrowing can reduce the availability of savings for private investment, as individuals and firms may opt to lend their funds to the government instead. This further reduces funds available for private investment. In addition, government spending can also lead to greater competition for savings and resources. As the government bids up the prices of inputs such as labor and capital, the cost-effectiveness of private sector projects can decrease, ultimately leading to less investment in the private sector. While government spending can have positive impacts on economic growth, employment, and inflation, it can also have negative effects on private sector investment and long-term economic performance, as Barro (1981) notes. The crowding-out effect of fiscal dominance highlights the trade-off between government spending and private sector investment, emphasizing the need for careful consideration in macroeconomic policy.

2.2. Empirical Literature

Bonzu (2022) explores the impact of discretionary fiscal policy on macroeconomic variables in Sierra Leone and identifies the most effective fiscal policy tool for short-term stabilization. The results indicate that government spending expansion can boost output and private consumption but leads to higher inflation, while tax increases have a negative effect on private investment and output. Additionally, the study finds that government investment spending is more effective than consumption expenditure in stimulating the economy, and spending cuts could be a more feasible option for achieving fiscal consolidation in the short run.

Sanusi (2020) estimated the degree of fiscal dominance by analyzing the degree of fiscal and monetary policy interdependence for both Nigeria and South Africa. The econometric estimation was done as a way of defining the extent of fiscal authority actions, which is confined to monetary policy actions. The empirical findings of the study show that both Nigeria and South Africa manifest a degree of interdependence of fiscal and monetary policy at a rate of 0.84 and 0.67 respectively. The degrees of fiscal dominance for both economies are 0.16 and 0.33 respectively, which is an indication that both Nigeria and South Africa are under low fiscal dominance. It implies that monetary authority in Nigeria has greater freedom of fighting inflation.

In their paper Ibrahima Diallo and Isatou Mendy (2018) using a Structural Vector Auto Regressive (SVAR) approach and drawing inspiration from the work of Canzoneri, Cumby, and Diba (2000), the research investigates the presence of fiscal dominance (non-Ricardian) regimes in this region over a substantial period spanning from 1990 to 2017. One of the central findings of

this study is the confirmation of the existence of fiscal dominance regimes in specific WAMZ countries, namely Ghana, Guinea, and Sierra Leone. Additionally, it identifies monetary dominance regimes in The Gambia and Nigeria, showcasing the diversity in policy dynamics within the WAMZ. The implications of these findings are profound and have important policy recommendations attached to them. For countries characterized by fiscal dominance, the study advocates for the implementation of active reaction functions in fiscal policy. This approach enables primary surpluses to respond dynamically to changes in debt levels, thereby enhancing credibility and ensuring fiscal solvency. Conversely, for countries exhibiting Ricardian regime characteristics, the study underscores the necessity of maintaining robust and effective monetary policy frameworks. These frameworks should operate independently, free from fiscal interference, and prioritize inflation stability, thereby mitigating the risk of inflationary biases.

Gali & Perotti (2017) used a DSGE model to analyze the impact of fiscal policy on the macroeconomic outcome of an economy through the redistribution channel. The research constitutes a significant addition to the field of macroeconomics, focusing on the intricate relationship between fiscal policy and the macroeconomic outcomes of an economy, particularly through the lens of the redistribution channel. Their study employs a Dynamic Stochastic General Equilibrium (DSGE) model, which serves as a powerful tool for analyzing these complex dynamics. One of the central themes explored in their research is the concept of fiscal dominance, where fiscal policy wields a substantial influence on macroeconomic variables. Within this framework, Gali and Perotti uncover a key insight: fiscal policy can exert a noteworthy impact on an economy's output, particularly when the central bank faces challenges in establishing a credible commitment to maintaining low inflation. The redistribution channel, as highlighted in their study, plays a pivotal role in this context. Fiscal policy measures aimed at income redistribution, such as changes in tax rates or social spending, can have far-reaching consequences for an economy's overall economic performance. Their findings illuminate the significance of understanding how fiscal policy choices influence the distribution of income and, consequently, macroeconomic outcomes.

Corsetti, Kuester, Meier & Stracca (2015), explored a DSGE model to analyse the impact of fiscal austerity and structural reforms on the macroeconomic outcome of the Eurozone during the financial crisis. They find that fiscal dominance can result in a significant impact of fiscal policy on output, particularly in cases where the central bank is unable to credibly commit to low inflation. Equally in the same year, Castelnuovo & Surico (2015) used a DSGE model to analyse the impact of fiscal policy on the macroeconomic outcome of advanced economies during the Great Recession. They find that fiscal dominance can result in a significant impact of fiscal policy on output, particularly in cases where the central bank is unable to credibly commit to low inflation.

Herrendorf & Valentinyi (2014) made use of a small open economy DSGE model to analyze the impact of fiscal policy on the macroeconomic outcome of an economy. Through the utilization of a small open economy Dynamic Stochastic General Equilibrium (DSGE) model, the study delves into the intricate relationship between fiscal policy decisions and their influence on

an economy's overall performance. One of the central findings of their investigation centers on the concept of fiscal dominance, a phenomenon whereby fiscal policy exerts a substantial impact on key macroeconomic variables. Their research highlights that fiscal policy, encompassing government spending and taxation, can wield significant influence over an economy's output, provided that the central bank lacks the ability to establish and uphold a credible commitment to low inflation.

This research explores the impact of fiscal dominance on macroeconomic performance in Sierra Leone, drawing from established theories like Central Bank Independence Theory, the Fiscal Theory of Price Level, and the Crowding-Out Effect Theory. The study provides valuable policy implications, highlighting challenges to central bank independence, inflation management, and overall economic stability. Using a tailored DSGE simulation approach, the research empirically examines how fiscal dominance influences key macroeconomic variables within Sierra Leone's economic context. Focusing on studies from 2012 to 2022 ensures contemporary relevance, offering timely insights for Sierra Leone's policymakers and enhancing understanding of how fiscal dominance shapes the country's macroeconomic performance.

3. Methodology

This section focuses on the examination of the government's role in financing its deficit through monetary policy. We construct a DSGE model where the monetary authority aims to stabilize prices using the Taylor rule, while the fiscal authority must make decisions regarding its spending composition. The government's primary function is to supply public goods and services to private entities, as well as to redistribute income to reduce inequality and improve the welfare of disadvantaged groups. Additionally, the government may invest in public capital to support the economy's production sector. This spending must be funded through taxation, public debt, or currency issuance. Generally, these three sources of funds can be considered as different forms of taxation with various costs and benefits for society. This section focuses on the incorporation of monetary financing and its consequence of fiscal dominance³ into our DSGE model. There are typically two methods to achieve this objective: the first approach involves issuing domestic debt through high-interest treasury bills to increase demand for government securities, while the second approach involves adjusting the tax structure by raising domestic taxes. Our study is primarily interested in the former.

³ Monetary financing is one way that the government can finance its spending, by having the central bank create new money to purchase government debt. Fiscal dominance, on the other hand, refers to the situation where the government's fiscal policy dominates the central bank's monetary policy. Debt issuance is another way that the government can finance its spending, by issuing bonds to investors in exchange for cash. In some cases, monetary financing can be a tool used to achieve fiscal dominance by reducing the government's reliance on debt issuance. However, this can lead to inflation and a loss of confidence in the currency if not managed properly.

In our completed model, fiscal dominance is established when the share of total government expenditure (G_t) financed by issuing debt (B_t), i.e. expenditures by monetary means) exceeds the portion financed by taxes and other revenue sources. In other words, fiscal dominance occurs when a majority portion of government spending (G_t) is covered by borrowing (B_t) rather than tax revenue (T).

3.1 Households

To examine the impact of fiscal dominance on various economic aggregates, our model adopts the methodology used by Junior (2016). Our economy is a closed one, with two types of infinitely lived working households; $H \in \{A, B\}$. A-type households represent Ricardian households and B-type households are non-Ricardian. The proportions of Ricardian and non-Ricardian households are represented by ω_A and ω_B , respectively. The model does not consider population growth. B-type households do not have access to financial markets, while A-type households can invest in bonds, accumulate physical capital, and rent services from firms. Additionally, we assume that both households have heterogeneous preferences and there is internal habit formation in consumption.

Each household H derives utility from consumption, $C_{h,t}$ and leisure (with labour $L_{h,t}$ in hours) as:

$$E_t \sum_{k=0}^{\infty} \beta^k \left[\frac{(C_{h,t-\phi_c} C_{h,t-1})^{1-\sigma}}{1-\sigma} - \frac{L_{h,t}^{1+\varphi}}{1+\varphi} \right], \quad (1)$$

The expectations operator is represented by E_t , while β is the discount factor, σ signifies the relative risk aversion, ϕ_c stands for the persistence parameter associated with consumption habits, and φ denotes the marginal disutility of labor supply. In the subsequent sections, we will elaborate on the behavior of each household type.

3.2 Ricardian households

Each household of type A maximizes its lifetime utility by balancing consumption and leisure. As a result, Ricardian households solve the following optimization problem:

$$\max_{C_{A,t}, K_{t+1}^P, B_{t+1}} E_t \sum_{t=0}^{\infty} \beta^t \left[\frac{(C_{h,t-\phi_c} C_{h,t-1})^{1-\sigma}}{1-\sigma} - \frac{L_{h,t}^{1+\varphi}}{1+\varphi} \right] \quad (2)$$

Subject to the budget constraint:

$$P_t \cdot (1 + \tau_t^c) \cdot C_{A,t} + \frac{B_{t+1}^P}{R_t^B} = (1 - \tau_t^l) W_t \cdot L_{A,t} + (1 - \tau_t^k) R_t K_t^P + B_t + \omega_A \cdot P_t \cdot TRANS_t \quad (3)$$

And with the following law of motion for capital

$$K_{A,t+1}^P = (1 - \delta) K_t^P + I_t^P, \quad (4)$$

The budget constraint for Ricardian households is given by, where P_t is the price level, τ_t^c is the tax rate on goods consumed, $\frac{B_{t+1}^P}{R_t^B}$ is the present value of bonds purchased by households, τ_t^l and W_t are the tax on labor income and the wage rate, respectively, τ_t^k is the income tax on capital owned by households, K_t^P , B_t represent the bonds issued by the government and t , $TRANS_t$

represents lump-sum transfers to households (proportional to the size of each type of household), and δ is the depreciation rate for private capital. Therefore, the Lagrangian applied to the problem.

3.3 Non-Ricardian households

Regarding non-Ricardian households, as previously noted, they do not have access to financial markets and can only supply labor to maximise consumption in the current period. Their budget constraint is given by the following equation (5):

$$(1 + \tau_t^k)P_t C_{B,t} = (1 - \tau_t^l)W_t \cdot L_{B,t} + (1 + \omega_B)P_t \cdot TRANS_t \quad (5)$$

Therefore, the Lagrangian for non-Ricardian households is expressed as follows:

$$\lambda_{B,t} = \frac{(C_{B,t} - \phi_c C_{B,t-1})^{-\sigma}}{(1 + \tau_t^c)P_t} - \phi_c \beta \frac{(E_t C_{B,t+1} - \phi_c C_{B,t})^{-\sigma}}{(1 + \tau_t^c)P_t} \quad (6)$$

3.4 Wage Dynamics

In our model, we assume that both Ricardian and non-Ricardian households earn the same wage rate, and they supply differentiated labor in a monopolistic competition market. They sell their labour to a representative firm, and the differentiated labour supplies are aggregated into one labour input, L .

$$L_t = \left(\int_0^1 L_{j,t}^{\frac{\psi W - 1}{\psi W}} dj \right)^{\frac{\psi W}{\psi W - 1}} \quad (7)$$

The elasticity of substitution among the different jobs is represented by ψW . $L_{j,t}$ is the amount of labour supplied by household j for job type j at time t . Each worker in job type j earns the wage $W_{j,t}$. The aggregated labor firms' goal is to maximise their profits, which is reflected in the following expression.

$$\max_{L_{j,t}} W_t L_t - \int_0^1 W_{j,t} L_{j,t} dj \quad (8)$$

Which can be rewritten by substituting L_t in equation 6 with:

$$\max_{L_{j,t}} W_t \left(\int_0^1 L_{j,t}^{\frac{\psi W - 1}{\psi W}} dj \right)^{\frac{\psi W}{\psi W - 1}} - W_{j,t} \int_0^1 L_{j,t} dj. \quad (9)$$

In addition, we assume the existence of wage stickiness, meaning that in each period, a fraction, $1 - \theta_W$, of households optimize their wages by choosing $W_{j,t}^*$. Meanwhile, the remaining portion of workers, θ_W , are characterised by following a wage stickiness rule that keeps the current period's wage rate equal to the previous period's wage rate ($W_{j,t} = W_{j,t-1}$). Additionally, households that try to optimise their wage rate face a probability of θ_W , which results in the wage

rate remaining unchanged for N periods. As a result, the wage determination problem for the household **H**, considering taxes on labor income, is expressed as follows:

$$\max_{W_{j,t}^*} \mathbb{E}_t \sum_{i=0}^{\infty} (\beta \cdot \theta_W)^i \left\{ -\frac{1}{1+\varphi} \left[L_{H,t+i} \left(\frac{W_{t+i}}{W_{j,t}^*} \right)^{\psi W} \right]^{1+\varphi} + \lambda_{H,t+i} \left[W_{j,t}^* L_{H,t+i} \left(\frac{W_{t+i}}{W_{j,t}^*} \right)^{\psi W} (1 - \tau_{t+i}^l) \right] \right\}, \quad (10)$$

Consequently, considering the hypothesis of wage stickiness, the wage rate level at period t is given as:

$$W_t = \left[\theta_W W_{t-1}^{1-\psi W} + (1 - \theta_W) W_t^{*1-\psi W} \right]^{\frac{1}{1-\psi W}} \quad (11)$$

3.5 Firms

In the economy, there are two types of firms. On one hand, there are firms that sell intermediate goods and on the other hand, a representative retail firm sells the final goods purchased from the first group of firms. While the retail firm, which represents several firms, operates within a framework of perfect market competition, the market structure of intermediate firms is characterised by monopolistic competition. Additionally, given the characteristics of the firms and the purpose of our model, we will further elaborate on the dynamics within intermediate firms.

For the intermediate firms, we assume the non-existence of fixed costs, meaning that the average total costs are equal to the variable costs. Furthermore, in the production function of these firms, we consider inputs such as labor and private capital, as well as public capital. Hence, the production function is given by:

$$Y_{j,t} = A_t K_{j,t}^{P,\alpha_1} L_{j,t}^{P,\alpha_2} K_{j,t}^{G,\alpha_3}, \quad (12)$$

The variables α_1 , α_2 and α_3 represent the elasticity of private capital ($K_{j,t}^P$), labor ($L_{j,t}$), and public capital ($K_{j,t}^G$), respectively, in the production process. We also assume the hypothesis of constant returns to scale, where $\alpha_1 + \alpha_2 + \alpha_3 = 1$.

Furthermore, productivity A_t follows an AR(1) process as follows:

$$\log A_t = (1 - \rho_A) \log A_{ss} + \rho_A \log A_{t-1} + \varepsilon_t$$

Let A_{ss} represent the steady state level of productivity, $|\rho_A| < 1$ be the autoregressive parameter, and ε_t be the error term that follows a normal distribution with standard deviation σ_A , meaning $\varepsilon_t \sim N(0, \sigma_A^2)$. Additionally, these firms solve their optimisation problem by minimising production costs subject to the production function. As a result, the Lagrangian for this problem can be stated as:

$$\mathcal{L} = W_t L_{j,t} + R_t K_{j,t} + \mu_{j,t} (Y_{j,t} - A_t K_{j,t}^{P,\alpha_1} L_{j,t}^{P,\alpha_2} K_{j,t}^{G,\alpha_3}) \quad (13)$$

From the Lagrangian equation, and given that $\mu_{j,t} = MC_{j,t}$, where $MC_{j,t}$ represents the marginal cost, which can be expressed as $MC_{j,t} = 1 \frac{1}{A_t K_{j,t}^{\alpha_3}} \left(\frac{W_t}{\alpha_2}\right)^{\alpha_2} \left(\frac{R_t}{\alpha_1}\right)^{\alpha_1}$, we can derive the first-order conditions for the firms' optimization problems and therefore find the demand for each input by the firms:

$$\frac{d\mathcal{L}}{dL_{j,t}} = 0$$

Regarding the price associated with the sale of these intermediate goods, and similarly to wage stickiness, the intermediate firms also face sticky prices. As a result, similarly to what occurs with household wages, we can define the aggregate price level as:

$$P_t = \left[\theta P_{t-1}^{1-\psi} + (1-\theta) P_t^{*,1-\psi} \right]^{\frac{1}{1-\psi}}, \quad (14)$$

Here, θ represents the probability that the firm will keep the same price P_t in the next period, ψ represents the degree of elasticity of substitution among the intermediate firms' goods, and P_t^* represents the optimal price sought by firms in each period.

3.6 The Government

In this section, the government is represented by two authorities, fiscal and monetary. The former is responsible for steering the model's fiscal policy, while the latter represents price stability via the Taylor rule. Besides, fiscal dominance in the model is defined as high excessive expenditure financed by monetary means.

3.7 Fiscal Policy

The government is responsible for collecting taxes T_t and using these revenues to finance not only the acquisition of goods and services from the economy G_t , but also investment I_t^G and the transfer of a portion of revenues to households $TRANS_t$, as previously stated. Furthermore, if tax revenues are insufficient to finance all types of public spending, the government can also issue debt B_t (financing a large share of its expenditures by monetary means). The dynamics of public capital are given by:

$$K_{t+1}^G = (1 - \delta_G) K_t^G + I_t^G, \quad (15)$$

Here, δ_G represents the depreciation rate associated with public capital. As a result, the budget constraint for fiscal policy can be defined as:

$$\frac{B_{t+1}}{R_t^B} - B_t + T_t = P_t \cdot G_t + P_t \cdot I_t^G + P_t TRANS_t, \quad (16)$$

Where $\frac{B_{t+1}}{R_t^B}$ represents the present value of the change in government debt in period t and

T_t represents the total nominal tax revenue:

$$T_t = \tau_t^c \cdot C_t + \tau_t^l \cdot W_t L_t + \tau_t^k (R_t - \delta) K_t^P, \quad (17)$$

Where τ_t^c , τ_t^l and τ_t^k are the tax rates imposed on consumption, labour, and net capital income, respectively. These tax rates and government spending variables are governed by the following policy rule:

$$\frac{Z_t}{Z_{SS}} = \left(\frac{Z_{t-1}}{Z_{SS}} \right)^{\gamma_Z} \left(\frac{B_t}{Y_{t-1} P_{t-1}} \right)^{(1-\gamma_Z)\phi_Z} S_t^Z, \quad (18)$$

Where Z_t is a set of fiscal policy variables including the tax rates on consumption, labour, net capital income τ_t^c , τ_t^l , τ_t^k , G_t , I_t^G , government spending G_t , public investment I_t^G , and transfers to households $TRANS_t$. The persistence of each of these variables is represented by γ_Z , and the shock associated with each fiscal policy variable follows an AR(1) process, described as S_t^Z with the following details:

$$\log S_t^Z = (1 - \rho_Z) \log S_{SS}^Z + \rho_Z \log S_{t-1}^Z + \varepsilon_t^Z \quad (19)$$

3.8 Monetary Policy

Regarding the monetary policy setup, the central bank's primary concern is with price stability and the trajectory of economic growth. The interactions between fiscal and monetary policies have significant impacts on other economic aggregates, as shown in various studies such as, Afonso and Balhote (2014), among others. However, since our focus is solely on the analysis of monetary financing, we use the following Taylor rule:

$$\frac{R_t^B}{R_{SS}^B} = \left(\frac{R_t^B}{R_{SS}^B} \right)^{\gamma_R} \left[\left(\frac{\pi_t}{\pi_{SS}} \right)^{\gamma_\pi} \left(\frac{Y_t}{Y_{SS}} \right)^{\gamma_Y} \right]^{1-\gamma_R} S_t^m, \quad (20)$$

Where γ_π and γ_Y are the degrees of sensitivity of the interest rate to inflation and the aggregate production, respectively, γ_R is a smoothing parameter, and S_t^m represents the monetary shock, which follows an AR(1) process, as described below:

$$\log S_t^m = (1 - \rho_m) \log S_{SS}^m + \rho_m \log S_{t-1}^m + \varepsilon_t \quad (21)$$

In conclusion, considering the model outlined earlier, the equilibrium conditions of our economy are as follows:

Equilibrium condition

$$Y_t = C_t + I_t^P + I_t^G + G_t \quad (22)$$

Aggregate consumption

$$C_t = \omega_A C_{A,t} + \omega_B C_{B,t} \quad (23)$$

Aggregate labour

$$L_t = \omega_A L_{A,t} + \omega_B L_{B,t} \quad (24)$$

4.0 Empirical Analysis and Findings

4.1 Calibration of Parameters

Calibrations play a pivotal role in estimating parameters within Dynamic Stochastic General Equilibrium (DSGE) models, and their significance is amplified in contexts like Sierra Leone, where data limitations and reliability issues prevail. In crafting these calibrated parameters, researchers rely on a blend of established empirical findings, economic theory, and expert insights, encapsulating their prior beliefs regarding parameter values before actual data observations. For Sierra Leone's DSGE model, parameter calibrations draw from diverse sources: firstly, empirical evidence gleaned from published studies, such as: Barrie and Jackson, (2022) Sillah and Barrie et al. (2021), which offer key estimates for parameters like labor supply elasticity and income elasticity of specific goods. Secondly, economic theory provides a robust underpinning, ensuring that the model aligns with fundamental economic principles. Lastly, expert input from economists and policymakers well-versed in Sierra Leone's economic intricacies contributes valuable refinements to parameter estimates.

By harmonizing these sources, researchers have fashioned calibrated parameters that best capture Sierra Leone's distinctive economic landscape, bolstering the model's credibility and reliability to the country's unique economic conditions and dynamics. One of the advantages of using Bayesian methods is that they can help to address the identification problem⁴ often found in DSGE models by improving the accuracy of the estimated parameters and identifying shocks more accurately. Additionally, prior specifications can be guided by economic theory and empirical evidence, making them an informative choice for the estimation of DSGE model parameters.

Parameter	Interpretation	Calibrated Value
σ	Relative risk aversion coefficient	7
α_1	Elasticity of level of production in relation to private capital	0.7
α_2	Elasticity of level of production in relation to labor	0.6
α_3	Elasticity of level of production in relation to public capital	0.5
β	Discount factor	0.95
δ	Depreciation rate	0.04
θ	Price stickiness parameter	0.85

⁴ The identification problem in Dynamic Stochastic General Equilibrium (DSGE) models refers to the difficulty of uniquely identifying the model's parameters from the available data. This arises because DSGE models typically contain many parameters, and many of these parameters have similar effects on the model's outcomes.

ψ	Elasticity of substitution among intermediate goods	0.7
θW	Wage stickiness parameter	0.35
ψW	Elasticity of substitution between differentiated labour	0.6
τ_{ss}^c	Rate of tax on consumption in steady state	0.15
τ_{ss}^l	Rate of tax on income from labor in steady state	0.14
τ_{ss}^k	Rate of tax on income from capital in steady state	0.17
ωR	Participation of Ricardians in consumption and labour in the economy	0.8
φ_c	Habit persistence	0.05
χ	Sensitivity of investments in relation to adjustment cost	1
δG	Rate of depreciation of public capital	0.025
γR	Interest rate persistence	0.79
γY	Sensitivity of interest rate in relation to GDP	0.06
$\gamma \pi$	Sensitivity of interest rate in relation to inflation	0.005
$\phi TRANS_{ss}$	Proportion of transfers in relation to GDP	0.20
ϕB_{ss}	Proportion of public debt in relation to GDP	0.76
ϕI_{GSS}	Proportion of public investment in relation to GDP	0.10
γG	Public spending persistence	0.3
γIG	Persistence of public investment	0.1
$\gamma TRANS$	Persistence of income transfer	0.5
γ_c^T	Persistence of tax on consumption	0.8
γ_l^T	Persistence of tax on labour income	0.9
γ_k^T	Persistence of tax on capital income	0.3
φG	Public spending over debt	0.4
ϕIG	Public investment over debt	-0.1

ϕ_{TRANS}	Income transfer over debt	-0.1
ϕ_{τ}^c	Tax on consumption over debt	0.1
ϕ_{τ}^l	Tax on labor income over debt	0.03
ϕ_{τ}^k	Tax on capital income over debt	0.3

The risk aversion coefficient is calibrated at 7, indicating a high level of risk aversion among economic agents. The parameters α_1 , α_2 , and α_3 measure the responsiveness of production to private capital, labor input, and public capital investment, respectively. The calibrated values of α_1 , α_2 , and α_3 are 0.7, 0.6, and 0.5, indicating that an increase in private capital investment, labor input, or public capital investment will lead to an increase in production levels, with varying degrees of sensitivity. The discount factor (β) measures economic agents' time preference and how much they value future consumption compared to current consumption, with a calibrated value of 0.95 for Sierra Leone indicating a high preference for present consumption. This could have implications for savings, investment, and aggregate demand. The parameter δ represents the annual rate of depreciation of capital stock due to physical wear and tear or other factors, calibrated at 0.04, meaning the capital stock loses 4% of its value each year due to depreciation (See Barrie and Jackson, 2022).

The θ parameter measures price stickiness, with a calibrated value of 0.85 suggesting that prices in Sierra Leone adjust relatively quickly. The ψ parameter represents substitution among intermediate goods, with a value of 0.7 indicating some substitutability. A lower ψ value implies that producers may find it difficult to switch between intermediate goods⁵. The parameter θW represents wage stickiness in the market, where a calibrated value of 0.35 indicates partial wage adjustment to changes in labour market conditions in Sierra Leone. A higher value of θW suggests greater wage stickiness and slower adjustment to labour market changes. The parameter ψW denotes the elasticity of substitution between different types of labour, with a value of 0.6 suggesting that the different types of labour are somewhat substitutable but not perfect substitutes, limiting the extent to which employers can substitute one type of worker for another.

The parameter " τ_{SS}^c " represent the steady-state rates of tax on consumption, income from labor, and income from capital, respectively. Their calibrated values are 0.15, 0.14, and 0.17, indicating that individuals will pay 15% consumption tax, 14% tax on labor income, and 17% tax on income from capital investments in the long run. These values were obtained from Barrie and Bah's (forthcoming) work. In the model, the parameter ωR represents the participation of Ricardians in consumption and labour, with a calibrated value of 0.8, indicating that 80% of economic agents

⁵ When the elasticity of substitution is close to zero, it means that the intermediate goods used in the production process are perfect complements, which implies that they are very specialized and cannot be easily replaced by other goods. On the other hand, an elasticity of substitution close to 1 suggests that different types of intermediate goods are very similar and interchangeable.

participate in some economic activities. The parameter ϕ_c represents habit persistence in the economy, with a value of 0.05, indicating that past consumption patterns only influence 5% of individuals' current consumption behavior. Lower degrees of habit persistence may facilitate adjustments to changes in economic conditions, potentially making it easier to stimulate consumption or investment.

The parameter χ in the model represents investment sensitivity to adjustment costs, calibrated with a value of 1 indicating that firms are highly responsive to the costs associated with changing their investment plans as firms are known to be profit maximizing and quite sensitive to cost overruns. This results in cautious investment behavior. The parameter δ_G represents the rate of depreciation of public capital and has a calibrated value of 0.025, meaning that public assets lose 2.5% of their value each year. Higher rates of depreciation may necessitate greater investment for infrastructure maintenance, while lower rates may allow for less investment. The parameter γ_R represents interest rate persistence, with a calibrated value of 0.79. Interest rate persistence refers to the time it takes for interest rates to adjust to changes in economic conditions, and a higher value indicates that changes may take longer to have an effect. A value of 0.79 suggests that it may be challenging for the Central Bank to use interest rate adjustments to stimulate economic activity.

The parameter γ_Y represents the sensitivity of interest rates to changes in GDP, with a calibrated value of 0.06. A low sensitivity suggests that changes in economic activity may not significantly affect interest rates. The parameter γ_π reflects the sensitivity of interest rates to changes in inflation, with a value of 0.005 also known as the Fisher Equation⁶. A higher sensitivity of interest rates to inflation implies that controlling inflation may require more aggressive action by the Central Bank, potentially affecting the effectiveness of monetary policy in maintaining economic stability. The parameter " $\phi_{TRANS_{SS}}$ " represents the proportion of government transfers relative to GDP in Sierra Leone's steady-state economy, calibrated at 0.2. This indicates that transfers represent a small proportion of the economy, equivalent to 1% of GDP. They are not a significant source of economic activity or growth in the steady state.

The parameter " $\phi_{B_{SS}}$ " represents the proportion of public debt to GDP in the steady state of the Sierra Leonean economy, calibrated at 0.76. This is because in Sierra Leone public debt is known to be 76% of the economy. Hence, the Sierra Leonean government is heavily indebted, and managing its debt burden and ensuring long-term economic stability may be challenging. The parameter " $\phi_{I_{GSS}}$ " has a value of 0.1 and represents the proportion of public investment to GDP in the steady state of the economy in Sierra Leone. This suggests that the government is investing a small portion of its resources in infrastructure, which may lead to slower economic growth, reduced productivity, and limited opportunities for individuals and businesses.

⁶ The Fisher effect is based on the idea that lenders will require higher nominal interest rates to compensate for the expected loss of purchasing power due to inflation. Therefore, if inflation is expected to increase, nominal interest rates will also increase to maintain the real rate of interest (the nominal rate minus the expected inflation rate).

The parameter " γ_G " in our model reflects public spending persistence, calibrated at 0.3, indicating that current spending decisions are not heavily influenced by past behaviour. The parameter " γ_{IG} " represents investment persistence, calibrated at 0.1, indicating that current investment decisions are somewhat influenced by previous ones. The parameter " γ_{TRANS} " shows the degree of persistence in income transfer decisions, calibrated at 0.5, indicating that such decisions are moderately influenced by past decisions due to political pressure and statutory commitment. The parameter " γ_C^T " has a value of 0.8, reflecting the high persistence of consumption tax, implying that the government is likely to maintain the same consumption tax rate from one period to the next. The parameter " γ_l^T " is 0.9, indicating that the government is likely to keep the same level of tax on labour income over a long period of time. The parameter " γ_k^T " is 0.3, suggesting that the government is less likely to maintain the same level of tax on capital income over a long period of time and does not consider its past behaviour when setting the current tax level.

The parameter " ϕ_G " is calibrated at 0.4, indicating that 40% of the government's public spending is financed by public debt and its spending behaviour is constrained by debt levels. The parameter " ϕ_{IG} " is calibrated at -0.1, implying that higher public debt levels are associated with lower public investment. The calibrated value of " ϕ_{TRANS} " is also -0.1, which suggests that the government's high levels of debt constrain its ability to provide income support or other social assistance. The parameter ϕ_τ^C reflects the relationship between tax on consumption and public debt, with a calibrated value of 0.1, indicating a limited relationship. The parameter ϕ_τ^l represents the ratio of tax on labor income to public debt, with a calibrated value of 0.01, indicating a small fraction. The parameter ϕ_τ^k represents the proportion of tax on capital income to public debt, with a calibrated value of 0.3, indicating a moderate influence.

4.2 Model Simulation Results

The eleven computed eigenvalues confirm that the model is stable, which is a crucial condition for having a unique equilibrium near the steady state. Meeting this requirement involves having as many eigenvalues with a modulus greater than one as there are system-wide variables with a forward-looking component. The model satisfies the Blanchard-Kahn criteria for stability and the verified rank condition, indicating that the equations are well-specified and consistent. Furthermore, the simulation results show a perfect foresight solution without convergence issues, as demonstrated in Appendix 1.

The means of several variables are examined, with Y, IG, CNR, G, and U having means close to zero, indicating proximity to the origin. Variables such as IP, CR, KP, LR, LNR, and R have slightly positive or negative means, indicating their displacement to one side, while W has a negative mean, indicating its shift to the left. These findings are presented in Appendix 2. Autocorrelation values for 18 simulated variables at lags 1 to 5 are shown in Appendix 3, indicating that the variables tend to maintain their values over time. However, as the lag increases, the

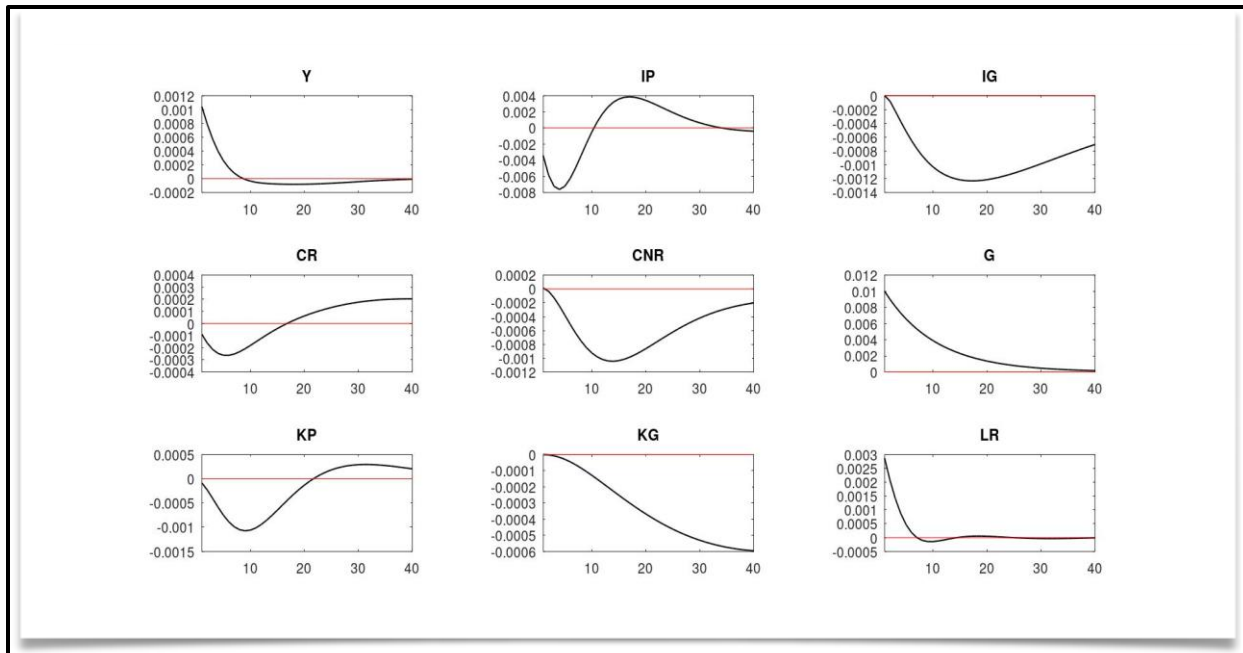
autocorrelation values decline, indicating a weaker correlation between the variable and its lagged values. These results suggest that the variables are influenced by randomness or variability, making their values less predictable over time. The autocorrelation values serve as a measure of the variables' persistence over time. Appendix 4 showcases the breakdown of multiple macroeconomic variables into linear and nonlinear components. This breakdown shows the impact of different structural shocks on the linear component, while the nonlinear component illustrates the contribution of higher-order moments of shock distribution. The results reveal that nonlinearities have a significant role in explaining the variance of some variables, while linear contributions dominate others, with different structural shocks having varying effects on the variance of different variables.

Using policy transition functions, the simulation of the economy under different policy scenarios allows for the evaluation of the potential impact of policy options. This helps decision-makers anticipate the effects of policy changes before implementation and make informed decisions in different economic situations. The details can be found in Appendix 5. The figures presented as impulse-response functions serve as crucial analytical tools to understand how the economy responds to government fiscal policies over time. These functions demonstrate the impact of monetary-financed changes in government spending on output and related components, using a calibrated DSGE macroeconomic model that reflects the structure and behavior of the Sierra Leone economy.

4.3 Impulse Response Function

The analysis of the impulse-response functions provides valuable insights into the consequences of using monetary means to finance government spending needs. The functions allow for a comparison of the effects of different fiscal policies on the economy and are powerful tools for policymakers and analysts to better understand policy impacts. By examining these functions, policymakers can make informed decisions that support economic growth and macroeconomic stability. The impulse-response functions depicted in Figure 1 offer valuable analytical tools for policymakers and researchers to better understand the effects of an expansion on government borrowing on the economy. Note that for the purposes of this research monetary financing is defined as government borrowing financing by the central bank financing (operations).

Figure 1: The Reaction of Key Macroeconomic Variables to the Effect of Fiscal Dominance



The outcomes presented in Figure 1, illustrates the impact of a one standard deviation shock to government borrowing, highlight a noteworthy pattern. The utilization of monetary means by the government to finance its expenditures leads to an initial boost in economic output (Y), but this effect is transitory. Interestingly, after the tenth month of the forecast horizon, a decline in output ensues, ultimately plunging the economy into a recession characterized by output contraction. This suggests that prolonged reliance on monetary-financed expenditure can detrimentally impact overall economic output. It's crucial to recognize that the distinct features of Sierra Leone's economy play a significant role in shaping the dynamics between government borrowing, fiscal expansion, and inflation.

In our specific economic context, these mechanisms are consistent with how fiscal policy can instigate inflation. Firstly, when the government escalates borrowing to finance its operations, it typically introduces bonds into the market, intensifying the demand for available funds. This heightened competition for capital has the potential to drive up interest rates, leading to increased borrowing costs for both businesses and consumers. Secondly, an expansionary fiscal approach, often funded through heightened borrowing, tends to cause a devaluation of the domestic currency. A weakened local currency implies that more of it is needed to acquire the same amount of foreign currency, elevating the costs of imported goods and services. Consequently, this results in an upsurge in prices for imported items, contributing to inflationary pressures.

The analysis reveals a substantial and prolonged downturn in Private Investment (IP), with a temporary recovery followed by a sustained period of sluggishness and negativity extending until the 40th horizon period. This decline is primarily attributed to the crowding-out effect of monetary financing, wherein elevated government borrowing triggers a rise in interest rates. The consequent increase in borrowing costs for private individuals and businesses makes it more expensive to

secure funds, leading to a reduction in private investment. This diminished investment, in turn, causes a contraction in output and a decrease in the overall capacity to produce goods and services.

Examining the dynamics of Public Investment (IG), we observe an initial increase in response to government borrowing or monetary financing. However, the subsequent decline in private investment (IP), as illustrated in Figure 1, indicates a quick downturn in public investment. This can be explained by the fact that the reduction in private investment results in lower tax revenues due to decreased incomes and profits. This decline in tax revenues, consequently, curtails the government's ability to invest in public goods and services, further contributing to a long-term decrease in economic growth and output. This reduction in public investment sets off a detrimental cycle, leading to additional declines in economic growth and output. As economic conditions worsen, tax revenues decrease, prompting the government to resort to more borrowing. Therefore, the observed decline in tax revenues, stemming from the economic output contraction depicted in Figure 1, offers a plausible explanation for the observed downturn in public investment in our analysis. This interconnected cycle creates a challenging scenario, where diminishing economic growth exacerbates the decline in public investment, leading to further economic contractions and increased reliance on government borrowing.

The surge in government borrowing has led to a reduction in consumption for both Ricardian (CR) and Non-Ricardian (CNR) households, mirroring the decline in real income as illustrated in Figure 1. The distinct patterns observed in these consumption behaviors can be attributed to the differing principles guiding the two household types. Ricardian households base their consumption decisions on their outlook on future income. As a result, they tend to curtail present consumption when anticipating lower future income, which could arise from a decline in wages and the impact of inflation. The dip in Ricardian consumption, as depicted in Figure 1, aligns with this rationale. Interestingly, the observed recovery in Ricardian consumption around the 19th month suggests that households are adapting to the "new normal" and anticipating a return to more typical future income levels.

In contrast, the decline in Non-Ricardian household (CNR) consumption, also evident in Figure 1, is linked to their reliance on current income levels for consumption choices. These households are more responsive to changes in present income, and a reduction in real income stemming from declining wages and increasing inflation prompts a decrease in their consumption. The permanent decline in Non-Ricardian consumption, highlighted in Figure 1, stems from the fact that these households do not base their consumption decisions on lifetime income. Consequently, they do not anticipate a return to previous levels of future income, contributing to a sustained reduction in consumption.

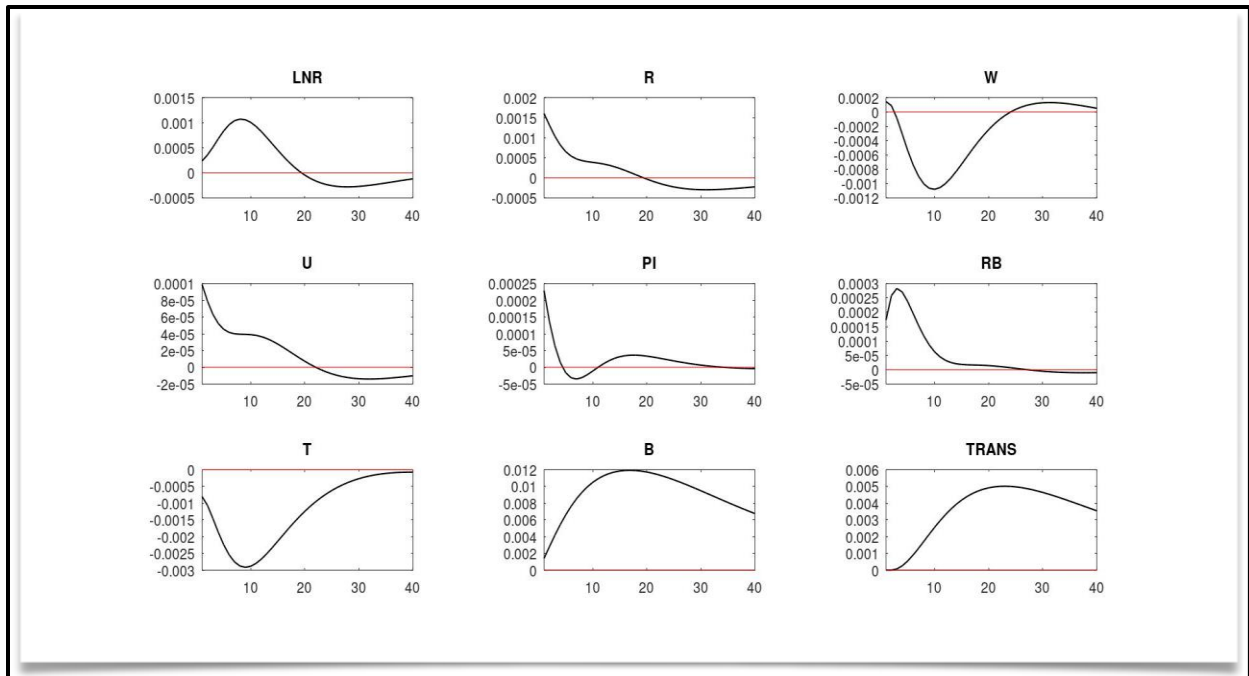
From figure 1 we also see significant increase in government expenditures (G), largely driven by increase in government borrowings (Figure 1). The rapid return of government expenditures to their steady-state is due to the decline in growth and investment and consequently tax revenue, this leaves the government primarily with the option of borrowing to finance it deficit.

The significant increase in government expenditures (G), primarily fueled by elevated government borrowings, reflects a common response to fiscal imbalances resulting from declining economic growth and reduced tax revenue. In such scenarios, governments often resort to borrowing to bridge the budget deficit and maintain essential public services and projects. The rapid return of expenditures to their steady-state level underscores the challenge posed by diminished growth and investment, leaving borrowing as the primary option for financing the deficit.

Regarding private sector capital stock (KP) in Figure 1, increased monetary financing of government expenditures by government borrowing initially leads to a sharp decline due to crowding-out effects. However, KP eventually recovers and surpasses its steady-state level around the 20th month. This recovery is attributed to a rebound in private sector investment as economic conditions improve, and firms innovate and adapt. In contrast to private sector capital stock (KP), the public sector's capital stock (KG) experiences an immediate decline in response to increased monetary financing and government borrowing, remaining below its steady-state level throughout the forecast horizon. This drop results from reduced public sector investment due to decreased tax revenues and increased government spending on public sector wages and transfers. The decline in KG has negative consequences for the economy's long-term growth and productivity, as public sector investment typically plays a major role in driving growth in Sierra Leone. Thus, the behavior of KP and KG underscores the intricate interplay between government policies and private sector investment in shaping economic outcomes.

Figure 1 also examines the behaviour of labour supply for Ricardian households (LR) in response to government fiscal policies, specifically high expenditure levels financed through monetary means. The analysis reveals that LR initially increases sharply above its steady-state value due to monetary financing, possibly due to the short-term boost in economic activity that typically accompanies government spending increases. However, this effect is transient, and LR soon declines below its steady-state value around the 8th month's forecast horizon. The model indicates that the decline is the result of various factors such as increased inflation and reduced investment, which negatively affect growth and labour market conditions. This in a nutshell indicates that when considering the potential impacts of policy changes on the labor market, policymakers must carefully balance short-term economic stimulus with long-term macroeconomic sustainability to promote stable and productive future labour market conditions.

Figure 2: The Reaction of Domestic Prices and Rates to the effect of Fiscal Dominance.



The trends depicted in Figure 2 regarding Non-Ricardian Household Labor Supply (LNR) reveal a nuanced interplay between government monetary financing, labor market dynamics, and their long-term consequences. Initially, the prospect of increased government spending and fiscal stimulus prompts households to boost their labor supply. However, as monetary financing persists, it leads to a crowding-out effect, resulting in higher interest rates that can increase household borrowing costs and reduce private sector investment and job opportunities. Consequently, LNR eventually falls below its steady-state level, indicating that the initial optimism and increased labor supply are unsustainable over time. This decline in labor supply carries adverse long-term implications for the labor market, leading to higher unemployment, and reduced economic growth prospects.

From figure 2, we see that increased government borrowing prompts the central bank to raise its nominal policy interest rates (R), accentuating a crucial interaction between fiscal and monetary policy. Nominal policy interest rates are a cornerstone of central banks' toolkit for managing economic conditions. While the central bank's decision to increase interest rates aims to counter inflationary pressures and anchor inflation expectations, it simultaneously makes government borrowing more expensive, this is because other rates such as treasury bills rate i.e. cost of government borrowing also creep in the direction of other policy rates. This dual impact is noteworthy as it influence the cost of financing for both the public sector and the private sector. Therefore, in Sierra Leone's case, the central bank's actions not only seek to safeguard economic stability but also have direct implications for the government's fiscal policies and its ability to borrow on cost-effective terms.

The trends observed in Real Wage Rates (W) in the data reveal a complex interplay between monetary financing, economic output, and wage dynamics. Initially, the modest increase in real wage rates can be attributed to the temporary stimulating effects of monetary financing, which we saw with output and investment, which temporarily boosts demand for labor. However, the subsequent and sustained decline in real wage rates, remaining below their steady-state value for an extended period, suggests that these initial benefits are not enduring. This decline is influenced by factors such as inflation eroding purchasing power, reduced economic output leading to decreased job opportunities, and intensified competition for available positions. The model underscores the challenges of relying solely on monetary financing to drive long-term wage growth and economic prosperity.

Labour usage by firms (U) initially rises in response to monetary financing and the increase in aggregate output, but ultimately declines below the steady state value, leading to layoffs exceeding hires in the economy. This decline is due to the crowding-out effect of monetary financing on private investment (IP), reducing the productivity of the economy. Observing Figure 2, we note that monetary financing instantaneously spikes in inflationary pressures (PI), as classical dichotomy would suggest. Inflation remains high until the 4th month due to the ongoing effects of monetary financing. However, we see a slight moderation in inflation pressures from the 5th to the 9th month because of a brief increase in aggregate output. Nonetheless, inflation remains elevated and above the steady-state value for the remainder of the forecast horizon. This persistent effect of monetary financing on the economy's price level is due to higher inflation expectations, leading to higher wages and prices as firms and households adjust their expectations.

Additionally, Figure 2 indicates that returns on government bonds/securities (RB) increase sharply above the steady state and remain high until around the 29th month. Nevertheless, returns on government bonds become negative after this period due to rising inflation, which reduces the real return on bonds. High inflation consequently and negatively affects the returns on government securities, prompting the Bank of Sierra Leone to raise interest rates to attract more subscriptions. However, raising interest rates can have negative long-term consequences on economic growth by decreasing (domestic) investment and consumption, ultimately harming the economy. Moreover, high interest rates for government securities encourages the financial institutions to hedge their risk in much more safer government securities instead of providing loans to firms, which diminishes the intermediation role commercial banks are supposed to play in the economy.

The analysis reveals that tax revenues (T) decline below their steady-state level due to the negative impact of monetary financing on growth and continue to decline in the long run forecast horizon. This decline is primarily due to the decrease in consumption, investment, and output as shown in Figure 2. Governments must therefore consider the impact of their policies on the overall economy and strive for stable economic growth to ensure sustainable tax revenue collection.

Furthermore, in Figure 2, we see that the shock variable in our model, government debt (B) rapidly increases and persists throughout the entire forecast horizon. This increase in debt is due to the government's borrowing to finance its current expenditures, as well as the decrease in tax

revenues resulting from the fall in economic activities. The increase in government debt leads to higher interest rates and discourage private investment, as well as making it more difficult for the government to borrow in the future.

Figure 2 reveals that government transfers (TRANS) experience a persistent increase throughout the entire forecast horizon, owing to weak growth, low investment, high inflation, and declining real wages within the economy. When economic growth is sluggish, firms tend to hire fewer workers and invest less, which can result in high unemployment rates and a reduction in consumer spending. This, in turn, decreases tax revenues, prompting the government to increase its transfer payments to support households in need, such as through social welfare programs like unemployment and health benefits and subsidies. Similarly, high inflation rates reduces the purchasing power of individuals, leading to a decrease in consumer spending and an increase in the cost of living, which can cause a decline in tax revenues and a rise in demand for government transfers. Overall, the increase in government transfers observed in Figure 2 is a result of weak economic growth, high inflation, and declining real wages, a consequence of increased government borrowing.

5.0 Conclusion and Policy Recommendations

5.1 Conclusion

In conclusion, this research delves into the intricate dynamics of fiscal dominance within the context of Sierra Leone's economy, highlighting the enduring fiscal instability spanning over four decades. Motivated by the challenges stemming from fiscal deficits exceeding 5% of GDP, the study emphasizes the common resort to central bank financing due to limitations in domestic revenue collection. The significance of this inquiry lies in exploring the potential repercussions of fiscal dominance on Sierra Leone's macroeconomic variables. Focused on the research question regarding the effects of fiscal dominance on highlighted indicators, the paper sets out two primary goals: constructing a structural model for Sierra Leone's economy and assessing the impact of fiscal dominance on crucial macroeconomic variables. Addressing a research gap in the application of a Dynamic Stochastic General Equilibrium (DSGE) framework, the study underscores the DSGE model's significance in providing quantitative insights for policymakers. In the face of Sierra Leone's fiscal biases and pro-cyclical behavior, the paper contributes to existing knowledge by comprehensively examining the disruptive effects of fiscal dominance on macroeconomic stability, recognizing the challenges it poses to the central bank. The anticipated findings aim to guide policymakers in making informed decisions and navigating the intricate relationship between fiscal and monetary policies to achieve macroeconomic stability in Sierra Leone.

The key findings from the analysis reveal a complex interplay of consequences arising from the government's reliance on monetary means to finance expenditures. Initially, there is a transient surge in output, followed by a decline leading to a recession. The crowding-out effect severely impacts private investment, resulting in a prolonged decline attributed to increased government borrowing and elevated interest rates. Public investment sees an initial boost but

subsequently declines due to reduced tax revenues from diminished private investment. Consumption decreases for both Ricardian and Non-Ricardian households, reflecting the anticipation of lower future income and the impact of inflation on present income. Government expenditures witness a significant increase, driven by heightened borrowings, posing challenges for sustained growth. Private sector capital stock experiences a sharp decline followed by recovery, highlighting the impact of crowding-out effects. Labor supply increases initially but declines in the long run due to inflation and reduced investment. The interaction between fiscal and monetary policies becomes evident as government borrowing influences nominal policy interest rates. Real wage rates show an initial increase but decline over time, emphasizing the limitations of relying solely on monetary means for wage growth. Labor usage rises initially but ultimately declines below the steady state, leading to layoffs exceeding hires. Lastly, the impact on government debt, tax revenues, and transfers underscores the consequences of weak economic growth and increased borrowing, shaping a comprehensive understanding of the challenges posed by fiscal dominance.

5.2 Policy Recommendations

This section outlines policy recommendations to navigate the intricate dynamics of fiscal dominance in Sierra Leone. These recommendations are crafted to enhance economic resilience, stability, and sustainability, providing a roadmap for policymakers to counter the complexities associated with fiscal dominance and safeguard the nation's economic well-being.

Policymakers should proactively explore, diversify and implement alternative means of funding government expenditures beyond the traditional reliance on Bank of Sierra Leone's financing. This approach aims to introduce flexibility into the financial structure, thereby mitigating the negative impact on key macroeconomic variables. By diversifying funding mechanisms, such as tapping into domestic and international capital markets, attracting foreign direct investment, and optimizing revenue collection through tax reforms, the governments can reduce the dependence on the Bank of Sierra Leone's operations. This not only enhances fiscal resilience but also fosters a more sustainable and stable economic environment. Additionally, a diversified funding strategy provides the government with increased financial maneuverability, allowing for better responsiveness to economic challenges and reducing the risk of crowding-out effects on private sector investment.

The fiscal authorities should implement prudent fiscal policy that takes into account the long-term implications of government borrowing on economic stability. Policymakers need to adopt a judicious and balanced approach to fiscal management, steering clear of an overreliance on monetary means for financing government expenditures. Striving for fiscal prudence involves carefully assessing the impact of government borrowing on the broader economy and considering its sustainability over the long term. By avoiding excessive reliance on central bank financing, policymakers can mitigate the crowding-out effects that hinder private sector investment. This

approach will not only promote a healthier investment climate but also fosters an environment conducive to sustained economic growth. A prudent fiscal policy involves setting realistic budgetary targets, optimizing revenue collection through efficient taxation systems, and allocating resources efficiently to prioritize projects with high economic returns. Such a comprehensive fiscal strategy not only safeguards against the detrimental effects of fiscal dominance but also contributes to the creation of a resilient and dynamic economic framework that benefits both the public and private sectors.

In light of the identified crowding-out effect on private investment, it is imperative to implement proactive policies aimed at fostering a conducive environment for robust private sector participation. Recognizing the vital role that private investment plays in driving economic growth, policymakers should prioritize initiatives that alleviate barriers hindering such investments. These measures will not only attract domestic investments but also position the country as an appealing destination for foreign direct investment, thereby bolstering the overall investment landscape. Ensuring a stable economic climate is equally crucial for sustaining investor confidence. Policymakers should prioritize measures that enhance economic stability, including sound fiscal management, transparent regulatory frameworks, and consistent monetary policies. By creating an environment characterized by predictability and reliability, governments can inspire confidence among investors, prompting them to make long-term commitments and strategic investments.

Addressing the persistent inflationary pressures stemming from increased monetary financing will require a proactive and multifaceted approach to inflation management. The Bank of Sierra Leone's (BSL) Policymakers should consider implementing measures aimed at controlling inflation expectations, including adjusting interest rates to align with economic conditions. While such interventions are crucial for curbing inflation, policymakers must also carefully weigh the potential impacts on both public and private sector financing costs. Striking a delicate balance is essential to avoid stifling economic activity and private sector investment while effectively managing inflationary pressures. Clear communication of inflation management strategies, coupled with transparent and predictable policy actions, can enhance market confidence and contribute to the effectiveness of inflation control measures. By taking a vigilant and adaptive stance on inflation management, policymakers can navigate the challenges posed by fiscal dominance and work towards maintaining price stability for sustained economic well-being.

Since fiscal dominance is found to lead to an increase in government debt, this necessitates the implementation of effective and sustainable debt management strategies. Policymakers should prioritize the development and execution of a comprehensive debt management framework that accounts for both short-term financial obligations and long-term fiscal sustainability. Responsible borrowing practices are paramount in this endeavor, involving a judicious evaluation of financing needs and the exploration of diverse funding sources to reduce reliance on excessive borrowing. Negotiating favorable terms with creditors, such as securing lower interest rates and favorable repayment schedules, can significantly alleviate the burden of debt service costs on the national budget. Ensuring debt sustainability requires constant vigilance and monitoring of key financial

indicators, with particular attention to the debt-to-GDP ratio. Policymakers should set prudent limits on this ratio to prevent it from reaching levels that could pose threats to economic stability. Regular assessments and adjustments to debt management strategies in response to changing economic conditions will be crucial to navigate the complexities of fiscal dominance and its potential impact on the nation's indebtedness. Moreover, transparency and accountability in debt management practices are essential. Open communication regarding the purpose of borrowing, terms of agreements, and the use of borrowed funds enhances public trust and helps avoid mismanagement that could lead to debt-related challenges. By adopting a proactive and disciplined approach to debt management, policymakers can safeguard the nation against the adverse consequences of unsustainable debt levels, fostering a more resilient and stable economic foundation for future generations.

To uphold economic stability and financial sustainability, it is crucial for the Bank to preserve its independence. The Bank of Sierra Leone should leverage its revised 2019 act, which bestows autonomy upon the Bank, allowing it to function without government interference in executing its monetary policy decisions. This involves the Bank ensuring that government borrowing is limited and does not surpass 5% of the prior year's domestic revenues, excluding private receipts, as specified in the BSL 2019 Act.

While the current research concentrated on delineating the directional influence of fiscal dominance on key macroeconomic variables in Sierra Leone, future investigations should delve into quantifying the extent of these impacts. This will involve a comprehensive assessment of the statistical significance associated with the identified trends. By incorporating quantitative measurements, researchers can provide a more nuanced understanding of the implications of fiscal dominance, offering policymakers and stakeholders valuable insights into the specific quantitative effects on economic variables.

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APPENDICES

Appendix 1: EIGENVALUES

Modulus	Real	Imaginary
0	0	0
0	0	0
0	0	0
0	0	0
1.60E-17	-1.60E-17	0
6.14E-17	6.14E-17	0
0.1022	0.1022	0
0.113	0.113	0
0.5057	0.5057	0
0.7758	0.7523	0.1897
0.7758	0.7523	-0.1897
0.8491	0.8491	0
0.8934	0.8893	0.08529
0.8934	0.8893	-0.08529
0.8982	0.8982	0
0.9	0.9	0
0.9	0.9	0
0.9	0.9	0
0.9	0.9	0
0.9	0.9	0
0.9	0.9	0
0.9	0.9	0
0.9584	0.9584	0
0.9779	0.9779	0
1.09	1.09	0
1.1	0.051	0.3244
1.1	1.051	-0.3244
1.157	1.135	0.2254
1.157	1.135	-0.2254
1.193	1.193	0
0.41	0.41	0
0.086	0.086	0
4.40E+15	-4.40E+15	0
5.35E+16	5.35E+16	0
5.48E+18	-5.48E+18	0

There are 11 eigenvalue(s) larger than 1 in modulus for 11 forward-looking variable(s)

The rank condition is verified.

(1) MODEL SUMMARY

(2) Number of variables: 37

(3) Number of stochastic shocks: 8

(4) Number of state variables: 24

(5) Number of jumpers: 11

(6) Number of static variables: 7

Appendix 2: MOMENTS OF SIMULATED VARIABLES

VARIABLE	MEAN	STD.DEV	VARIANCE	SKEWNESS	KURTOSIS
Y	-0.007519	0.104376	0.010894	-0.402528	0.801001
IP	0.011668	1.996179	3.984729	-0.375481	0.835477
IG	-0.007396	0.05259	0.002766	-0.195769	0.427622
CR	-0.003488	0.117594	0.013828	-0.532473	1.136582
CNR	-0.01532	0.207472	0.043045	-0.081174	0.485829
G	0.00013	0.025595	0.000655	-0.028648	-0.470744
KP	-0.012803	0.386437	0.149333	-0.460865	1.067599
KG	-0.005337	0.020686	0.000428	0.086588	-0.656033
LR	0.005151	0.613886	0.376856	0.181114	0.475313
LNR	-0.005344	0.641422	0.411423	-0.240165	0.499548
R	0.00715	0.372026	0.138403	0.493781	1.08209
W	-0.005997	0.255233	0.065144	0.405584	0.587921
U	0.000188	0.010804	0.000117	0.403027	0.998229
PI	-0.000852	0.041335	0.001709	-0.419859	1.152557
RB	0.000464	0.023204	0.000538	0.442613	1.591609
T	-0.028879	0.674755	0.455294	0.40416	0.989678
B	0.061806	0.322011	0.103691	0.295075	-0.089874
TRANS	0.02817	0.161831	0.026189	0.26739	0.476774

Appendix 3: AUTOCORRELATION OF SIMULATED VARIABLES

VARIABLE	1	2	3	4	5
Y	0.991	0.9702	0.9399	0.9034	0.8633
IP	0.9596	0.8634	0.7316	0.5798	0.4207
IG	0.9442	0.8719	0.7997	0.7292	0.6614
CR	0.9912	0.9716	0.9436	0.9096	0.8718
CNR	0.9635	0.8887	0.7959	0.6944	0.5898
G	0.9157	0.8381	0.7689	0.7075	0.6498
KP	0.9907	0.9668	0.9287	0.8788	0.8195
KG	0.9972	0.9924	0.9847	0.9743	0.9616
LR	0.5138	0.1955	0.0685	0.0061	-0.0449
LNR	0.5624	0.2764	0.1516	0.0766	0.0077
R	0.9634	0.9049	0.847	0.7925	0.7395
W	0.9044	0.7252	0.5282	0.3375	0.1633
U	0.9692	0.9359	0.8982	0.8503	0.7907
PI	0.9283	0.867	0.8044	0.7259	0.6328
RB	0.928	0.7642	0.5633	0.3624	0.1836
T	0.8326	0.639	0.4733	0.3259	0.1899
B	0.9963	0.9894	0.9791	0.966	0.9508
TRANS	0.9885	0.9648	0.9312	0.8911	0.8471

**Appendix 4: VARIANCE DECOMPOSITION SIMULATING ONE SHOCK AT A TIME
(in percent)**

Variables	E	e_m	e_G	e_IG	e_TRANS	e_tau_c	e_tau_l	e_tau_k	Total linear contribution
Y	0.51	103.44	0.03	0	0	0	0	0	103.98
IP	0.28	97.97	0.01	0	0	0	0	0	98.27
IG	2.05	65.36	1.99	25.78	0.22	1.23	0.01	0	96.63
CR	0.86	91.9	0.02	0	0	0.01	0.01	0	92.79
CNR	2.33	101.67	0.05	0	0	0.01	0.01	0	104.08
G	0	0	100.11	0	0	0	0	0	100.11
KP	0.28	96.34	0.01	0	0	0	0	0	96.63
KG	5.04	120.9	5.71	24.84	0.62	3.55	0.02	0	160.67
LR	0.97	98.77	0	0	0	0	0.01	0	99.76
LNR	2.08	97.57	0	0	0	0	0	0	99.66
R	1.23	91.96	0.01	0	0	0	0.01	0	93.22
W	2.69	98.43	0.02	0	0	0.01	0	0	101.17
U	1.21	92.29	0.05	0	0	0	0.01	0	93.57
PI	0.48	96.89	0.01	0	0	0	0	0	97.38
RB	0.09	99.5	0.09	0.01	0.01	0.02	0	0	99.72
T	2.06	96.2	0.03	0	0	0.67	0	0	98.96
B	2.86	103.88	5.1	0.13	0.58	3.51	0.03	0	116.09
TRANS	3.52	97.88	3.59	0.08	1.47	2.24	0.01	0	108.78

Note: numbers do not add up to 100 due to non-zero correlation of simulated shocks in small samples

Appendix 5: POLICY AND TRANSITION FUNCTIONS

	Y	IP	IG	CR	CNR	G	KP	KG	LR	LNR	R	W	U	PI	RB	T	B	TRANS
Y(-1)	0.001476	-0.006505	0.09	-0.000172	-0.000081	0	-0.000163	0.00225	-0.012563	0.016898	0.001575	-0.00037	0.000222	0.001437	0.000579	-0.008141	0.002725	0
IG(-1)	0.002133	-0.002002	0.1	-0.000054	0.000538	0	-0.00005	0.0025	0.01289	-0.0065	0.004346	0.001338	0.000186	0.000181	0.000268	0.003873	0.002101	0
KP(-1)	0.054919	-1.103218	0	-0.008536	0.231417	0	0.94742	0	1.8525	-2.553303	-0.843067	0.449601	-0.057733	-0.064681	-0.013912	1.185527	-0.063124	0
KG(-1)	0.011431	-0.095229	0	-0.005461	0.040872	0	-0.002381	0.975	0.327358	-0.444109	0.02619	0.082481	-0.002083	-0.005899	-0.000627	0.2295	-0.010368	0
W(-1)	-0.063458	0.135383	0	0.00531	-0.169758	0	0.003385	0	-1.968198	1.750298	0.33234	0.465822	0.024532	0.10276	0.024482	-0.482729	0.043226	0
RB(-1)	-0.086811	-3.825257	0	-0.084992	0.187684	0	-0.095631	0	3.437795	-3.677316	0.110634	0.200506	-0.029888	-0.269695	0.71041	1.715421	0.646321	0
TRANS(-1)	-0.000493	-0.005226	0	-0.000138	-0.000627	0	-0.000131	0	-0.026849	0.025275	-0.002597	-0.001749	0.000061	0.001416	0.000375	-0.012919	0.000927	0
B(-1)	0.000004	0.001382	-0.09	0.000879	0.00337	0	0.000035	-0.00225	0.048703	-0.048784	0.013464	0.013607	0.000102	0.001369	0.000411	0.041986	1.011963	0
A(-1)	0.187822	-1.183995	0	-0.049086	0.599813	0	-0.0296	0	4.80498	-6.958217	0.069068	1.104432	-0.041254	-0.187673	-0.03752	3.020989	-0.164938	0
Sm(-1)	0.08406	-31.85357	0	-0.811375	3.617026	0	-0.796339	0	46.152784	-45.79115	8.116675	7.824289	-0.111569	-1.290946	0.521122	31.760315	-0.799273	0
SG(-1)	0.093779	-0.3065	0	-0.007958	0.001278	0.9	-0.007663	0	0.25885	0.021475	0.144231	0.012981	0.008912	0.020643	0.015571	-0.07215	0.1262	0
SIG(-1)	0.015701	-0.065746	0.9	-0.00237	0.002185	0	-0.001644	0.0225	0.054922	-0.00804	0.029976	0.008084	0.001549	0.005234	0.00314	0.002788	0.021136	0
STRANS(-1)	-0.001711	0.061477	0	0.001527	-0.010685	0	0.001537	0	-0.086918	0.083598	-0.015534	-0.015981	-0.002107	-0.015775	-0.004904	0.060906	-0.098434	0.9
Stau_c(-1)	-0.007414	-0.076366	0	0.000532	-0.012213	0	-0.001909	0	-0.061252	0.03896	-0.023185	-0.012603	-0.000563	-0.007696	-0.00305	2.241933	-0.125895	0
Stau_l(-1)	-0.008768	0.095897	0	0.00388	-0.032909	0	0.002397	0	-0.305812	0.278527	-0.056372	-0.042398	0.000331	0.002578	-0.000103	0.201966	-0.013629	0
Stau_k(-1)	-0.000754	-0.024934	0	0.000599	-0.000385	0	-0.000623	0	-0.002153	0.003001	0.001852	-0.002004	-0.003432	-0.000393	-0.000193	0.036425	-0.002295	0
IP(-1)	0.027837	0.700087	0	-0.003227	0.013316	0	0.017502	0	0.175091	-0.092068	0.076093	0.037431	0.00285	0.009193	0.005542	0.166159	-0.002939	0
CR(-1)	0.346332	-1.949922	0	0.899916	0.096532	0	-0.048748	0	1.688949	-0.666673	0.4779	0.013736	0.046975	0.164799	0.084073	-0.029079	0.064844	0
CNR(-1)	0.35878	-1.001499	0	-0.029632	0.978683	0	-0.025037	0	1.307303	-0.216845	0.736555	0.205932	0.014605	-0.051777	0.020345	2.580638	-0.103879	0
P(-1)	0.001476	-0.006505	0.09	-0.000172	-0.000081	0	-0.000163	0.00225	-0.012563	0.016898	0.001575	-0.00037	0.000222	0.001437	0.000579	-0.008141	0.002725	0
e	0.208691	-1.315549	0	-0.05454	0.666459	0	-0.032889	0	5.338866	-7.731352	0.076743	1.227147	-0.045838	-0.208526	-0.041689	3.356655	-0.183264	0
e_m	-0.0934	35.392866	0	0.901527	-4.018918	0	0.884822	0	-51.280871	50.879056	-9.018527	-8.693654	0.123965	1.434385	-0.579025	-35.289239	0.888081	0
e_G	0.104199	-0.340556	0	-0.008842	0.00142	1	-0.008514	0	0.287611	0.023861	0.160257	0.014423	0.009902	0.022937	0.017301	-0.080167	0.140222	0
e_IG	0.017446	-0.073052	1	-0.002633	0.002427	0	-0.001826	0.025	0.061024	-0.008933	0.033306	0.008982	0.001721	0.005816	0.003489	0.003098	0.023484	0
e_TRANS	-0.001901	0.068307	0	0.001697	-0.011873	0	0.001708	0	-0.096575	0.092887	-0.01726	-0.017757	-0.002341	-0.017528	-0.005449	0.067673	-0.109371	1
e_tau_c	0.008238	0.084851	0	-0.000591	0.01357	0	0.002121	0	0.068057	-0.043289	0.025761	0.014003	0.000626	0.008551	0.003389	-2.491036	0.139883	0
e_tau_l	0.009743	-0.106552	0	-0.004311	0.036566	0	-0.002664	0	0.339791	-0.309474	0.062635	0.047109	-0.000367	-0.002864	0.000115	-0.224406	0.015143	0
e_tau_k	0.000838	0.027704	0	-0.000666	0.000428	0	0.000693	0	0.002392	-0.003334	-0.002058	0.002227	0.003813	0.000436	0.000215	-0.040473	0.00255	0