The Fiscal Theory of Income Distribution in Action: South African Low-Income vs High-Income Earners Response to Fiscal Policy Shocks

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Abstract

This study seeks to test the fiscal theory of income distribution in action in South Africa using low- and high-income earners, covering the period 1979–2022, using the Bayesian Vector Autoregression (BVAR) model with hierarchical priors. This study examines the impact of fiscal policy on income distribution among low-income and high-income earners. The results are interesting as they show that the impact of the Fiscal Theory of Income Distribution depends on the level of income, as the finding shows that for low-income earners, an unexpected increase in government expenditure decreased income inequality, while for the high-income, it exacerbated income inequality. While on the side, taxation is found to play a significant role in reducing income inequality for the high-income earners model, while for the low-income earners it was found to contribute to income inequality.The lagged response suggests that expectations and market dynamics play a crucial role in reducing income inequality regardless of income level. This study suggests that South Africa should adopt a balanced tax policy by combining progressive income taxes with targeted regressive taxes, while offsetting the burden on low-income groups through rebates, credits, and social programs. This would ensure an equitable distribution of burdens across income levels, with revenue from progressive taxes used to fund social welfare programs, such as education, healthcare, and affordable housing. This approach could reduce the wealth gap, promote social mobility, and create a more just society, making it an effective solution for income inequality in the country.

Keywords: *BVAR, Fiscal Theory of Income Distribution, Hierarchical priors, Monetary policy, South African*

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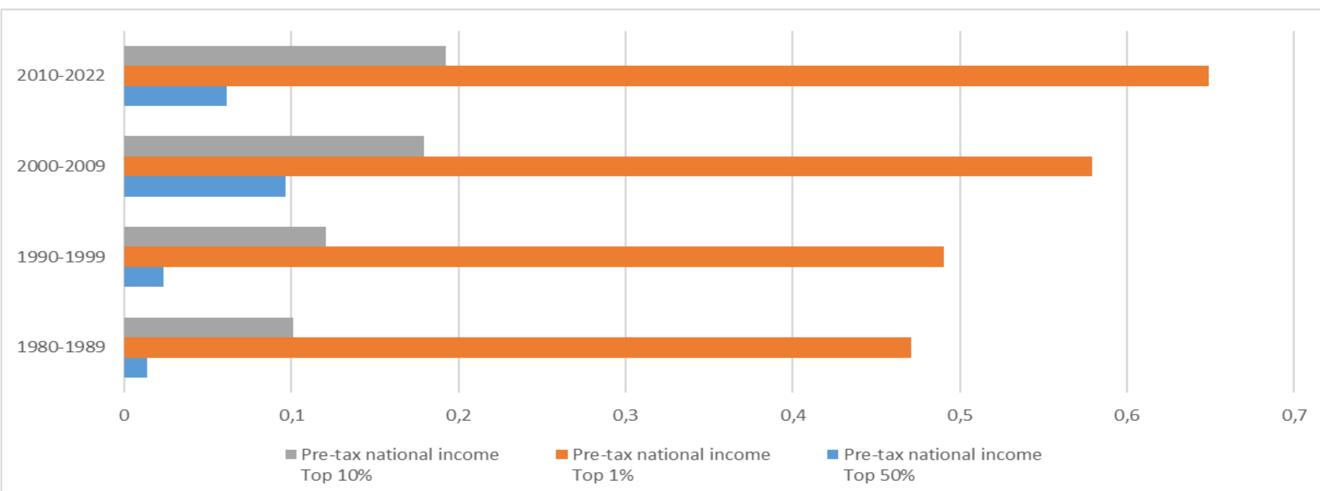
1. Introduction

Undoubtedly, growing income inequality within and among countries has become a significant global issue that has been steadily increasing over the past few decades (United nation, 2020). This global issue has become a defining challenge for the United Nations Sustainable Development Goals. The gap between the wealthy elite and the rest of the population continues to widen, leading to social unrest, economic instability, and overall dissatisfaction among the masses, which subsequently undermines investment and life-improving public policy reforms (Jenkins, 2017; Piketty and Saez, 2003). The World Inequality Report 2022 reveals that the wealthiest 10% of the global population currently holds 52% of the global income, while the poorest half holds 8.5% (Chancel et al., 2022, p. 10). South Africa is one of the most unequal societies with a Gini coefficient of 0.67, which is one of the highest in the world (United nation, 2020). Historical factors, such as apartheid and colonialism, are believed to exacerbate the divide between the rich and the poor, where the top 1% of earners in the country control almost 20% of the nation's income, while the bottom 60% struggle to make ends meet (Coady and Dizioli, 2018; Nolan et al., 2019). Further support is shown in Figure 1, which shows the top 1%, top 10%, and top 50%.

Figure 1. Graphic analysis of the trend of pre-tax national income of Share top 1%, top 10% and the top 50% respectively starting from 1980–2022.



Source: Author's calculation based on wid world data (2024).

This extreme level of inequality has far-reaching consequences, including limited access to quality education, healthcare, and economic opportunities for most of the population. Givin the highlighted the inequality issue, and efforts to combat this issue of a high income gap between the rich and the poor within and among countries have been considered through various structural and policy-oriented changes; however, the issue seems to further undermine the policy effort.

Fiscal Theory of Income Distribution (FTID) is a key concept in economics, arguing that fiscal policy decisions significantly impact income distribution within a society (Lerner, 1943; Tobin, 1965; Diamond, 1971; Keynes, 1936; Lucas,1988). This theory is crucial, as nations address economic growth, social equity, and fiscal sustainability, emphasizing the need to understand how different population segments respond to fiscal policy shocks. This study explores the fiscal policy transmission dynamics across income groups in South Africa, examining whether policy shocks would have a beneficial effect on low-income and high-income earners in South Africa. South Africa's fiscal policy and income distribution are influenced by historical inequalities, with income inequality remaining high despite progress since the 1994 Democratic transition (IMF, 2020). The key pillars of South Africa's redistributive agenda include progressive income taxes, social grants, and public expenditures on education, healthcare, and social services. Understanding these interactions can help in designing more effective policies for financial stability and equal-income distribution.

The literature on this subject has revealed two strands of research in these subject matter. The first strand, based on the fiscal theory of income distribution, argues that fiscal policy through government expenditure is detrimental to income inequality (Moene and Wallerstein, 2003; Samanta & Cerf, 2009; Bhatti et al., 2015; Aye and Odhiambo. 2022; Abramovsky and Selwaness, 2023; Gunasinghe et al., 2020; Smith, 2024; Kebalo & Zouri, 2024). The second strand builds on taxation as a policy that promotes redistribution of income (Gupta et al., 2014; Cevik and Correa-Caro, 2020; Gupta and Jalles, 2022; Malla and Pathranarakul, 2022; Wienk et al., 2022; Brown et al., 2023; Carneiro, 2023; Laura Abramovsky and Selwaness, 2023). The heterogeneity in results can be attributed to various issues such as the model specifications, data sets, and estimating methodologies used in existing literature and crises, which has led to numerous studies creating a paradox in the current subject matter empirical wise.

This study builds on the seminal work of numerous studies, such as the study by Gupta et al. (2014), Cevik and Correa-Caro (2020), Malla and Pathranarakul (2022), and Aye and Odhiambo (2022). However, the variables are adopted from the study by Aye and Odhiambo (2022) using data from 2010 to 2018 in a middle-income country. Their study uses the Generalized

Method of Moments (GMM) to analyze two fiscal policy measures: government expenses and taxes on income, profits, and capital gains. This study contributes to the existing literature by investigating the fiscal theory of income distribution in action for the South African low-income and high-income earners. The idea is to trace how inequality for low-income earners and high earners will respond to fiscal policy shocks. The study seeks to further compute two variables for fiscal consolidation: time-varying Cyclically Adjusted Primary Balance (CAPB) for government expenditure and total government revenue, adopting the similar method adopted by Buthelezi and Nyatanga (2023). The main aim of comparing the two income earners is to trace the income group that benefits the most from the fiscal policy shock. Therefore, this study used Bayesian Vector Autoregression (BVAR) with hierarchical priors, covering the period 1979–2022 due to data availability. The BVAR is constructed with hierarchical priors in response to two measurable defects: when the data quality is uncertain, and when it is frequently short (ie, observation less than 30). Thus, prior selection in a BVAR can help adjust for these flaws. Furthermore, the impulse response function is more accurate when the present matter is estimated using Bayesian approaches. Banbura et al. (2010) argue that Bayesian vector autoregression (BVAR) is a useful tool for large dynamic models because of its credibility, structural analysis, dynamic relationships, uncertainty accounting, modeling interdependencies, time-series analysis, and flexibility. Therefore, as in the current study, we address the dynamic impact of socioeconomic issues. The researcher believes that these kinds of issues have structural characteristics, which is why we find the BVAR suitable for this study. BVAR allows for simultaneous estimation, which is useful in dealing with uncertainty in parameter estimation and further constructing the impulse response. This model tests the following hypotheses: (i) the fiscal theory of income distribution does not hold for the South African economy, (ii) income tax creates more inequality than tax on goods and services, (iii) the theory of income distribution is more beneficial to high-income earners than to low-income earners, and (iv) fiscal consolidation variables are more beneficial to low-income earners.

The rest of the paper is organized as follows: Section 2 provides a brief overview of the literature on the subject, and Section 3 provides a summary of our model. Section 4 explores the BVAR results, and Section 5 concludes and discusses policy implications.

2. Literature review

2.1.Fiscal theory of income distribution

Fiscal Theory of Income Distribution (FTID) is a framework that examines how government fiscal policies impact income distribution within a society. This concept was developed by economists over time with early proponents such as Lerner (1943). Modern formulations have been attributed to Tobin (1965), Diamond (1971), Keynes (1936), and Lucas (1988). Their research and theoretical frameworks have deepened our understanding of how fiscal policies influence income distribution and contribute to the evolution of FTID as a field of study within economics. Despite not having a single individual credited with its creation, FTID remains a significant area of research. FTID suggests that fiscal policies, including taxation, government spending, and public debt management, shape the distribution of income among individuals and households. Tax policies can redistribute income by imposing higher taxes on higher-income individuals, while providing tax breaks or credits to lower-income groups. Government spending programs such as welfare, healthcare, and education can directly affect income distribution by providing assistance to those in need. The FTID also emphasizes the role of public debt in the dynamics of income distribution. Governments often finance spending through borrowing, which can have redistributive effects (Lerner, 1943; Tobin, 1965; Diamond, 1971; Keynes, 1936; Lucas,1988). For example, if a government borrows to finance social welfare programs, it effectively redistributes income from future taxpayers to current beneficiaries of government spending (Keynes, 1936). Financial policies are not neutral in their distributional effects, as they can either exacerbate or mitigate income inequality (Gupta and Jalles, 2022). For instance, tax cuts that disproportionately benefit the wealthy can widen income disparities, whereas targeted spending on education or healthcare can help reduce inequality by improving opportunities for lower-income individuals. Critics argue that FTID oversimplifies the complex interactions between fiscal policies and income distribution, ignoring other factors, such as technological change, globalization, and labor market dynamics. However, FTID provides valuable insights into the relationship between government fiscal policies and income distribution, guiding policymakers in designing more equitable economic policies (Diamond, 1971; Keynes, 1936; Lucas,1988).

2.2.Empirical studies on Fiscal Theory of Income Distribution (FTID) and income inequality

Fiscal policy, which includes taxation and government expenditure, plays a crucial role in shaping income distribution and reducing income inequality within society, as explained by FTID (Cevik and Correa-Caro, 2020; Aye and Odhiambo, 2022; Gupta and Jalles, 2022;Aye and Odhiambo, 2022; Brown et al., 2023; Carneiro 2023). Progressive taxation policies can redistribute wealth, whereas regressive policies can exacerbate inequality. Government spending on social welfare programs, education, and healthcare can also help reduce income inequality by providing resources and opportunities to those in lower-income brackets. Overall, fiscal policy plays a significant role in shaping the income distribution within a society. Studies on the impact of fiscal policy on income inequality have been based on the two stands that build on taxation policy as a means of reducing income redistribution (Muinelo-Gallo and Roca-Sagalés, 2013; Gupta et al., 2014; Cevik and Correa-Caro, 2020; Aye and Odhiambo, 2022; Gupta and Jalles, 2022; Malla and Pathranarakul, 2022; Wienk et al., 2022; Aye and Odhiambo, 2022; Brown et al., 2023; Carneiro 2023; Abramovsky and Selwaness, 2023); The second strand are those studies that believe in redistribution policy (Moene and Wallerstein, 2003; Samanta & Cerf, 2009; Bhatti et al., 2015; Heshmati, and Kim. 2014; Aye and Odhiambo., 2022; Abramovsky and Selwaness, 2023; Gunasinghe et al., 2020; Smith, 2024; Kebalo & Zouri, 2024).

These studies suggests that progressive taxation can reduce income inequality, especially when combined with redistribution policies (i.e government expenditure) (Odhiambo, 2022; Gupta and Jalles, 2022; Malla and Pathranarakul, 2022; and Wienk et al., 2022). This is because high-income earners often have lower marginal propensities to consume, which can be reduced by lowering their disposable income, according to studies by Aye and Odhiambo (2022), Gupta and Jalles (2022), Malla and Pathranarakul (2022), and Wienk et al. (2022). Progressive taxation when it accompanied by other distributive measures can reduce income inequality by raising the purchasing power of those with lower incomes and boosting economic activity by reducing wealth concentration (Muinelo-Gallo and Roca-Sagalés 2013; Carneiro 2023). However, some studies claim that goods and service taxes do not reduce income inequality; only income taxes do (Malla and Pathranarakul, 2022). Debates exist over the ideal progressivity of tax structures and the possible compromises between promoting economic expansion and mitigating inequality. Emerging economies are affected by this issue (Dotti 2020, Muinelo-Gallo, and Lescano 2022). According to Dix-Carneiro et al. (2022), high tax rates can hinder economic expansion and job creation by deterring investment, entrepreneurship, and hard labor.

The balance between improving economic efficiency and decreasing inequality is an ongoing topic of discussion. Social spending programmes and redistributive payments can address income inequality by supporting low-income households. Social assistance, unemployment insurance, and welfare programs can help reduce poverty and economic inequality. Research shows a connection between social spending and economic equality, with more spending in Latin American countries leading to reduced economic disparities (Cimoli et al., 2017). Incorporating education into social expenditure plans can have a negative and significant impact (Celikay and Gumus, 2017; Gründler and Scheuermeyer, 2018).

Income distribution is influenced by income replacement programs, such as disability, sickness pay, unemployment insurance, and occupational illness (Moene and Wallerstein, 2003; Gunasinghe et al., 2020). Social expenditure on education and human capital development predicts income disparity. Fiscal policies supporting access to high-quality education and skill development can increase human capital development, labor market results, and income inequality. According to Moyo et al. (2022), educational attainment plays a significant role in wealth distribution, and reducing economic disparity requires equitable access to education and addressing the skill gaps. Artige and Cavenaile (2023) argued that equitable public education can significantly reduce wealth disparity across different national categories.

Macroeconomic policies, economic growth, and income inequality are interconnected. Fiscal measures, such as infrastructure and R&D, can improve income distribution, but factors such as labor market structures, skill-biased technological advancement, and development methods also influence economic growth distribution (Rezk et al., 2022). Fiscal policy design significantly affects income inequality, particularly in foreign direct investment. Financial development moderately influences money distribution, making foreign direct investment less effective as a nation reaches certain growth levels (Lee and Wang, 2022; Ofori et al., 2023). The impact of fiscal policies on income inequality is influenced by the political economy and institutional issues. Inclusive political institutions, strong institutions, effective tax administration, and transparency can reduce income inequality (Zuazu, 2022). Improved democratic institutions, removal of bureaucratic barriers, high-quality legal and regulatory systems, control of corruption, and governance can also reduce income disparity. Political polarization can negatively impact income distribution (Kouadio and Gakpa, 2022). Fiscal policy and income disparity are influenced by tax laws, social spending, human capital investments, macrofiscal policies, and institutional variables. Investments in education, social spending, and progressive taxation can help reduce economic disparities (Gu and Wang, 2022).

3. Methodology and data used for the study.

3.1. *Justification of variables*

This study uses data from the to 1979-2022 time series to test the validity of the Fiscal Theory of Income Distribution in the South African economy using the BVAR model with hierarchical priors, following the works of Ebalo and Zouri (2024), Malla and Pathranarakul (2022), Cevik and Correa-Caro (2020), and Gupta et al. (2014). Economic variables in this paper are reflected in Table 1, where two indexes of the Gini coefficient have been adopted to capture income inequality: the top 1% of pre-tax national income and the top 50% of pre-tax national income. A measure of income inequality that captures income before tax is preferable for this study for various reasons. i) It helps to capture the role of fiscal policy in reducing income inequality, and ii) disposable income significantly influences individual borrowing decisions, investments, and consumption. These two variables are the central economic variables of interest when investigating the fiscal theory of income distribution in action on the South African low- and high-income earners. It serves as the anchor for understanding how fiscal policy impacts income inequality for both low- and high income earners in South Africa. These two income indices are adopted to compare how low- and high-income earners respond to the Fiscal Theory of Income Distribution. For fiscal policy, the study adopted distributional and taxation variables accounting for both progressive and regressive taxes. For distributional variables, this study adopted government expenditure captured by total government expenditure (% GDP) (Malla and Pathranarakul, 2022), and government health expenditure captured by total expenditure on health (% GDP) (Zungu, 2024). According to the results documented by Zungu (2024), using machine learning through the random forest algorithm, governmental health expenditure was found to be a strong determinant of income inequality. All these variables reflect how government spending decisions directly impact the economy; this would help analyze how income inequality responds to fiscal policy changes, particularly on the redistribution side. The study utilized both progressive and regressive taxation strategies; however, with regressive tax, policy adjustments take time.

Table 1. Variables employe for hypothesis testing

Variable(s) code	Description	Sourced
Theoretical framework variables		
Variable for income inequality used to capture low and high income earners		
gi	Top 1% of pre-tax national income	WID[2] (2024
gw	Top 50% of pre-tax national income	WID (2024)
Variable for fiscal policy fiscal theory of income distribution		
gh	Government expenditure on health	WID[3] (2024)
tg	Total government expenditure	WID (2024)
itx	Income tax	WID (2024)
ts	Taxes on goods and services	WID (2024)
tr	National government revenue as % of GDP	WID (2024)
Economic variables that proxy fiscal consolidation used a discretion of fiscal authorities		
tvp	Time-varying CAPB for government expenditure	Buthelezi and Nyatanga (2023)
tv	Time-varying CAPB for total government revenue	Buthelezi and Nyatanga (2023)
Other control variables in the model		
em	Real balance	WID(2024)
gd	GDP per capita	WID (2024)
inf	Inflation	WID (2024)
gf	Government effectiveness	Polity-V Project
cc	Corruption control	Polity-V Project

Therefore, income tax is captured by the total income tax revenues (% GDP) to control for progressive tax, while taxes on goods and services are captured using the total revenue raised from taxes imposed on the consumption of goods and services (% GDP) to control for regressive tax. The study further adopted two variables for fiscal consolidation: time-varying CAPB for government expenditure and time-varying CAPB for total government revenue (Buthelezi and Nyatanga, 2023). This variable provides a detailed analysis of government fiscal policy by analyzing the cyclically adjusted primary balance for government expenditure, taking into account economic fluctuations. The tvp variable provides insights into the cyclically adjusted primary balance for total government revenue, allowing the evaluation of the evolution of fiscal sustainability and budget constraints over time and their impact on income inequality. While the study controls for government effectiveness, corruption, National government revenue as % of GDP (PPR), and the overall level of economic development captured using GDP per capita (constant 2010 US$). The variables were chosen following the theoretical foundations and empirical literature that underpin the relationship under investigation.

[2] World inequality Database
[3] World Development Indicators

3.2.*Model specification.*

The Bayesian VAR (BVAR) model adopted in the paper is reflected in equation 1.

$$y_t = \alpha_0 + A_1 y_{t-1} + \cdots + A_p y_{t-p} + \in_t, \in_t \tilde{N}\left(0, \sum x\right) \quad (1)$$

In the model we have a column vector consisting of 13 endogenous variables, denoted as $gi, gh\ \ gt\ , st, its, tv,\ \ tvp\ , tr, em, gd, inf\ , gf$ and cc. There is 13×1 vector represented by α_0, which serves as the intercept. On the other hand, we have a 13×13 matrix $(j = 1, \dots, p)$ that contains autoregressive coefficients for the regressors, where p is the order the BVAR. Finally, $\in_t$ is a 13×1 vector comprising Gaussian exogenous shocks characterized by a zero mean and a variance-covariance matrix denoted as $\sum x$. The total number of coefficients to be estimated in this model is $13{+}13^2_p$, and this number increases quadratically with the number of included variables and linearly with the lag order.

The Bayesian methodology employed for the estimation of VAR (Vector Autoregressive) models effectively addresses a notable constraint by introducing an augmented structural framework. This augmentation entails the incorporation of prior information, a strategic choice that has garnered empirical validation in alleviating the curse of dimensionality. Evidenced by the empirical studies of (Marta et al., 2010), this approach enables the estimation of expansive models. The utilization of informative priors serves to guide model parameters towards a more parsimonious reference point, yielding a reduction in estimation errors and a consequent improvement in out-of-sample projection accuracy, as expounded upon by Koop (2013). Notably, this process of "shrinkage" bears resemblance to prevalent frequentist regularization techniques, as delineated in the research of De Mol et al. (2008).

3.3. Selection of hierarchical priors and specification

Informing prior beliefs effectively is crucial, with flat priors often yielding suboptimal results (Marta et al., 2010). Del Negro and Schorfheide (2004) favored values optimizing data density, and Marta et al. (2010) addressed overfitting. Giannone et al. (2015) introduced data-driven hyperparameters in a Bayes' Law as reflected in equation 2 to 3.

$$p(\gamma|y) \alpha p(y|\theta,\gamma) p(\theta|\gamma) \quad (2)$$

$$p(y|\gamma)\int p(y|\theta,\gamma)p(\theta|\gamma)d\theta \tag{3}$$

The equation $y = (y_p + 1 \dots, y_p)$ defines VAR parameters θ and hyperparameters γ. Equation 1 marginalizes Equation 2, yielding a data density function $p(y|\gamma)$ and the marginal likelihood (ML). ML depends on γ and informs hyperparameter choice. Giannone et al. (2015) advocate this empirical Bayes approach, as it robustly explores the hyperparameter space while acknowledging uncertainty, yielding theoretically sound results when efficiently implemented. In the selected Normal-inverse-Wishart (NIW) framework we approach the model in Equation 1 by letting $A = [a_0, A_1, \dots, A_p]^T$ and β=*vec*(A), then the conjugate prior setup as reflected in equation 4 to 5.

$$\beta|\sum \sim N\left(b, \sum \otimes \Omega\right) \tag{4}$$

$$\sum \sim IW(\Psi, d) \tag{5}$$

Where b, and Ω, Ψ, and d are all dependent on a lower-dimensional vector of hyperparameters denoted as γ. Giannone et al. (2015) considered three priors in their study, which were called the sum-of-coefficients prior, the single unit-root prior, and the Minnesota (Litterman) prior that is used as a baseline. The prior is characterized in question 6 to 7.

$$E(A_s)_{ij}|\sum = \begin{cases} 1, and\ i = j, s = 1 \\ 0, and\ otherwis \end{cases} \tag{6}$$

$$cov(A_s)_{ij}(A_r)_{kl}|\sum = \begin{cases} \lambda^2 \dfrac{1}{S^{\sigma}} \dfrac{\sum jk}{\Psi/(d-m-1)}, and\ if\ l = j\ and\ r = s \\ 0, and\ otherwis \end{cases} \tag{7}$$

Where λ controls prior influence, with $\lambda \to 0$ enforcing strict priors and $\lambda \to \infty$ approximating ordinary least squares. The ψ manages prior standard deviation on variable lags. The Minnesota prior reduces the deterministic component, while the sum-of- coefficients prior assumes no change initially, using dummy observations (Giannone et al., 2015). It is implemented via the Theil mixed estimation by adding artificial dummy observations to the data matrix, which are reflected in equation 9.

$$\underset{M*M}{y^+} = diag\left(\frac{\bar{y}}{\mu}\right) + \underset{M*(1+MP)}{x^+} = [0, y^+, \dots., y^+] \tag{9}$$

In equation 9 is a 13×13 vector of variable averages over the initial p observations. Variance is controlled by μ, and $\mu \to \infty$ makes the prior uninformative, as well as $\mu \to 0$ leads to unit roots with no co-integration. The single unit-root (SUR) prior by Sims and Zha (1998) allows co-integration relations and influences variables accordingly. These kinds of priors, associated with dummy observations in equation 10.

$$\underset{1*M}{y^{++}} = \frac{\bar{y}}{\delta} + \underset{1*(1+MP)}{x^{++}} = \left[\frac{\bar{y}}{\delta}, y^{++}, \dots, y^{++}\right] \tag{10}$$

where $\bar{y}$ is again distinct, as above, likewise, δ is the key parameter, governing the tightness of the SUR prior. Numerous heuristics for determining hyperparameters associated with prior distributions have been explored in the literature, with notable contributions by Doan et al. (1984) and Marta et al. (2010). The estimation of these hyperparameters, achieved through the maximization of the marginal likelihood (ML), embodies an empirical Bayes methodology, as elucidated by Giannone et al. (2015), offering a distinct interpretation from the frequentist perspective within the realm of economic analysis.

4. Empirical analysis and interpretation results

This study uses the Bayesian VAR model to examine the response of income inequality to Fiscal Theory of Income Distribution (FTID) in South Africa from to 1979-2022, utilizing Bayesian GMM for robustness. Following what has been done in the BVAR literature for model estimation, the current study follows the transformation of variables following the function documented by Kuschnig and Vashold (2019). This function deals with numerous transformations within the system, including stationarity. Furthermore, dealing with fiscal policy analysis, considering the number of variables used to capture for fiscal policy, it is very difficult to choose the appropriate variable to capture for fiscal policy, for instance, the total government expenditure (% GDP), the total expenditure on education (% GDP), and the total expenditure on health (% GDP). Therefore, following the approach adopted in the literature, this study adopted the results reported by Zungu (2024), who used machine learning (ML) through the random forest (RF) algorithm (Breiman, 2001) to determine the fiscal policy variable that significantly contributes to income inequality. The study found that government expenditure on health, total government expenditure, and education expenditure are significant determinants of income inequality. ML using the RF format was used to model the study, revealing that the model specification would be in the following format: gi, gh, tg, ts, tx, itx, tvp, em, gd, inf, gf, cc.

4.1. Data transformation and stationarity

When estimating any model, it is important to ensure that the data are compatible with a rectangular numeric matrix with no missing data points, as this is a requirement for the BVAR model. As noted in the methodology, this is a 13×13 matrix, considering $y_t = gi_t, gh_t$, $tg_t, ts_t, itx_t, tv_t,\ tvp_t\ , tr_t, em_t, gd_t, inf_t\ , gf_t, cc_t$. Only gd per capita (gd) is provided in billions of dollars, with the exception of variables in rates; gi is an index. The study uses Kuschning and Vashold (2019) and McCracken and Ng (2016) to transform gd to the log level by applying code 4[4], creating a new variable with the definition of gd. The remaining variables were coded as 1 without transformation. This study uses the Augmented Dickey-Fuller test (ADF) and Phillips-Perron test (PP) to test for the stationarity of variables, which are crucial for accurate predictive models in economics, finance, and other fields. The results show that all variables are non-stationary in levels and stationary after the initial differencing; please see Appendix 1A for more information on the stationarity requirements. To address this, code 2[5] with the transformation function is initiated to transform all variables into first differences, allowing for ADF and PP results of nonstationarity data in levels. Considering that the study used a yearly time interval, and in accordance with the Akaike criterion (AIC) and Schwarz (BIC), the research adopted 2 as the number of lag length for this study.

4.2.The prior setup and configuration

The recent VAR econometric paradigm emphasizes the importance of prior setups in addressing missing data points and questionable data quality. Traditional maximum likelihood VARs are overparameterized, leading to a loss of degrees of freedom. Therefore, BVAR was used to address these limitations. The model setup follows Kuschnig and Vashold's prior setting function (Kuschnig and Vashold's, 2019), which includes arguments for Minnesota and dummy-observation priors and hierarchical handling of their hyperparameters. The prior hyperparameter

[4] Code 4 is used in the BVAR code to transform the data to stationary 1 is for those variables that do not require transformation.

[5] Code 2 is used in the BVAR code to transform all variables into first differences in accordance with the results of the ADF and PP results of nonstationarity.

is given lower and upper restrictions for its Gaussian proposal distribution and gamma hyperprior, but is not treated hierarchically. Following Kuschnig and Vashold's prior setting function, it allows the outhor to set Ψ to the square root of the innovation variance after fitting the AR(p) models to each variable. We add a sum-of-coefficients prior to a single unit-root prior, pre-constructing three dummy observation priors. Essential parameter hyperpriors are allocated gamma distributions similar to λ. This version of the BVAR provides a character vector.

4.3.Estimation of the model and identification via sign restrictions

The BVAR model requires data preparation and transformation with the order of p as an argument. Customization settings are required for this function. The initial iterations, burns, and draws are defined as 1500 000 and 500 000 respectively to allow for model accuracy. The author then set verbose true, as recommended by Kuschnig and Vashold (2019), as the function shows a progress bar during the Markov chain Monte Carlo stage (MCMC). Table 2 shows the posterior marginal likelihood results.

Table 2. Posterior marginal likelihood

Bayesian VAR With no sign restrictions	*Bayesian VAR With sign restrictions*
Optimisation concluded. Posterior marginal likelihood: -783.693 Hyperparameters: lambda = 0.43265 |==========================| 100% Finished MCMC after 10.85 mins.	Optimisation concluded. Posterior marginal likelihood: -932.553 Hyperparameters: lambda = 0.27747 |=============================| 100% Finished MCMC after 8.93 mins.

Source: Author's calculation based on WDI (2024) and SWIID (Solt, 2020) data.

The BVA function returns a BVAR class object that generates outputs, such as hyperparameters, VCOV matrix, and VAR coefficients. The BVAR object also contained marginal likelihood values, prior settings, initial hyperparameter values, and established values from the original call to the BVAR function. This object is hierarchically handled and automatically established. For the model with the sign restriction, the author follows the identification via sign restrictions. BVAR uses various schemes, such as sign restrictions, to facilitate the interpretation of impulse response functions. These schemes are flexible and user-friendly, relying on forming expectations about response directions following specific shocks (Rubio-Ramirez et al. 2010). Economic theory is used to set up sign identification of shocks in BVAR, which can be accessed directly or through the ellipsis argument of irf(). To toggle identification, the author creates a matrix SR with sign restrictions, setting all elements SRij equal to 1 (-1) if the contemporaneous response of variable i to a shock from variable j is expected to increase (decrease). Setting elements equal to 0 imposes zero restrictions, while setting elements to NA allows no restrictions, requiring unique identification of shocks (Kilian and Lütkepohl 2017). After running the bv-irf() function, the author prints and chooses the sign restrictions, while irf() calculates IRF using ellipsis arguments. IRFs are calculated using suitable shocks, following algorithms by Rubio-Ramirez et al. (2010) or Arias et al. (2018) if zero restrictions are imposed. Table 1A in the appendix shows how the variables were restricted for the second model, where the impulse responses are reported in Figure 4.

4.3.1. The result of the convergence of Markov chain Monte Carlo in a BVAR model

This section provides an overview and convergence of the model stimation MCMC algorithm, which is important for stability.

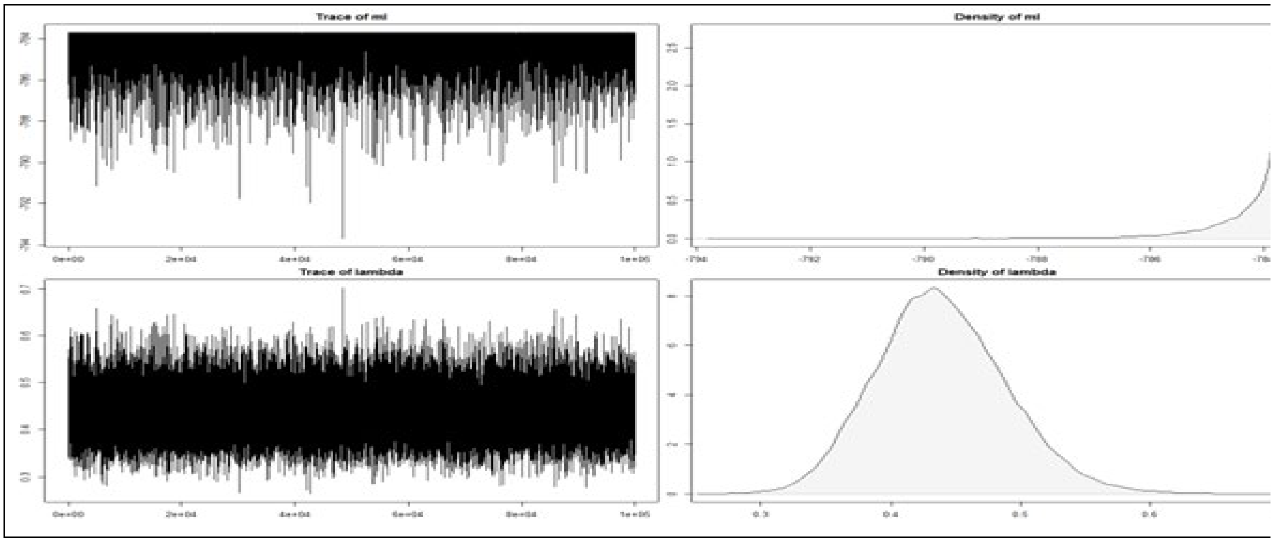
Table 3. Summary of the BVAR model

Bayesian VAR With no sign restrictions	*Bayesian VAR With sign restrictions*
Bayesian VAR consisting of 29 observations, 13 variables and 2 lags. Time spent calculating: 10.85 mins Hyperparameters: lambda Hyperparameter values after optimisation: 0.43265 Iterations (burnt / thinning): 1500000 (500000 / 1) Accepted draws (rate): 36322 (0.363)	Bayesian VAR consisting of 29 observations, 12 variables and 2 lags. Time spent calculating: 8.93 mins Hyperparameters: lambda Hyperparameter values after optimisation: 0.27747 Iterations (burnt / thinning): 1500000 (500000 / 1) Accepted draws (rate): 36913 (0.369)

Source: Author's calculation based on WDI (2024) and SWIID (Solt, 2020) data.

Table 3 provides a summary of the BVAR models with and without sign restrictions. Arguments $var\_impulse$ and $var\_response$ provide a concise alternate method for acquiring autoregressive coefficients.

Figure 2. Trace and density plots of all hierarchically treated hyperparameters and the ml.



Source: Author's calculation based on WDI (2024) and SWIID (Solt, 2020) data.

The researcher used a reasoned approach to select a visualization technique, as shown in Figure 2, which displays the density[6], trace[7], and hierarchical hyperparameter treatments. The analysis indicates convergence in the critical hyperparameters within the estimated BVAR model, and the MCMC chain effectively explores the posterior distribution without identifying outliers.

4.3.2. Impulse responses of the Bayesian VAR With no sign restrictions

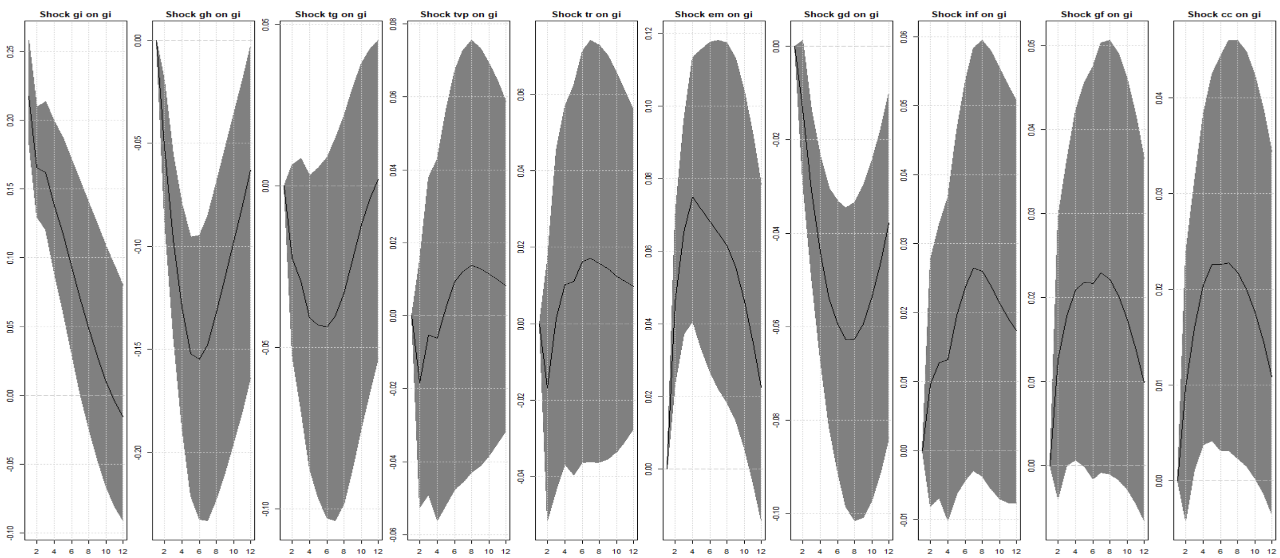
This study aims to understand how income inequality responds to the fiscal theory of income distribution and both regressive and aggressive taxes and government expenditure in the South African economy from 1979- 2022. This is motivated by the fact that the government adopted a taxation system to achieve two goals: (1) to reduce income inequality by taxing more on those earning more, and (2) providing a means of revenue collection to fund government expenditures. The impulse response functions (IRFs) generated from the BVAR using hierarchical selection are depicted in Figure 3, where the coefficients for the dynamic impact of tg, ge, ts, tx, itx, tvp, em, gd, inf, gf, and cc on income inequality have been given a tighter hierarchical prior distribution, with shaded regions representing the 16% and 84% credible sets, respectively. Figure 3a shows the results of the fiscal theory of income distribution and the impact of government expenditures

[6] This Figure presents graphical representations of the density, trace, and hierarchical treatment of hyperparameters. The scrutiny of these density and trace plots serves as an indicator of the convergence achieved in the critical hyperparameters within the estimated BVAR model.

[7] The trace plot, on the other hand, is a time series plot that displays the values of the hyperparameters as the MCMC chain progresses. It allows us to monitor how the chain traverses the parameter space.

on income inequality. This study adopted variables such as total government expenditure (% GDP), government education expenditure (Malla and Pathranarakul, 2022), and government health expenditure (gh) to capture the fiscal theory of income distribution (Zungu, 2024). The results for both progressive taxes (itx) and regressive taxes (ts) are also included in Figure 3b.

Figure 3a. Generated impulse responses of the income inequality redistributional fiscal policy from the Bayesian VAR..



Source: Author’s calculation based on WDI (2024) and SWIID (Solt, 2020) data.

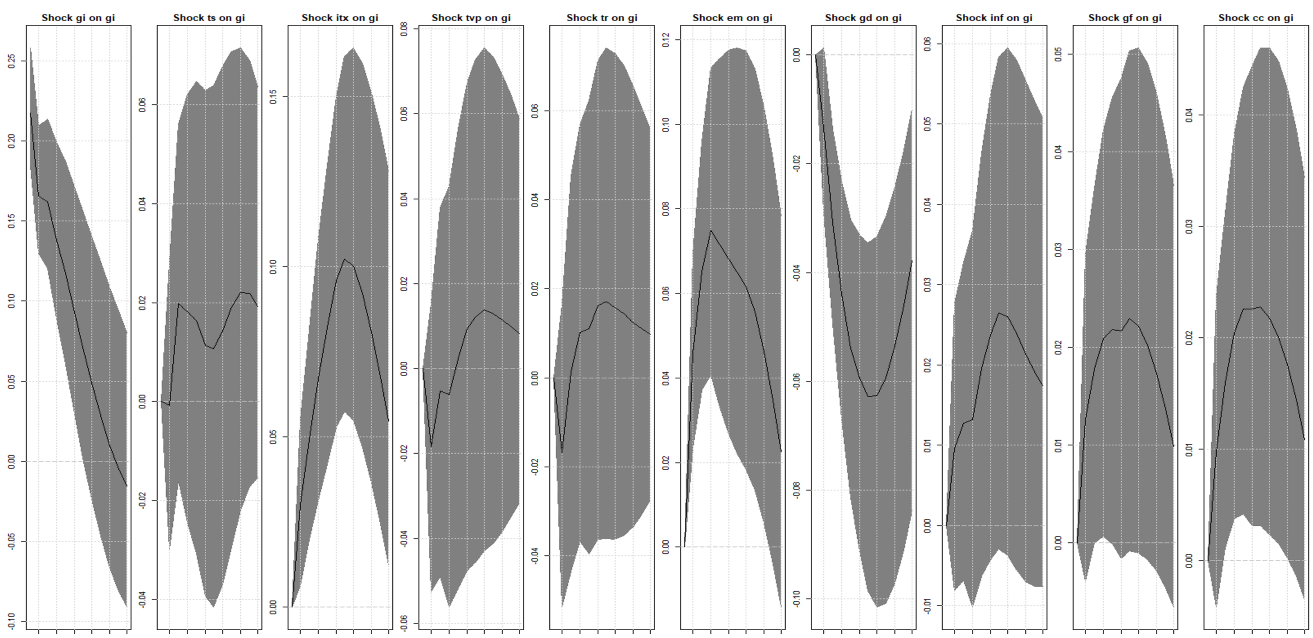
As expected, the results in Figure 3a depict that government expenditure appears to be more instrumental in reducing income inequality, when both Total government expenditure (tg) and Government expenditure on health (gh) are used a fiscal policy instance[8], following a one percent standard deviation shock to total government expenditure (tg) and attaining a maximum impact of 0.12 seven years after the shock to tg, which then converges immediately, reversing to the steady state region and dying after 11 years. While for government expenditure on health (gh), it reaches a maximum impact of 0.03 in 4 years and dying after 10 years. The findings are empirical and credible with the current literature on the impact of fiscal policy on income inequality, such as those of Moene and Wallerstein (2003), Samanta and Cerf (2009), Aye and Odhiambo

[8] Note that a separate model was estimated to see if there were any differences from the results when both tg and gh were estimated separately. However, the results were not different from the one reported.

(2022), Abramovsky and Selwaness (2023), Gunasinghe et al. (2020), Smith (2024), and Kebalo and Zouri (2024).

Figure 3b shows the impact of fiscal policy shocks, captured by regressive and progressive taxes on income inequality. A positive response is observed after a one percent standard deviation shock on ts and itx, reaching a maximum impact of 0.02% after three years, which then converges immediately; however, this does not reach the steady-state region. For itx, it reaches a maximum impact of 0.10 after 5 years, converges to the steady state, and dies after 12 years. These results contradict the government's definition of taxation as a revenue-generation tool. The findings of this study are supported by existing literature on fiscal policy and income inequality, including studies by Sameti and Rafie (2010), Cevik and Correa-Caro (2015), Balseven and Tugcu (2017), Demirgil (2018), and William and Taskin (2020) for Iran, China, and Turkey.

Figure 3b. Generated impulse responses of income on taxation variables from the Bayesian VAR.



Source: Author's calculation based on WDI (2024) and SWIID (Solt, 2020) data.

This study used time-varying CAPB for government expenditure (tvp) to assess fiscal sustainability and budget constraints over time, evaluating their impact on income inequality and total government revenue evolution. The results showed that tvp has a gradually declining impact on income inequality in both models, reaching a minimum level in five years and -0.02 in two years, then converges and dies after 12 years and 3 years, respectively, with an asymmetric and persistent impact, especially in Model 3b.

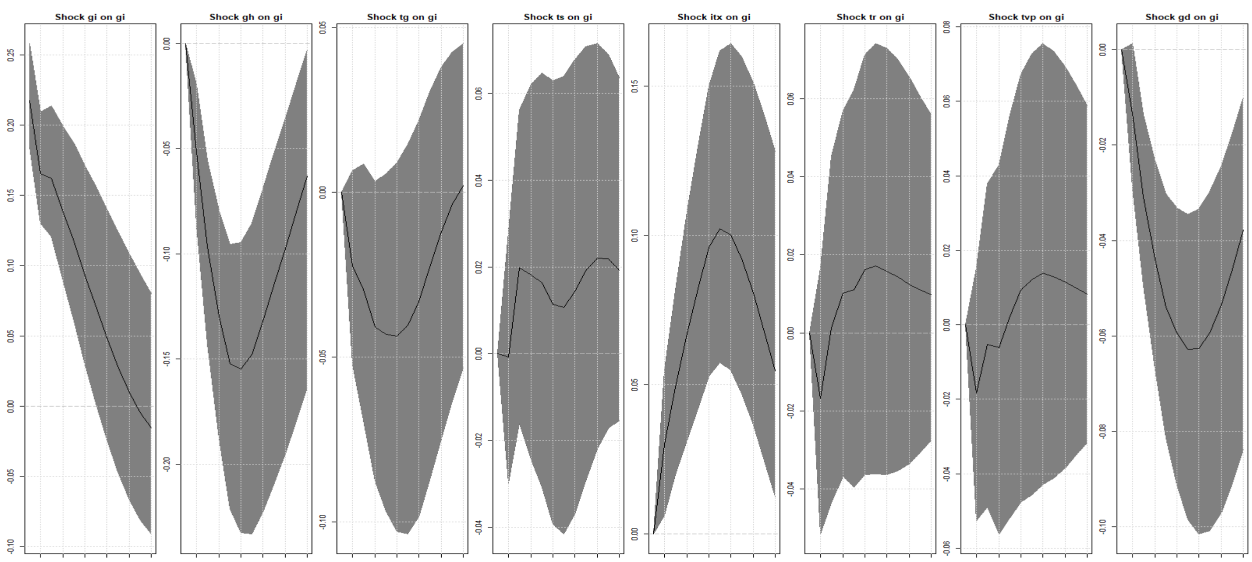
This study investigates the impact of fiscal policy shocks on income inequality by controlling for real balance (em) in the model. em, representing the real value of money or financial assets held by households and firms, plays a pivotal role in the transmission of fiscal policy shocks to income inequality. The results show that income inequality responds positively to a one percent standard deviation shock on em, reaching a maximum impact of 0.07 over eight years in model 2a. In Model 2b, the effect occurs four years after the shock on em. The effect declined gradually and became statistically insignificant after 12 years. The empirical findings in this context support those of Majumdar and Partridge (2009). In both models, income inequality declines following a one percent standard deviation shock on GDP per capita (gd), reaching a maximum impact of -0.09, eight years after the shock on gd. The study also controls for inflation, showing that income inequality responds positively to a one percent standard deviation shock on inflation (inf) shock, reaching a maximum of 0.04 eight years after the shock in model 3a. This supports the findings reported by Ndou (2024) for South Africa and Glawe and Wagner (2024) in a panel of 101 countries.

Lastly, the examination of government effectiveness and corruption control and how it triggers the current subject matter was undertaken, and the results are reported in Models 2a and 2b. It was found that inequality in low earnings initially improves after a one percent standard deviation shock, reaching a maximum level of 0.03 after seven years for gf and six years for cc. The impact converged immediately, reverted to the steady-state region, and died after 12 years. This result supports the findings of Gupta et al. (1998) pertaining to the impact of corruption and income inequality.

4.3.3. Impulse responses of the Bayesian VAR with sign restrictions for only fiscal policy variables

In Figure 3c, the author included sign restrictions in the model for all fiscal policy variables, considering the definition and fiscal theory of income distribution (FTID) and GDP per capita given its definition. The negative sign restriction on GDP per capita when modeling fiscal policy impacts on income inequality serves to highlight how reduced economic output from fiscal contraction may exacerbate inequality, particularly among lower-income groups. All these variables were restrained to have a negative shock to income inequality, and the main interest was to determine how income inequality responds to a simultaneous shock on the fiscal policy variable given its full definition and considering the level of the country's economy. Table 1A in the appendix shows how the variables were restricted for this model. The transmission mechanism using the sign restriction identification method involves imposing constraints on the expected direction of responses from fiscal variables to shocks, such as government spending or taxation. This method allows for the identification of how fiscal policy affects income inequality by observing the signs of the dynamic responses of income distribution and macroeconomic variables. For example, a positive government spending shock could be expected to reduce inequality, while a tax cut for the wealthy might increase it. The sign restrictions help isolate causal relationships and improve the accuracy of the model's predictions.

Figure 3c. Generated impulse responses of income on taxation variables from the Bayesian VAR.



Source: Author's calculation based on WDI (2024) and SWIID (Solt, 2020) data.

What is observed is that the results are not different from what has been reported in Figures 3a and c. This further suggests that fiscal policy through government expenditure reduces income inequality in South Africa; however, fiscal policy through taxation instruments failed to achieve its definition, as it exacerbated income inequality for low-income earners. Fiscal policy transmission can fail when tax cuts or increases disproportionately benefit higher-income earners, leaving lower-income groups without relief. This widens the income gap, as the wealthy have more capacity to save or invest, while lower-income earners experience little improvement in disposable income. As a result, instead of stimulating broad-based demand, the policy exacerbates income inequality. In such cases, fiscal policy fails to achieve its goal of equitable economic growth and poverty reduction.

4.3.4. Impulse responses of the Bayesian VAR for the high income eaners

Fiscal policy significantly impacts high earners' through taxation, government spending, and regulatory policies, making them sensitive to changes due to their reliance on investments and business profits.This section of the paper investigates the influence of fiscal policy on high-income earners, examining how changes in tax rates and government spending affect their economic status and overall well-being[9]. Therefore, the researcher utilized the top 10% of the World Inequality Database to measure income inequality among high-earners. The idea behind the results generated in Figure 4 was based on the assumption that both high-income and low-income earners receive benefits from the government.The results drawn from this section are interesting and make significant contributions to both the empirical literature and useful policy conclusions . Figures 4a to b show the generated impulse responses of income inequality of the high earner to policy change from the Bayesian VAR, similar to the variable definition adopted in the first model in Figures 3a to b. However, for this model sensitivity, an additional variable, time-varying CAPB for government expenditure (tv), was included as a control variable in the model..

Figure 4a shows that government expenditure (gh) is more effective in accelerating income levels for high-income households, with a maximum impact of 0.14 five years after a one percent standard deviation shock, then converges, reverts to the steady state, and dies after 10 years.

The study found that a one percent standard deviation shock to total government expenditure (tg) had a positive response to income inequality, reaching a maximum impact of 0.005 in four years. This impact increased to 0.18 in a year, then converged, reverted to a steady state, and died after 12 years. This asymmetric and persistent impact contradicts the fiscal theory

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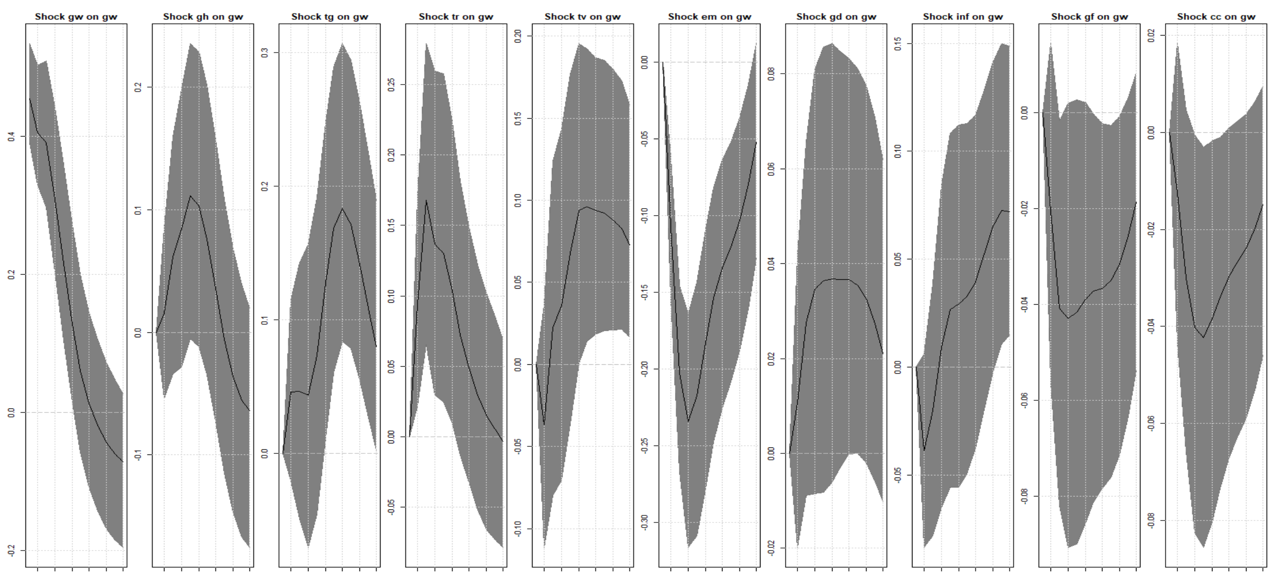
[9] High-income earners often benefit from tax breaks, deductions, and subsidies that favor wealth accumulation, such as capital gains tax rates or tax-exempt investment vehicles, and government policies that enhance access to public services like education and healthcare through their ability to afford private alternatives.

of income distribution, which suggests fiscal policy as the main means to reduce income inequality. However, these results are not surprising, as in this section, the focus was on high-income earners. Government expenditure can accelerate income levels for high-income households through targeted investments in infrastructure, technology, and financial markets that primarily benefit high-net-worth individuals and industries. Additionally, subsidies or tax incentives for businesses owned by wealthier individuals can lead to increased profits and higher incomes for them.

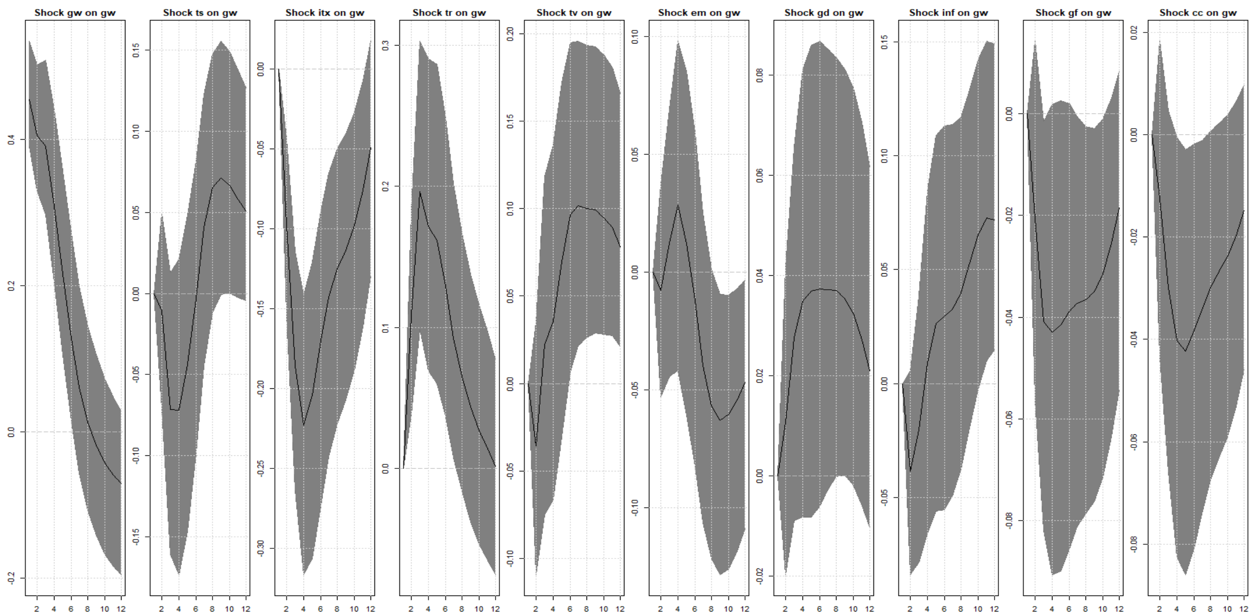
Figure 4a. Generated impulse responses of the income inequality redistributional fiscal policy from the Bayesian VAR..



Source: Author's calculation based on WDI (2024) and SWIID (Solt, 2020) data.

Figure 4b illustrates the impulse responses of income inequality to fiscal policy shocks through regressive tax (taxes on goods and services) and progressive tax (income tax) using the Bayesian VAR for goods and services. Interestingly, the study reveals that income inequality decreases after a one percent standard deviation shock on goods and services taxes (ts), reaching a maximum impact of 0.08% after 4 years. This converges immediately, reverts to the steady-state region, and dies after 8 years. The overall effect of ts on income inequality is asymmetric and persistent. The results further report that income inequality gradually declines after a one percent standard deviation shock on income tax (itx), attaining a maximum impact of -0.24 four and becoming statistically insignificant after 12 years.

Figure 4b. Generated impulse responses of the income inequality redistributional fiscal policy from the Bayesian VAR.



Source: Author's calculation based on WDI (2024) and SWIID (Solt, 2020) data.

The control variables yielded different results when the same model was used. The study reveals that income inequality responds to investment in both Models 3a and 3b, as shown in Figures 3a and 3b. However, income inequality responds oppositely to a shock in Models 2a and 3a, as shown in Table A2. This is because of the different Gini coefficients used to capture high-income earners, and the results are consistent across all variables. This exercise was dome for robustness check of the main models.

For instance, starting with gd, which captures the level of economic development, this study reveals that economic development, specifically gd, benefits high-income earners, leading to increased inequality. This effect is accelerated by a one percent standard deviation shock to gd, reaching a maximum impact of 0.004 within seven years. The impact then converged, reverted to a steady state, and died after 12 years. The logic behind these results is that economic development boosts productivity, creating job growth and higher wages for high-earning households[10]. Investments in infrastructure and education attract skilled workers, drive innovation and increase wealth and income. Interestingly, as expected in Model 2, when the study controls for government effectiveness (gf) and corruption (cc), the study shows that income inequality gradually declines following a one percent standard deviation shock on government effectiveness and corruption, reaching a maximum impact of -0.005 four years and -0.005 five years after the shock. The effect declined gradually and became statistically insignificant after 12 years.

4.3.3 Discussion of the Bayesian VAR results.

Income inequality in South Africa has persisted even during and post apartheid eara, a result of historical injustices and systemic issues that perpetuate wealth and opportunity disparities. Therefore, the democratic government has adopted various policy measures to create a more equitable society, including government expenditure (Zungu, 2024).. This study aims to illustrate how low-income and high-income earners respond to fiscal policy shocks in South Africa. This is to determine who benefits the most from fiscal policy, assuming that both high- and low-income earners benefit from the government.The findings show that government expenditure on health and social welfare programs in South Africa is beneficial in reducing income inequality. Access to quality health care is essential for all citizens to lead healthy and productive lives. Addressing health disparities can improve overall health outcomes, reduce health care costs, and prevent poverty. This study adopted variables such as total government expenditure (% GDP), government education expenditure (Malla and Pathranarakul, 2022), and government health expenditure (gh) to capture the fiscal theory of income distribution (Zungu, 2024).

Allocating resources for health and social welfare programs is a privilege for citizens, especially in developing countries. Government expenditures on health can indirectly affect income inequality by addressing the social determinants of health that contribute to disparities in health outcomes. Investments in education, literacy programs, clean water sanitation, housing, and employment issues can positively impact overall health and well-being, ultimately helping reduce income inequality. Social welfare programs, such as social grants, unemployment benefits,

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[10] Government investments in high-skill industries, innovation, and education boost demand for specialized labour, creating a competitive labour market and higher wages for skilled professionals and executives

housing subsidies, and food assistance, provide a safety net for individuals and families struggling to meet ends. These programmes can also help reduce the intergenerational transmission of poverty by providing opportunities for children and families to access education, healthcare, and other essential services. The findings are empirical and credible with the current literature on the impact of fiscal policy on income inequality, such as those of Moene and Wallerstein (2003), Samanta and Cerf (2009), Aye and Odhiambo (2022), Abramovsky and Selwaness (2023), Gunasinghe et al. (2020), Smith (2024), and Kebalo and Zouri (2024).

With regard to both forms of taxation,the study reveals that low-income households in South Africa are most affected by both income tax and goods and services tax. These taxes are crucial for governments to generate revenue and redistribute wealth; however, their regressive nature has led to an increase in income inequality. VAT, a consumption tax, is imposed on goods and services at each production stage, based on an individual's ability to pay. However, it has a greater impact on lower-income households, as they tend to spend more on basic necessities, which are subject to VAT at a standard rate of 15%. The VAT system in South Africa also includes exemptions and zero-rated items that primarily benefit higher-income households, such as basic food items, such as fruits and vegetables. An income tax is a progressive tax aimed at ensuring that higher-income earners contribute more to government revenue for social services and support. In South Africa, the income tax system is relatively flat, with a top marginal tax rate of 45% applied to individuals earning over R1.5 million per year. This places the burden of income tax on middle-income earners, while high-income earners can use tax loopholes and deductions to reduce their taxable income. However, the Gini coefficient of high-income earners suggests that higher-income households benefiting from the government increase income inequality. The transmission mechanism is that government policies benefiting higher-income households disproportionately increase their wealth and income, thereby increasing the income gap between high-income and low-income earners, as the benefits are not equally distributed. Consequently, government interventions that favor wealthier households can exacerbate income inequality, reflected in a rising Gini coefficient.

Taxation is a key tool in fiscal policy, but it can negatively affect high-income household income. This is because the progressive nature of the tax system results in higher tax rates, reducing the overall income of high earners. Additionally, additional taxes, such as the Alternative Minimum Tax or net investment income tax, can further affect their earnings. This results in less disposable income for savings, investments, or spending, which can hinder economic growth and wealth accumulation. The findings of this study are supported by existing literature on fiscal policy and income inequality, including studies by Sameti and Rafie (2010), Cevik and Correa-Caro (2015), Balseven and Tugcu (2017), Demirgil (2018), and William and Taskin (2020) for Iran, China, and Turkey.

5. Conclusion

This study uses Bayesian Vector autoregression to analyze the South African income inequality response to fiscal policy shocks from 1979 to 2022, providing valuable insights for policymakers and researchers and offering new insights into the dynamics of the South African economy. First, the study analyzes the impact of fiscal policy on the income distribution of low- and high-income earners, examining how changes in tax rates and government spending can impact their economic status and overall well-being. Contrary to the predictions of the fiscal theory of income distribution, an unexpected 1% increase in government expenditure results in a decrease in income inequality, while all forms of taxation positively contribute to income inequality among low-income earners. Interestingly, with regard to high-income earners, the findings show that income inequality responds positively following an unexpected 1% increase in government expenditure, while taxation was found to play a significant role in reducing income inequality as the response was found to be negative. Second, this study explores how income inequality responds to shifts in government expenditure. The lagged response of income inequality to unexpected shifts in these two variables suggests that expectations and market dynamics play a pivotal role in reducing income inequality, whether it is high or low. These findings underscore the need for coordinated policymaking.

To address income inequality in South Africa, a balanced tax policy that combines regressive and progressive measures is recommended, as this could aim to stimulate economic growth while addressing income inequality. Regressive taxes, such as VAT, disproportionately affect lower-income individuals, while aggressive taxes, such as higher-income tax rates for the wealthy, target higher-income individuals. Balancing these taxes ensures an equitable distribution of the burden across income levels. Revenue from progressive taxes can be used to fund social welfare programs such as education, healthcare, and affordable housing, thereby reducing the wealth gap, promoting social mobility, and creating a more just society. This comprehensive, balanced tax policy could be an effective solution to income inequality in South Africa. The key difference from existing policies would be ensuring that regressive taxes do not disproportionately burden the poor while ensuring that progressive taxes are robust enough to fund critical social welfare programs. This balance could promote both social equity and economic development, a shift from current policies that often lean too heavily on regressive taxes that exacerbate inequality.

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Appendix

Table A1. Sign restriction for the ristrited model

Variables	Sign restriction
Government expenditure on health	Negative
Total government expenditure	Negative
Income tax	Negative
Taxes on goods and services	Negative
National government revenue as % of GDP	None
Time-varying CAPB for government expenditure	Negative
Time-varying CAPB for total government revenue	Negative
Real balance	Negative
GDP per capita	None
Inflation	None
Government effectiveness	None
Corruption control	None

Table A2. Summary of the shocks of BVAR for both model 2 and 3

Variables	**Low-income earners: gi**		**Hight-income earner: gw**	
	Model 2a	*Model 2b*	*Model 3a*	*Model 3b*
Government expenditure (gh)	Negative		Positive	
Government health expenditure (gt)	Negative		Positive	
Taxes on goods and services (ts)		Positive		Negative
Income tax (itx)		Positive		Negative
Time-varying CAPB for government expenditure (tv)			Negative	Negative
Time-varying CAPB for total government revenue (tvp)	Negative	Negative		
National government revenue as % of GDP (tr)	Negative	Negative	Positive	Positive
Real balances (em)	Positive	Positive	Negative	Negative
Economic development (gd)	Negative	Negative	Positive	Positive
inf	Positive	Positive	Negative	Negative
Government effectiveness (gf)	Positive	Positive	Negative	Negative
Control for corruption (cc)	Positive	Positive	Negative	Negative

Source: Author's calculation based on WDI (2024) and SWIID (Solt, 2020) data.