Welfare Implication of Alternative Tax Rates Adjustment Policy in Nigeria: A DSGE Analysis

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This study sets out to determine the desirable policy adjustment in the tax rate for Nigeria that ensures the least welfare cost. A calibrated small open-economy New Keynesian Dynamic Stochastic General Equilibrium (NKDSGE) model of the Nigerian economy is applied to achieve this objective. Within this framework, we examined the impact of an increase in value-added tax (VAT) rate from 7.5 to 15 percent on key macroeconomic variables relative to the impact of an increase in company income tax (CIT) rate from 30 to 35 percent on macroeconomic variables. Furthermore, we examined the welfare costs of the increases in the rates by ranking their welfare costs. The results indicate that increases in VAT and CIT rates decrease output, consumption and investment in the short run. Furthermore, findings revealed that households are willing to give up around 23 percent of their non-stochastic steady-state consumption to ensure that an increase in VAT rate policy is implemented. This is so because the increase in the VAT rate policy resulted in an 11.33 percent welfare cost relative to an increase in the CIT rate policy, which resulted in a 23.18 percent welfare cost. Therefore, the Nigerian government should not consider the increase in CIT rate policy as a desirable policy option.

Keywords: DSGE models; fiscal policy; welfare

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1. Introduction

The aftermath of the 2014-2016 global dip in oil prices created limited fiscal space in Nigeria, which limited the country's ability to respond to any shock without resorting to alternative sources of finance. The 2016 recession placed the Nigerian fiscal authority in the spotlight due to its performance in the management of the reces-

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sion (Ibrahim & Abubakar, 2019). Taxation is among the key instruments employed to aid recovery as emphasised in the 2019, and 2020 Finance ACTs. Specifically, the ACTs emphasised: mitigating instances of regressive tax; adopting global best practices in tax administration; and incentivizing investment in infrastructure, capital markets, and small and medium-scale enterprises through taxation. Also, the 2019 Finance ACT raised the Value Added Tax (VAT) rate to 7.5% to finance part of the fiscal stimulus programmes as well as the 2020 budget (Sani-Omolori, 2019). The link between tax policies and economic growth as well as welfare is well-established in the literature (Ibrahim *et al.* 2022; Taha *et al.* 2020; and Adoho & Gansey 2019).

In 2019, Nigeria increased the VAT rate from 5% to 7.5% and channelled considerable expenditure toward fiscal stimulus (Sani-Omolori, 2019). Owing to the limited fiscal space in Nigeria, oil revenue continues to deteriorate and expenditure needs to be expanded to aid the recovery. In addition, Domestic Revenue Mobilization (DRM) has to improve as the tax-to-GDP ratio remains as low as 6% (Solomon & Fidelis, 2018). Thus, an increase in tax rates becomes one of the most reliable short-term policy options. The increase in tax rate and fiscal stimulus policies have implications and opportunity costs particularly on the welfare of the citizenry, considering the series of shocks the Nigerian economy experienced within a decade such as the 2014 to 2016 global dip in oil price, the resulting 2016 recession, the recent impact of COVID-19 pandemic, and the aftermath of lockdown measures. Therefore, analysis of the welfare cost of VAT and CIT rates increases is usefulness in evaluating the possible impact of future increments in Nigeria, This is important because an increase in either VAT or CIT affects the household welfare indirectly via the price channel, by distorting the household consumption/leisure allocation, income, and welfare.

Researchers and academics are concerned about which of VAT and CIT rates if increased would result in maximum revenue generation and the least welfare cost. This concern is further intensified by the Keynesian theoretical postulation, which proposes government spending during an economic crisis to influence the components of aggregate demand (Ekpo, 2017; Fatás & Summers, 2018). Determining the least welfare cost ultimately requires comparing the welfare cost of the increase in alternative tax rates policies. Understanding the welfare implication of tax raise is

underscored by the fact that increasing the wrong tax rate, particularly during the recovery period could affect growth and ultimately lead to welfare deterioration.

Globally, taxation is seen as a principal source of government revenue being spent on infrastructure and other economic development initiatives. Noteworthy is that there is a considerable amount of empirical work that focuses on different aspects of tax policies in Nigeria. For example, Ebi & Ayodele (2017) examined the effect of tax policy on Nigeria's revenue and concluded that tax reform positively impacted the revenue flow of Nigeria, while Nwaorgu *et al.* (2016) established a positive link between tax policy and economic performance in Nigeria. While Aminu (2019) found that in four years Nigeria can achieve a 15% VAT increase with tolerable welfare loss. In a comparative study, Ibrahim *et al.* (2022) found that the choice between an increase in VAT and CIT rates in Nigeria involves a trade-off between higher revenue generation and the least welfare loss. The increase in the VAT rate leads to higher revenue but also results in a greater loss in welfare compared to an increase in the CIT rate, which results in to least revenue generation and minimum welfare loss.

There are relatively few studies that compare the welfare cost of tax rates increase in Nigeria. Therefore, this is an attempt to provide an empirical assessment of the welfare cost of alternative increases in tax rates. By so doing, the study has added to the existing literature on tax reform in Nigeria and most importantly, by applying the methodology of the New NKDSGE model.The model makes it possible to capture policy responses to business cycle fluctuations, the impact of any policy change on macroeconomic variables and households, and complex micro-macro relationships (Alege, 2008).

An attractive departure from the work of Aminu (2019) and Ibrahim *et al.* (2022) is that this study applied the NKDSGE model. Unlike the computable general equilibrium (CGE) model that assumes price flexibility in Nigeria, the NKDSGE reflects the true pricing behaviour in Nigeria by assuming price rigidity, particularly how prices are sticky downward in Nigeria. Another important difference is that shocks are regarded as stochastic to reflect sudden increases in prices perceived by the majority of Nigerians who are not aware of government policies. In contrast to Aminu (2019) and Ibrahim *et al.* (2022), this study applied the quadratic welfare cost function,

which provides an estimated welfare loss or gains in percentage rather than monetary compensation, to maintain the same level of welfare in the absence of any shock. An interesting value addition of the current study is the welfare cost comparison between the feasible highest increase in VAT relative to the feasible highest increase in CIT rates.

The remaining sections of this paper are organized as follows: Section 2 provides a literature review and the theoretical anchor that guides the analytical structure of the study. Section 3 covers the methodology. In Section 4, the results were presented and discussed. Finally, the paper ends with Section 5, concludes and presents policy implications.

2. Literature Review

This section is divided into three subsections. The first section deals with the review of relevant theories, while the second subsection contains a review of relevant empirical literature. The third section presents stylized facts about the Nigerian economy.

2.1 Theoretical Literature

There are competing theories that seek to explain the relationship between taxation and economic growth. As noted by Odhiambo & Olushola (2018), the two notable theories are the Lindahl and the Bowen models. The former views the relationship in terms of voluntary exchange, where the state provides public goods and services in return for the tax paid by the citizens, while the latter views the production of public goods as the opportunity cost of private goods. The Bowen model is one of the theories adopted in this study to model the relationship between an increase in tax rates and macroeconomic variables. The choice of this theory is informed by its ability to present the implication of social goods financed through cost increase and it best describes the economic structure of Nigeria as a resource-based economy (Odhiambo & Olushola, 2018).

Similarly, the Lindahl model guides the analysis of welfare costs associated with increases in tax rates. The theory is based on the Pareto optimality condition, which is anchored on the premise that alternative tax types should generate different amounts of revenue that would improve the welfare of at least one agent without lowering the welfare of another agent (Stiglitz, 2018). According to Bedhaso & Jayamohan

(2020), a tax policy that failed the requirement of Pareto improvement would satisfy the requirement of Pareto allocational efficiency, even if it causes inefficiencies relative to zero tax conditions. This theory could be viewed as a synthesis of the allocational theory of taxation, the normative theory of taxation and the redistribution theory of taxation. In simple terms, the allocational theory of taxation analyses the welfare loss caused by distortionary taxes, while the normative theory of taxation ensures that only the tax types with minimum distortion are administered. On the other hand, the redistribution theory of taxation is primarily concerned with how taxation can be used to achieve income distribution (Tresch, 2022). The general equilibrium model like the NKDSGE model can encompass the second-best theory of taxation, which is based on optimized solutions (Tresch, 2015). The goal of optimal taxation is to ensure maximum social welfare within a set of constraints (Besley & Persson, 2013).

However, most taxes create distortion, which in turn results in resource misallocation and allocational inefficiency, though it is an unavoidable consequence of raising revenue through taxes. There is evidence of natural conflict between tax policy and allocational efficiency (Bedhaso & Jayamohan, 2020). Furthermore, taxes tend to affect taxpayers' purchasing power negatively, thereby making them rely on public goods. Even though taxes are made to improve the welfare of the citizens, some factors constrain the government from achieving the distributional goal of taxation such as the inability to set with certainty that the current tax policy would ensure optimal distribution. Another constraint is the trade-off that exists between equity and efficiency in tax administration (Tresch, 2015).

2.2 Empirical Literature

There is a considerable amount of empirical work that focuses on different aspects of tax policies. Taha *et al.* (2020) investigate the welfare implication of the Malaysian tax reform on consumers by analysing and comparing consumer prices during pre- and post-reform periods. The study found that tax reform does not lead to general price increases and consumer welfare was not affected by the reform. A contrasting result was found in the Democratic Republic of Congo, Adoho & Gansey (2019) applied a compensating variation measure of welfare and found that the purchasing

power of all Congolese households decreased by a factor of 10 to 12% following the introduction of VAT in the country. In Norway, Gaarder (2019) employed a regression discontinuity design to compute households' welfare following a food VAT rate cut and found a decrease in welfare inequality among the different household groups. A two-country heterogeneous agent incomplete markets model was utilized by Kabukçuoğlu (2014), to compute the welfare effect of replacing the capital income tax with a higher labour income tax in the US. The study concludes that the fall in the post-tax wage income is insignificant and the poor benefit the most. Ahmed *et al.* (2013) found a contrasting result for Pakistan by employing the Almost Ideal Demand System (AIDS) model to analyse the welfare effect of a uniform tax rate on all final goods relative to a different tax rate policy on final goods. The study found that the uniform tax rate policy is welfare superior as households spent 10% less and maintained the same level of welfare.

CGE models are often used to assess the welfare implications of tax reform. In this spirit, Amir *et al.* (2013) evaluate the welfare impact of Indonesian tax reform and found that personal income tax and CIT cuts lead to a reduction in poverty incidence at the cost of widening income inequality under a balanced budget. In the same vein, Nguyen *et al.* (2017) found that tax cut leads to improvement in welfare in Vietnam, though at the cost of higher deficit and income inequality. Still in Vietnam, Bhattarai *et al.* (2019) utilized the CGE approach and compared the welfare implication of the change in the VAT rate to the change in the CIT rate. The study found that an increase in the VAT rate by 2% and a decrease in the CIT rate by 3% is associated with the highest welfare.

In Nigeria, Aminu (2019) applied the CGE model to investigate how Nigeria can achieve a 15% VAT increase that ensures maximum revenue generation for the government and minimum welfare loss for the public. The study found that Nigeria can achieve such a policy in four years by increasing the rate by 2.5% annually. Still in Nigeria, Ibrahim *et al.* (2022) applied a CGE model to compare the welfare loss of an increase in VAT rate policy from 5% to 7.5% relative to an increase in CIT rate policy from 30% to 35%. The study indicated that choosing between an increase in VAT or CIT rates involved a trade-off.

It is evident from the strands of literature reviewed that there have been concerted efforts globally to measure the welfare implications of tax policies, though there is no consensus in the literature In this direction, two notable studies for Nigeria are Aminu (2019) and Ibrahim *et al.* (2022). Unlike the latter, this study compares the welfare cost of an increase in VAT rate from 5% to 15% relative to an increase in CIT rate from 30% to 35 %. The departure from Aminu (2019) and Ibrahim *et al.* (2022) is that the current study utilized the welfare loss function, which estimates the percentage loss or gain in household welfare following a policy change. In terms of methodology, this study differs from the studies of Aminu (2019) and Ibrahim *et al.* (2022) by applying the NKDSGE model to reflect the stochastic aspect of a policy shock from the perspective of an ordinary citizen. Welfare analysis of tax rate policy is important, particularly in a recovering economy with dual concerns of maximum revenue mobilization and least welfare loss. This can help to assess current tax policy and provide guidance for the future.

2.3 Stylized Facts

For an oil-dependent economy like Nigeria, the effect of dependence on the international oil market could substantially determine both the size of government revenue and GDP as well as the magnitude of foreign exchange reserves (Ibrahim *et al.*, 2022). These factors, in turn, could determine the welfare level of the country. To shield the Nigerian economy from the volatile oil market, from 2019 Nigeria is committed to domestic revenue mobilization policy as contained in its 2019 and 2020 Finance Acts as seen in Figure 1. It can be observed from the figure that the non-oil tax to GDP ratio in Nigeria improved following the enactments of the 2019 Act in 2020.

Also, from 2011 to 2016 there was a consistent downward trajectory in the non-oil tax to GDP ratio, which could be attributed to the improvement in oil revenue from 2011 to 2013 as the country pays little attention to tax revenue. The year 2016 marked the turning point of the tax-to-GDP ratio in Nigeria, as the economy commenced its effort toward DRM strategy as an alternative source of revenue to support the country's recovery during a recession.

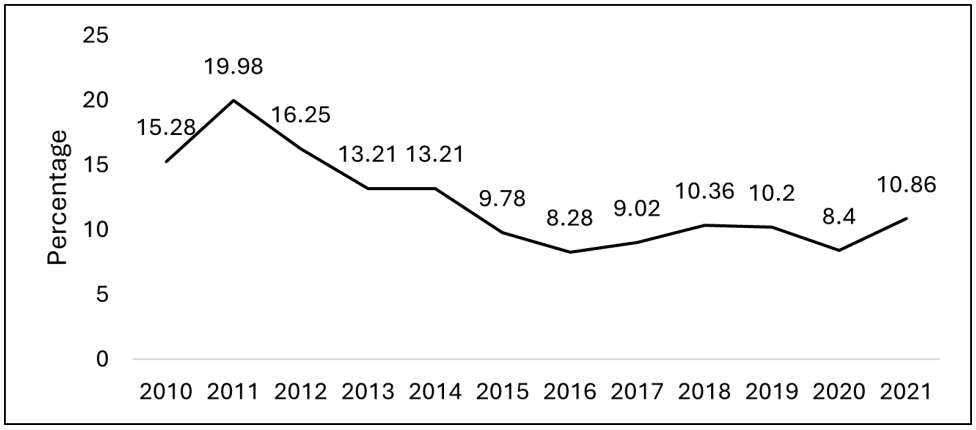

Figure 1: Nigerian Tax to GDP Ratio

However, the positive trajectory in the Nigerian tax-to-GDP ratio suffered some setbacks in 2019. Following the enactment of the 2019 Finance Act, which took effect in 2020, as tax to GDP ratio in Nigeria returned to an upward trajectory. Also, recent reports reveal that poverty in Nigeria has reached an alarming state, with about 63 % of Nigerians considered to be multidimensionally poor in 2022 (NBS, 2022).

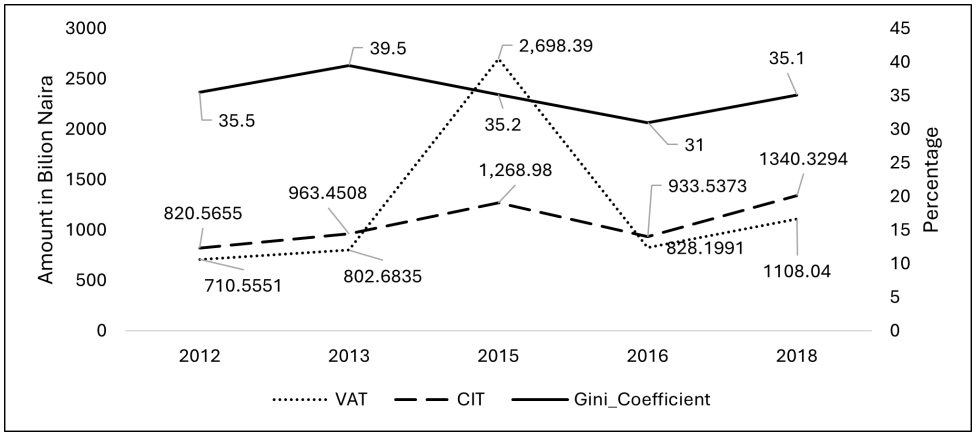

Figure 2: Gini Coefficient, VAT and CIT Revenue for Nigeria

It can be observed from Figure 2 that the higher the revenue generated through either VAT or CIT, the wider the income inequality becomes, as an increase in taxes reduces the disposable income of the poor household. Furthermore, the figure indicated that

VAT is associated with the least income inequality gap compared to an increase in CIT. This could be attributed to the fact that in Nigeria essential consumables like medicine, food and others are exempted from VAT and the rate is considerably low compared to other countries. Contrarily, the CIT rate in Nigeria is as high as 30% apart from other taxes borne by companies in addition to the high cost of doing business, as such when firms pass out an increase in the cost of production to the household it affects their welfare as and widens the income inequality gap. From 2011 to 2015, income inequality and CIT revenue have been on the upward trend, while VAT revenue remained stable., This could be attributed to stable GDP growth. From 2015 to 2016, income inequality reduced in Nigeria, which could be attributed to a decrease in company incomes induced by the 2014 to 2016 global dip in oil prices and the accompanied 2016 recession. Following the adoption of domestic revenue mobilization as an alternative to oil revenue in 2016, income inequality and CIT revenue trajectory turned to a positive rise, while VAT revenue continued to improve from 2015.

3. Data and Methodology

3.1 Data

For simulation, quarterly data from 2010Q1 to 2021Q4 was utilized. The choice of the base period is based on data availability. Data on the variables of interest are sourced from the CBN statistical database such as the domestic consumer price index, domestic interest rate (MPR), and domestic output (real GDP), denoted as ,*i*,and *y*,respectively. To achieve stationarity, the data were transformed prior to parameter estimation, in accordance with Pfeifer (2014): Dome.: Domestic output (real GDP) y was first converted into logs, thereafter de-trended and demeaned by one side HP filter. Domestic prices (CPI) data was transformed by: $O_t^{obs}=log\left(O_t^{data}\right)-log\left(mean\left(O_t^{data}\right)\right)=O$

where O_t^{obs} is the transform non-trend variable of interest and O_t^{data} is the actual observed data of interest. While domestic interest rate (MPR) data was transformed to achieve stationarity as:

$$I_t^{obs}=log\left(1+\frac{\left(I_t^{data}\right)}{4\times100}\right)-mean\left(log\left(1+\frac{\left(I_t^{data}\right)}{4\times100}\right)\right)=I$$

Where I_t^{obs} is the percentage deviation of the quarterly gross interest rate from its steady state. The first part of the equation represents the gross quarterly interest rate, expressed as a percentage, while the last part corresponds to the steady state data reflecting its long-run average.

3.2 Model Specification

The model adapted for this paper is based on Iwata (2009). For the details of the model adapted for this study including the mathematical and log-linearised models see Iwata (2009). The modified model captures the key distortionary taxes employed by the Nigerian fiscal authorities in smoothing the business cycle such as VAT rate, Personal Income Tax (PIT) rate and CIT rate. In addition, the model captures the government spending, investment and transfers to households. Finally, the government debt rule is also captured in the model. Thus, these features allow us to carry out the macroeconomic assessment and the distributional impact of increased tax rate policies in Nigeria. The model also incorporates downward price stickiness, an important feature of pricing behaviour in the Nigerian economy (CBN, 2013).

3.2.1 Household

The household sector consists of liquidity and non-liquidity-constrained households. The non-liquidity-constrained household forms a fraction of the total population $(1 - \omega)$, while the liquidity-constrained households form the remaining proportion of the population (ω).

Ricardian Household (Non-liquidity constraint)

The household maximises its intertemporal utility by choosing consumption, investment and leisure and also decides on saving instruments i.e. physical capital or government bonds. The household earned income through; wages (W), Rent to firms (R) and returns from government securities acquired previously. The household also pays VAT, PIT and CIT. The household maximizes its intertemporal utility subject to a budget constraint as follows:

$$\begin{aligned}(1+\tau_t^c)C_t^R(r) + I_t(r) + \varphi Z_t(r)K_{t-1}(r) + \frac{B_t(r)}{R_t P_t} = \left(1+\tau_t^l\right)W_t(i)L_t^R(r) \\ + \left(1-\tau_t^k\right)r_t^k Z_t(r)K_{t-1}(r) + (1-\tau_t^k)\frac{D_t(r)}{P_t} + \frac{B_{t-1}(r)}{P_t}\end{aligned} \tag{1}$$

where τ_t^c, and τ_t^K represent VAT, and CIT respectively. The degree of capital utilization is denoted by While the stock of capital is represented by . Denotes price level. Households' incomes consist of real income wages. , the rental rate of capital , riskless returns on government bond s, and dividend s received by a Ricardian household.

Non-Ricardian Household (Liquidity constraint)

The non-Ricardian household has a simpler behaviour i.e. does not maximize intertemporal utility. The non-Ricardian household earned income from only a source i.e. wage income and received government transfer. Like the non-liquidity-constrained household, the liquidity-constrained household pays VAT and PIT on wage income. Thus, the non-Ricardian household simply allocates its entire disposable income to consumption under the hypothesis in Equation 2:

$$(1+\tau_c)\,C_t^{NR}(j) = \left(1-\tau_t^l\right)W_t(j) + G_t \tag{2}$$

The above equation τ_t^l represents VAT and PIT respectively. Consumption is denoted by While labour supply is represented by . The household income consists of real wage income and government transfer G_t.

3.2.2 Wage Settings

The Ricardian household is a wage ($W_t^R(i)$) setter for its differentiated labour services $L_t^R(i)$ in a monopolistically competitive labour market, while its nominal wage is set in the spirit of Calvo (1983). The non-Ricardian household, on the other hand, set its wage $W_t^{NR}(j)$ for its differentiated labour service $L_t^{NR}(j)$ to be equal to its average nominal wage. Within each group of households, wages and labour hours are equal, as households face the same labour demand schedule:$W_t^R = W_t^{NR} = W_t(n)L_t^R = L_t^{NR} = L_t(n)$. It is assumed that an independently competitive employment agent bundles the differentiated labour services $L_t(n)$ into one type of effective labour input L_t. The aggregate wage law of motion follows the process in Equation 3:

$$W_t = \left[\varepsilon_w\left(W_t^{\star}(n)\right)^{-\frac{1}{\lambda_{w,t}}} + (1-\varepsilon_w)\left(\left(\frac{P_{t-1}}{P_{t-2}}\right)^{\gamma_w} W_{t-1}(i)\right)^{-\frac{1}{\lambda_{w,t}}}\right]^{-\lambda_{w,t}} \tag{3}$$

In the above equation, ε_w there is the probability that the Ricardian household may reset its wage to its optimal level , while the non-optimal wage of the non-Ricardian household is represented by . The degree of price indexation is denoted by While labour hours and price level are denoted by and respectively.

3.2.3 Firms

For simplicity, it is assumed that there are only two types of representative firms in the domestic economy, i.e. perfectly competitive final-good firms, and monopolistically competitive intermediate-good firms (IGFs) indexed by $f\epsilon[0,1]$, in addition to the domestic retail importers.

Intermediate Goods Firms

It is assumed that each firm follows an increasing-returns-to-scale Cobb-Douglas technology to produce a differentiated good $Y_t(j)$. The IGFs set prices in a staggered manner as proposed by Calvo (1983). Each intermediate goods producer j maximized profit subject to its demand functions, production technology and capital accumulation. The profit maximization solution of the intermediate good producer is:

$$D_t^j = OCF_t - \tau_t^k(NOCF_t) \tag{4}$$

where D_t^J is the period dividend and OCF_t is the difference between overall revenue and expenditure. Like in the previous equations is CIT.

$$OCF_t = P_t Y_t - \frac{(1 - TSP_t W_t^{1-\alpha}(K_t^r)^{\alpha})}{\varepsilon_t^{\alpha}\alpha^{\alpha}(1-\alpha)^{1-\alpha}} \tag{5}$$

In Equation (5), $(1 - TSP_t W_t^{(}1-\alpha))$ is the cost of labour plus the employer's social security contributions, While net operating cash flow is defined as:

$$NOCF_t = P_t Y_t - \frac{(1 - TSP_t W_t^{1-\alpha} + Q_t(K_t^r)^{\alpha})}{\varepsilon_t^{\alpha}\alpha^{\alpha}(1-\alpha)^{1-\alpha}} \tag{6}$$

In Equation, (6) Q_t is Tobin's Q.

Distributors

In the domestic economy, there exists a continuum of distributors for each form of final goods. Each form of the final good is bought by a distinct type of customer:

household demands for consumer goods (C), firm demand for capital goods (I) and government demands for goods (G). Distributors sell their goods at a price plus a markup over the marginal costs $P_t^f(f)$. Domestic distributors similarly set prices with domestic intermediate goods producers.

Domestic Retail Importers

In the domestic economy, there is a continuum of retail importers distributing differentiated goods. Importers pay the world market price for imported goods. To set prices in local currency optimally, the retail importers must solve an optimal markup problem. Thus, a deviation from the law of one price becomes obvious. Import retailers, like the domestic producers, set prices $\dot{P}_f^I(f)$ following Calvo (1983) to maximize profit.

3.2.4 Monetary and Fiscal Policy

Monetary Policy

The apex bank sets the country's interest rates according to a modified Taylor rule following CBN (2013) in the form of:

$$i_t = [\rho_i i_{t-1} + (1-\rho_i)](\psi_\pi \pi + \psi_x Y + \psi_e (e_t - e_{t-1})) + \varepsilon_t \tag{7}$$

In the above equation, i_t represents the natural level of nominal interest rate, p1which is the interest rate smoothing coefficient ε_t and is an i.i.d interest rate shock. The parameters ψ_π, ψ_x and ψ_e represent weights assigned to inflation, output and exchange rate stability respectively.

Fiscal Authority

The fiscal authority earned revenue through Value Added Tax (VAT), Personal Income Tax (PIT) and Company Income Tax (CIT) represented by τ_t^c, τ_t^l, and τ_t^k, respectively. In addition, the fiscal authority issues bonds B_t which pay debt interest outlays $(i_{t-1} - 1)B_{t-1}$. The fiscal authority spends the earned revenue on government consumption G_t, and government investment GI_t and performs lump-sum transfers to household TRG_t. Thus, the fiscal authority has a budget constraint:

$$G_t + \frac{B_{t-1}}{P_t} + TRG_t + GI_t = C_t\tau_t^c + W_t L_t \tau_t^l + \tau_t^k r_t^k Z_t K_{t-1} + r_t^k \frac{D_t}{P_t} + \frac{1}{R_t}\frac{B_t}{P_t} \tag{8}$$

Based on the above budget constraint the following fiscal rules are adopted (Iwata, 2009)

$$\hat{\tau}_t^c = \rho_{tc}\hat{\tau}_{t-1} + (1-\rho_{tc})\psi_{tc}(\hat{b}_{t-1} - \hat{Y}_{t-1}) + \eta_t^{tc} \tag{9}$$

$$\hat{\tau}_t^l = \rho_{tl}\hat{\tau}_{t-1} + (1-\rho_{tl})\psi_{tl}(\hat{b}_{t-1} - \hat{Y}_{t-1}) + \eta_t^{tl} \tag{10}$$

$$\hat{\tau}_t^k = \rho_{tk}\hat{\tau}_{t-1} + (1-\rho_{tk})\psi_{tk}(\hat{b}_{t-1} - \hat{Y}_{t-1}) + \eta_t^{tk} \tag{11}$$

$$\hat{G}_t = \rho_t\hat{G}_{t-1} + (1-\rho_g)\phi_{gy}\hat{Y}_{t-1} + \eta_t^g \tag{12}$$

$$\hat{GI}_t = \rho_{gi}\hat{GI}_{t-1} + (1-\rho_{gi})\phi_{gi}\hat{Y}_{t-1} + \eta_t^i \tag{13}$$

$$\hat{TRG}_t = \rho_{trg}\hat{TRG}_{t-1} + (1-\rho_{trg})\phi_{gty}\hat{Y}_{t-1} + \eta_t^{tg} \tag{14}$$

Equations 9 to 14 are the fiscal rules. Where τ_t^c, τ_t^l and τ_t^k are the log deviations from the steady state VAT, PIT and CIT rates, respectively. G_t, GI_t, and TRG_t are government spending, government investment and transfer to households respectively. b_t Denotes government bonds, while Y_t is the national income. The speed of adjustment of debt to GDP ratio and policy shocks are donated by s and ns respectively.

3.2.5 Calibration

Some of the parameters of this model are obtained from literature on economies sharing a similar structure with the Nigerian economy while others are computed based on data for the Nigerian economy. Table 1 presents the calibrated parameters of the model. The model steady-state parameters are estimated on the Nigerian data from 2010:Q1 to 2021:Q4. We followed Iwata (2009) and Li and Spencer (2016), by taking the sample period averages, as reported in Table 1.

Table 1: Calibrated Parameters and Steady-state Ratios

Parameter Description	Parameter	Value	Source
Calvo parameter for domestic producers	θ_h	0.64	CBN (2013)
Calvo parameter for domestic wage	γ_w	0.6	CBN (2013)
Calvo wage indexation	ζ_w	0.5	Authors
Calvo parameter for retail importers	θ_f	0.64	Authors
Calvo parameter for foreign producers	θ_h	0.75	Steinbach *et al.* (2009)
AR(1) shock process for domestic producers	$\rho_\phi h$	0.2	Steinbach *et al.*
Government expenditure AR coefficient	ρ_g	0.8	Iwata (2009)
Con tax. AR coefficient	ρ_c	0.75	Iwata (2009)
Labour tax AR coefficient	ρ_l	0.5	Iwata (2009)
Capital tax AR coefficient	ρ_k	0.75	Iwata (2009)
Persistence of preference shoack	ρ_{sc}	0.5	Iwata (2009)
Persistence of labour supply shoack	ρ_{sl}	0.75	Iwata (2009)
Persistence of inv. adj. cost shoack	ρ_k	0.75	CBN (2013)
Inflation	ψ_π	1.45	CBN (2013)
Output	ψ_x	0.53	CBN (2013)
Nominal exchange	ψ_e	0.28	CBN (2013)
government exp. output gap coefficient	ψ_{gy}	0.1	Iwata (2009)
Consumption tax debt coefficient	ψ_c	0.1	Iwata (2009)
Labour tax debt coefficient	ψ_l	0.1	Iwata (2009)
Capital tax debt coefficient	ψ_k	0.1	Iwata (2009)
i.i.d. productivity shock	η_a	0.4	Iwata (2009)
i.i.d. preference shock	η_{sc}	0.1	Authors
i.i.d. labour supply shock	η_{sl}	0.2	Authors
i.i.d. wage markup	η_l	0.1	Authors
i.i.d. Price markup	η_p	0.15	Iwata (2009)
i.i.d.Interest markup	η_r	0.1	Iwata (2009)
i.i.d. Government spending shock	η_g	0.3	Iwata (2009)
i.i.d. Consumption tax shock	η_c	0.2	Authors
i.i.d. Labour tax shock	η_l	0.1	Iwata (2009)
i.i.d. Capital tax shock	η_k	0.3	Authors

Table 1: Cont'd

Parameter Description	Parameter	Value	Source
Fiscal Steady-state parameters			
Consumption tax	τ_c	0.05	Federal Inland Revenue Service (FIRS, 2023)
Personal income tax	τ_l	0.24	Federal Inland Revenue Service (FIRS, 2023)
Capital income tax	τ_k	0.30	Federal Inland Revenue Service (FIRS, 2023)
Dividend income tax	γ_d	0.25	Model
Depreciation rate	δ	0.25	Model
Wage increment	γ_{wl}	0.1	Model
Level of government transfer	γ_t	0.4	Model
Employer social contributions	τ_{cc}	0.19	Almeida *et al.* (2013)
Steady-state ratio parameters			
Debt-to-GDP	γ_b	0.42	Data
Wage-to-GDP	γ_l	0.27	Data
Consumption-to-GDP	γ_c	0.62	Data
Government Consumption-to-GDP	γ_g	0.07	Data
Investment-to-GDP	γ_b	0.15	Data
Capital-to-GDP	γ_k	0.15	Model

For other steady-state parameters like the inverse adjustment, capital utilization, depreciation cost, labour-output ratio, steady-state wage increment etc., we set their values to be consistent with the steady-state conditions implied by the model, as reported in Table 1.

This study utilizes the Bayesian estimation technique to estimate the model presented in this study using the Nigerian data (2010-2021) under two scenarios. The estimated model implies impulse response functions to the two exogenous shocks that are consistent with economic intuition.

3.3 Welfare Loss Function

After we estimated the NKDSGE model for this study, we proceeded with a microsimulation by adopting Schmitt-Grohé and Uribe's (2000) welfare criteria. The welfare cost associated with a particular change in tax burden is estimated by the fraction of non-stochastic steady-state consumption that a household will sacrifice to remain indifferent between the corresponding constant sequences of consumption $(c_t - hc_{t-1})$ including habit formation and hours l_t. Therefore, the welfare cost of the

tax policy (ζ) is such that:

$$u((1-\zeta)c, h) = E\left[u(c, h)\right] \tag{15}$$

In (15), ζ denotes the unconditional mathematical expectation and the equation implies that a positive ζ indicates that tax policy is costly while a negative ζ indicates that the tax policy is beneficial. Second-order Taylor expansion is used in approximating ζ concerning (lnc_t, lnh_t), while $E[ln\frac{y}{t} = 0]$ for all $y_t = c_t, h_t$ is also an approximation. ζ is given as

$$\zeta = 1 - \left[1 + \frac{(1-\sigma)^2}{2} var(\hat{x}_t)\right]^{\frac{1}{v(1-\sigma)}} \tag{16}$$

such that: $\hat{x}_t = c_t^v(1-h_t)^{1-v}$ where σ and v are preference parameters, which are set at 1 and 0.75 respectively, while $var(\hat{x}_t)$ denotes the log deviation from the non-stochastic steady state of the unconditional variance of $\hat{x}_t$. As in (15) c_t^v and h_t represent consumption and habit formation respectively.

3.4 Description of Policy Simulations

The structure of the model presented in this section allows us to quantitatively compare the welfare cost of alternative increases in tax rates. To achieve this set objective, we implemented a set of simulations and formulated two scenarios.

a.) **VAT scenario:** This scenario captures the welfare cost of an increase in the VAT rate from 7.5 % to 15 % while holding other tax rates and expenditure components constant. The choice of raising the VAT to 15 % is informed by the findings of Aminu (2019), who concluded that Nigeria can achieve a 15 % VAT that ensures maximum revenue generation for the government and the least welfare loss for the public.

b.) **CIT scenario:** This scenario captures the welfare cost of an increase in the CIT rate from 30 % to 35 % while holding other tax rates and expenditure components constant. This choice is informed by what is obtainable in other African countries like Sudan, Equatorial Guinea, Chad and others.

4. Results and Discussion

This section is concerned with presenting, analysing and discussing the results emanating from this study. For ease of understanding, the section is divided into three subsections.

4.1 Estimation Result The estimated parameters of our model are presented in this subsection. We use the random walk Metropolis-Hastings algorithm to generate the parameter posteriors, where 150,000 draws were generated to carry out a sample from the posterior. The MCMC result obtained from the change in the VAT rate policy model is 33% for the first chain and 34% for the second chain while that of the change in the CIT rate model is 27% for the first chain and 33% for the second chain. Thus, the model converged, because the acceptance ratios are within the range of 20% to 49%, which is in line with the recommended benchmark as stated by Stephane *et al.* (2011). The model posterior distributions are reasonable, as the results are not wild. A tighter or looser posterior mean distribution implied that the data is quite informative while identical parameters signify that the data do not provide additional information. The posterior results are presented in Table 2.

Table 2: Parameter Posterior

Parameter Description	Parameter	Posterior	Source	Posterior
Calvo parameter for domestic producers	θ_h	0.64	CBN (2013)	0.74
Calvo parameter for domestic wage	γ_w	0.6	CBN (2013)	0.66
Calvo wage indexation	ζ_w	0.5	Authors	0.85
Calvo parameter for retail importers	θ_f	0.64	Authors	0.95
Calvo parameter for foreign producers	θ_h	0.75	Steinbach *et al.* (2009)	0.74
AR(1) shock process for domestic producers	$\rho_\phi h$	0.2	Steinbach *et al.*	0.18
Government expenditure AR coefficient	ρ_g	0.8	Iwata (2009)	0.90
Con tax. AR coefficient	ρ_c	0.75	Iwata (2009)	0.74
Labour tax AR coefficient	ρ_l	0.5	Iwata (2009)	0.50
Capital tax AR coefficient	ρ_k	0.75	Iwata (2009)	0.74
Persistence of preference shoack	ρ_{sc}	0.5	Iwata (2009)	0.50
Persistence of labour supply shoack	ρ_{sl}	0.75	Iwata (2009)	0.74
Persistence of inv. adj. cost shoack	ρ_k	0.75	CBN (2013)	0.74
Inflation	ψ_π	1.45	CBN (2013)	1.23
Output	ψ_x	0.53	CBN (2013)	0.60
Nominal exchange	ψ_e	0.28	CBN (2013)	0.30
government exp. output gap coefficient	ψ_{gy}	0.1	Iwata (2009)	0.14
Consumption tax debt coefficient	ψ_c	0.1	Iwata (2009)	0.13
Labour tax debt coefficient	ψ_l	0.1	Iwata (2009)	0.13
Capital tax debt coefficient	ψ_k	0.1	Iwata (2009)	-0.06
i.i.d. productivity shock	η_a	0.4	Iwata (2009)	0.29
i.i.d. preference shock	η_{sc}	0.1	Authors	0.09
i.i.d. labour supply shock	η_{sl}	0.2	Authors	0.12
i.i.d. wage markup	η_l	0.1	Authors	0.06
i.i.d. Price markup	η_p	0.15	Iwata (2009)	0.01
i.i.d.Interest markup	η_r	0.1	Iwata (2009)	0.09
i.i.d. Government spending shock	η_g	0.3	Iwata (2009)	0.13
i.i.d. Consumption tax shock	η_c	0.2	Authors	0.13
i.i.d. Labour tax shock	η_l	0.1	Iwata (2009)	0.65
i.i.d. Capital tax shock	η_k	0.3	Authors	0.22

4.2 Macroeconomic impact of alternative increase in tax rates

In this section, we present the results of the impact of increasing tax rates on the Nigerian economy. We used the impulse response graphs to analyze the effects of

different tax rate increases on the major macroeconomic variables in Nigeria. To interpret the impulse response results, we applied the deviation from the steady state criteria. This method helps us observe how long it takes for a variable to return to its initial steady state after experiencing a change.

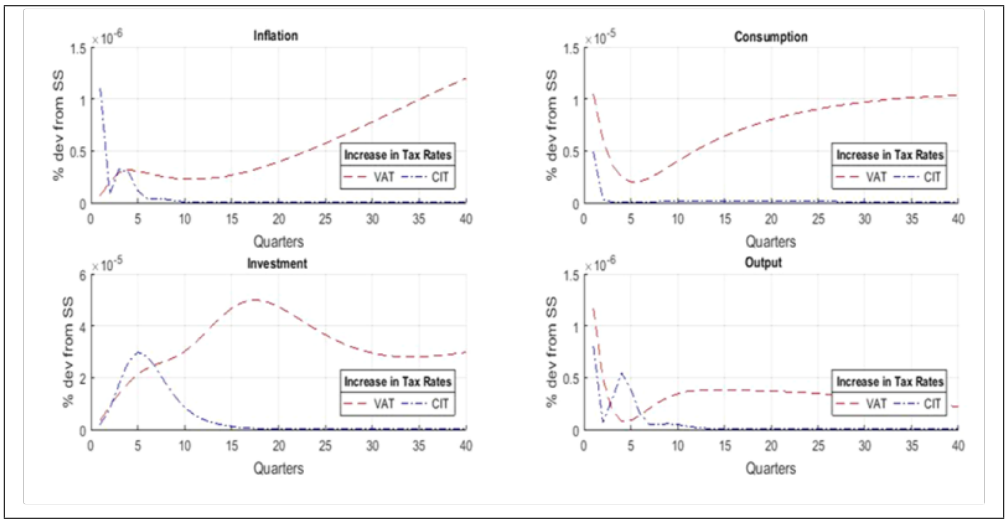

Figure 3: Impact of Alternative Increase in Tax Rates Policy in Nigeria

The impact of an increase in the VAT rate from 7.5 to 15 % is transmitted into the economy via the price transmission channel as indicated in Figure 3. Following the adoption of this consumption/leisure allocation is distorted, as inflation rises above its steady-state level for more than 35 quarters. This implied that the increase in the VAT rate is inflationary in Nigeria. This in turn affected the real value of household wealth negatively and caused a welfare cost of 11 % as presented in Table 2. In response to the sudden increase in the VAT rate, output and consumption declined in the short run. This can be attributed to a reduction in the real income of the household induced by the increase in the VAT rate. It can be observed that from quarter 10, the economy experienced a sustained recovery in consumption and output. This could be attributed to improvement in economic growth. On the other hand, it can be observed from the figure that the economy witnessed a sudden rise in investment, which could be attributed to public investment financed by the additional tax revenue generated through the increase in the VAT rate. However, quarter 17 marks the turning point of

investment.

Likewise, as observed from Figure 3, consumption is also distorted through the price transmission channel in the case of an increase in CIT rate from 30 to 35 %. It follows that inflation and output become volatile within the first 5 quarters. This could be attributed to the fact that it takes time for a company to readjust its prices optimally in line with the Calvo assumption as firms readjust their prices and output in line with their new demand.

Similarly, consumption decreased in the short run and thereafter stabilized. Like in the case of VAT, investment suddenly rose and thereafter began to fall from quarter 5 and became stable from quarter 15. This could be attributed to public investment financed by the additional tax revenue generated through the increase in the CIT rate.

It can be observed from Figure 3, that an increase in the VAT rate results in higher inflation, but it also leads to a more desirable consumption level, improved output, and increased investment. In contrast, raising the CIT rate is associated with minimal inflation, yet it results in an undesirable consumption level, poor output, and reduced investment.

4.3 Welfare Cost of Alternative Increase in Tax Rates

The results of the welfare cost of alternative increases in tax rates in Nigeria are presented in this section and reported in Table 3. The results indicate that the increase in VAT rate to 15 % is associated with 11. 37 % welfare cost, which implies that, as a result of implementing this policy, households will forego 11. 37 % of their non-stochastic steady-state consumption. Similarly, the increase in the CIT policy to 35 % is associated with 23.18 % welfare cost, which implies that households will forego 23.18 % of their non-stochastic steady-state consumption following the implementation of the policy.

Specifically, the increase in the VAT rate to 15 % is more desirable relative to the increase in the CIT rate to 35 %, because it leads to the least welfare cost. Therefore, Table 3 can also be interpreted as households willing to give up around 11.37% of their non-stochastic steady-state consumption to ensure that an increase in VAT rate policy is implemented. This is so because the increase in the CIT rate takes away

private agents' incentive to invest in new or existing ventures as it erodes profit. Consequently, high unemployment, low consumption, low output and a fall in the standard of living would be experienced.

Table 3: Welfare Cost of Alternative Increase in Tax Rates

Forms of tax reforms	Welfare cost Posterior
Increase in VAT	11.3653
Increase in CIT	23.1823

4.4 Model Diagnostics Test

The models used in this study are assessed in terms of their ability to be identified by the data. Figures A1 and A2 in the appendix plot the sensitivity of the models concerning data, under the two alternative policy options. The results obtained from identification tests with the aid of DYNARE show that all parameters are well-identified from the data used. Persistence parameters have the lowest identification strength, which can be improved by adding related data series.

5. Conclusion and Policy Recommendations

This study aimed to find the most desirable tax rate policy for Nigeria by comparing the impact of increasing VAT and company income tax rates. Results showed that both VAT and company income tax increases lead to decrease in output, consumption, and investment in the short run. Households were found to be more accepting of an increase in VAT rates, resulting in an 11.33% welfare cost compared to a 23.18% cost for an increase in company income tax rates. The study suggests that increasing the company income tax rate may not be a desirable policy option for the Nigerian government. The findings from this study are consistent with the a priori expectation based on Keynesian theory, which asserts that an increase in tax rate is anti-growth and could lead to welfare deterioration. However, changes in different tax rate policies are associated with different welfare implications. Other findings of this study are as follows:

Firstly, increases in tax rates during economic recovery are costly because they result in welfare costs. An increase in the VAT rate to 15 % in Nigeria is associated with the lowest welfare cost relative to an increase in the CIT rate to 35 %. This finding is

supported by Aminu (2019). To conclude, we compare the welfare cost of an increase in the VAT rate to 15 % relative to an increase in CIT rate policy to 35 % and found that an increase in CIT rate policy is undesirable, as it is associated with a higher welfare cost. This is so because it takes away the incentive for private investors to invest in either new or existing ventures. As a consequence, unemployment is likely to be affected and lead to low consumption, and output, ultimately decreasing welfare.

The policy implication is that an increase in the CIT rate to 35 % disincentivizes investment. Therefore, the government can increase the VAT rate which does not undermine the welfare of households as much as CIT does. This policy advisement is the suggestion of Aminu (2019).

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Appendix

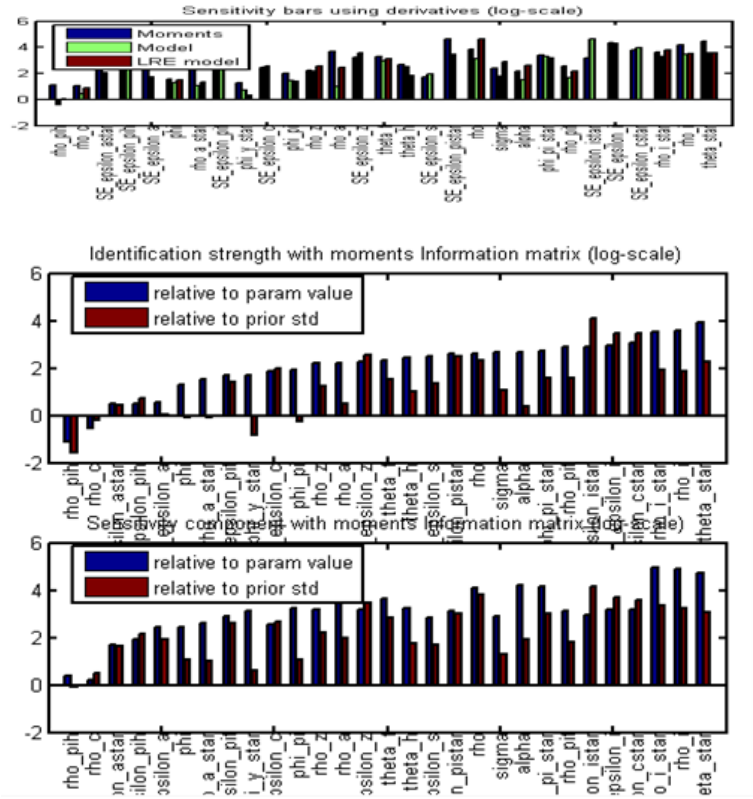

Figure 4: Identification and Sensitivity Graph (VAT)

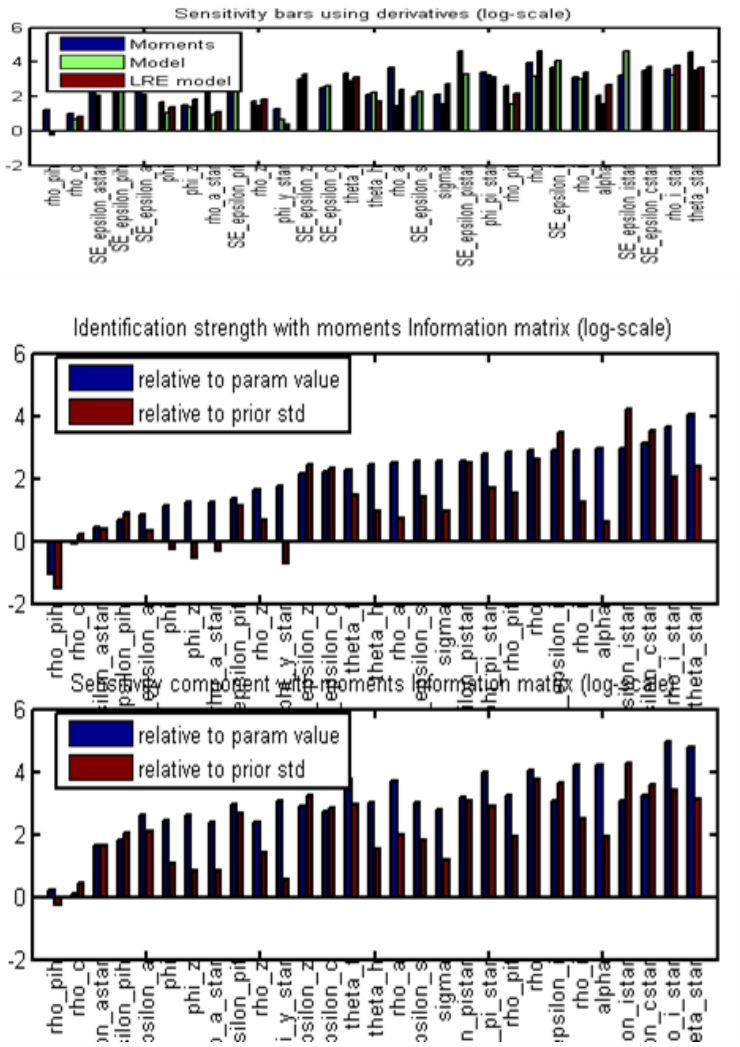

Figure 5: Identification and Sensitivity Graph (CIT)