ALTERNATIVE PUBLIC FINANCING OPTIONS, TAX AND ECONOMIC GROWTH NEXUS IN THREE SELECTED SUB-SAHARAN AFRICAN COUNTRIES, 1990-2016

BY

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DEDICATION

Allah (SWT) says “And if you should count the favours of Allah, you could not enumerate them. Indeed, Allah is Forgiving and Merciful” Qur’an 16:18. He also says “if you are grateful, I will add more (favours) unto you Qur’an 14:7. I am indeed very grateful.

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ABSTRACT

The effectiveness of tax in inducing economic growth in Sub-Saharan Africa (SSA) countries remained unclear. Countries with comparable chequered economic growth rates had varying levels of Tax-to-GDP Ratios (TGDPRs). South Africa, Nigeria, and Republic of the Congo are three prominent SSA countries with unstable growth rates. With TGDPRs of 24.8% and 9.1%, respectively, South Africa and Republic of Congo experienced growth rates that rose from -0.3% and 1.0% in 1990 to 5.3% and 6.4% in 2005 before falling to 0.4% and -2.8% in 2016. Nigeria had a TGDPR of 7.6%, and its growth rate dropped from 11.8% in 1990 to 5.3% in 2005 and further to -1.6% in 2016. These countries also used Alternative Public Financing Options (APFOs) such as Public Debt (PD), seigniorage, and Total Natural Resource Rents (TNRR), which could shape the tax-growth nexus pattern. Existing studies had focused primarily on the tax-growth nexus in SSA but paid little attention to the influence of APFOs. This study was, therefore, designed to examine the effect of APFOs on tax-growth nexus in three selected SSA countries.

The Endogenous Growth Theory provided the framework. A Two-Stage Least Squares method was deployed to address potential endogeneity issues among the variables. The method allowed for the interaction of APFOs in the tax-growth nexus, such that high PD accumulation could reduce tax revenue necessary to facilitate growth, and high reliance on seigniorage and TNRR could stifle tax mobilisation efforts and lead to low growth. A simulation was used to investigate how APFOs might affect the tax-growth nexus. The data which covered 1990 to 2016 were sourced from the World Development Indicators, International Centre for Tax and Development, and the Monetary Authorities database of the three countries. All estimates were validated at $\alpha \leq 0.05$.

Tax and PD interaction had significant negative effect on growth in South Africa (-0.004, p=0.01), Nigeria (-0.002, p=0.01) and Republic of Congo (-0.002, p=0.01), suggesting that PD reduced the effectiveness of tax in financing growth. The interaction between tax and seigniorage had no discernible impact on growth in South Africa and Republic of Congo but had a significant negative effect on growth in Nigeria (-0.02, p=0.004), suggesting that seigniorage significantly reduced the effectiveness of tax in fostering economic growth in Nigeria. Tax and TNRR interaction significantly impacted growth in South Africa (-0.03, p=0.00) and Republic of Congo (-0.005, p=0.00), while it had negligible effect in Nigeria. The simulation results showed that a higher PD resulted in higher taxes and slower growth in the three countries. A higher seigniorage increased tax and growth in the three countries. A higher TNRR increased growth but lowered taxes in Nigeria and Republic of Congo but not in South Africa.

The impact of taxes on economic growth was weakened by public debt, seigniorage, and total natural resource rents in sub-Saharan African countries. In order to encourage tax-driven economic growth across all countries, these Alternative Public Financing Options should be used with caution.

Keywords: Alternative public financing options, Tax in Economic Growth, Natural Resource Rent, Tax Seigniorage

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LIST OF ABBREVIATIONS

ADF:	Augmented Dickey-Fuller
APFOs:	Alternative Public Financing Options
CIA:	Cash-In-Advance
EGT:	Endogenous Growth Theory
GBC:	Government Budget Constraint
GLC:	Growth Laffer Curve
HIPC:	Heavily Indebted Poor Country
MDRI:	Multilateral Debt Relief Initiative
OECD:	Organisation for Economic Co-operation and Development
PD:	Public Debt
PP:	Phillip-Perron
REA:	Representative Economic Agent
SDGs:	Sustainable Development Goals
SSA:	Sub-Saharan Africa
TGDPR:	Tax-to-GDP Ratio
TIN:	Taxpayer's Identification Number
TNRR:	Total Natural Resource Rents
TSLS:	Two-Stage Least Squares

CHAPTER ONE

INTRODUCTION

1.1.Background to the Study

Investments, both public and private, are crucial for a country or region to grow. This necessitates the governments to raise revenue from tax to finance such investment. This further boost economic activities. Thus, the important role of taxation has been acknowledged as fundamental to achieving a stable economy. More so, the private sector benefits from the externalities created by public sector through taxation. The role of taxation in the long-run economic growth process was examined in the endogenous growth model by Barro (1990)[1]. The nature of the relationship between tax and economic growth was termed as *Growth Laffer Curve (GLC)* by Ehrhart, Minea, and Villieu (2014).

In the macroeconomics realm, the question always arises on whether taxation promotes or retards economic growth in both developing and developed nations. More so, there have been some theoretical and empirical explorations in the literature to understand the nature of the relationship between tax and growth. Barro (1990) in an endogenous growth model illustrated the existence of an inverted-U shaped relationship between taxes and economic growth which is different from the traditional Laffer curve[2]. This suggests a nonlinear relationship between tax and economic growth. Deduction from his argument shows that despite the government's commitment to raising the required revenue from tax, higher taxes provide revenues for public investment but may have a

[1] Bajo-Rubio (2000).

[2] Distinguishably, GLC is different from traditional Laffer curve, Debt Laffer curve and Seigniorage Laffer curve. Laffer curve is a hump-shaped or U-shaped curve specifically describing the relationship between tax revenue and tax rate (See Malcomson, 1986; Agell and Persson, 2001; Laffer, 2004; and Fullerton, 2008), while debt laffer curve is the inverted-U shaped curve derived from the relationship between government revenue and debt (see Classens, 1990; Reinhart, et al., 2003; Cordella, 2010; Reinhart, et al., 2012, Megersa, 2015). Finally, seiniorage Laffer curve is basically the U-shaped relationship between inflation and seiniorage revenue (see Friedman, 1971; Sargent and Wallace, 1973; Bruno and Fischer, 1990; Kiguel, 1989; and Burdekin et al., 2004).

more distortionary effect on private capital accumulation. In furtherance, the sources of government finance were expanded to capture public investment, public transfers, and distortionary taxation in the endogenous growth model by Cashin (1995). Similarly, Bajo-Rubio (2000) established a non-monotonic linkage between government size and long-run economic growth using the Solow growth model. The theoretical model further reveals a U-shaped relationship between public sector size and economic growth. Thus, the role of government in growing the economy cannot be overemphasised. However, governments are facing the challenge of raising optimal revenue from taxation necessary to maintain and sustain long-run economic growth.

In addition, two prominent strands have been documented in the literature on the role of taxation in an economy. The first strand believes that tax retards growth by reducing the benefits expected by industrious innovators which may reduce the zeal for the continuous investment needed for growth. On the other hand, the second strand argues that tax promotes growth when the necessary revenues that accrue from taxes are judiciously used for the provision of public goods. Intuitively, public services serve as a crucial input in the production process of the private sector. More so, the efficient utilisation of tax revenue collected creates a potential positive relationship between taxation and long-run economic growth. By this, taxation creates an enabling environment for businesses to thrive through the benefits derived from positive externalities created by public services.

Both arguments depict the tax system observed in developing and developed countries. In the developing countries, especially sub-Saharan African (SSA) countries, there are still some fundamental challenges facing the tax structure[3] with far-reaching implications for their growth patterns. On the other hand, the most developed nations rely heavily on tax as a catalyst for their growth and provision of public goods[4]. Undoubtedly, tax effort to mobilise needed finance is significantly low in countries in the sub-Saharan African region relative to the developed regions. The low tax revenue

[3] Tax structure in this context means the composition of tax yields generated from different types of tax that are levied on economic agents.

[4] Thus, Aghion et al. (2016) explained that higher taxation can enhance the provision of public goods for the entrepreneurs and innovators through the increase in expected returns to them thereby promoting growth. This suggests that taxation is key driver of growth as it provides government with necessary revenues for public investment in the economy.

requires them to explore other public financing options to augment the financing gap in their expenditures needed for stable and sustainable economic growth. Consequently, the articulation and effectiveness of these options could have amplifying/dragging effect on the capacity of the countries to raise the required tax to facilitate long-run economic growth.

1.2.Statement of the Problem

Maintaining high, stable and sustainable economic growth remains a key objective but is most challenging to achieve in the SSA region over years. Specifically, Nigeria, South Africa, and the Republic of Congo are top among SSA countries facing challenges of chequered economic growth. For instance, the growth rates of South Africa and the Republic of Congo increased from -0.4% and 1.0% in 1990 to 5.3% and 6.4% in 2005, respectively. While South Africa's growth rate declined to 3% in 2010, the Republic of Congo's growth rate further rose to 8.8% in the same year. However, their respective growth rates drastically decreased to -2.8% and 0.4% in 2016. More so, Nigeria's growth rate significantly declined from 11.8% in 1990 to 5.3%% in 2005. However, it followed an upward trend to 8% in 2010 before declining to -1.6% in 2016. These poor growth patterns are worrisome for countries aiming to address several developmental challenges. One of the major factors responsible for observed economic growth is attributed to paucity of tax revenue (ICTD/UNU-WIDER, 2017; Coulibaly and Gandhi, 2018).

Additionally, these countries are still unable to meet up with growth in government size relative to the revenue mobilisation through taxation. This poses critical problems for them in expanding public infrastructures that are essential for long-run economic growth. Higher tax rates generate more revenue for government to finance its growth through provision of public goods that potentially benefit private investment. On the other hand, the resultant effect of higher tax rates is the distortion of private capital accumulation that may inhibit long-run economic growth if it exceeds the optimal level[5]. On the other hand, low taxes generate low revenue to finance public investment which affects the provision of public infrastructures for the expansion of private capital needed

[5] This is summarized by Laffer curve where higher tax rates beyond optimal level can lead to low tax revenue.

for long-run growth. This latter scenario is found in these countries as their tax revenue-to-GDP ratios are significantly low except in South Africa. Therefore, it is very difficult to expand public investment that will benefit the teeming population in the economy (Oyinlola et al., 2020).

Consequently, Nigeria and the Republic of Congo remain the lowest tax collectors among the three countries. Tax-to-GDP ratio (TGDPR) of Nigeria rose from 5.9% in 1990 to 9.5% in 2005 but marginally declined to 8% in 2010. This later increased slightly to 10.4% in 2016. In the case of Republic of Congo, TGDPR declined significantly from 10.4% in 1990 to 6.5% in 2005. However, it climbed back to 9.4% and 10.5% in 2010 and 2016, respectively. On the other hand, South Africa is one of the high tax collectors in the SSA region. Its TGDPR increased from 22.8% in 1990 to 26.1% in 2005 but declined slightly to 25% in 2010. Afterwards, it rose to 27% in 2016. Despite high tax mobilisation, the country is facing challenges in maintaining high, stable and sustainable growth as Nigeria and the Republic of Congo with low tax mobilisation. Moreover, the underperforming tax revenue is due to poor tax capacity and inefficient tax revenue mobilisation framework (see Coulibaly and Gandhi, 2018). These financing challenges undermine the objective of broad-based growth[6] in these countries.

Achieving high and sustainable economic growth, reducing poverty and income inequality, increasing employment, and achieving the Sustainable Development Goals (SDGs) have become challenging due to the observed difficulties of these countries in mobilising necessary resources from taxes (especially Nigeria and the Republic of Congo). To address the huge financing gap, these countries utilised alternative public financing options (APFOs) to foster their economic growth. This allows them to raise additional resources to finance the huge public investment gaps. Specifically, these countries sourced funds through public debt (PD), seigniorage and total natural resource rents-TNRR (Ndikumana and Abderrahim, 2010; Ehrhart et al., 2014; World Bank, 2018; African Development Bank, 2019). However, these APFOs have implications on how tax influences economic growth in these countries.

[6] High, stable, and sustainable long-run economic growth.

One of the APFOs explored by these countries is public debt (PD). In South Africa, public debt-to-GDP rose from 31.8% to 33.2% in 1999. It further increased to 45.4% in 2016. The dwindling domestic revenue continues to push their public debt upward as it rose from 46.9% in 2018 to 52.7% in 2019 whereas debt servicing to revenue stands at 29.1% in 2018. Also, there is an increasing trend in public debt-to-export as it increased from an average of 70.2% in period 1990-2009 to 161% in 2016. This observed growth in debt is highly associated with growth challenges in the economy. Thus, debt accumulation and servicing pose a great danger for long-run economic growth (Bhorat and Baskaran, 2021; Olamide and Maredza, 2021), hinder tax performance, and loss of revenue required for growth-enhancing investments. In Nigeria, PD has been declining over time. For instance, public debt-to-GDP ratio declined from 120.4% in 1990 to 83.6% in 1999 and further down to 10.9% in 2016. Nevertheless, it rose from 17.5% in 2018 to 20.1% in 2019 and debt service accounts for more than 50% of federal total revenue in 2019. Though public debt-to-export declined from an average of 198.8% in period 1990-2009 to 83.8% in 2016, this is still very high.

For the Republic of Congo, public debt-to GDP ratio also increased from162% in 1990 to 231.6% in 1999. However, it significantly declined to 52.1% in 2016. Moreover, the public debt-to-export decreased from an average of 269.5% in period 1990-2009 to 62.6%. Despite the decline, the country is currently facing the problem of debt servicing as its outstanding rose from 8% in 2018 to 21% in 2019 (African Development Bank, 2020a). Additionally, debt forgiveness and intermittent favourable commodity international market, the resource paucity is now aggravating the debt level in these countries. Given the infrastructure gaps and sustainable development problems coupled with borrowing, these countries still fail to raise enough funds from additional taxation to fulfil the obligation of debt repayment (Selassie, 2018). Hence, growing public debt dampened the effectiveness of high tax mobilisation and worsened low tax mobilisation. Hence, Pattillo et al. (2004) observed that at a low level, debt is growth-enhancing through accumulation of capital and productivity growth while at a high level, long-run growth is dampened through higher long-term interest rates, inflation, higher distortionary taxation in the future as well as policies and prospects uncertainty which largely weaken investments.

These countries also rely on revenue from natural resources[7]. This serves as an additional way of raising more revenue for public investment to stimulate long-run economic growth. Consequently, long-run growth is expected to be amplified due to high government revenue (i.e., natural resource rents) used in financing huge public investment deficits as well as sustaining private investment that can expand needed productivity. However, total natural resource rents have proven to be unstable and detrimental to economic growth over time. South Africa's TNRR-to-GDP ratio declined marginally from 5.8% in 1990 to 4.7% in 2016. Also, Nigeria experienced a huge drop in TNRR-to-GDP ratio from 50.4% in 1990 to 5.4% in 2016. In the case of the Republic of Congo, TNRR-to-GDP ratio slightly decreased from 47% in 1990 to 41.5% in 2016. Moreover, the recent economic crisis of 2016 and the fallout of Covid-19 pandemic further demonstrate the risk associated with over-reliance on commodity exports. This puts these countries at the risk of both unstable fiscal positions and growth patterns[8]. Moreover, Nigeria and Republic of Congo are characterised by unstable public investments due to unstable revenue from commodity export which negatively affects government spending and economic growth. Apart from output loss, there is also a problem of high debt repayment since there is low revenue from taxation.

Consequently, this over-reliance on total natural resource rents has hampered these countries from expanding their tax capacity as well as tax revenue to address huge developmental goals. This seemingly easy source of revenue continues to create instability in the growth pattern as a result of the global economic downturn. This led to the crash of most traded commodities in the international market. Hence, the unstable nature and associated challenges of this source of finance to sustain and expand public investment coupled with challenges of maintaining private capital accumulation, continue to weaken the tax-growth relationship in these countries. Christensen (2016) further argued that declining commodity prices weakened the growth rate of exporting countries. More so, countries with strong financial buffers can only cope temporarily as

[7] Though debt accumulation may imply that larger proportion of the revenue from natural resources is diverted towards debt servicing thereby reducing revenue that can be expended on public investment to spur growth.

[8] African economic growth declined from 3.9% in 2013 to 3.7% and it further declined significantly to 2.2% in 2016 due to oil price shock (African Development Bank, 2018). The volatility associated with export commodity prices will always pose challenges to SSA region in terms of public investment financing options.

long-term decline in the commodity price will undermine their growth. Hence, this public financing source cannot ensure stable revenue to finance broad-based growth.

In addition to the aforementioned APFOs, seigniorage also plays a significant role in financing government spending which influences economic growth in these SSA countries. The generation of revenue from printing money occasionally accounts for a sizeable share in GDP and sometimes above 10% of total government revenue in many SSA countries (African Development Bank, 2019). Expectedly, for South Africa, seigniorage accounts for 10.9% of the GDP on average, between 1990 and 2016. This is relatively high compared to Nigeria and the Republic of Congo with 1.23% and 0.47%, respectively. Governments are often faced with difficulties in reducing their expenditures which require them to explore financing option such as seigniorage- "devil's alternative" (Udoh, 2011). The effective management of revenues from printing money (seigniorage) to finance government spending is very critical for economic growth.

According to Fielding and Mizen (2001), many developing countries still rely heavily on revenue from seigniorage to raise needed funds for public investment. This, however, may constitute a loss or gain to the economy depending on whether the money generated is worth less or more than its cost of production. The fundamental challenge with this source of finance is the high inflationary risk. This may result in a reduction of the real value of payments and the imposition of tax on existing money holders. More so, the utilisation of seigniorage revenue generated by the Central Bank to fund government expenditures is perceived to be a bad policy approach due to hyperinflation (Udoh, 2011). This may lead to huge social and economic problems. Seigniorage may further weaken the tax system, public investment, and economic growth when not prudently managed. It is always difficult for countries to depend largely on this revenue policy that will promote inflation in the economy. Thus, raising revenue from seigniorage is tricky for these countries as it requires a level of inflation that can guarantee optimal seigniorage revenue and maintain fiscal sustainability (taxation).

In sum, the key challenges with poor tax performance and chequered economic growth in these SSA countries can be largely attributed to poor management of alternative

sources of finance (seigniorage, debt, and resource rents) available to the governments. Despite many fiscal reforms initiated to address these problems, the outcome has been proving abortive over time. The sub-optimal level of these APFOs deteriorates the growth patterns of these countries. It is against this background that this study attempts to provide a detailed empirical analysis and evaluation of the impact of these APFOs on the tax and economic growth nexus in these selected SSA countries. More pointedly, we provide answers to some pertinent research questions: To what extent does public debt affect the relationship between tax and economic growth in the selected SSA countries? What is the effect of total natural resource rents on the relation between tax and economic growth in the selected SSA countries? To what extent does seigniorage influence the relation between tax and economic growth in the selected SSA countries?

1.3.Objectives of the Study

The broad objective of this study is to investigate the effect of alternative public financing options on tax and economic growth relationship in selected SSA countries. Consequently, the study specifically examines the following:

(i) The effect of public debt on the tax and economic growth nexus in selected SSA countries.

(ii) The effect of natural resource rents on the tax and economic growth nexus in selected SSA countries.

(iii) The effect of seigniorage on the tax and economic growth nexus in selected SSA countries.

1.4.The Justification for the Research

Extant studies have contributed to the literature on the relationship between tax and economic growth. From a theoretical perspective, Barro (1990) developed an endogenous growth model with public capital through taxation. The study indicates the existence of nonlinear relationship between taxes and economic growth. This suggests that there is an optimal tax level that maximises economic growth. More so, higher taxes generate more revenues to the government for public investment reflecting the increasing side of GLC, thus it is growth-enhancing. On the flip side, the consequence of these higher taxes is the large distortion on the part of private capital accumulation which reflects the decreasing side of GLC (growth-reducing). Thus, this implies that as

the tax rate goes above a threshold value, a further increase in tax leads to a fall in the economic growth trajectory. However, the model is built on the assumption that government only finances its investment with tax revenue suggesting the non-existence of other financing sources.

Furthermore, other theoretical studies such as Devereux and Love (1994), Deverajan, Swaroop and Zhou (1996), Bajo-Rubio (2000) and others, have also examined the role of public capital in different growth models either through taxation or public spending. Their conclusions indicate that there is a level of taxation or government spending that maximises economic growth. However, these studies do not capture how other public financing options influence the growth-maximising tax rate. More so, recent findings from some of the foremost studies such as Arnold et al. (2011); Misch et al. (2013); Ormaechea and Morozumi (2013); Afonso and Jalles (2014); Gemmell et al. (2014); Oyinlola et al. (2020a); Oyinlola and Adedeji (2022) among others, remain mixed on the nature of the relationship between tax and growth. Thus, a recent study by Ehrhart et al. (2014) captures the influence of two key public financing options (seigniorage and public debt) on the relationship between tax and economic growth rate in the developing region. Their theoretical proposition shows that the optimal tax that ensures long-run economic growth is different from Barro (1990) and others due to the influence of other public financing options. This shows a clear deviation from Barro's proposition.

Specifically, the level of debt and seigniorage determines how much revenue government raised from tax to finance its economic growth. Most developing countries are faced with the challenges of optimising different public financing options to maximise economic growth. More importantly, SSA countries are also experiencing similar challenges given the long history of unstable economic growth and low tax mobilisation coupled with the effects of other public financing methods. Specifically, three SSA countries are considered in this study due to the following reasons. The unstable economic growth experienced in these countries has worsened socio-economic outcomes[9] such as poverty, inequality, human capital development. More so, these

[9] According to National Bureau of Statistics (2022), more than half of the Nigeria's population (63%) are multidimensionally poor due to deprivation from clean energy, quality health care, education, food security and housing. Also, over 30% of the population are poor due to low income. South Africa also faced one of the highest inequalities in the world. The poverty rate of the country in the category of upper-

countries have varying level of taxes, public debt, seigniorage and total natural resources. While Nigeria has low tax-to-GDP ratio with moderate total natural resource rents, South Africa has high tax-to-GDP ratio with low total natural resource rents. More so, Republic of Congo has low tax-to-GDP with high total natural resource rents. In the case of debt, South Africa and Nigeria maintain low and moderate public debts, respectively, while Republic of Congo maintain high debt. These varying characteristics provide based for chosen these countries.

Following the Ehrhart et al. (2014) argument, this study contributes to the existing literature in three ways. First, the study analytically demonstrates the effects of APFOs on tax and economic growth nexus. This was done by augmenting the extended endogenous growth model by Ehrhart et al. (2014) with total natural resource rents. In essence, the unbalanced budget constraint is further extended to include revenue from natural resources which the government relied on to finance its public investment to enhance economic growth. This important public financing option is not captured in Ehrhart et al.'s model. In particular, this revenue source played a crucial role in influencing the growth pattern and tax mobilisation capacity of SSA countries (International Monetary Fund, 2007a; and Ndikumana and Abderrahim, 2010). Furthermore, the augmented theoretical model is simulated to determine the effects of these APFOs (public debt, seigniorage, and total natural resource rents) on the tax and growth relationship. As established earlier, the selected SSA countries (South Africa, Nigeria and Republic of Congo) relied on these APFOs to fund their public spending. Thus, the theoretical propositions of Ehrhart et al. (2014) are taken into consideration in the augmented theoretical model. By this, the study accounts for the effects of APFOs on tax and economic growth nexus in these SSA countries.

Second, this study also empirically tests the inferences from the augmented theoretical model for the three selected SSA countries. By implication, the study determines the extent to which the APFOs influence the relationship between tax and economic growth. It is equally important to note that our empirical test is additionally considered under total taxes and disaggregated taxes (such as direct and indirect taxes). This is due to the

middle-income stood at 62.6% in 2022 (World Bank, 2022). In the case of Congo, more than 40% of the population are living below poverty while 24.3% of the population are multidimensional poor (Oxford Poverty and Human Development Initiative/United Nations Development Programme, 2022).

peculiar nature of taxes in the SSA region. This distinguishes our study from earlier studies that rely on total government revenue to measure total taxes for developing countries. It is very important to explore disaggregated forms to further deepen the understanding and avoid overgeneralisation of the effects of the APFOs on taxes-growth relationship. Moreover, how these APFOs the disaggregated taxes-growth relationship provides a clearer picture for evidence-based policy direction in the context of these countries.

Several studies (Kneller et al., 1999; Bleaney et al. 2001; Myles, 2009; Gemmell, 2011, Afonso and Jalles, 2014; Gemmell et al., 2011, 2014 among others) on tax-growth nexus have been conducted on European Monetary Union, Organisation for Economic Co-operation and Development (OECD) countries, developed region, and SSA region (Bruckner, 2012; Jalles, 2017; Oyinlola et al., 2020, Oyinlola and Adedeji, 2022). However, the existing studies on SSA have not provided any empirical evidence on the role of APFOs in the tax and growth relationship. Thus, it is pertinent to provide robust and convincing empirical evidence in this regard and also determine the optimal tax and economic growth at different APFOs for policy purposes.

Lastly, the estimation of growth models from cross-sectional and panel approaches generates contradicting empirical results[10]. This arises from improper treatment of country-specific effects and reverse causality which may lead to bias estimation. Notably, most studies on tax and growth follow a panel approach with the use of recent econometric approaches to address some of the problems. Given the importance and policy relevance of this study, it is more informative and adequate to explore country-specific analysis. Relying on panel analysis for policy prescription may be misleading as these countries have their inherent differences[11] in terms of fiscal structure and resource endowment. Hence, the country-specific analysis is explored in this study. More so, the endogeneity issue is common with APFOs. Thus, this study employed one methodological approach to address the concerns highlighted above. This allows for

[10] See Caselli et al. (1996), Temple (1999), Gemmell (2001), and Gemmell et al. (2013).
[11] Previous studies assumed homogeneity and no cross-sectional dependence across the countries which in reality is not so. This is because these countries are characterized by different tax system and by assuming homogeneity through panel approach may be misleading in terms outcomes and policy implications.

testing the validity of the augmented theoretical model. This approach is Two-stages Least Squares (TSLS).

Furthermore, this technique eliminates any potential problems of reverse causality, simultaneity issues, autocorrelation, and endogeneity that are associated with the growth model. Exploring this approach provides robust estimates. More specifically, the inferences from this study should be of primary interest to these SSA countries given its relevance to their fiscal space which shows how a given amount of government spending may be optimally funded through different public financing sources for optimal economic growth. Additionally, net effects of taxes under different financing options are computed to ascertain the overall effect of taxes on economic growth. This study also computes the minimum threshold of values of taxes under the financing options to determine the minimum tax required to achieve positive economic growth in these countries. This computation is very important to policy formulation (Asongu and Odhiambo, 2020; Boateng, Asongu, Akamavi, and Tchamyou, 2018; Batuo, 2015).

1.5.The Scope of the Study

The study covers 27 years spanning between 1990 and 2016 for three SSA countries. The choice of the period is informed by the availability of data across these countries. The research specifically focuses on three countries drawn from our sample of three SSA countries. These countries have highly unstable economic growth patterns with different tax-to-GDP ratios. Therefore, three countries were selected from the categories with their corresponding GDP growth and GDP per capita. These countries include Nigeria, South Africa, and the Republic of Congo. Particularly, the study examines the role of public debt, seigniorage, and total natural resource rents on the nature of the relationship between tax and economic growth. In addition, aggregate tax revenue as a percentage of GDP, as well as the two disaggregated categories of taxes (direct taxes, and indirect taxes) were utilised. Total natural resource rents are captured in line with the World Bank measurement, thus total natural resource rents are used to measure earnings from natural resources. In the World Bank measurement, natural resources are categorised into five groups: oil, natural gas, coal (hard and soft), forest, and mineral. The aggregation of these groupings yields total natural resource rents, which is measured in proportion to GDP. Also, some studies used the monetary change in base or base money

(Fielding and Mizen, 2001; Buiter, 2007; Aisen and Veiga, 2008; Blackburn et al., 2008; and Ehrhart et al., 2014). Also, Click (2000) used a change in M1 to GDP. In the case of this study, we computed seigniorage using a change in base money in percentage of GDP. The data for base money is sourced from the country's Central Bank. However, change in money supply in percentage of GDP was used for the Republic of Congo due to data unavailability as explored by Chalmley (1991). Also, public debt is captured as the gross general government debt expressed as a percentage of GDP (International Monetary Fund, 2018).

1.6.Plan of the Study

This study is structured into five chapters. Following the introduction in chapter one, is chapter two which focuses on the elaborate analysis of APFOs, taxes and economic growth in the selected countries. Also, relevant issues around tax policies in these countries are examined. It also examines theoretical issues and reviews empirical literature. Chapter three focuses on methodology which captures the theoretical underpinnings, model specification, estimation and estimation procedure. Chapter four focuses on the presentation of empirical results and discussion of findings. Lastly, chapter five provides a summary, conclusion, and recommendation.

CHAPTER TWO

LITERATURE REVIEW

2.0.Overview

The chapter provides an in-depth discussion of the behaviours of key variables used in the study. Specifically, trend and descriptive analysis are employed to explicate the behaviour of economic growth, taxes, public debt, natural resource rent, and seigniorage in sub-Saharan Africa. Specifically, the analysis is structured into four categories namely: global, regional, and country-specific. It also captures the policies/initiatives that influence taxes, external debt, natural resource rent, and seigniorage in these countries. Additionally, there have been strong debates in the literature over the years on the important role of fiscal policy (tax) in the growth process. This has led to the development of several models under different growth theories. Also, the findings from the theoretical and empirical models on this relationship have been intriguing. Thus, subsequent sections explore relevant and related studies on fiscal policy and economic growth linkages thus dividing it into four parts. The first part hinges on theoretical literature which reviews relevant theories with models (fiscal policy and growth). The second part reviews the strengths and weaknesses of different methodologies on fiscal policy and growth. The third part examines relevant empirical studies on the relationship between tax and economic growth. The final part discusses the gap in the literature from theoretical, empirical and methodological perspectives which the study seeks to address.

2.1.Background

2.1.1. Trend Analysis of Output Growth

Comparative Analysis of Output Growth across the regions

One of the macroeconomic objectives of any region in the world is to achieve a high, stable, and sustainable output growth rate over time. Moreover, GDP and its per capita remain crucial metrics to evaluate the economic performance and standard of living of

any region or country. Thus, regions[12] strive diligently to maintain strong and sustainable growth. To ascertain the growth performance of these regions, we focus on GDP per capita[13] as a suitable metric. Quality growth is expected to yield a high GDP per capita. Therefore, Figure 2.1 presents the proportion of GDP per capita across the regions. This figure reveals that Northern America, and Europe, and Central Asia accounted for the highest global share of GDP per capita, 44% and 20%, respectively. On the other hand, the SSA region accounted for 1%, which is the lowest among the regions. According to Picker (2019), SSA has recorded a significant decline in its GDP per capita relative to 1974 with over 11% reduction.

The low share of SSA in the global distribution of GDP per capita reflects a high level of poverty and inequality in the region as well as low standard of living. Picker (2019) further explains that the lowest GDP per capita translates to the observed poverty challenges in the region. For example, one in ten poor citizens in the world lived in Africa in 1974 which increased to one in two in 2000. Many factors can be attributed to the low share which includes low investment rate, poor human capital development, huge infrastructure gap, conflicts, public sector inefficiency, resource paucity, low institutional quality, policy distortions, and high unemployment rate, among others.

[12] As classified by World Bank (see World Development Indicators, 2018), namely: such as Arab world, Europe and Central Asia, North America, Central Europe, and the Baltics, Latin America and Caribbean, East Asia and Pacific, sub-Saharan Africa and the Middle East and North Africa.
[13] Measures a country's economic output share per individual and gives idea about income distribution among the population of any country or region.

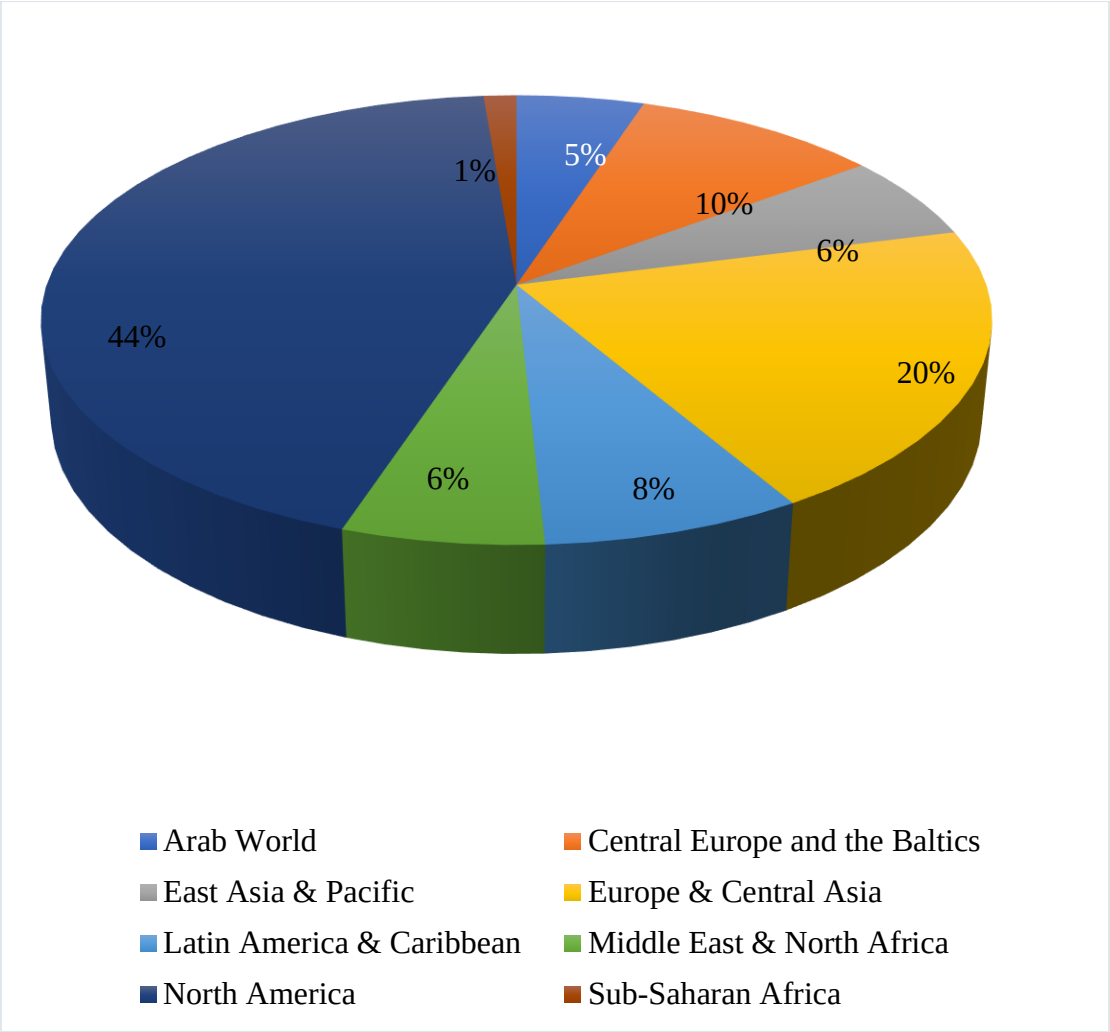


Figure 2.1: Global Distribution of GDP per capita, Constant 2010 US$, (1990-2016)
Source: Constructed from World Development Indicators, 2018

Table 2.1 presents the GDP per capita across global regions from 1990 to 2016. The table shows that SSA recorded the lowest GDP per capita over the period. Developed regions such as North America, and Europe, and Central Asia, have GDP per capita that are at least 31 and 15 times of SSA, respectively. Further comparison with developing regions such as Latin America and Caribbean, Middle East and North Africa, and Arab World shows that their GDP per capita is at least 4 times of SSA. More so, GDP per capita and growth rate of SSA is abysmal relative to both developed and other developing regions; thus, reiterating Artadi and Sala-i-Martin (2003) submission that Africa and the sub-Saharan subset are not catching up despite starting from a relatively backward position.

Table 2.1: GDP per capita (US$) by regions (1990-2016)

Region	1990-1994	1995-1999	2000-2004	2005-2009	2010	2011	2012	2013	2014	2015	2016
Sub-Saharan Africa	1,178	1,157	1,217	1,454	1,552	1,576	1,591	1,622	1,652	1,656	1,632
Arab World	4,306	4,545	4,880	5,673	5,916	5,987	6,154	6,238	6,282	6,366	6,440
Central Europe and the Baltics	6,644	7,678	9,251	11,869	12,557	12,996	13,100	13,302	13,721	14,251	14,701
East Asia & Pacific	4,406	5,028	5,647	6,854	7,678	7,979	8,294	8,630	8,924	9,228	9,543
Europe & Central Asia	17,405	18,466	21,000	23,390	23,515	24,001	23,963	24,047	24,356	24,692	24,995
Latin America & Caribbean	6,646	7,161	7,397	8,416	8,943	9,227	9,378	9,531	9,551	9,435	9,275
Middle East & North Africa	4,979	5,297	5,762	6,720	7,076	7,197	7,259	7,315	7,402	7,455	7,563
North America	36,689	40,903	45,788	48,932	48,290	48,758	49,426	49,920	50,716	51,566	52,003
World	7,183	7,660	8,353	9,254	9,509	9,695	9,813	9,948	10,108	10,263	10,391

Source: Constructed from World Development Indicators, 2018

In Figure 2.2, the GDP per capita growth rate of the SSA region over the years is presented. The growth rate significantly declined from -0.4% in 1990 to -3.4% in 1993. The growth rate sharply rose to 2.4% in 1996 but drastically decreased to -0.5% in 1999. Unexpectedly, the growth rate increased astronomically to 3.8% in 2004. The reason for this sharp rise can be ascribed to improved macroeconomic policies, a substantial decline in debt, high commodity prices, expansion of mineral resource exploitation, and increased foreign aid (World Bank, 2013). However, the growth rate was short-lived. It declined precipitously to 0.3% in 2009. The growth rate continued to oscillate until the end of 2016 when it declined to -1.4%. This observable pattern is particularly bothersome as the region could not sustain a high and stable growth rate. In the first instance, this growth rate was not built on a solid foundation as its drivers are largely external related. These drivers are subjected to international shocks that are not healthy for the region's economy in urgent need of high and sustainable growth.

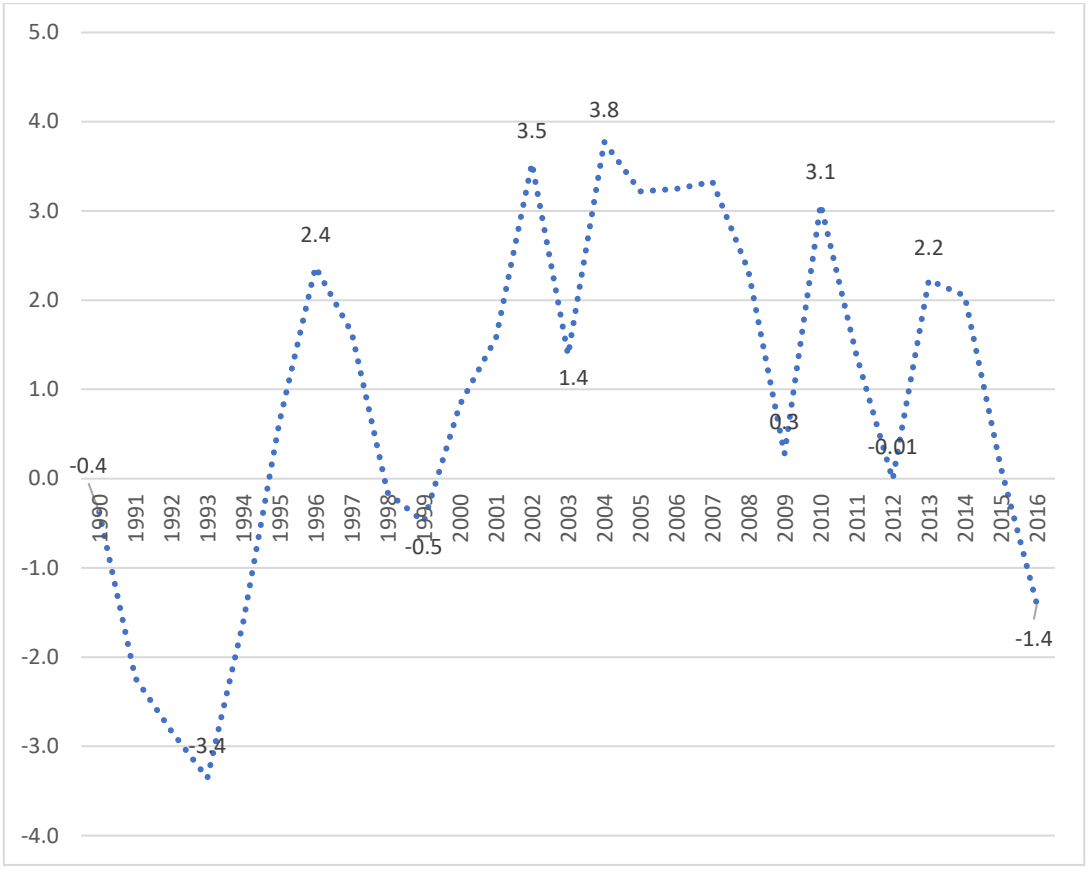


Figure 2.2: GDP per capita growth rate in SSA (1990-2016)
Source: Constructed from World Development Indicators, 2018

Comparative Analysis of Output Growth in three selected countries

Three countries were selected from the SSA region based on their chequered GDP growth and GDP per capita growth (see Appendix I). specifically, these countries are South Africa, Nigeria and Republic of Congo. Carrying out a country-specific analysis, Figures 2.3 and 2.4 present the comparative analysis of GDP per capita and its growth among the three countries. Nigeria is one of the largest economies in SSA but with relatively low GDP per capita. Available information from the graph shows that the country's GDP per capita rose from an average value of US$428 in the period 1990-1994 to US$1,788 in the period 2005-2009. Also, the yearly analysis reveals that the GDP per capita declines from US$2,291 in 2010 to US$2,176 in 2016. Despite the upward trajectory of the GDP per capita in most of the years, the value remains relatively low for an economy with huge human resources and resource endowment.

Over the years, many policies/initiatives/programmes have been introduced to put the economy at a high pace. However, these efforts were undermined by policy failure/inconsistency, poor governance, and over-reliance on commodity prices. Additionally, different episodes of economic growth are associated with volatility in the international market which continues to jeopardise the growth's objective over the years. A classical example is economic recession in 2016 mainly caused by a drastic crash in international oil prices. The challenges in the economy were worsened by huge depreciation of Naira against the US Dollar, high inflation, and low productivity. Among the three countries, Nigeria disturbingly recorded the lowest value of GDP per capita with an unstable pattern.

Despite an average GDP per capita growth of 2.2%, the country remains poorest among the three countries in terms of average GDP per capita. Comparing its performance with SSA and the world average over the period, the graph further reveals that its average GDP per capita is above SSA average but particularly worrisome relative to the world average. This finding reflects the enormous developmental problems facing the country. Since the economy depends heavily on commodity prices, the objective of high, stable, and sustainable growth remains challenging. A broad-based growth requires reallocation of resources and labour to a productive sector which will foster efficiency (Oyejide, 2018). This translates to an overall increase in productivity and a stable long-run growth

rate. However, this expectation is fundamentally absent in the case of Nigeria, thus, reflecting a high unemployment rate, high inequality, high poverty rate, and failure to achieve most objectives of SDGs.

Similarly, the Republic of Congo is a highly resource-rich country relative to many SSA countries. The pace and pattern of the growth were neither significantly high nor stable over the period. For instance, the country recorded a significant decrease in its GDP per capita from US$2,622 in the period 1990-1994 to US$2,523 in the period 2005-2009. In addition, the yearly finding shows that the GDP per capita increases from US$2,737 in 2010 to US$2,926 in 2015 but later drops to US$2,798 in 2016. The country still performs better relative to Nigeria (with a high GDP per capita growth rate). However, its average GDP per capita is disturbingly unattractive relative to the world average. Though, this country enjoys a very low inflation rate with a high fiscal surplus. As a resource-rich country, the economy fundamentally relies on resource rents to finance government spending. This path cannot guarantee broad-based growth. Moreover, the country is facing a tenacious poverty rate, high income inequality, and poor human capital development. More so, the precarious effect of commodity price shocks continues to disrupt the fiscal strength and growth pattern of the country.

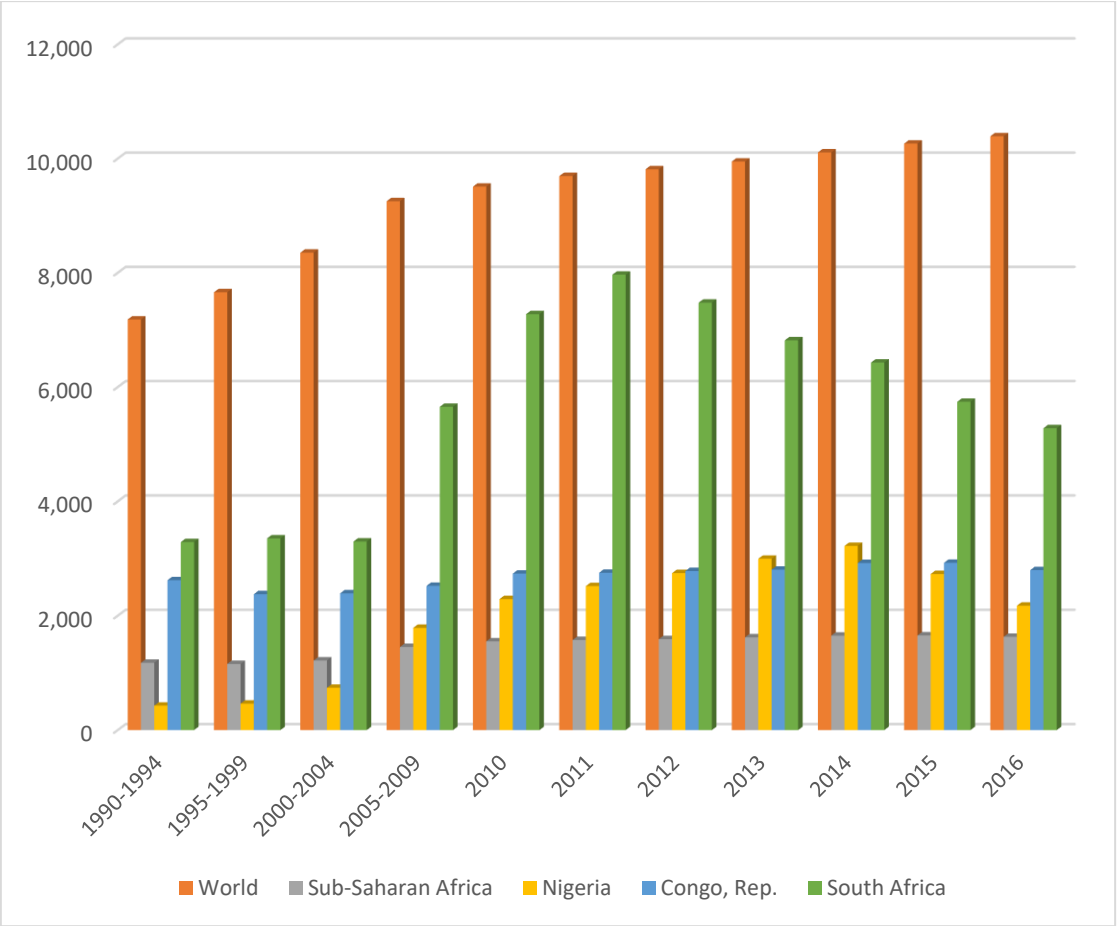
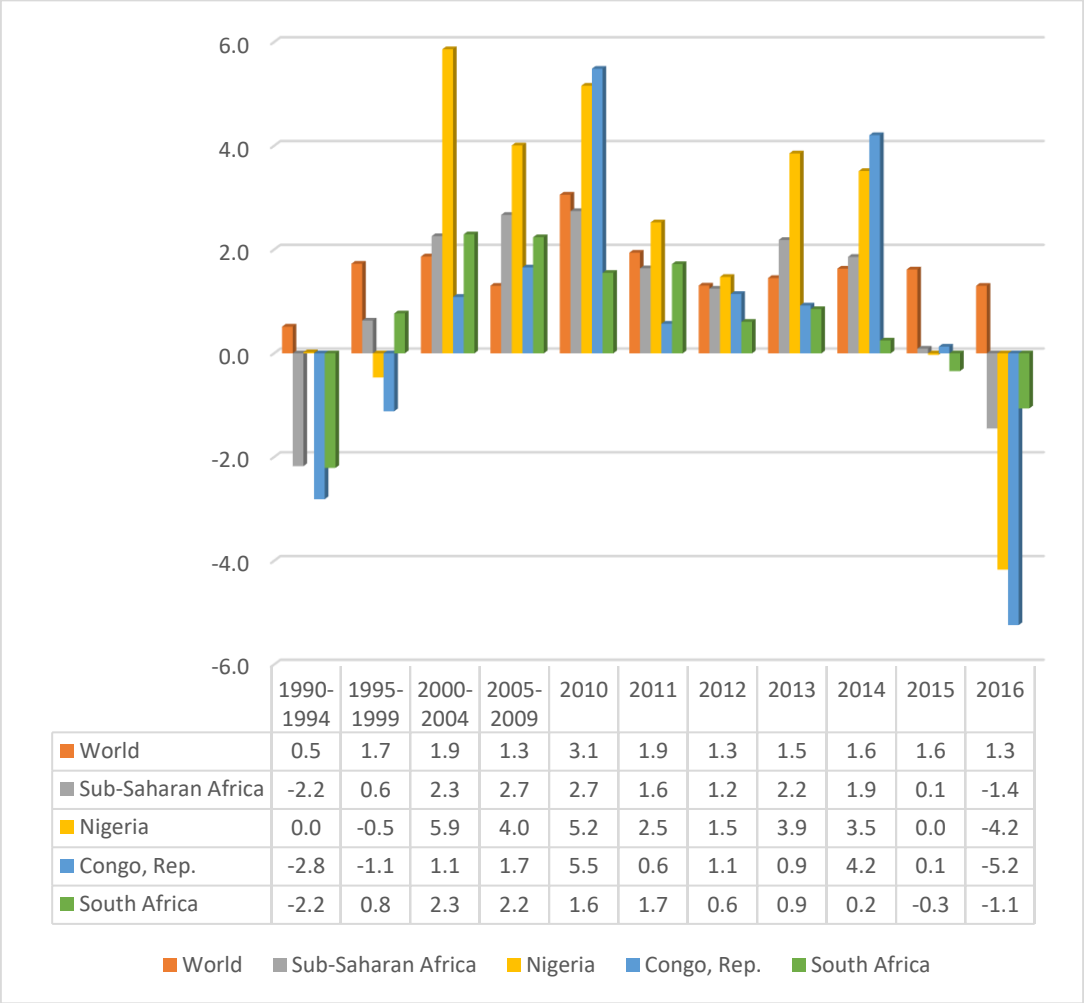


Figure 2.3: Comparative analysis of GDP per capita (1990-2016)
Constructed from World Development Indicators, 2018

Given the economic importance of South Africa in the SSA region, it is ranked among the top country with higher GDP per capita compared to Nigeria and the Republic of Congo. Between 1990 and 2016, its GDP per capita increased from an average of US$3,289 in 1990-1994 to an average of US$5,655 in 2005-2009. However, its yearly performance between 2010 and 2016 reveals that GDP per capita declined sharply from US$7,276 in 2010 to US$5,280 in 2016. It can be observed that its GDP per capita is higher than the SSA average but remain below the world average. Moreover, it continues to follow an unstable path over the period under consideration. More so, the output growth has continued to be sluggish. Over the years, South Africa has been initiating different reforms such as maintenance of stable exchange and inflation rates, debt sustainability, domestic revenue mobilization, and infrastructure expansion, to maintain a stable economy. Despite various efforts directed towards stable economic growth, there are still many challenges that make the country susceptible to shocks. These challenges include low private investment, weak integration into a global value chain, dependency on commodity price changes, and high inequality and poverty level. These issues continue to stifle the inherent potential in the economy.

The below description clearly shows the poor economic performance in these key countries which require proactive efforts. It would be expected that countries with enormous challenges will show a promising outcome in rigorously pursuing quality growth, but the case is hapless in these countries. These countries' growth scenario is captured in the statement of Artadi and Sala-i-Martin (2003, pp. 1) that "*the newly free citizens had high hopes when their countries became independent during the second half of the century, but most of them are substantially poorer now than they were when their nations were born*"



	1990-1994	1995-1999	2000-2004	2005-2009	2010	2011	2012	2013	2014	2015	2016
World	0.5	1.7	1.9	1.3	3.1	1.9	1.3	1.5	1.6	1.6	1.3
Sub-Saharan Africa	-2.2	0.6	2.3	2.7	2.7	1.6	1.2	2.2	1.9	0.1	-1.4
Nigeria	0.0	-0.5	5.9	4.0	5.2	2.5	1.5	3.9	3.5	0.0	-4.2
Congo, Rep.	-2.8	-1.1	1.1	1.7	5.5	0.6	1.1	0.9	4.2	0.1	-5.2
South Africa	-2.2	0.8	2.3	2.2	1.6	1.7	0.6	0.9	0.2	-0.3	-1.1

Figure 2.4: Comparative analysis of GDP per capita growth (1990-2016)
Source: Constructed from World Development Indicators, 2018

2.1.2. Analysis of Tax Performance

Comparative Analysis of Tax Performance across the regions

Sub-Saharan African countries are at a critical point in achieving their optimal development as the objective of sustainable and stable growth is being threatened by intermittent external shocks. These shocks are mostly revenue-related such as volatile commodity prices, market inaccessibility, debt challenges, and political instability. Thus, this raises the question on the efforts towards tax mobilisation. Taxation is a key policy issue facing developing regions such as sub-Saharan Africa. Starting with the global distribution of total tax as a percentage of GDP in Figure 2.5, Europe & Central Asia, and Central Europe & the Baltics have a high tax-to-GDP ratio. More so, sub-Saharan Africa is the third by ranking with about 18%. There is a relative improvement in the tax performance which may be attributed to different tax reforms initiated by many countries in the region. However, the ratio falls short of the desired level and remains below the ratios of Europe and Central Asia and Central Europe & the Baltics regions. Given the huge resource paucity and enormous developmental challenges facing the region, there is a need to do more in the area of tax revenue mobilisation by solidifying the tax capacity and promoting good governance (reducing corruption and promoting accountability) in the revenue collection framework.

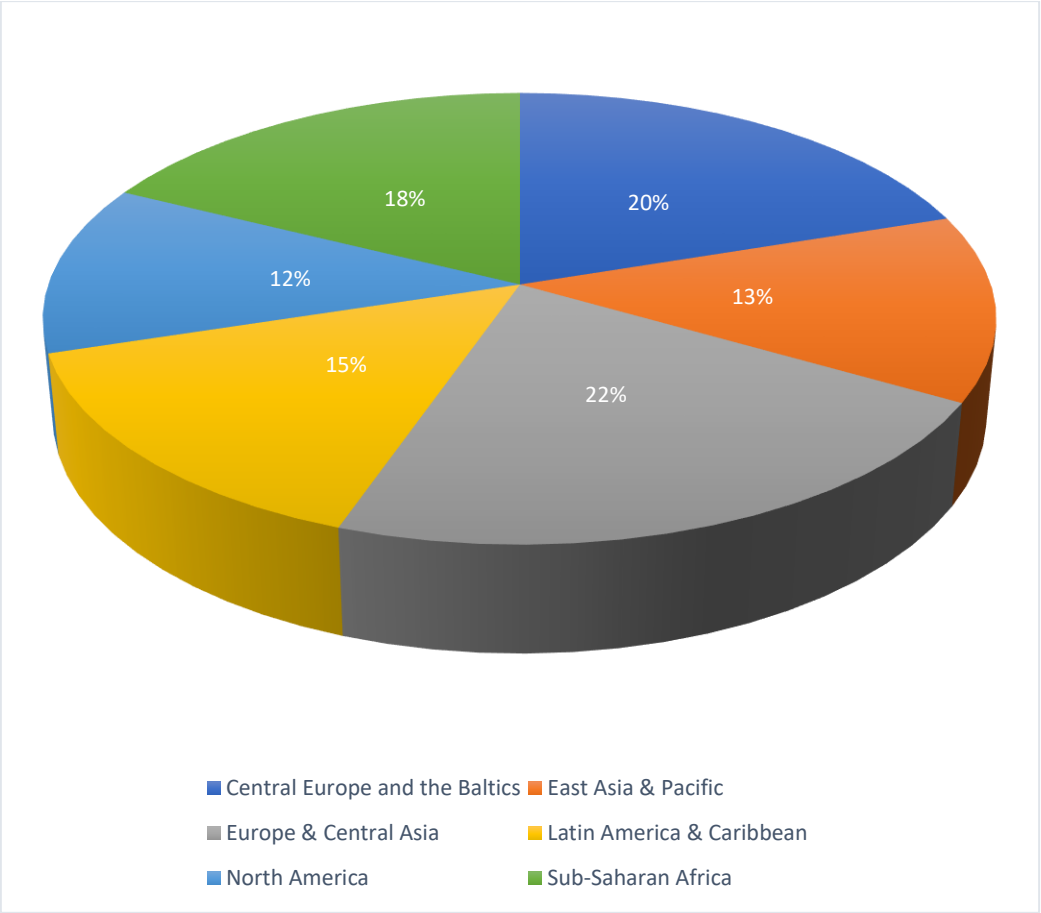


Figure 2.5: Global distribution of total tax as a percentage of GDP (2000-2016)
Source: Constructed from World Development Indicators, 2018

Furthermore, Table 2.2 presents tax performance across the regions in the world between 2000 and 2016. Central Europe recorded a marginal increase in its tax-to-GDP ratio from 17.5% in the period 2000-2004 to 17.6% in the period 2005-2009. Similarly, Europe & Central Asia, and North America recorded a marginal increase in the tax ratio while it was constant for East Asia & Pacific between the periods. On the other hand, Latin America & Caribbean, and sub-Saharan Africa recorded relatively high tax ratio changes between the periods. The yearly analysis shows that the SSA tax ratio has been oscillating above 15% but relatively low when compared with an average of 16.2% in the period 2005-2009. Besides, the tax ratio has been below the value of Europe & Central Asia and Central Europe & the Baltics over the years. Though, the region has recorded above world average throughout the periods except in period 2000-2004.

Undoubtedly, the SSA region has introduced both administrative and legislative reforms in the 1990s and 2000s to improve tax revenue collection (Fossat and Bua, 2013). Some of these reforms include the introduction of electronic filing systems, the initiation of programmes improvement in taxpayer services, and the introduction of value-added tax in many countries (Organisation for Economic Co-operation and Development/African Tax Administration Forum/African Union Commission, 2017). The progress in the tax system can also be attributed to the improvement in the activities of quasi-autonomous revenue mobilisation agencies in many countries in the region (Ebeke et al., 2016). However, there is still a need for improvement in domestic resource mobilisation. This is a prerequisite for sustainable, high, and stable growth given the uncertainty in the commodity market.

Table 2.2: Total Tax as percentage of GDP by regions (2000-2016)

Region	2000-2004	2005-2009	2010	2011	2012	2013	2014	2015	2016
Central Europe and the Baltics	17.5	17.6	17.0	17.1	17.2	17.1	17.1	17.4	17.4
East Asia & Pacific	11.6	11.6	11.2	11.5	11.7	11.8	12.0	11.9	11.7
Europe & Central Asia	19.2	19.4	18.9	19.1	19.2	19.4	19.4	19.2	19.1
Latin America & Caribbean	12.2	13.4	12.9	13.4	13.1	13.0	12.9	13.4	13.3
North America	11.0	10.5	8.9	9.8	10.0	10.7	11.1	11.4	11.1
Sub-Saharan Africa	14.6	16.2	15.1	15.3	15.6	15.6	15.4	15.4	15.5
World	14.9	14.4	13.6	14.0	14.0	14.3	14.5	14.5	14.4

Source: Constructed from World Development Indicators, 2018

In Figure 2.6, the trend analysis of the tax ratio in SSA is presented to shed light more on the tax performance in the region. It has made some improvement in mobilising tax revenues over the past one and half decades. As depicted in the figure, the total tax ratio declines from 14.7% in 2000 to 13.8% in 2003. However, there is improvement between 2003 and 2008 as it rose from 13.8% to its peak of 17.2%. The increment can be traced to the improvement in the tax system through tax effort and collection processes in some countries in the region. However, the tax ratio declined by about 1.7% after the peak recorded between 2009 and 2016. Some of the factors responsible for the decline are high tax exemption, low coverage of income taxes, and inability to fully harness new technologies.

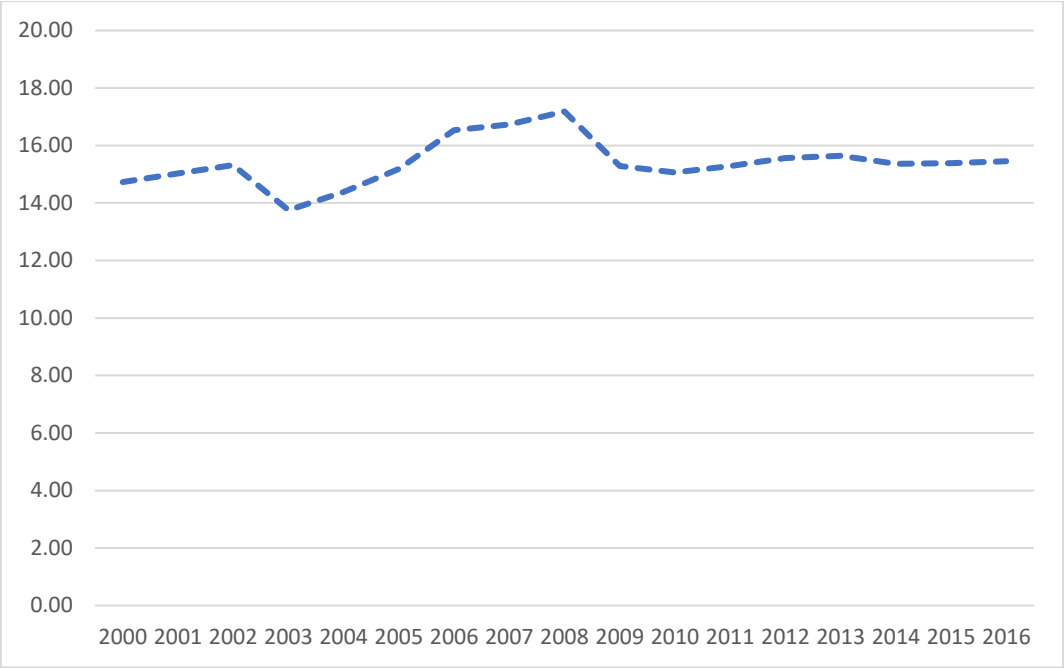


Figure 2.6: Total Tax as a percentage of GDP, in sub-Saharan Africa (2000-2016)
Source: Constructed from World Development Indicators, 2018

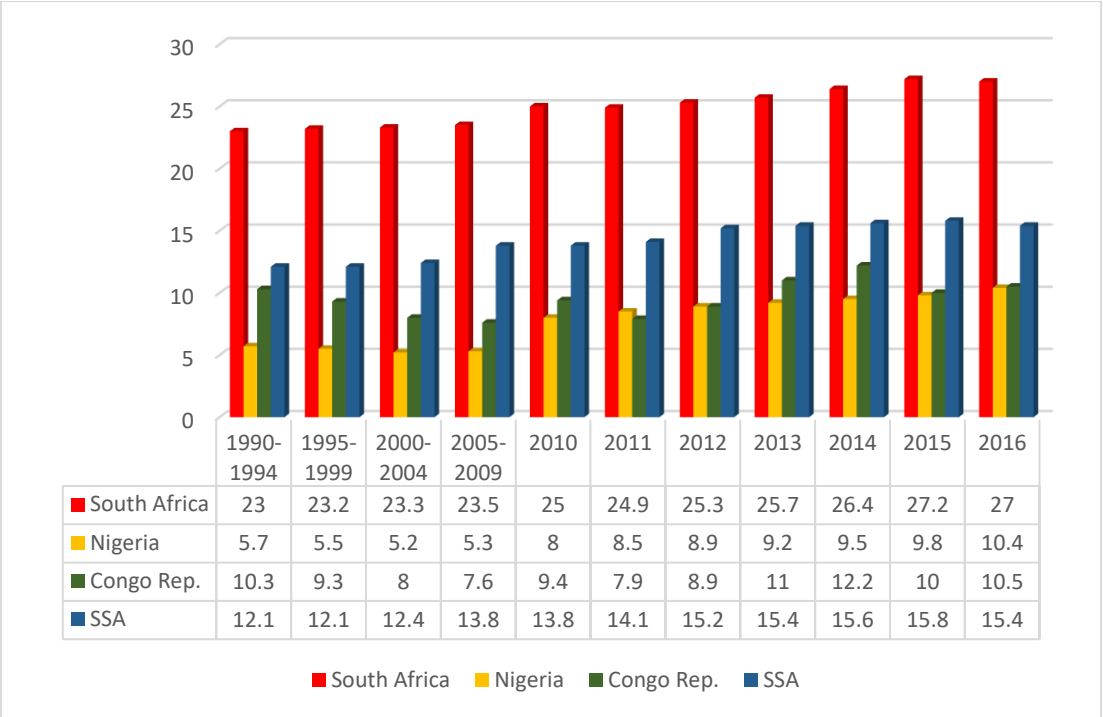
Comparative Analysis of Tax Performance in three selected countries

To further examine the issues around tax revenue mobilisation in the region, we proceed to analyse aggregated and disaggregated taxes in Nigeria, South Africa, and the Republic of Congo (as presented in Figures 2.7-2.9). This prevents over-generalisation of the performance of taxes in the selected countries. Figure 2.7 presents an interesting story about tax performance by unravelling the real nature of domestic mobilisation across the countries. Specifically, South Africa is ranked as the best performer with the largest total tax ratio relative to other countries under consideration. Within the periods, the total tax ratio marginally increased from 23% in the period 1990-1994 to 23.5% in period 2005-2009. Likewise, the yearly analysis reveals that the total tax ratio rose from 25% in 2010 to 27% in 2016. This shows some progress in tax mobilisation.

Historically, from the apartheid period to the democratic period in the early 1990s, the country relied on the tax structure designed by the colonial master which was based on five distinct tax structures with homelands incorporated. In the early 1990s, Hut Tax and other African taxes were abrogated under Public Amenities Repeal Act (Act No. 100, 1990). The advent of democracy brought major changes to the tax system of the country. This was motivated by important tax reforms. Lieberman (2003) explained that the democratic transition in the early 1990s allows redesigning of various policies in the tax administration of the country. More so, the challenges of huge government spending, dwindling revenues, and disinvestment necessitate urgent tax reforms in the country's history.

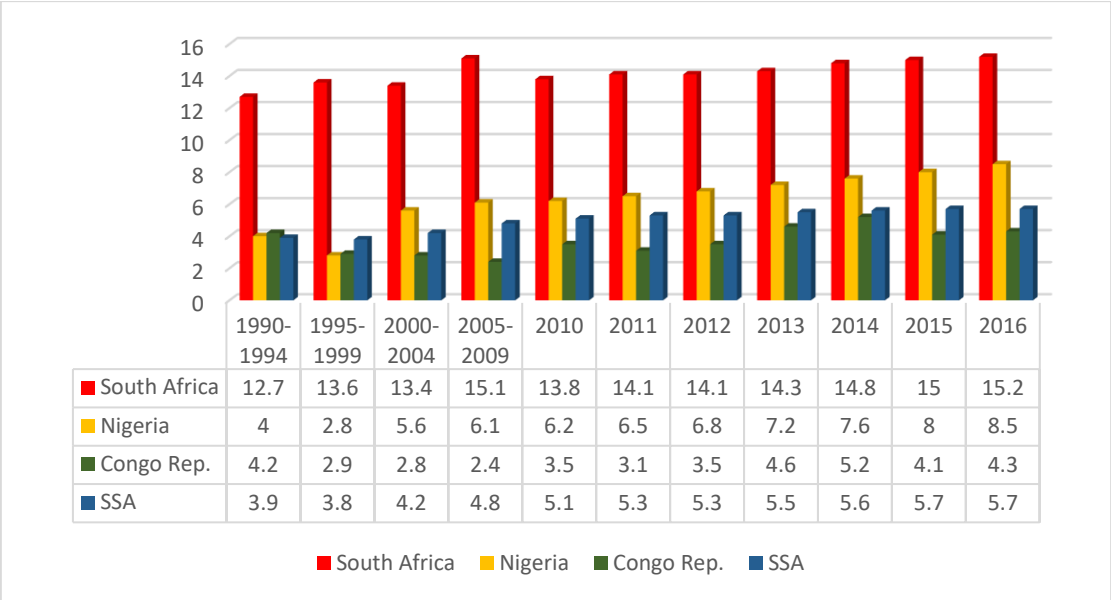
In addition, the Margo commission came up with several recommendations on tax reforms in South Africa. Their recommendations include initiation of Value Added Tax (VAT), reduction of company tax rate, initiation of secondary tax on companies, systematic removal of tax-deductible spending and special benefits, reduction of distortion to foster economic efficiency through tax base expansion, minimisation of tax avoidance and evasion and refocusing the Personal Income Tax towards individual charges rather than couple charges (see Black, Calitz and Steenekamp, 2005). Most of these recommendations were implemented by the government in the 1990s. Notably, the government faced a lot of challenges when introducing VAT in the country with strong resistance from labour unions.

Another commission known as Katz Commission was set up to design a framework that can enhance tax administration and collection and promote efficiency and equity in the different taxes. More importantly, the commission was saddled with the responsibility of re-engineering the South African tax system towards acceptable international standards and practice. This commission recommended a significant change of the entire tax system, creating awareness for people on the importance of tax payment, departmental coordination in policy design, benefits of tax collected should be equally distributed, widening the tax base and re-designing the Income Tax Act, and critical reforms in Inland Revenue and Customs and Excise. These reforms led to the introduction of the South African Revenue Service Act (1997) for an efficient and effective tax commission called the South African Revenue Service (replacing existing Inland Revenue and Customs and Excise).



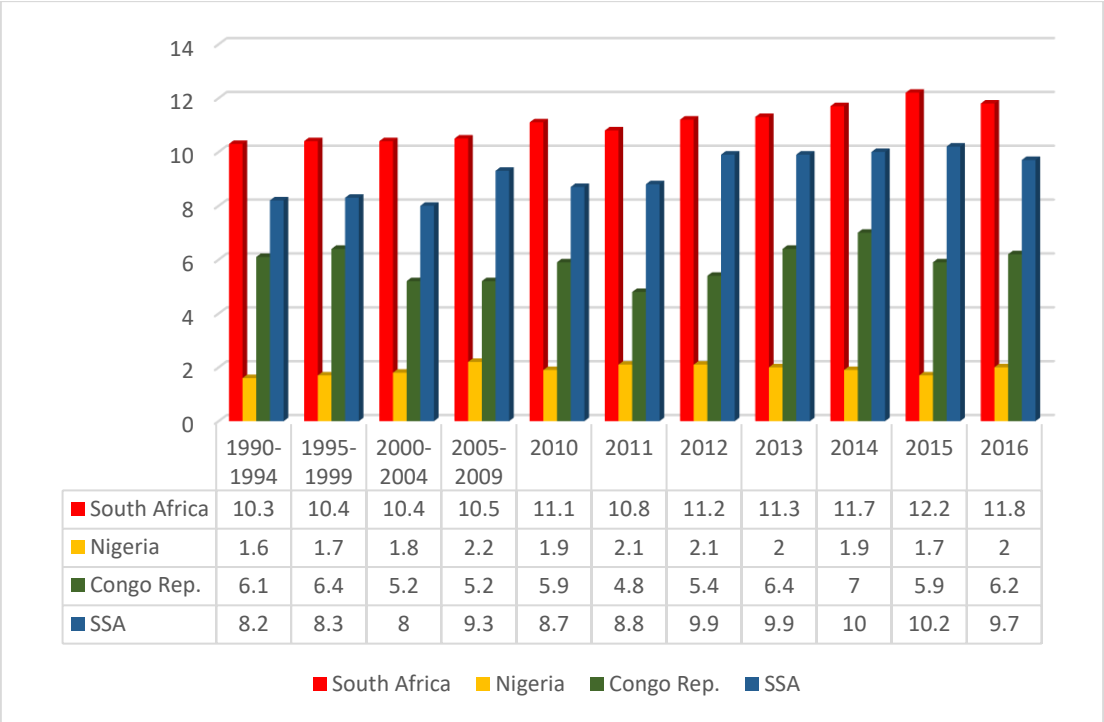
	1990-1994	1995-1999	2000-2004	2005-2009	2010	2011	2012	2013	2014	2015	2016
South Africa	23	23.2	23.3	23.5	25	24.9	25.3	25.7	26.4	27.2	27
Nigeria	5.7	5.5	5.2	5.3	8	8.5	8.9	9.2	9.5	9.8	10.4
Congo Rep.	10.3	9.3	8	7.6	9.4	7.9	8.9	11	12.2	10	10.5
SSA	12.1	12.1	12.4	13.8	13.8	14.1	15.2	15.4	15.6	15.8	15.4

Figure 2.7: Total tax as a percentage of GDP across the selected countries (1990-2016)
Source: Computed from International Centre for Tax and Development, 2018



	1990-1994	1995-1999	2000-2004	2005-2009	2010	2011	2012	2013	2014	2015	2016
South Africa	12.7	13.6	13.4	15.1	13.8	14.1	14.1	14.3	14.8	15	15.2
Nigeria	4	2.8	5.6	6.1	6.2	6.5	6.8	7.2	7.6	8	8.5
Congo Rep.	4.2	2.9	2.8	2.4	3.5	3.1	3.5	4.6	5.2	4.1	4.3
SSA	3.9	3.8	4.2	4.8	5.1	5.3	5.3	5.5	5.6	5.7	5.7

Figure 2.8: Direct tax as a percentage of GDP by country (1990-2016)
Source: Computed from International Centre for Tax and Development, 2018



	1990-1994	1995-1999	2000-2004	2005-2009	2010	2011	2012	2013	2014	2015	2016
South Africa	10.3	10.4	10.4	10.5	11.1	10.8	11.2	11.3	11.7	12.2	11.8
Nigeria	1.6	1.7	1.8	2.2	1.9	2.1	2.1	2	1.9	1.7	2
Congo Rep.	6.1	6.4	5.2	5.2	5.9	4.8	5.4	6.4	7	5.9	6.2
SSA	8.2	8.3	8	9.3	8.7	8.8	9.9	9.9	10	10.2	9.7

Figure 2.9: Indirect tax as a percentage of GDP by country (1990-2016)
Source: Computed from International Centre for Tax and Development, 2018

The new commission was saddled with responsibilities of collecting different taxes such as personal income tax, capital gain tax, value-added tax, corporate income tax, transfer duty, fuel levy, custom/import duties, estate duty, environmental levy, and any other forms of tax (South African Revenue Service-SARS, 1997). SARS brought meaningful development into the country's tax system. These include tax system simplification, removal of nonperforming tax, reconciliation of tax system, cancellation of tax exemptions, and abrogation of non-resident shareholders tax (Lieberman, 2003). In addition, the staffs of the commission are well trained which contributed significantly, to the progress in tax collection. According to the National Treasury Republic of South Africa (2015), the commission has worked rigorously to enlighten the people about tax compliance. The commission took a further step in introducing e-filing which simplifies the process and motivates the taxpayers to be more tax compliant. It must be noted that SARS makes progress by incorporating the black South African into a cordial interaction with the state. This was achieved by massive education on taxation, introduction of amnesty for tax defaulters, and consistent auditing (Lieberman, 2003). Specifically, the country generates more revenue from income tax and value-added tax. The tax structure remains very solid compared to the other two countries.

Subsequently, Nigeria can be classified as one of the lowest tax collectors among these three countries and the SSA region as a whole (as presented in Figure 2.7). It has one of the lowest total tax ratios between 1990 and 2009. Its total tax ratio trend reveals a worrisome situation. The country's tax ratio marginally declined from an average of 5.7% in the period 1990-1994 to an average of 5.3% in the period 2005-2009. This points to the fact that the tax system is very poor. In addition, it shows that enough revenue is not generated from domestic resource mobilisation. On the yearly analysis, the total tax ratio rose slightly from 8% in 2010 to 10.4% in 2016. This implies that the country could only increase its tax by 2.4% within six years. Despite the growing government size, fundamental development goals, and huge infrastructure deficit in the country, there is still no remarkable progress in introducing an efficient and effective tax system. Over the years, the country's tax system is built on a tripartite structure that includes Legislation, Policy, and Administration. The essence is to lay a solid foundation for the tax system that can generate huge domestic revenue as well as promote the overall goals for economic growth and prosperity in the country.

One key policy initiative by the presidential committee was National Tax Policy (2008). This was designed to create a strong tax system that will enhance the social and economic wellbeing of the citizens in the country. Specifically, National Tax Policy focuses on sustaining existing tax policies as well as instituting new tax policies that will guarantee optimal tax generation and promote transparency and accountability in the utilisation of tax revenue for the benefit of Nigerians. It also takes into consideration the minimisation of economic disequilibrium associated with tax if not well managed. The policy is expected to address the following: promote equity and fairness in the tax system, ensure economic growth and development across the country, guarantee economic stability, address market imperfections, and promote stable domestic revenue that will enable the government to finance its developmental projects and investments for the benefit of Nigerians.

Furthermore, the policy was able to identify some of the challenges facing the Nigerian tax system. These are: paucity of information about taxpayers and their compliance, lack of transparency and accountability of tax revenue, and multiple taxations across the three tiers of government. Other challenges include overlapping in taxation powers among the three tiers, lack of trained and technical staff, unconventional tax collection approach, obsolete tax laws, and lack of coordination among the tax authorities. Despite the huge problems with the tax system identified in the National Tax Policy, not much progress has been recorded as the country continues to rely on a volatile source of finance (oil revenue). Given several legislations such as Company Income Tax Act 1990 (CITA), Personal Income Tax Act 1993 (PITA), Value Added Tax Act 1993 (VAT), Petroleum Profit Tax Act 2007 (PPTA), Stamp Duty Act 1990, and Tertiary Education Trust Fund Act 2011 (formerly called Education Tax Act 1993). All these efforts have not yielded any significant outcome as shown in the low tax ratio depicted in Figure 2.8.

An electronic method for tax collection was also introduced with aim of addressing the challenges with the tax system in the country. This approach was called Taxpayer's Identification Number (TIN). The adoption of TIN was effective in the country from February 2008. This is a 10-digit number that is uniquely attached to each taxpayer in the country. This method is expected to boost the tax revenue of the country by

electronically capturing a large number of taxpayers (both individuals and companies) as well as expanding the tax net. However, the approach has not brought huge transformation to domestic revenue mobilisation in the country. The reason can be attributed low enrolment and weak social contract in the country. In 2016, the country came up with a revised National Tax Policy that can proffer a reliable implementation strategy for an efficient tax system. The revised policy was structured to achieve the key objectives such as promotion of the operation and review of the tax system, provision of a strong foundation for the subsequent tax laws and administration, guideline for tax stakeholders, and coordination of roles and responsibilities of tax authorities. Overall, the country still has a long way to go in improving its domestic resource mobilisation through tax.

Similarly, the Republic of Congo relies on three main tax structure which includes income tax of physical person, corporate income tax and the value-added tax. The average total tax ratio for the Republic of Congo remains very low compared to South Africa but slightly higher than Nigeria. It could be observed that tax mobilisation is significantly low in resource-rich countries such as the Republic of Congo. The commitment to pursue a vibrant tax system is largely undermined by seemingly available natural resource rents. This is a fundamental problem in many SSA countries which is reflected in their unstable fiscal sustainability. The country's tax system focuses more on consumption and wealth-related taxes which cannot generate huge revenue for the country. Between 2011 and 2013, the country introduced a reform in Personal Income Tax (PIT). This reform has not yielded the expected result due to its regressive nature. More so, huge tax exemption in the economy further aggravates the poor tax revenue mobilisation. For instance, there is an exemption for the Republic of Congolese companies that engaged in business activities outside the country.

Figures 2.8 and 2.9 present the disaggregated tax (both direct and indirect tax). A careful inspection of the figures shows that South Africa and Nigeria raised more tax from direct tax compared to the Republic of Congo. Also, South Africa remains the highest direct tax collector. Exceptionally, South Africa explored extensively its direct tax to raise most of the government revenue than any country in the SSA region. The peculiar features of this economy are its commitment towards strong domestic resource

mobilisation as well as efficient tax policy delivery. For instance, personal income tax accounts for most proportion of the direct tax due to successful awareness and enlightenment by the tax authority, its simple and efficient tax procedure, e-filing, accountability, and transparency. These are lacking in the other two countries. Observably, alternative sources of funds further dampened the success of the different reforms initiated in those countries. For both high and low tax performance countries, the governments need to do more to domesticate their revenue mobilisation through tax, to maintain sustainable growth rather than relying on unstable sources of finance. Also, South Africa and Nigeria have direct tax higher than the SSA's average. However, the Republic of Congo explores more indirect tax relative to other countries given its higher proportion in the country's total tax. Despite this, South Africa is still the highest tax collector among the three countries.

2.1.3. Analysis of Public Debt

Public Debt in sub-Saharan Africa

The definition of debt is clearly stated in the Government Finance Statistics Manual (GFSM) as "all liabilities that require payment or payments of interest and/or principal by the debtor to the creditor at a date or dates in the future*"* (International Monetary Fund, 2007b). In the context of public debt, it can be defined as a gross general government debt expressed as a percentage of GDP. In Figure 2.10, the composition shows that SSA has the highest public debt among the regions. Increasing domestic and external shocks in the region have led to debt accumulation in many SSA countries since 1990s. This is not too surprising as the region majorly explores debt as a financing source for its public investment. Given the huge investment gap and developmental challenges coupled with poor domestic resource mobilisation, the region sourced for loans through debt to address some of its public investment gaps. For instance, SSA was facing a significant deficit in its investment financing estimated at $230 billion on average per year over the next five years (Coulibaly and Gandhi, 2018). Given the enormous financing gaps, the region continues to rely on external borrowing to meet its needs.

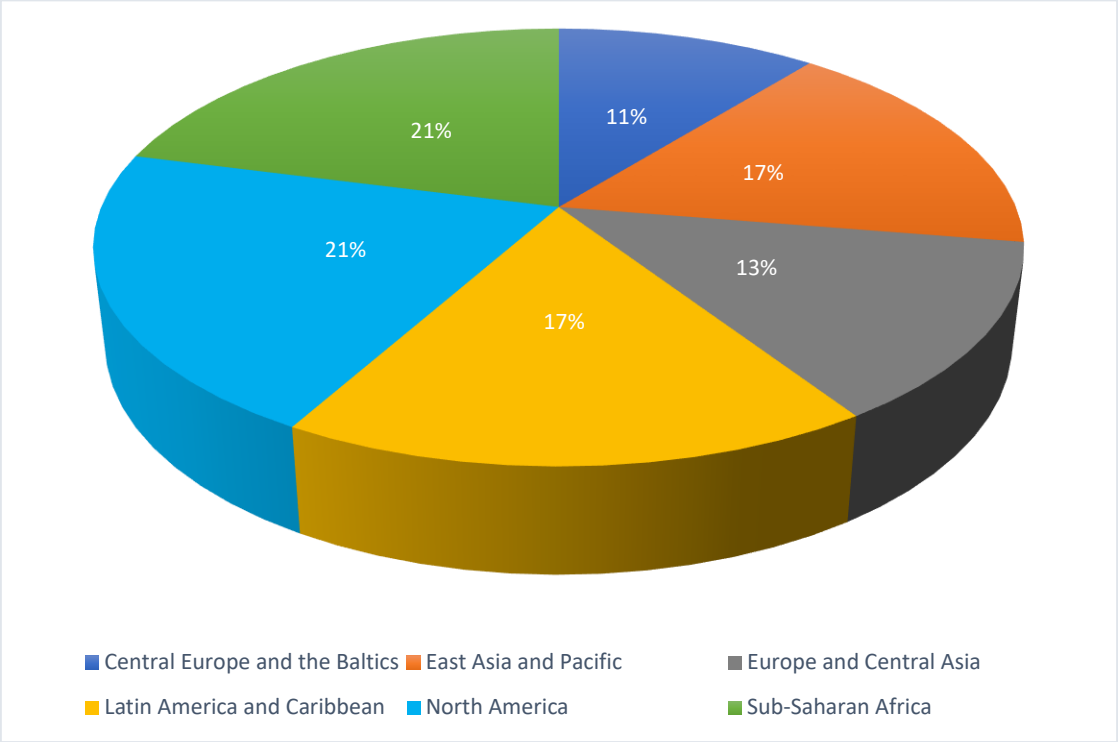


Figure 2.10: Global Distribution of Public Debt as a percentage of GDP (1990-2016)
Source: Constructed from IMF Historical Public Debt Data (2018)

There has been a policy-orientated discourse on public debt to finance public spending. Table 2.3 shows that SSA has the highest public debt between 1990 and 2004 among the regions. The plausible explanation for this observed pattern was due to increasing debt accumulation among many SSA countries. Precisely, many SSA countries in the 1990s were enormously indebted resulting in repayment challenges. From 1990 to 2004, public debt witnessed an upward trend and was more than the GDP of the region in periods 1995-1999 and 2000-2004. During these periods, there were challenges in the repayment of debt which resulted in debt crisis. In the period 2005-2009, there has been some moderate decline in the public debt relative to other regions as it declined significantly to 59.1% due to debt relief initiatives under the Heavily Indebted Poor Country (HIPC) and the Multilateral Debt Relief Initiative (MDRI). Focusing on the yearly analysis, the table reveals that public debt has been rising as it roses from 40.2% in 2010 to 50.5% in 2015. This supported the finding of World Bank (2018) that debt accumulation in SSA is growing faster after the debt reliefs. This implies that these countries are moving to the path of debt unsustainability. More so, International Monetary Fund (2018) noted that the number of SSA countries classified as debt risky has increased from 8 to 12 countries. These are due to several factors: decline in development assistance; volatilities in commodity price; mismanagement in fiscal policies; huge infrastructure gaps, among others.

Table 2.3: External debt by regions (1990-2016)

Region	1990-1994	1995-1999	2000-2004	2005-2009	2010	2011	2012	2013	2014	2015	2016
Central Europe and the Baltics	63.4	32.2	31.8	28.9	39.6	41.6	44.9	47.9	49.7	49.3	49.5
East Asia and Pacific	81.6	69.4	70.7	50.1	47.0	47.7	48.7	50.3	52.1	54.8	53.5
Latin America and Caribbean	100.9	61.0	66.4	51.5	51.1	51.2	52.9	54.5	54.9	55.9	55.4
North America	77.5	80.3	67.6	70.6	87.9	90.3	93.7	95.4	95.4	98.3	96.9
Europe and Central Asia	57.1	50.5	47.4	38.5	48.1	50.2	53.0	55.3	57.3	58.7	58.0
Sub-Saharan Africa	95.7	105.5	108.1	59.1	40.2	39.7	38.9	40.6	44.7	50.5	47.6
Average	79.4	66.5	65.3	49.8	52.3	53.4	55.4	57.3	59.0	61.3	60.1

Source: Computed from IMF Historical Public Debt Data (2018)

Comparative Analysis of Public Debt in three selected countries

At the country-specific level, apart from tax mobilisation, the selected countries also explore public debt due to growing government spending and resource paucity. To further explore debt issues, the subsection focuses on public debt-to-GDP ratio in South Africa, Nigeria, and the Republic of Congo as depicted in Figure 2.11. From Reinhart and Rogoff (2010), the public debt-to-GDP ratio is classified into four debt regimes which include low public debt (less than 30%); medium-low public debt (from 30% to 60%); medium-high public debt (from 60% to 90%); high public debt (greater than 90%). Starting with South Africa, the public debt-to-GDP ratio has been moderate and below the average of SSA. The public debt of the country rose marginally between 1990 and 2009 but remains very low. Specifically, it rose from 1.1% in period 1990-94 to 3.8% in period 2000-2004 suggesting a 2.7 percentage point increase in more than a decade. The upward trend continues as external debt climbed to 5.9% in the period 2005-2009 accounting for a 2.1 percentage point increase. This level of public debt is not worrisome compared to other countries. However, the yearly analysis further shows a steady rise in the public debt-to-GDP ratio.

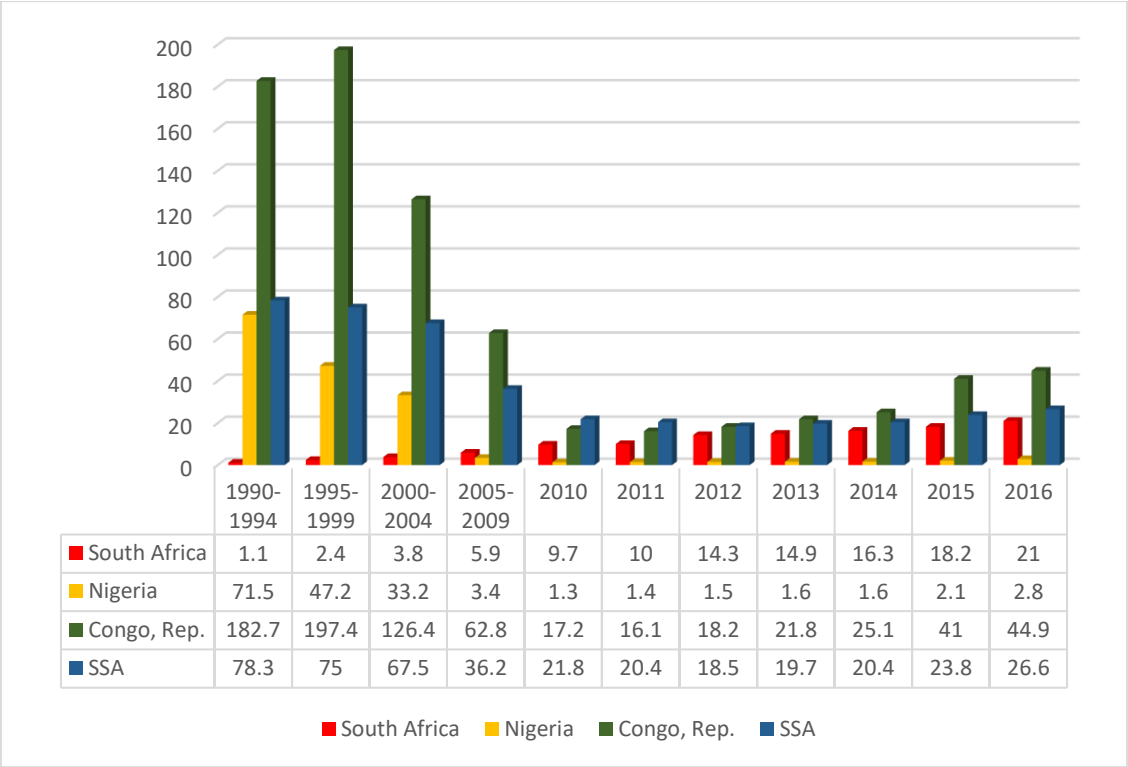
For instance, the public debt-to-GDP ratio rose from 9.7% in 2010 to 14.9% in 2013 which surpasses the percentage point increase recorded under averaged period analysis. This rise was due to the challenges facing the economy which include weak institutions, slow economic performance, growing unemployment rate, and growing external imbalances (Naraido and Raputsoane, 2015). This trend continues as the debt rose to 21% in 2016 suggesting a 11.3 percentage point increase within seven years. This was prompted by slowdown in economic activities as domestic revenue is declining. It could be recalled that the economy started experiencing a recession in 2015. In addition, the country faced the difficulty of attaining target tax revenue, monumental infrastructure pursuit, and stupendous social expenditure which require the government to explore borrowing. Though, the public debt is still below the SSA average and relatively lower than other countries in the region.

More so, there is massive infrastructure spending on projects such as rail, electricity, ports, water, roads, and telecommunications. This continues to put pressure on the government to raise enough revenue to meet up with growing developmental projects.

Racial polarisation in the country further expands government spending. Given that the South African economy is one of the flourishing economies in Africa, there is a growing number of migrants which puts more pressure on the government to expand the existing social infrastructure. Putting all these together contribute extensively to the growing external debt in the country.

In Nigeria, the public debt has been on a decrease from period 1990-1994 to period 2004-2005. For example, public debt-to-GDP declined substantially from 71.5% in the period 1990-1994 to 3.4% in the period 2005-2009. Despite a moderate average debt ratio, Nigeria has also faced similar experiences like the Republic of Congo. Given the economic challenges, the country continues to explore public debt in the 1990s to revamp the economy and expand infrastructure. Many events occurred between 1990 and 2009 that account for the observed pattern of the public debt. In the pre-2005 periods, Nigeria was faced with debt arrears owing to London Club, Paris Club, Multilateral, Promissory Note, Bilateral, and others. This necessitates rescheduling of debt owed to the London and Paris Club. The framework for debt relief through debt restructuring method resulted in other problems.

Contrary to expectation, debt rescheduling only gives more time to the debtor for debt repayment rather than debt elimination. The debt adjustment was unachievable due to failure to earn the so-called "new money" (Raheem, 1994). Thus, the country needed to explore other strategies to address the debt challenges. Fortunately, the country was repositioned in terms of debt management when Paris Club granted debt relief in 2006 where a huge proportion of the debt was offset. This was reflected in the huge decline in the public debt in the period 2005-2009. A yearly analysis shows a stable public debt over the year. Public debt ratio rose from 1.3% in 2010 to 2.8% in 2016. Hence, the country's debt is below the SSA average.



	1990-1994	1995-1999	2000-2004	2005-2009	2010	2011	2012	2013	2014	2015	2016
South Africa	1.1	2.4	3.8	5.9	9.7	10	14.3	14.9	16.3	18.2	21
Nigeria	71.5	47.2	33.2	3.4	1.3	1.4	1.5	1.6	1.6	2.1	2.8
Congo, Rep.	182.7	197.4	126.4	62.8	17.2	16.1	18.2	21.8	25.1	41	44.9
SSA	78.3	75	67.5	36.2	21.8	20.4	18.5	19.7	20.4	23.8	26.6

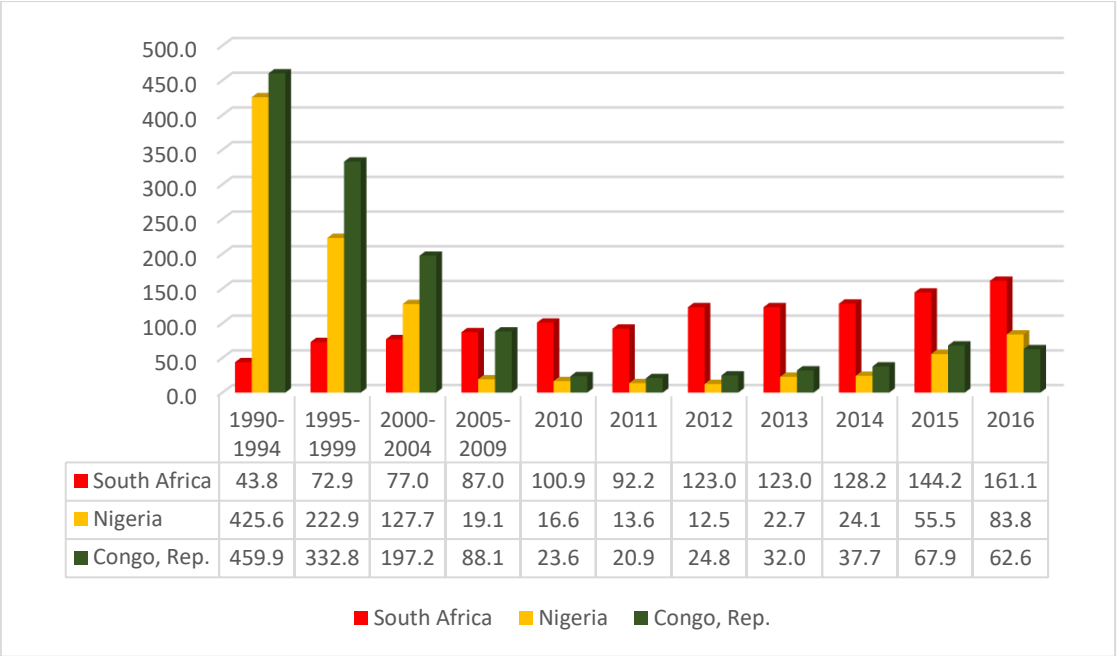
Figure 2.11: Public Debt as a percentage of GDP by country (1990-2016)
Source: Constructed from International Monetary Fund Historical Public Debt Data (2018)

From period 1990-1994 to period 2000-2004, the Republic of Congo witnessed substantially high level of public debt relative to Nigeria and South Africa. Specifically, public debt-to-GDP ratio rose from 182.7% in the period 1990-1994 to 197.4% in the period 1995-1999. Subsequently, it declined from 126.4% in period 2000-2004 to 62.8% in period 2005-2009. Historically, the Republic of Congo has faced huge debt challenges in the past. The trend analysis reveals that the country has been in a high public debt regime before the debt relief initiative. In addition, the HIPC/MDRI debt relief actualised in 2010 contributes largely to the reduction of public debt in the country. On the yearly analysis, public debt-to-GDP ratio has started rising in this country. For instance, it rose from 17.2% in 2010 to 44.9% in 2016. Within seven years, the country has added approximately 27.7% to its debt level. The public debt-to-GDP ratio has been increasing progressively over the past seven years showing a new trend of borrowing for the country. It was noted that the country relies heavily on borrowing (International Monetary Fund, 2015). The sharp reduction of oil prices in the second half of 2014 contributes to the upward trend in public debt. Thus, World Bank (2018) posited that most fragile countries always faced the problem of high growing debt resulting from poor institutions, over-reliance on commodity prices, and political instability.

Relying on the level of public debt-to-GDP ratio is not sufficient to provide a complete picture of debt challenges in these countries especially South Africa and Nigeria. Hence, we examined the public debt-to-exports ratio in Figure 2.12. Interesting information emerges across the countries under consideration. Between the periods 1990-1994 and 2005-2009, public debt ratios were extremely high in the Republic of Congo and Nigeria. In simple terms, the Republic of Congo, Nigeria, and South Africa are expected to pay US$459.9, US$425.6, US$43.8, respectively, in return for every US$100 borrowed in the period 1990-1994. As the public debt ratio declined in the subsequent periods for Nigeria and the Republic of Congo, South Africa recorded an increase.

More importantly, the yearly analysis reveals intriguing facts about the issue of public debt in these countries. First, the figure shows fast-rising debt in South Africa as it rose from 100.9% in 2010 to 161.1% in 2016. Second, Nigeria also experienced an upward trend in the debt ratio as it substantially rose from 16.1% in 2010 to 83.8% in 2016. Third, the Republic of Congo recorded an increasing trend as the debt ratio climbed from

23.6% in 2010 to 62.6% in 2016. More so, this shows that South Africa, Nigeria, and the Republic of Congo recorded a percentage increase of 60.2%, 67.7%, and 39%, respectively. Nigeria with lowest public debt is using more of its export earnings to pay public debt and this has increased tremendously over the seven years. South Africa experienced a fast pace while the Republic of Congo has the lowest pace. Besides, the relatively low public debt-to-exports ratios in Nigeria and the Republic of Congo were largely due to increased earnings from exports (especially oil exports).



	1990-1994	1995-1999	2000-2004	2005-2009	2010	2011	2012	2013	2014	2015	2016
South Africa	43.8	72.9	77.0	87.0	100.9	92.2	123.0	123.0	128.2	144.2	161.1
Nigeria	425.6	222.9	127.7	19.1	16.6	13.6	12.5	22.7	24.1	55.5	83.8
Congo, Rep.	459.9	332.8	197.2	88.1	23.6	20.9	24.8	32.0	37.7	67.9	62.6

Figure 2.12: Public Debt as a percentage of exports of goods and services by country (1990-2016)
Source: Constructed from Word Development Indicators (2018)

A more detailed analysis of public debt regimes is presented in Figure 2.13. Specifically, we examined the number of years in each categorisation for the three countries and the SSA region. The figure shows that South Africa experienced a more medium-low public regime for 25 years out of 27 years under consideration. However, Nigeria was in a low public debt regime for the greater part of the period (12 years). the Republic of Congo was mostly in high (14 years) and medium-low (10 years) public debt regimes. Generally, the SSA region was mostly in a high public debt regime. Figure 2.14 further indicates that South Africa and the Republic of Congo remain in the medium-low regime while Nigeria has a low public debt level. Additionally, the Republic of Congo has the fastest-growing public debt while Nigeria has the lowest. In sum, debt situations in these countries remain worrisome which can undermine their economic performance.

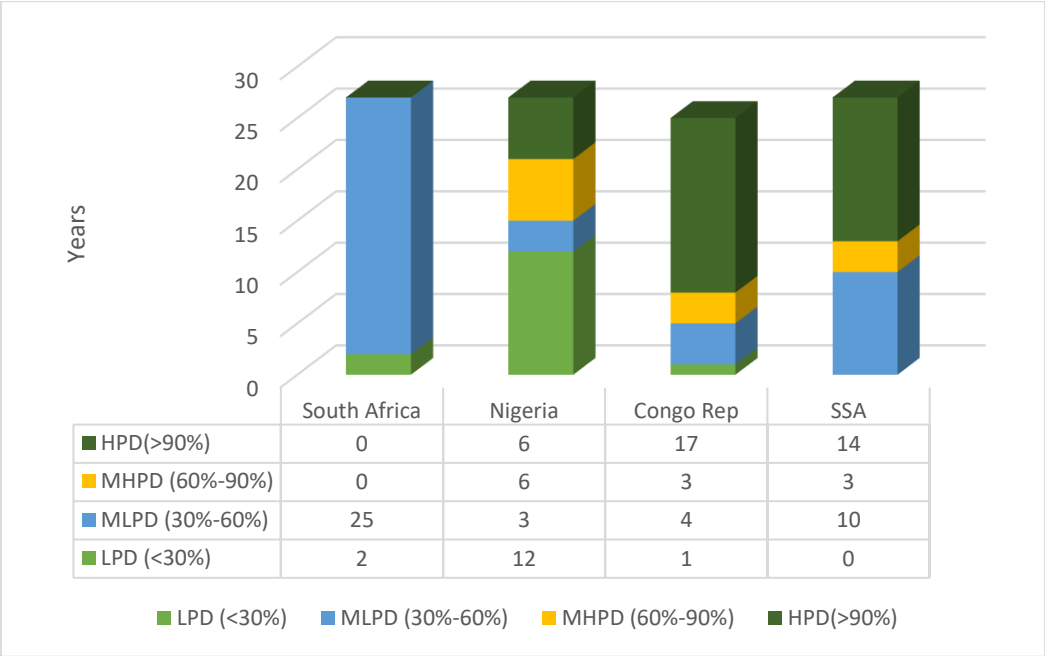


Figure 2.13: Categorisation of Public Debt Regimes across the three countries
Source: Constructed from IMF Historical Public Debt Data (2018)

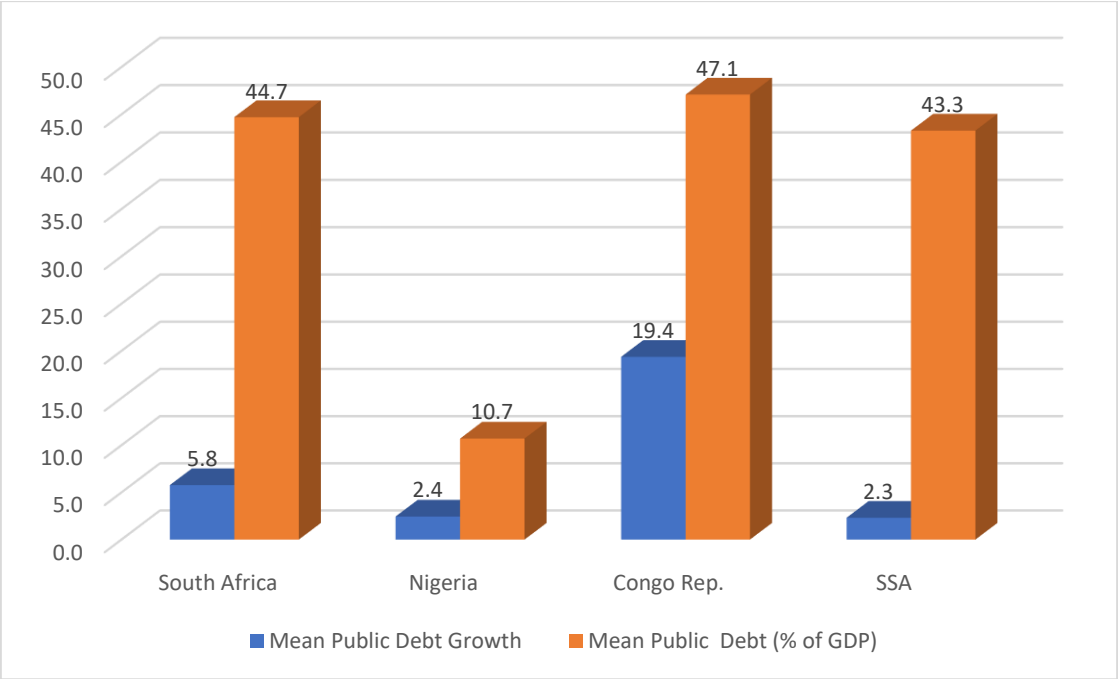


Figure 2.14: Mean public Debt-to-GDP ratio and Mean Debt Growth across the three countries (1990-2016)
Source: Constructed from IMF Historical Public Debt Data (2018)

2.1.4. Analysis of Total Natural Resource Rents

Trend Analysis of Total Natural Resource Rents in sub-Saharan Africa

Total natural resource rents are a key source of finance in many regions of the world. According to the World Bank definition, natural resources are grouped into five: oil, natural gas, coal (hard and soft), forest, and mineral. Thus, total natural resource rents are the aggregation of all rents received from the sales of oil, natural gas, coal, forest, and mineral. According to Lee and Gueye (2015), a country is classified as resource-rich if its average natural resource rents as a percentage of GDP for the period under consideration is greater than 10%. In addition, countries with natural resource endowment but not commercially explored are not regarded as resource-rich countries.

Figure 2.15 presents the global distribution of total natural resource rents as a percentage of GDP. Arab World, Middle East, and North Africa (MENA), and sub-Saharan Africa can be categorised as resource-rich regions while Europe and Central Asia, Central Europe and the Baltics, East Asia and Pacific, Latin America and Caribbean, and North America are less-resource-rich regions based on Lee and Gueye (2015) definition. Both the Arab World and MENA are endowed with oil and nonfuel minerals. Moreover, the SSA region is endowed with many natural resources such as oil, uranium, natural gas, diamond, gold, copper, cocoa beans and cocoa butter, iron ore, silver, chromium ore, zinc, and others.

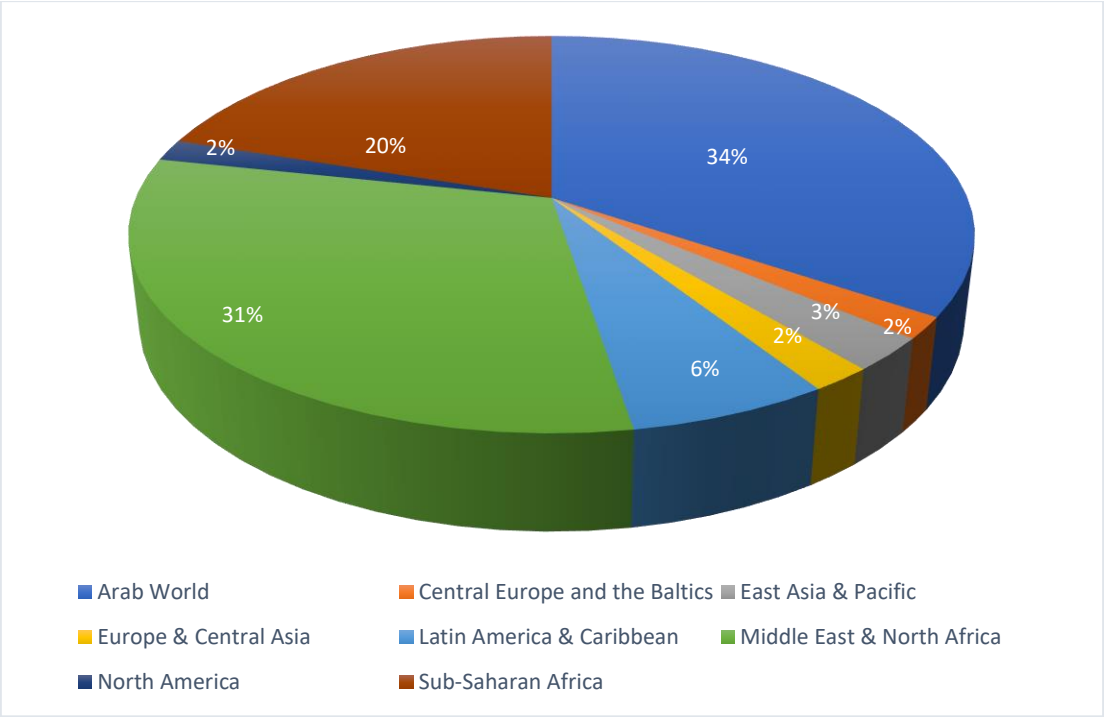


Figure 2.15: Global Distribution of total Natural Resource Rent as a percentage of GDP (1990-2016)
Source: Computed from World Development Indicators, 2018.

In Table 2.4, Arab World, MENA, and SSA have the highest resource rents which are above the world average. It can be observed from the table that the three regions' rents fluctuate over the years. This is largely due to high proportion of oil and gas rents in the total natural resource rents. Over the years, the oil price has been unstable, and this is reflected in the total natural resource rents oscillation in the resource-rich regions. Specifically, the period 1995-1999 witnessed the oil price crisis. The oil prices started declining at the end of 1997 to 1998. This was a major cause of the sharp decline in the total natural resource rents in the period 1995-1999. This oil price increased in the subsequent years with a slight decline in 2012. This problem was aggravated in mid-2014 and led to a significant fall in oil prices. Thus, oil prices play a significant role in the dynamics of the total natural resource rents. The dynamics in the total natural resource rents coincide with the dynamics in the oil price.

Table 2.4: Total natural resource rent as a percentage of GDP by regions (1990-2016)

Region	1990-1994	1995-1999	2000-2004	2005-2009	2010	2011	2012	2013	2014	2015	2016	Average
Sub-Saharan Africa	11.5	10.6	12.3	18.1	14.8	18.5	16.5	14.7	12.3	8.0	10.2	13.3
Arab World	17.5	15.0	22.0	32.1	27.3	33.5	32.0	29.6	26.5	15.2	20.9	22.9
Central Europe and the Baltics	1.9	0.8	0.9	1.2	1.2	1.4	1.2	0.9	0.8	0.7	0.8	1.2
East Asia & Pacific	1.0	0.7	1.1	3.0	3.6	4.6	3.3	3.1	2.4	1.2	1.8	1.8
Europe & Central Asia	0.9	0.6	1.2	1.9	1.9	2.5	2.6	2.2	2.0	1.2	1.6	1.3
Latin America & Caribbean	3.0	2.3	3.9	6.7	5.6	7.1	6.6	6.1	5.0	3.1	4.1	4.3
Middle East & North Africa	16.2	13.1	19.5	29.2	24.3	29.5	27.9	26.4	24.2	13.9	19.0	20.6
North America	1.2	9	1.2	1.6	1.2	1.4	1.0	1.0	1.0	0.3	0.7	1.2
World	11.5	1.2	2.0	3.7	3.7	4.8	4.2	3.9	3.3	1.7	2.5	2.5

Source: Computed from World Development Indicators, 2018

Figure 2.16 further sheds light on the issues of total natural resource rents in SSA. The figure clearly shows the unstable nature of total natural resource rents over the years under consideration. The fluctuation was largely caused by unstable commodity prices. Precisely, it is driven by the behaviour of oil prices in the international market. Most resource-rich countries in SSA are oil-dependent which is reflected in the pattern of total natural resource receipts. It can be seen from the graph that there was a steady rise in the resource revenue between 2000 and 2008. The major factors that largely account for the upward trend are oil price induced which include the Gulf War, Asian economic crisis, reduction in Russian production, terrorist attack (September 11, 2001), disastrous strike in Venezuela (2003), oil market glut (2004/2005), and global economic crisis.

Also, forests, minerals, and coal are other major sources of revenue for SSA. The minerals and coal in the region are affected by the under-development of the mining industries in most countries. In addition, poor policies and regulatory environments contribute to unstable revenue from natural resources. Between 2010 and 2016, the period is characterised by a boom and burst of natural resource revenue most especially oil and gas. In mid-2014, the oil price began to decline sharply which resulted in low revenue for most oil-dependent countries thereby leading to recession. This clearly shows the extent to which the region continues to rely on this source of revenue for its economic growth.

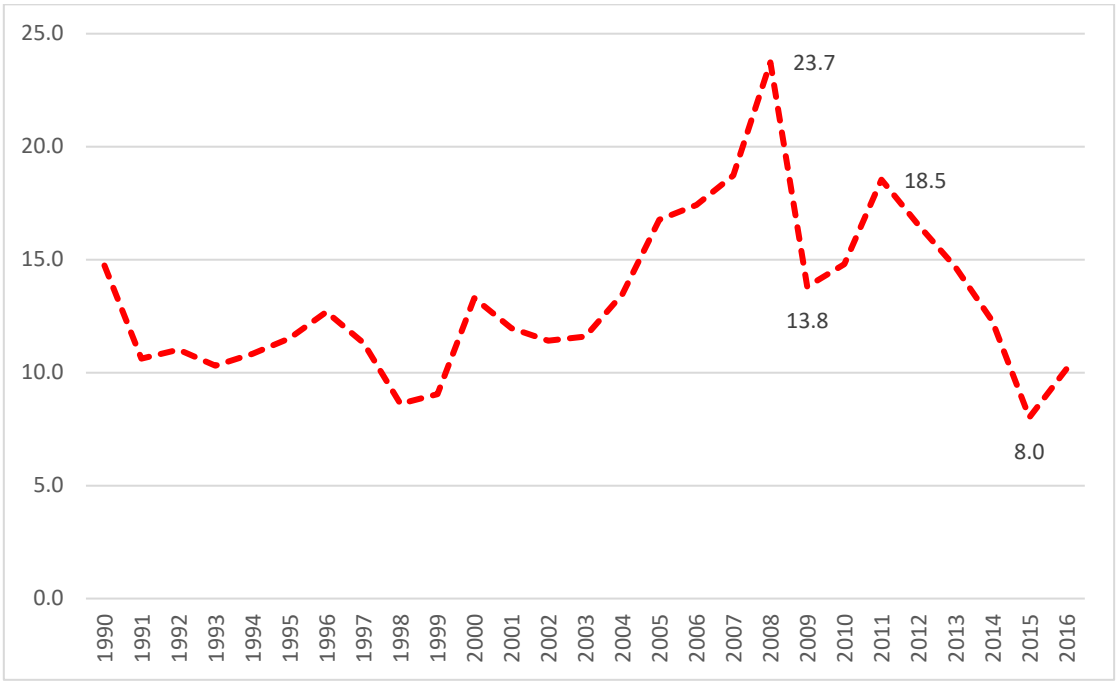


Figure 2.16: Total natural resource rents as a percentage of GDP, in sub-Saharan Africa (1990-2016)

Source: Computed from World Development Indicators, 2018

Country Analysis of Natural resource rents

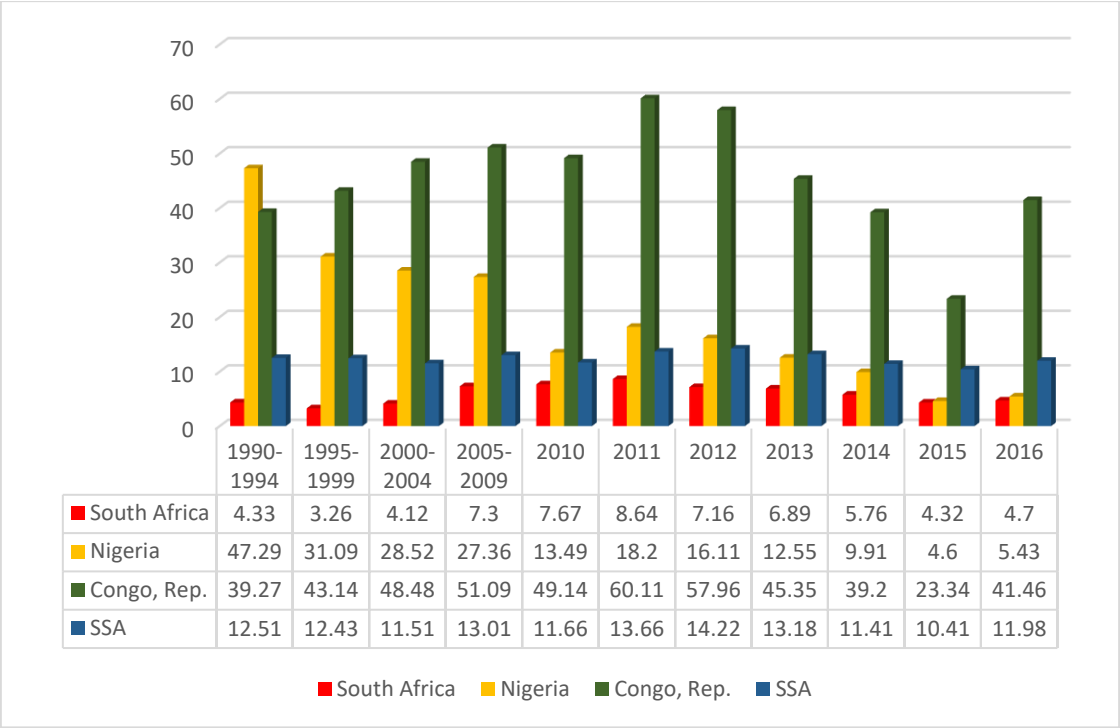
Unpacking the issues of total natural resource rents performance, Figure 2.17 illustrates the total resource rents among the countries under consideration. The Republic of Congo is the highest earner of total resource rents among the three countries. The country relied heavily on this source of financing to fund government expenditure. Oil dominates the country's natural resources. Specifically, oil revenue accounts for more than 30% of GDP, 80% of total exports, and 66% of fiscal revenues (World Bank, 2019) in the country. The figure shows that total natural resource rents (as a percentage of GDP) rose from 39.3% in the period 1990-94 to 43.1% in the period 1995-99. The upward movement was consistent over the periods as it further climbed to the peak of 51.1% in period 2005-2009. This country benefits from huge revenue from its natural resource rents. Also, the country enjoyed a very friendly economic position due to an increase in international oil prices which leads to high resource rents received in the period 2005-09.

In the yearly analysis, total natural resource rents oscillate between 2010 and 2016. It has a record high of 60.1% in 2011 which is relatively higher than other countries. This can be associated with favourable oil prices, an increase in production, and other non-oil products such as rough wood, refined copper, special purpose ships, and passenger and cargo. From 2012, natural resource rents started declining to their lowest value of 23.3% in 2015. Specifically, companies such as Italian oil company (ENI the Republic of Congo), the Republic of Congolese oil company (SNPC), Africa Oil and Gas Corporation, and French oil company (Total E&P) show commitments to start exploration in 2015 but some of these investments in the oil sector do not happen.

Also, the sharp decline in international oil prices and barrels of oil further reduces the proceeds from natural resource rents. This pushed the oil companies to adjust their position to address the sharp drop in the oil price. Most of the companies deferred their parts of the commitments to the country triggering a decline in the foreign direct investment in the oil sector. However, it returned to its upward trend of 41.5% in 2016. This is due to the improvement in other non-oil products and transparency recorded in the management of oil resource rents. Notably, the oil and gas sector contributes majorly

to the earnings received by the country from total natural resources. Also, forestry contributes a substantial amount of money to the total earnings from natural resources.

Furthermore, Nigeria is one of the resource-rich countries in the SSA region. The country has proven crude oil reserves and natural gas reserves of 37 billion barrels and 5.7 trillion cubic metres, respectively (OPEC, 2018). The oil and gas sector continues to drive the economy as it provides more than 65% of total revenue. The country has a daily capacity of crude oil production of 2.5 million barrels. This varies depending on the international oil market situation. The country remains the largest oil producer in Africa and 13th in the world. A quick inspection of Figure 2.19 shows that total natural resource rents were at their peak of 47.3% in the period 1990-94. It later declines to 27.4% in period 2005-09 representing 19.9 percentage point decrease. The huge decline in the rents can be attributed to oil price volatility and Niger/Delta agitation.



	1990-1994	1995-1999	2000-2004	2005-2009	2010	2011	2012	2013	2014	2015	2016
South Africa	4.33	3.26	4.12	7.3	7.67	8.64	7.16	6.89	5.76	4.32	4.7
Nigeria	47.29	31.09	28.52	27.36	13.49	18.2	16.11	12.55	9.91	4.6	5.43
Congo, Rep.	39.27	43.14	48.48	51.09	49.14	60.11	57.96	45.35	39.2	23.34	41.46
SSA	12.51	12.43	11.51	13.01	11.66	13.66	14.22	13.18	11.41	10.41	11.98

Figure 2.17: Total natural resource rent as a percentage of GDP by country (1990-2016)
Source: Constructed from World Development Indicators, 2018

The key reform during these periods to reposition the oil sector was introduced by former President Olusegun Obasanjo. This reform was termed National Oil and Gas Policy (NOGP) which was initiated by Oil and Gas Sector Reform Implementation Committee (OGIC). The committee was inaugurated on April 24, 2000. It proposed that policymaking, regulatory and commercial activities in the oil sector should be separated. This was kick-started to actualise the restructuring of the oil sector in the country. In 2007, the committee was saddled with the responsibilities of designing a comprehensive framework based on NOGP for the effective and efficient institutional structure with legal backing for judicious management of the oil and gas sector in the country.

Specifically, OGIC examines the operational strategy and functional items that are important to propel the oil industry to a global and competitive level as well as proposes possible recommendations on fiscal policy challenges and communal problems affecting the efficiency and effectiveness of the petroleum industry in the country. More importantly, the separation of non-revenue generating institutions from the revenue-generating institutions was necessary for the sector to survive.

In essence, delineating the activities of the Nigerian National Petroleum Corporation and its subsidiaries are key to the restructuring of the industry. Six institutions were proposed which include the National Petroleum Directorate (NPD)-to be saddled with responsibilities of introducing, and executing the petroleum policy in the oil and gas sector; Nigerian Petroleum Inspectorate (NPI)- to be responsible for regulatory activities in the upstream division of the oil and gas sector; Nigerian National Petroleum Company (NNPC)-to be repositioned with objectives of global National Oil Corporation by focusing on commercial and business activities relating to oil and gas sector; National Petroleum Assets Management Agency (NAPAMA)- to be responsible for commercial and operational activities of the oil and gas sector; National Petroleum Research Centre (NPRC)-to be responsible for research and development activities in the oil and gas sector. All these rigorous policy initiatives have not materialised in restructuring the oil and gas sector. More so, the projection in the policy framework in transforming the oil and gas sector to drive the economy to the top 20 largest economies in the world by 2020 may not be realised if all activities in the sector are not well articulated.

In addition, the solid mineral sector that is supposed to boost revenue generation of the country remains underdeveloped. The Mineral and Mining Act (No. 2007) which designed to give legal backing to the activities of the solid minerals sector. Over the years, the seemingly easy revenue from oil continues to undermine the potential in the sector. Furthermore, the yearly analysis gives more insight into the volatile nature of rents received from natural resources (largely from crude oil production). There was a slight increase in rents from 13.5% in 2010 to 18.2% in 2012. However, it declined sharply to 9.9% and 5.4% in 2015 and 2016, respectively. This worrisome pattern of resource rents continues to put pressure on fiscal spending and other macroeconomic indicators (such as external reserve, exchange rate, among others). These fiscal plans are largely disrupted when there is any shock at the international commodity market as observed in 2015. Between 2010 and 2016, the proposed petroleum industry governance bill initiated in 2012 by the legislature continues to undergo scrutiny and debate with many contradictions. It was also characterised by lopsidedness in terms of regulation, policy formulation, research and development, and commercial activities.

In the case of South Africa, the country can be classified as less-resourced rich based on the classification of Lee and Gueye (2015) and relative to other two countries. Nevertheless, the country's natural resources are dominated by gold. Specifically, the country accounts for at least 10% of global gold production. From the figure, the total natural resource rents-to-GDP ratio rose from 4.3% in the period 1990-1994 to 7.3% in the period 2005-2009. This country recorded a marginal increase in the proceed received but remains below the average of SSA. Unlike Nigeria and the Republic of Congo, the mining industries for gold and diamonds are well developed. Subsequently, the yearly analysis shows an unstable pattern of total natural resource rents-to-GDP ratio. This was majorly affected by unstable commodity prices. For example, the total natural resource rents ratio rose from 7.7% in 2010 to 8.6% in 2011 but subsequently declined 4.7% in 2016. This partly explains dwindling revenue in the country.

Regimes in total natural resource rents were examined in Figure 2.18. The illustration from the graph reveals that South Africa experienced a low total natural resource rents regime for almost all the years relative to other countries. This results from a small share of the financing source in the total revenue. This suggests that South Africa is not susceptible to huge revenue shocks compared to other countries. Additionally, Nigeria experienced more of both high total natural resource rents and medium-low resource regimes during the period under consideration. This shows that the country experienced more resource revenue booms. More so, the figure shows the importance of the total natural resource rents in the economy. The over-reliance on this source of finance indicates that country is susceptible to external shocks. The economy remains undiversified in the area of revenue mobilisation for its growth process. This further reinforced the earlier argument that resource-dependent will always face the challenges of unstable and unsustainable growth in the long-run due to unpredictable international commodity market. However, the Republic of Congo enjoys mostly a high total resource rents regime throughout the period. For instance, the country was in a high total natural resource rents regime for 24 years out of the 27years. This suggests the country relies largely on proceeds from natural resources and benefits from the revenue boom. However, this has not translated to meaningful and stable growth in the country.

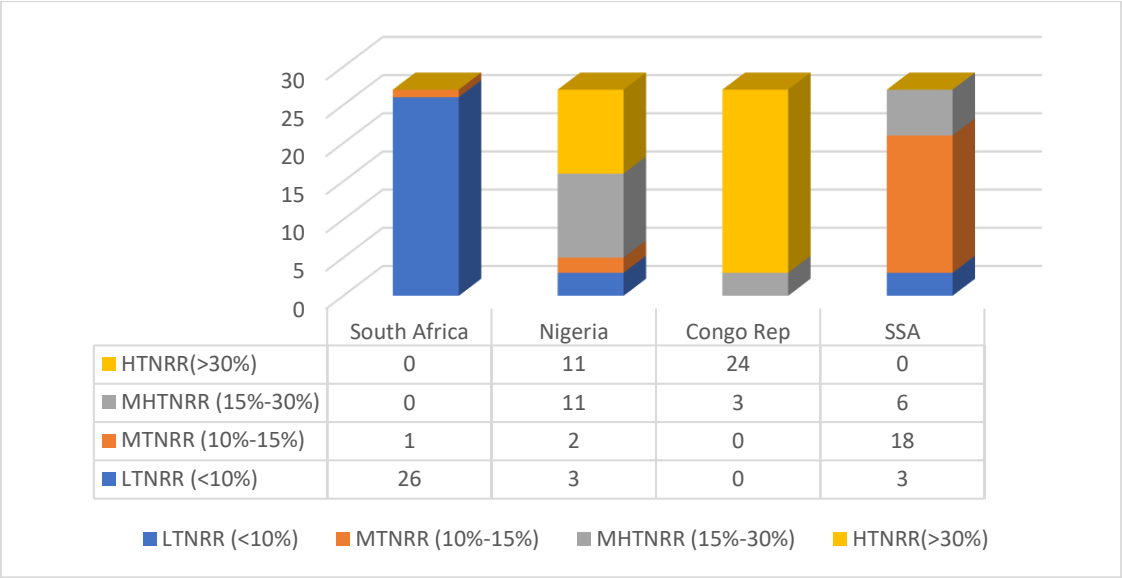


Figure 2.18: Categorisation of Total Natural Resource Rents Regimes across the three countries

Source: Constructed from World Development Indicators, 2018

Further analysis presented in Figure 2.19 shows the average total natural resource rents-to-GDP ratio and its growth across these countries. The graph indicates that both Nigeria and the Republic of Congo enjoy huge revenue from natural resources compared to South Africa. In fact, the average values of Nigeria and the Republic of Congo are at least 5 times of South Africa. This implies that the financing source is critical to the growth process. More so, it can partly explain the low tax efforts from these countries while South Africa has high tax efforts. On the growth of this financing source, South Africa and the Republic of Congo recorded positive mean growth while Nigeria recorded negative mean growth. Specifically, many factors such as oil bunkering, militancy and partly volatile commodity price, are responsible for the huge negative growth of total natural resource rents in Nigeria.

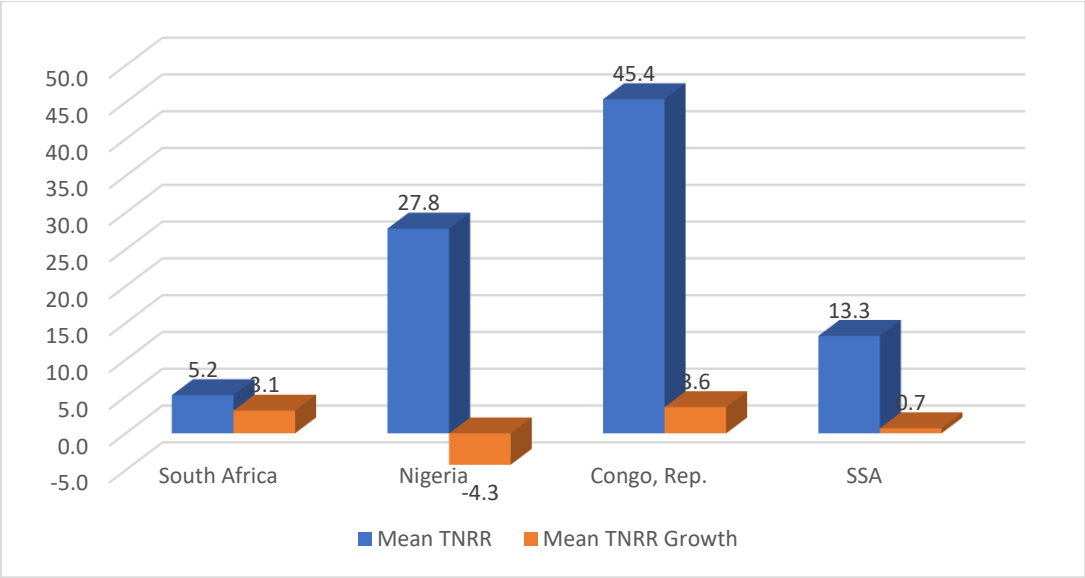


Figure 2.19: Mean total natural resource rents (% of GDP) and mean growth across the three countries (1990-2016)
Source: Constructed from World Development Indicators, 2018

2.1.5. Analysis of Seigniorage

Trend Analysis of Seigniorage in sub-Saharan Africa

The government also finances its public investment and growth through seigniorage revenue. Seigniorage is broadly defined as revenues received from the base money issuance by the consolidated government (Veiga, and Aisen, 2008). Seigniorage allows the government to raise funds for the developmental project. It may result in sizeable proportions of GDP as well as accounting for more than 10% of the total revenue. This is a crucial source of revenue for the government as money printed to offset public spending is accompanied by inflation thereby reducing the real value of payments and levying a tax on the existing holders of money (African Development Bank, 2019). It is therefore important to consider seigniorage[14] when analysing sources of government finance in the SSA region.

Table 2.5 presents the seigniorage among the regions in the world. East Asia and the Pacific received the highest seigniorage revenue on average among the regions. On the other hand, the SSA recorded the lowest seigniorage revenue relative to other regions. The trend of the seigniorage revenue for the SSA region oscillates throughout the periods. Between 1990 and 2009, the region recorded an upward trend in seigniorage revenue but relatively low. However, it begins to decline in the subsequent years. Surprisingly, the region recorded a loss in the last two years. In addition, the region's revenue was below the world average in all years under consideration.

[14] In the literature, there are different measures of seigniorage. These measures are monetary change in base or base money (Fielding and Mizen, 2001; Buiter, 2007; Aisen and Veiga, 2008; Blackburn et al., 2008; and Ehrhart et al., 2014); the change in M1 to GDP (Click, 2000); change in money reserve as fraction of total revenue. Though there are still some challenges (most especially data unavailability) with these measures. In the case of this study, we computed change in broad money in percentage of GDP which is the closest proxy to base money to measure seigniorage due to data constraint (as used by Chalmley, 1991).

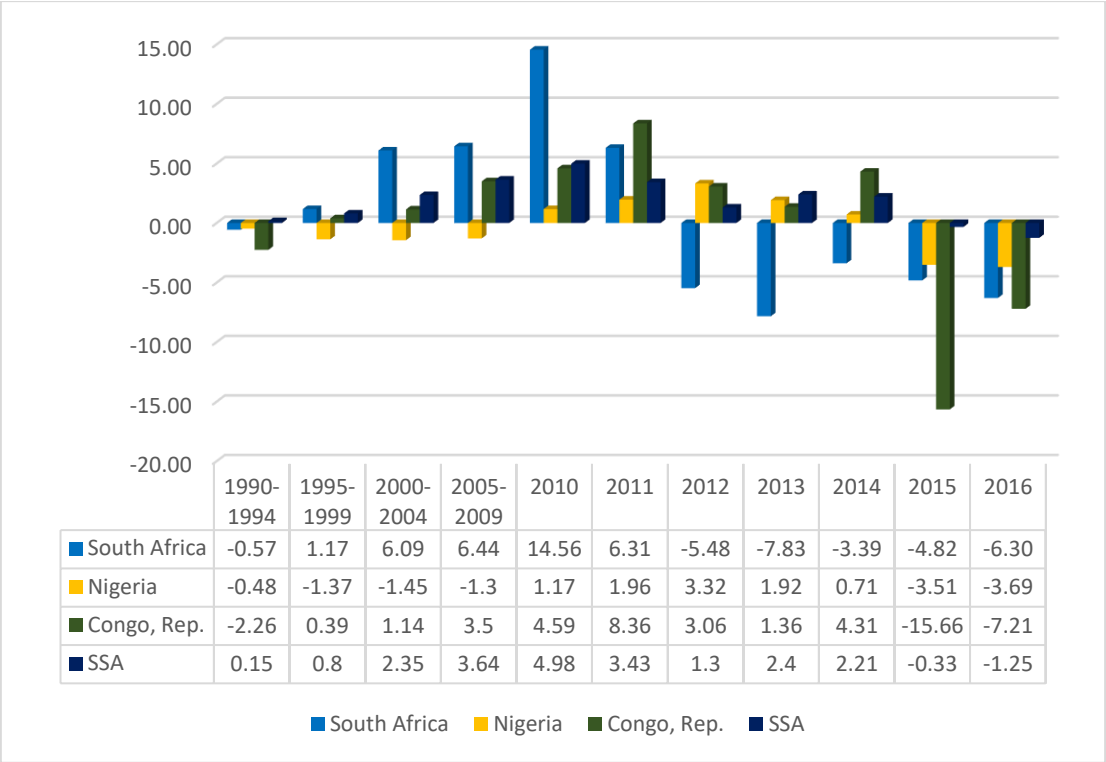
Table 2.5: Seigniorage (percentage of GDP) by global regions (1990-2016)

Region	1990-1994	1995-1999	2000-2004	2005-2009	2010	2011	2012	2013	2014	2015	2016	Average
Arab World	3.48	3.34	5.06	8.40	5.49	6.00	3.79	6.62	5.97	0.92	6.12	5.16
Central Europe and the Baltics	1.20	2.34	8.18	4.64	-12.58	6.58	-3.78	4.37	2.61	-6.76	3.85	3.46
East Asia & Pacific	16.16	5.77	2.49	15.88	21.71	25.92	14.73	3.63	8.71	5.53	12.83	10.69
Latin America & Caribbean	-1.96	1.27	2.49	8.49	11.45	9.47	2.62	1.78	3.19	-10.76	1.93	2.53
Middle East & North Africa	3.27	3.93	4.87	9.61	6.69	7.62	4.34	5.34	-1.34	1.36	6.70	5.26
Sub-Saharan Africa	-0.70	1.33	4.03	5.73	5.79	3.85	0.47	0.01	0.76	-2.28	-2.35	2.15

Source: Constructed from World Development Indicators, 2018

Country analysis of Seigniorage

Analysing seigniorage by country, Figure 2.20 shows that South Africa recorded the highest seigniorage revenue compared to other countries for the period under consideration. The seigniorage revenue (percentage of GDP) rose from -0.6% in period 1990-94 to 6.1% in period 2000-2004. It further increased to 6.4% in 2005-2009. Apart from raising huge revenue from tax, the growing size of government expenditure necessitates utilisation of other sources of finance such as seigniorage. South Africa continues to explore this revenue source diligently to prevent inflation rate from growing out of target. The yearly analysis further reveals that the seigniorage-to-GDP ratio was at the peak in 2010 relative to other years. Subsequently, the seigniorage ratio declined drastically from 14.6% in 2010 to 6.3% in 2011. However, the seigniorage revenue was negative over the remaining the years. This suggests that the country only benefits from economic profit of seigniorage for a short period while economic loss persisted for long period. In essence, exploring seigniorage comes with its consequence if not well-managed.



	1990-1994	1995-1999	2000-2004	2005-2009	2010	2011	2012	2013	2014	2015	2016
South Africa	-0.57	1.17	6.09	6.44	14.56	6.31	-5.48	-7.83	-3.39	-4.82	-6.30
Nigeria	-0.48	-1.37	-1.45	-1.3	1.17	1.96	3.32	1.92	0.71	-3.51	-3.69
Congo, Rep.	-2.26	0.39	1.14	3.5	4.59	8.36	3.06	1.36	4.31	-15.66	-7.21
SSA	0.15	0.8	2.35	3.64	4.98	3.43	1.3	2.4	2.21	-0.33	-1.25

Figure 2.20: Seigniorage by country (1990-2016)
Source: Constructed from World Development Indicators, 2018

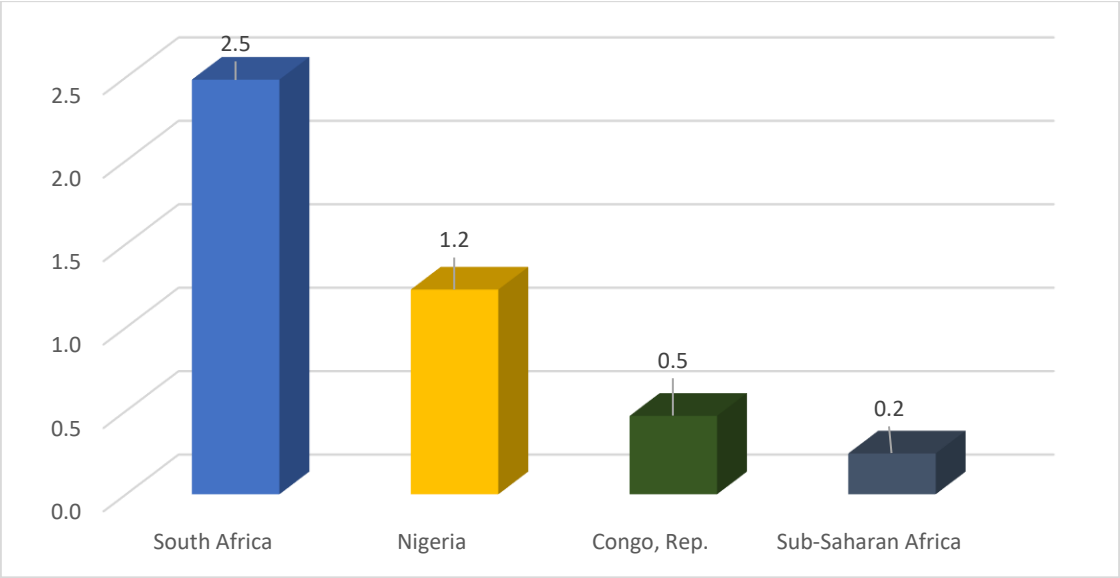


Figure 2.21: Mean Seigniorage by country (1990-2016)
Source: Constructed from World Development Indicators, 2018

On the other hand, the Republic of Congo and Nigeria do not raise huge revenue from seigniorage which may be due to the availability of other financing sources especially natural resources and public debt. The averaged analysis shows that countries recorded an economic loss from seigniorage-to-GDP ratio between periods 1990-1994 and 2005-2009. More so, this increased from -0.48% in period 1990-1994 to -1.3% in period 2005-2009. On the yearly analysis, seigniorage ratio rose from 1.2% in 2010 to 3.3% in 2012. This indicates that the country has appreciable revenue from this financing source. Dwindling oil revenue and low tax revenue may be attributed to this increase. Afterwards, seigniorage ratio followed a downward trend in the remaining years.

For the Republic of Congo, the averaged analysis shows that the seigniorage-to-GDP ratio rose consistently between periods 1990-1994 and 2005-2009. For instance, seigniorage ratio rose from -2.3% in period 1990-1994 to 3.5% in period 2005-2009. Moreover, the yearly analysis reveals seigniorage ratio climbed from 3.5% in 2010 to 8.4% in 2011. Subsequently, this declines drastically by 7.2% in 2016. A virtual inspection of Figure 2.21 shows that seigniorage ratio is higher in South Africa relative to Nigeria and the Republic of Congo. This implies that this financing source contributes to the revenue generation of these countries. According to Fielding and Mizen (2001), many developing countries such as SSA countries still explore seigniorage revenue to finance government compared to developed countries. The figure further shows South Africa raised more seigniorage revenue relative to the other two countries. This is expected as Nigeria and Republic of Congo leveraged their natural resource revenue to finance their growth. In addition, seigniorage imposes an inflationary pressure on the economy if it is not well managed. A classical example is Nigeria where the inflation is very high (18% on average) relative to other countries.

2.1.6. APFOs and Output growth across the three countries

In the literature, there are ongoing debates on how government can finance its expenditure and the implications of government financing options for economic growth. In developing countries, most especially the SSA countries, there have always been questions about how the government can effectively finance its developmental projects for policymakers and academics. The figures below show the relationship between

APFOs and GDP per capita across the three countries and the SSA region as a whole. The stories emerging from these figures are quite intriguing.

To put the situation in a proper context, Figure 2.22 shows the relationship between the average total tax ratio and GDP per capita. Starting with South Africa, the country has an average total tax ratio of approximately 25%. This country explores tax more than the other two countries. More than 50% of this tax comes from direct taxes. This provides the government with more revenue to enhance investment for higher productivity. Despite the high tax ratio, the average growth of its GDP per capita remains very low (not up to 1%). The challenges with the South African economy can be traced to the 1990s due to unstable macroeconomic policies, increasing population, poor growth and the 2007/2008 global financial crisis.

Also, the country witnessed recessions in 2015 and 2016. This was largely attributed to poor growth of private investment, huge human capital gap, and constrict fiscal space (World Bank, 2018). Moreover, tax revenue could not meet up with growing government spending. For Nigeria and the Republic of Congo- Republic, their total tax ratios remain very low compared to South Africa. In addition, Nigeria has the lowest total tax ratio among the countries. However, the average economic growth rate of the country is relatively higher than the averages of South Africa and the Republic of Congo. Expectedly, tax cannot significantly influence growth in these countries as they rely heavily on other sources of finance to drive their economic growth.

Apart from the tax-growth relationship, Figure 2.23 further shows the relationship between public debt and economic growth in the three countries. Observation from the graph indicates that Republic of Congo and Nigeria accumulate more debt compared to South Africa. Generally, high public debt is mostly associated with low economic growth. For instance, the average public debt ratio of Republic of Congo is more than 90% with an average growth of 0.05% compared to South Africa with an average public debt ratio of 39.1% and growth of 0.71%. The public debt stock of the country is creating a worrying situation. However, Nigeria has an average public debt ratio of 59.2% with an average growth of 2.2%. Among these countries, the substantial decline in average growth is linked with public debt of more than 90% (in the case of Republic of Congo).

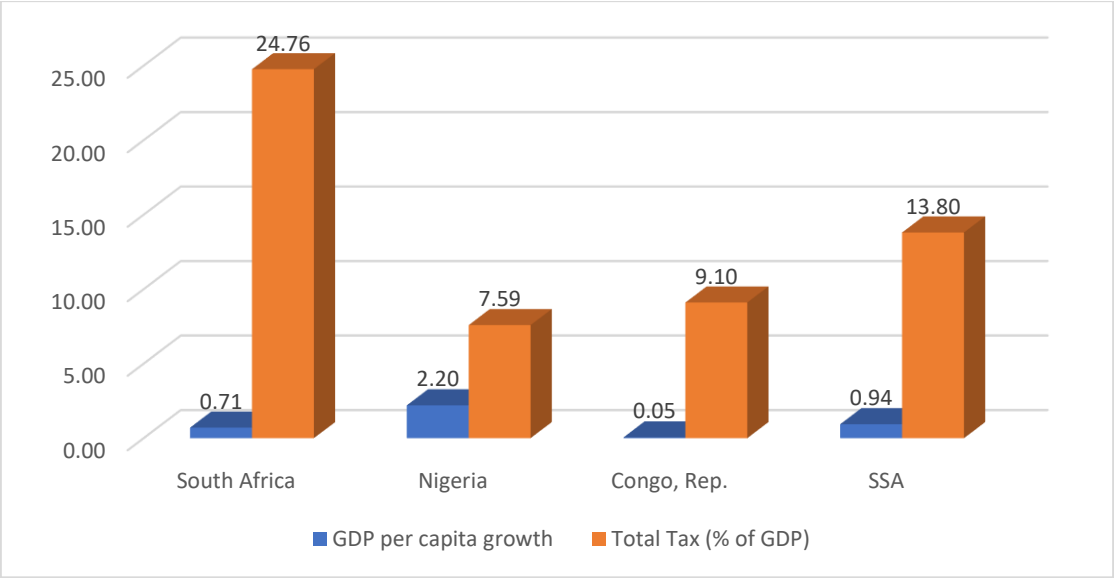


Figure 2.22: Nature of Tax-Growth Nexus across the three countries (1990-2016)
Source: Constructed from World Development Indicators (2018) and International Centre for Tax and Development (2018)

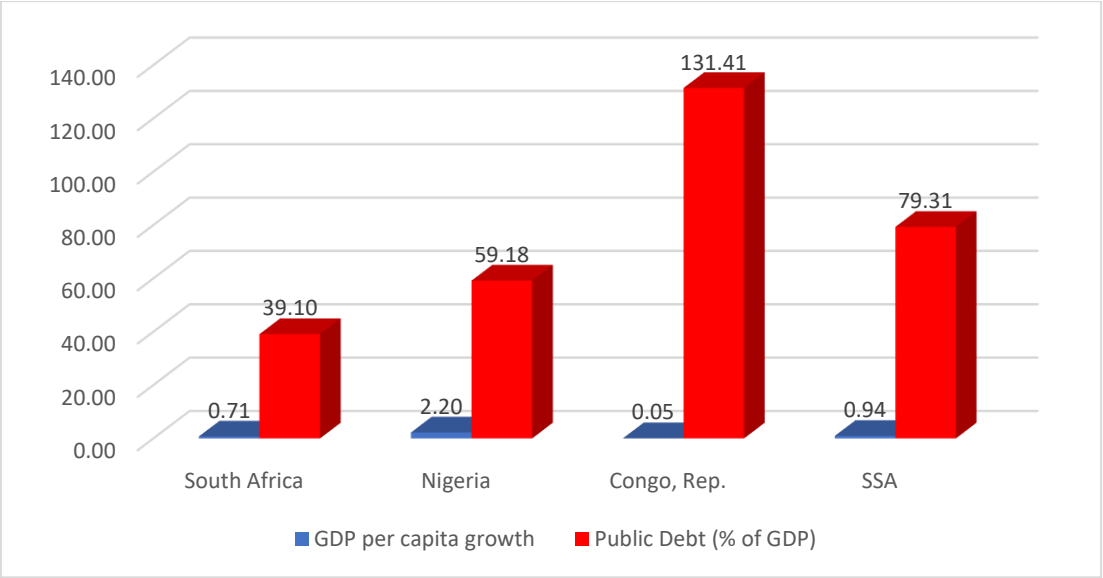


Figure 2.23: Nature of Public Debt-Growth Nexus across the three countries (1990-2016)

Source: Constructed from World Development Indicators (2018) and International Monetary Fund Historical Public Debt Data

Furthermore, Figure 2.24 shows the relationship between seigniorage and growth rate across the countries. The paucity of resources and objective of high, stable and sustainable growth further push these countries to explore additional financing sources such as seigniorage. On average, the Republic of Congo has the highest seigniorage ratio relative to the other two countries, but this additional revenue source has not translated into improved growth. Also, South Africa follows the Republic of Congo given its average seigniorage ratio. This financing source has not significantly improved the revenue paucity facing the country as reflected in the poor growth rate. Further, Nigeria has the lowest seigniorage ratio among the three countries. The country still relies on this financing source to fund government spending even though it is not that pronounced like natural resource revenue. Consequently, seigniorage can trigger more inflationary pressure but only Nigeria recorded a high level of inflation among these countries.

On the total natural resource rents-growth nexus, it could be observed from Figure 2.25 that Republic of Congo has more than 40% of the total natural resource rents ratio while its growth rate remains very low among the three countries. Since the country's total natural resource rent is dominated by oil revenue, which is subjected to oil price volatility, thus country's economic growth is expected to be unstable. This is the major characteristic of the resource-rich countries in the SSA region. However, this unstable nature of finance has not served as a critical lesson for the country to improve its tax revenue mobilisation.

Also, Nigeria has enjoyed an appreciable amount of total natural resource rents like the Republic of Congo with relatively average growth. Unlike the Republic of Congo, low level of public debt in the country may partly explain this. This does not suggest that the country is immune to external shocks. Moreover, the country is still battling with the recession of 2015/2016 arising from commodity price shocks. The pattern of GDP per capita remains unstable and this productivity level has not significantly improved the income per person over the years. In South Africa, the country experienced low growth with a low resource rents ratio. Natural resource rent in South Africa is dominated by mining activities (especially gold). There has been a contraction in the sector over the years. This was due to poor linkage between the manufacturing and mining sectors.

According to African Development Bank (2020b), South Africa has resorted to exporting the largest share of its raw mineral resources which expose the country to external shocks (arising from unstable commodity price).

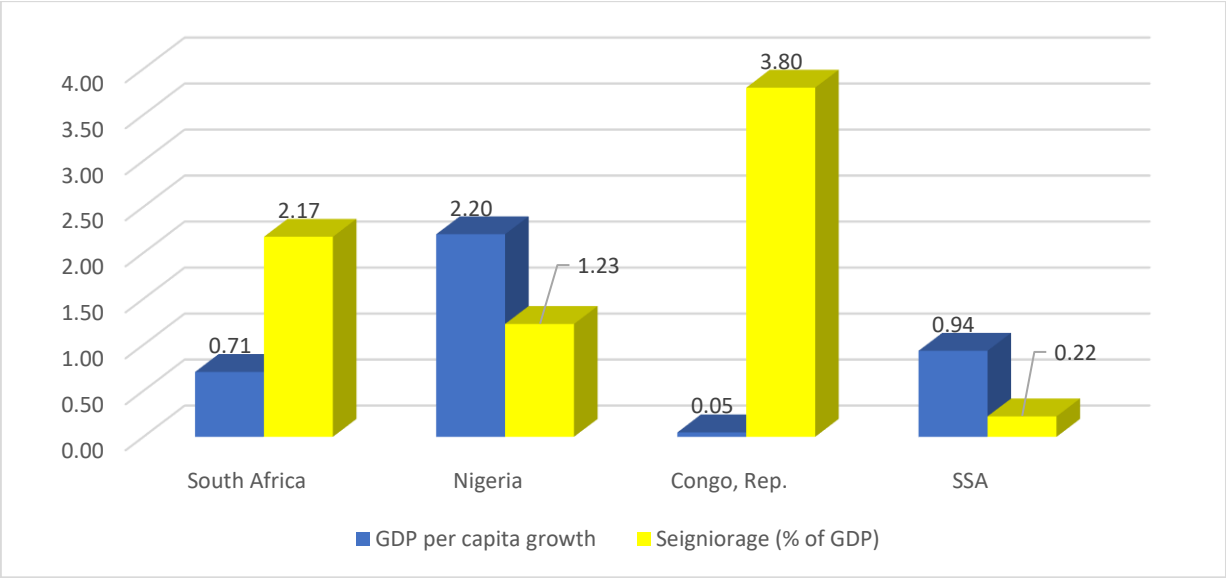


Figure 2.24: Seigniorage-Growth Nexus across the three countries (1990-2016)
Source: Constructed from World Development Indicators, 2018

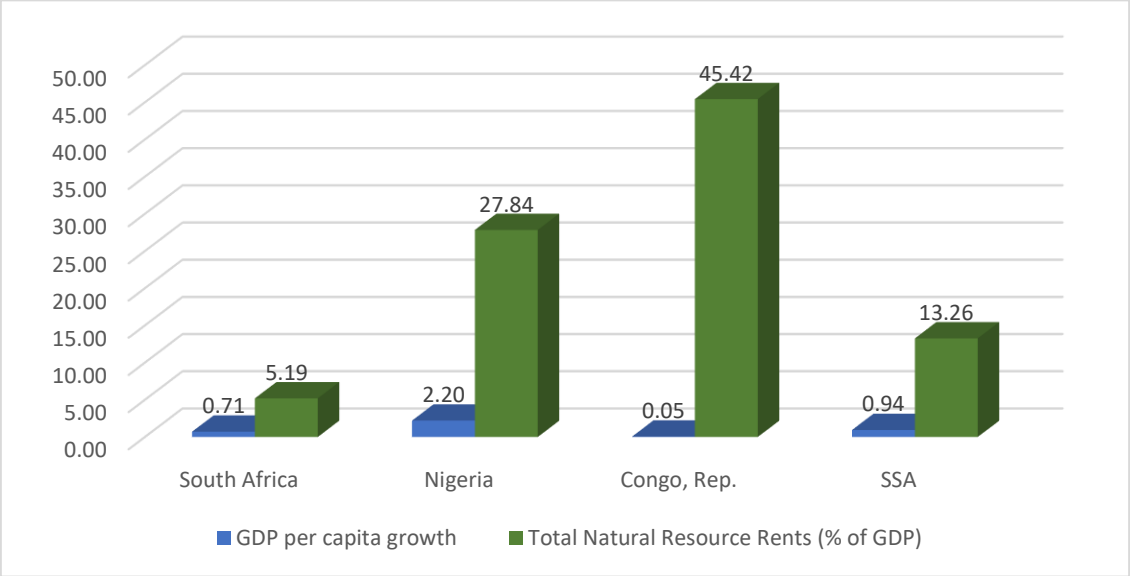


Figure 2.25: Total Natural Resource Rents-Growth Nexus across the three countries (1990-2016)

Source: Constructed from World Development Indicators, 2018

The availability of natural resource rents in these countries makes it difficult for them to pursue tax mobilisation. The economic challenges associated with tax make it unattractive to pursue. A peculiar feature of resource-rich economies (in this case, Nigeria and Republic of Congo) in SSA is the huge debt accumulation. This public debt is relatively high with the lowest revenue accruing from seigniorage. Unfortunately, the resource-rich countries recorded the lowest GDPPC. In addition, a country such as Republic of Congo is moving towards debt distress. The management and improvement of the APFOs are quite challenging in these countries.

From the foregoing, the analysis reveals several interesting issues across these countries. First, it was discovered that these countries' performance in GDPPC is unimpressive as the countries recorded one of the lowest GDPPC values in the world. South Africa with a relatively high tax-to-GDP ratio with low resource rent maintains comparatively high GDPPC while Nigeria and the Republic of Congo maintain low GDPPC. Second, the presence of natural resource rents discourages Nigeria and Republic of Congo from exploring tax options thus exacerbating the growth challenges. Notably, the economic conditions appear to be relatively unstable in these countries. Third, it was observed that many challenges are facing the countries' public investment due to a huge financing gap. Unsurprisingly, the debt accumulation is growing in these countries especially South Africa and the Republic of Congo though it may be due to seemingly easy revenue from natural resources.

In the mid-2000s, the issue of the debt crisis in Nigeria and the Republic of Congo was addressed through different debt relief initiatives and debt forgiveness. However, it appears that these countries are returning to that ordeal as they continue to accumulate debt at an alarming rate. Between 2011 and 2016, the public debt-to-export/GDP ratios have been following an upward trending path. The unstable economic growth pattern in these countries will continue to reoccur as the bedrock of their public finance rest on natural resource rents. Moreover, the global shocks in the commodity market will continue to undermine the growth potential of these countries. The developmental challenges such as huge infrastructure gaps, poor investment, unemployment, poverty, poor growth inclusiveness, will continue to exist when the source of income remains unstable over time. It could also be deduced from the trend analysis that unstable revenue

leads these countries to borrow since the economies are not resilient to avoidable external shocks. Lastly, seigniorage is found to be an important source of revenue mobilisation explored by the countries in the region.

2.2. Theoretical Literature Review

2.2.1. Keynesian Theory of Growth

Harrod (1939) explains the role of government in the growth process and how government activity in the economy can influence the equilibrium growth path. Government through its policies should stabilize the economy for output expansion. The dynamic disequilibrium in the economy necessitates the need for government policies to prevent the oscillation of output growth. Therefore, Harrod (1939) argues that fiscal policy is required to pursue long-run growth. He further demonstrates the importance of changing the tax rates given that government expenditure is constant. His study explores the equilibrium condition of the commodity market to the understanding of government policy and also utilises the natural rate of growth as given. The use of fiscal policy from a traditional position to explain the business cycle is too narrow considering the importance of government in the economy (See Harrod, 1973). Therefore, there is a need to examine the role of fiscal policy in achieving long-term growth by changing the tax rates given that government spending remains constant (see Harrod 1973).

A simple approach was explored by Harrod by assuming that saving plus taxation is equal to government spending:

$$s(1-t+r_b b)+t = kg + h + r_b b \tag{2.1}$$

Where s measures the private sector's propensity to save $(0 < s < 1)$; t measures average tax rate; r_b is the interest rate on government bond; b measures government bond; k is the capital-output ratio; g is the growth rate of the economy; h is government spending on goods and services. The equation can be explored to analyse the role of fiscal policy to achieve potential growth in the economy as presented below:

$$g = \frac{s(1-t+r_b b)+t-h-r_b b}{k} \tag{2.2}$$

Such that $\frac{dg}{dt} > 0$, observation of the simple model shows that change in tax rate continue to influence growth when the simplified form of the balanced government budget (where *t=h>0* and *b=0*) is considered thus resulting in equation 2.3:

$$g = \frac{s(1-t)}{k} \tag{2.3}$$

Where $\frac{dg}{dt} < 0$ equation (2.3) shows that the growth rate is not affected by changes in *t* on the propensity to save and capital-output ratio. In equation (2.2), the government bond and the interest rate pose a challenge to the relationship between growth, monetary and fiscal policies. Kaldor's (1958) Memorandum explains how the policy of government can impact stability and growth. The monetary policy is necessarily used to enhance the stability of interest rates in the short-run. Higher long-term interest rates pose huge challenges for government management. This increases the probability of defaulting in repayment of the firm's loans and creating uncertainty for the lending institution thereby retarding growth.

Kaldor highlighted five points on the role of government in the growth process: (i) government policy is necessary for growth; (ii) government policies are not necessarily compatible with a complex set of objectives; (iii) the monetary policy is used to address fluctuation in the economy whereas fiscal policy is effective in pursuing the long-run and sustained growth; (iv) variations in tax rate as an aspect of fiscal policy is more important for growth rather than variations in government expenditure; and (v) determination of fiscal policy (tax rate) intensity that is suitable for realising specific growth rate. However, Kaldor does not present his view in a formalised way on the role of government policy in the growth process. Thus, Steedman (1972) was the first to present formally, the explicit role of government policy in the growth process.

Steedman (1972) further shows that the assumption of government balanced budget without outstanding bonds make the Cambridge equation holds. Thus, different debates sprang up as Fleck and Domenghino (1987) challenged the Cambridge equation when there is an unbalanced government budget but a large number of studies established the validity of the Cambridge equation. Considering Denicolo and Matteuzzi (1990) examination of the Cambridge equation if it holds or not. This approach was based on

many assumptions such as a closed economy, two classes (proletarian and capitalist), government issues bonds to finance its budget while private firm raises resources through sale of share to finance their productive activities, capitalists raise income through returns on their wealth, and different propensities to save for proletarian and capitalist. To address the factors driving the steady growth, equilibrium condition in the market economy is considered through dynamic equilibrium conditions between savings and wealth growth as well as the dynamic equilibrium condition between public sector budget and its debt. This condition is presented as follows:

$$\alpha_c(1-\tau)\beta(\lambda b+\gamma k)+\alpha_p(1-\tau)[1+\lambda b-\beta(\lambda b+\gamma k)]+\tau = gk+\phi+\lambda b \tag{2.4}$$

$$\alpha_c(1-\tau)\beta(\lambda b+\gamma k) = g\beta(b+k) \tag{2.5}$$

$$gb = \phi+\lambda-\tau \tag{2.6}$$

The left-hand side of equations 2.4 and 2.5 captures private financing while the right-hand side represents public sector financing. Where α_c measures the saving propensity of the capitalist class $(0<\alpha_c<1)$; τ is the lump-sum income tax rate $(0<\tau<1)$; β is the capitalist's wealth owned quota $(0\le\beta\le1)$; λ is the interest rate on bonds; b is the government bonds stock as a proportion of the net output of the economy $(b\ge0)$; γ is the rate of return on real capital; k is the capital-output ratio $(k>0)$; α_p is the proletarian's saving propensity $(0<\alpha_p<\alpha_c)$; g is the growth rate; ϕ measures the government spending on goods and services as a proportion of net output $(h\ge0)$. However, if there is strict equality between the interest rate on bonds, and the rate of return on real capital, then equation (2.5) reduces to:

$$\alpha_c(1-\tau)\alpha = g \tag{2.7}$$

Where $dg/d\tau<0$ and $d\tau/d\alpha>0$. This establishes the validity of the Cambridge equation given the role of the tax rate which helps to determine the compatible value of tax for the steady growth. From equations (2.4-2.7), the formal approach that Kaldor was unable to establish in his Memorandum was demonstrated. Kaldor views the effect

of tax changes on steady growth through a propensity to save but the formal analysis above clearly shows how government can influence demand and growth irrespective of variation in saving propensities and capital-output ratio. This theory demonstrated the critical role of government in sustaining economic growth basically from a simplified approach. However, there are many issues that the theory does not consider in its analytical approach. These include the role of technological progress, the returns to scale, the role of the household utility function, the nature of taxation and the implication of other sources of public finance.

2.2.2. The Neoclassical Growth Theory

Many efforts have been directed towards understanding growth in economics. Despite the risk of enormously overgeneralising the rich insights about economic growth gained over the last three centuries, growth theory focuses on human and nonhuman capital accumulation, diminishing returns, and discoveries. One of the primary concerns of Smith (1776) was to explain the drivers of economic growth. During the industrial revolution era, Smith emphasizes the rising ratio of capital to labour as a key driver of economic growth (Mare, 2004). In the eighteenth century, a high level of capital accumulation (through deliberate savings) contributes extensively to output growth thus helping Smith to understand so much about century growth. In providing a further explanation, increasing the quantity of factor inputs enhances the output expansion, thus, understanding the process of accumulating factor inputs is fundamental to the growth process.

The development of neoclassical growth theory was a result of criticisms in the neo-Keynesian growth theory (United Nations Development Programme, 2011). First, the neo-Keynesian understanding of the growth process was based on capital accumulation while other factors such as technological progress, the growth of education, skills, were ignored. Second, neo-Keynesian relies on the assumption of immutable capital share in output but neoclassical allows capital and labour to be used interchangeably in the production process which captures variation in the capital's coefficient. Different combinations of factor inputs can generate a certain level of output given the technical equipment in the production. Third, neo-Keynesian neglects the possibility of a market mechanism for automatic readjustment while neoclassical allows for the possibility of a

competitive market system for balanced economic growth. Thus, state intervention in the economy is termed as a factor of stability violation given the possibility of inflationary government spending.

Therefore, the neoclassical growth theory emphasises the accumulation of productive factors and the existence of diminishing returns through production function. The production function shows the amount of output that can be produced with a combination of inputs. The theory utilised the Cobb-Douglas production function to demonstrate how output grows as inputs (capital and labour) is accumulated. It relies on the assumption that the quantity of labour input is fixed while capital accumulation is done through the saving of a fixed proportion of output and investing it in new capital. The fundamental and prominent model of this theory was developed by Robert Solow in 1956 in an article titled "*Technical Change and Aggregate of Economic Growth*" but fully developed in 1957 was then titled "*Technical Change and Aggregate Production Function*". The Solow model relies on the assumption that equilibrium can only be achieved in the economy through the equalisation of aggregate demand and aggregate supply. The aggregate supply is captured in the Cobb-Douglass production function that shows the functional dependency of output quantities and factor inputs combination. This reveals the interdependency of three drivers of growth, namely: workforce, investments, and technological progress.

The model demonstrates the key role played by the savings rate in the determination of the level of capital intensity. A large capital accumulation depends on a higher saving rate thereby increasing the level of productivity. In addition, the model assumes that population growth is necessary for steady-state economic growth in the economy. This depends on the assumption that investments continue to increase, if not, there would be a reduction in the capital stock per worker. Thus, the model points to the fact that countries with higher population growth rates not matched by corresponding investment growth experienced lower capital-labour ratio thereby recording lower incomes. The model further identifies technical progress as another driver of growth. Technological progress is viewed in the model as qualitative adjustments in the production process (such as knowledge acquisition, production scale growth, and organisation improvement) rather than replacement of human labour by machines. Unlike previous

models, the Solow growth model sheds light on the understanding of production economic efficiency. Production economic efficiency is not related to the factor of growth and social progress in the twentieth century. Thus, technical progress serves as a source of stable growth of living standards (per capita income). The model shows how optimal savings generate the optimal level of consumption at steady-state growth relative to a previous traditional approach that relies on the optimum size and cost-effectiveness to determine the highest level of consumption.

There are many models under neoclassical growth theory[15] but for this study, the review would be limited to models that capture the role of government. These models include the Ramsey-Cass-Koopmans model, Diamond model, and Bajo-Rubio model.

The Ramsey-Cass-Koopmans Model

The model assumed that the government spends on output, $G(t)$ per effective labour per unit of time. Government spending is further assumed to be unimportant to the utility from private consumption. Thus, the government engages in some activities that leave the utility unchanged or when the utility is the summation of private consumption utility and public goods utility. These spendings are directed towards government consumption rather than public investment thereby not affecting output in the future. They are assumed to be financed by lump-sum income taxes $G(t)$ per unit of effective labour and hence government cannot incur either deficits or surpluses (the government is expected to run a balanced budget every time). Also, the choice between tax and deficit financed by the government does not affect the variables in the model. Therefore, assuming in the model that government spending is financed by current taxes only gives room for the simplicity of the model presentation. Investment is therefore captured in the model as the difference between output and the sum of private consumption and government spending. The equation of motion is presented as:

$$\dot{k}(t) = f(k(t)) - c(t) - G(t) - (n+g)k(t) \tag{2.8}$$

15 The study acknowledged the issues around the New Neoclassical Synthesis which combines dynamic representative agent within the general equilibrium framework with short-run nominal rigidities and monetary policy on output and employment during the business cycle (Linnemann and Schabert, 2003). However, this is not the focus of the study.

An increase in the value of $G(t)$ shifts $\dot{k}=0$ locus down which implies that as the government purchased more goods, fewer goods would be available to the private firm to buy given that k is held constant. Since the evolution of C is derived from households' preferences and does not consider the lifetime budget constraint. Also, the lump-sum taxes finance government spending influence households' budget constraint which gives:

$$\int_{t=0}^{\infty} e^{-R(t)}c(t)e^{(n+g)t}dt \le k(0)+\int_{t=0}^{\infty} e^{-R(t)}\left[w(t)-G(t)\right]e^{(n+g)t}dt \qquad (2.9)$$

The model isolates the effects of permanent and temporary changes in government spending. By this, there is an assumption that the economy is on a balanced growth path with constant $G(t)$ at the level of G_L and there is an unanticipated permanent increase in G to G_H. Since government spending does not affect the evolution of consumption (C), the $\dot{c}=0$ locus is unaffected (see Figure 2.27). The change results in c jumping to make the economy be on the new saddle path. If this fails to hold, either capital would be negative at some period or households would accumulate wealth infinitely. Thus, C would have to decline by the equivalent amount of increase in G and the economy returns immediately to a new growth path. Explicitly, the unanticipated and permanent increase in government spending and taxes decrease the lifetime wealth of the households. The households cannot expand their utility by adjusting the time pattern of their consumption due to constraints placed by a permanent increase in government spending and taxes. The implication is that the amount of decline in consumption is equivalent to the amount of increase in government spending thereby leaving the capital stock and the interest rate unchanged.

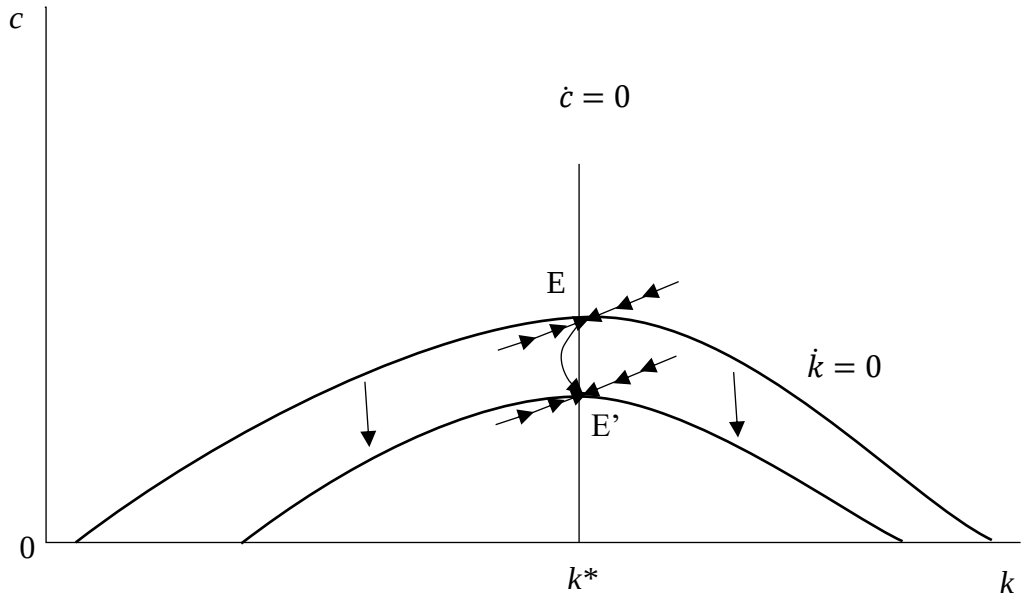
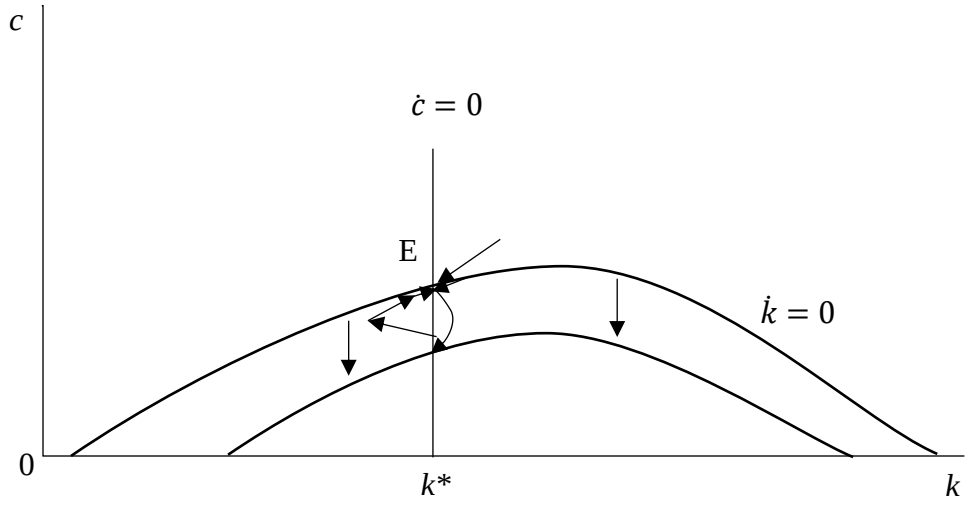


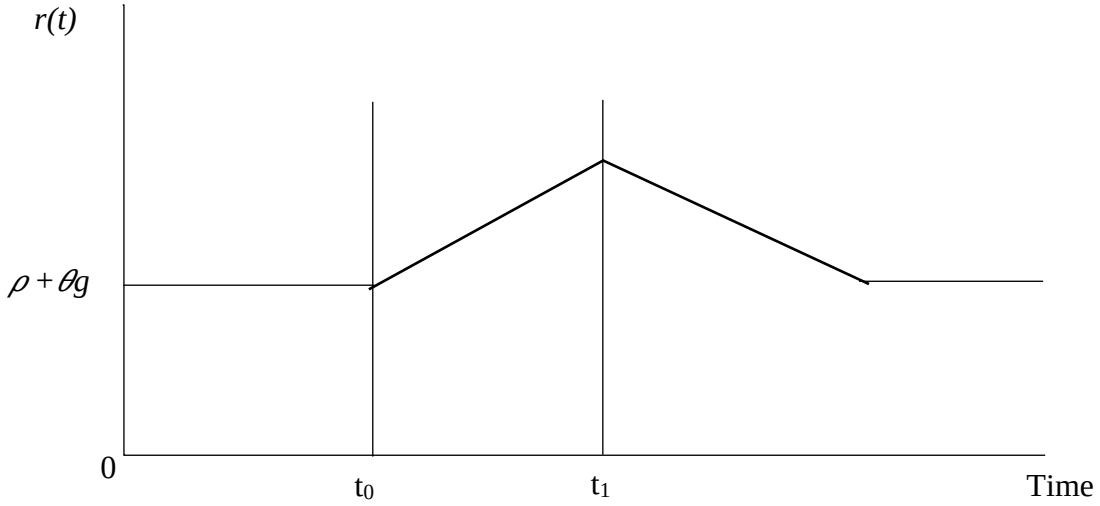
Figure 2.27: The effects of a permanent increase in government spending

Source: Romer (2006)

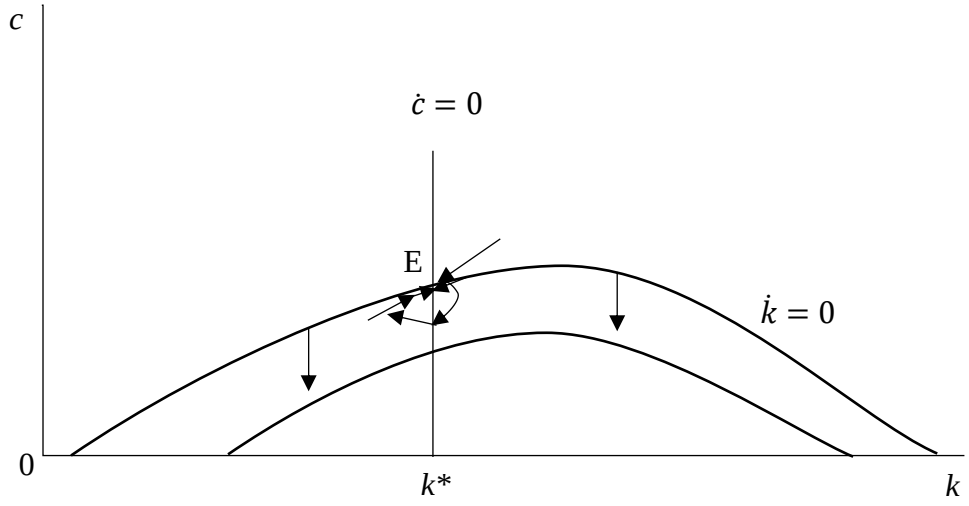
However, in the Solow approach, the consumption behaviour of households is modelled in a manner that shows that consumption depends only on current disposable income. It assumed that consumption is a proportion of current disposable income and thus consumption falls by less than the amount of increase in government spending thereby reducing capital stock and crowding out investment. This analysis can be viewed from an unanticipated and temporary increase in government spending scenario. A temporary and unanticipated increase in G shows that consumption will not fall by the full amount of the increase in G (that is $G_H - G_L$). If otherwise, there would be a discontinuous jump up in the consumption (discontinuous fall in marginal utility) which will push government spending to G_L. After G returns to G_L is expected, the discontinuous marginal utility would be expected which would be suboptimal for households.



(a)



(b)



(c)

Figure 2.28: The effects of a temporary increase in government spending

Source: Romer (2006)

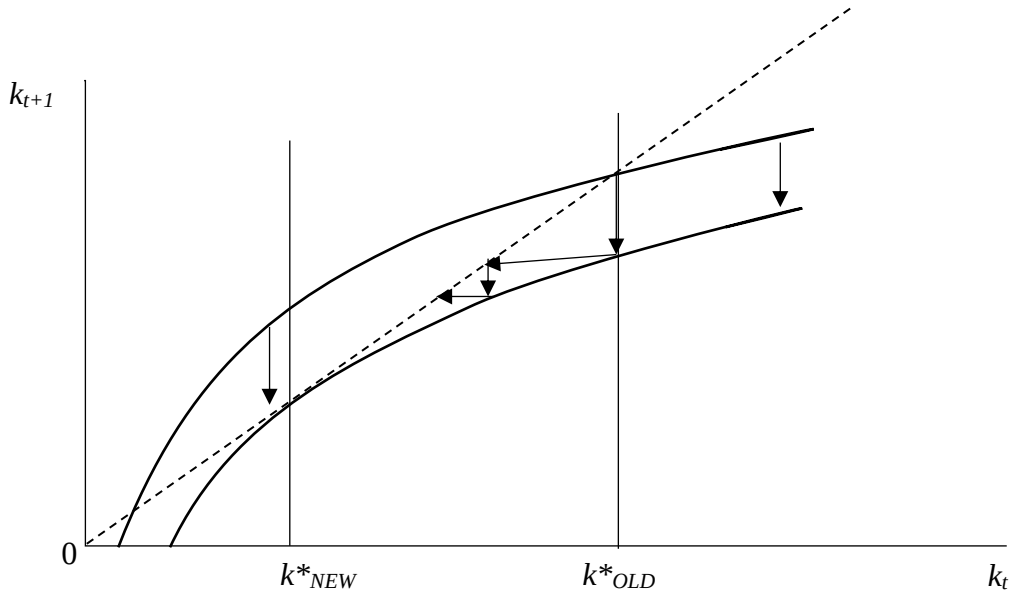
Panel (a) in Figure 2.28 reveals a situation where an increase in G is relatively long-lasting. In this situation, c declines by a corresponding increase in G. Thus, as G returns to G_L, capital holdings decline as a result of an expected decline in G while households' consumption increases. In panel (b) t_0 captures the period of high G and t_1 measures the period of return to the initial value. Panel (c) reveals the situation of a short-lived increase in G. In this situation, there is a little change in households' consumption while focusing on payment of the temporary increase in taxes from their savings. Since high government spending is temporary, capital stock and the real interest rate are marginally affected. This model is intuitive in analysing the role of government in the growth process but the nature of government spending is not captured in the model. The implication of other sources of government finance is not taken into account in the model. Since the model relies on neoclassical assumption exogenous technical progress as a source of growth, then the long-run effect of government spending was not captured by the model.

The Diamond Model

In the diamond model, the role of government is also captured through government spending and taxes levied. The model assumed logarithmic utility and Cobb-Douglas production function. G_t captures the government spending on goods and services per unit of effective labour in time *t*. The taxes levied on young people are used to finance government spending. As the government finances its expenditure with the total taxes collected, the income after-tax in time *t* becomes $(1-\alpha)k_t^{\alpha} - G_t$ rather than $(1-\alpha)k_t^{\alpha}$. Thus, the evolution of k is given by:

$$k_{t+1} = \frac{1}{(1+n)(1+g)}\frac{1}{2+\rho}\left[(1-\alpha)k_t^{\alpha} - G_t\right] \tag{2.10}$$

An increase in G_t leads to a reduction of k_{t+1} given the level of k_t. To ascertain the effect of government spending and assuming that the growth is on the balanced path, a permanent increase in G_t leads to a reduction in k_{t+1} as depicted in Figure 2.29.



(c)

Figure 2.29: The effects of a permanent increase in government spending
Source: Romer (2006)

This permanent increase in government spending reduces capital stock from k^*_{old} to k^*_{new}. Contrary to the infinite-horizon model, an increase in government spending will result in to decline in capital stock and an increase in real interest rate. Instinctively, households reduce their consumption in the first-period in less than one-for-one with an increase in government spending since they live for only two periods. The households' saving decline as the government levied taxes only in the first period of life thereby moving the economy to a new balanced growth path. On the other hand, a temporary increase in government spending will not motivate the households to respond immediately since the effect is short-lived.

Bajo-Rubio's Model

Bajo-Rubio (2000) developed the augmented form of the Solow growth model with the introduction of the public sector. The aggregate production function captures private capital, capital of government, public physical capital and indirect capital through externalities resulting in accumulation and growth, (Cashin, 1995). The transfer is captured in the model to account for property rights. He proposed the following production function as presented:

$$Y = K^{\alpha} Z_1^{\beta_1} \cdots Z_m^{\beta_m} (AL)^{1-\alpha-\sum_{i=1}^{m}\beta_i} \left(\frac{KG}{K}\right)^{\gamma} \left(\frac{TR}{K}\right)^{\theta} \quad (2.11)$$

Where $\alpha > \gamma + \theta$

Y captures the output in the economy, K is the capital for the firm, Z measures other private inputs (such as human capital- see Mankiw et al. (1992); knowledge capital-see Nonneman and Vanhoudt (1996), L is labour, A is the efficiency of labour, KG and TR measures the government-provided inputs: public physical capital and transfer payment, respectively. The model relies on the assumption that public services are congested (rivalry and non-excludable). All the producers benefit from the provision of public inputs, and consumption by a producer reduces the availability of the inputs for others (see Barro and Sala-i-Martin, 1992). Thus the per capita form of equation 2.11 is presented as:

$$y = Ak^{\alpha} z_1^{\beta_1} \cdots z_m^{\beta_m} (AL)^{1-\alpha-\sum_{i=1}^{m}\beta_i} \left(\frac{KG}{K}\right)^{\gamma} \left(\frac{TR}{K}\right)^{\theta} \quad (2.12)$$

Equation 2.12 exhibits decreasing return to scale in private capital and all private inputs gave the level of crowdedness in the utilization of public capital and transfers (unlike Barro, 1990; that relies on the assumption of constant returns to scale). The equations of motion for K and Z are:

$$\dot{K} = s_K(1-\tau)Y - \delta K \tag{2.13}$$

$$\dot{Z} = s_{Z_i}(1-\tau)Y - \delta Z_i \;\; \forall \; i = 1,...,m \tag{2.14}$$

s_K and s_{Z_i} capture the shares of gross investment in private physical capital and other private inputs, respectively in the private aggregate output. τ measures the size of the public sector; δ is the depreciation rate. Thus, the evolution of public capital is expressed as:

$$\dot{KG} = s_{KG}\tau Y - \delta KG \tag{2.15}$$

Where s_{KG} is the share of gross public investment in public output and depreciation is the same as the one charged on private capital. Thus, the rates of change in the stocks of the reproducible factors are given as:

$$g_k = \frac{\dot{K}}{K} - g_A - n \tag{2.16}$$

$$g_{z_i} = \frac{\dot{Z}_i}{Z_i} - g_A - n \quad \forall i = 1,...,m \tag{2.17}$$

$$g_{kg} = \frac{\dot{KG}}{KG} - g_A - n \tag{2.18}$$

Therefore, $g_.$ captures the rate of growth of private capital, other private inputs, and public capital, g_A is the rate of technical progress. The steady-state values can be derived from equations (2.16)-(2.18). There is also an assumption that transfer is:

$$\bar{tr}^* = \frac{s_{TR}\tau y^*}{A} \tag{2.19}$$

s_{TR} is a share of transfers in public output at steady-state. By taking the log, the steady-state output can be presented as:

$$\ln y^* = \ln A_0 + g_A t - \frac{\alpha + \sum_i \beta_i - \theta}{1-\alpha-\sum_i \beta_i}\ln(\delta + g_A + n) + \frac{\alpha-\gamma-\theta}{1-\alpha-\sum_i \beta_i}\ln s_k +$$
$$\frac{\beta_1}{1-\alpha-\sum_i \beta_i}\ln s_{z_i} + \cdots + \frac{\beta_m}{1-\alpha-\sum_i \beta_i}\ln s_{z_m} + \frac{\gamma}{1-\alpha-\sum_i \beta_i}\ln s_{KG} + \quad (2.20)$$
$$\frac{\theta}{1-\alpha-\sum_i \beta_i}\ln s_{TR} + \frac{\gamma+\beta}{1-\alpha-\sum_i \beta_i}\ln \tau + \frac{\alpha + \sum_i \beta_i - \gamma - \theta}{1-\alpha-\sum_i \beta_i}\ln(1-\tau)$$

Following Barro and Sala-i-Martin (1995), an approximation around steady-state was made such that:

$$\frac{d \ln \bar{y}}{dt} = -\lambda(\ln \bar{y} - \ln \bar{y}^*) + \theta(g_{TR} - g_A - n)t \quad (2.21)$$

The speed of convergence is measured by $\lambda = (1-\alpha-\sum_{i=1}^{m}\beta_i + \theta)(\delta + g_A - n)t$

Re-arranging and manipulating equations 2.20 and 2.21, we have:

$$g_y = (1-\theta)g_A + \frac{(1-e^{-\lambda t})}{t}\left\{\begin{array}{l} \ln A_0 - \frac{\alpha+\sum_i \beta_i - \theta}{1-\alpha-\sum_i \beta_i}\ln(\delta + g_A + n) + \frac{\alpha-\gamma-\theta}{1-\alpha-\sum_i \beta_i}\ln s_k + \\ \frac{\alpha-\gamma-\theta}{1-\alpha-\sum_i \beta_i}\ln s_k + \frac{\beta_1}{1-\alpha-\sum_i \beta_i}\ln s_{z_i} + \cdots + \frac{\beta_m}{1-\alpha-\sum_i \beta_i}\ln s_{z_m} + \\ \frac{\gamma}{1-\alpha-\sum_i \beta_i}\ln s_{KG} + \frac{\theta}{1-\alpha-\sum_i \beta_i}\ln s_{TR} + \frac{\gamma+\beta}{1-\alpha-\sum_i \beta_i}\ln \tau + \frac{\alpha+\sum_i \beta_i - \gamma - \theta}{1-\alpha-\sum_i \beta_i}\ln(1-\tau) - \ln y_0 \end{array}\right\} + \theta(g_{TR} - n) \quad (2.22)$$

Note that $g_y = \frac{(\ln y_t - \ln y_0)}{t}$, equation 2.22 shows the non-monotonic relationship between per capita output growth rate and the public sector's size. This implies an inverted U-shaped relationship between growth and the public sector. Intuitively, higher levels of public inputs enhance growth however, a small share of output is available for private capital accumulation. This model is intuitive in analysing the role of the public sector. However, the model does not take into account the utility functions of the households, nature of government expenditure (nature of taxes) and government budget

constraint. In essence, issues about productive or unproductive or taxes (distortionary and non-distortionary) are not captured in the model.

2.2.3. The Endogenous Growth Theory

The endogenous growth theory (EGT) was developed due to some deficiencies in the neoclassical growth theory in explaining long-run growth. The theory argues that long-run growth emanates from economic activities that produce new knowledge of technological progress. It further explains that long-run economic growth is determined by internal forces within the economic system especially, those forces that guide the incentives and opportunities to produce new ideas on technological progress. Long-run growth depends on total factor productivity (TFP) growth rate which is driven by the technological progress rate. As cited in Aghion and Howitt (1998), Rea (1934) appears to have argued for the invention as a key source of economic growth. The argument for long-run economic growth by the neoclassical growth theory of Solow (1956) and Swan (1956) proposes that technological progress is determined by independent or external economic forces. Thus, it suggests that the long-run growth rate relies heavily on exogenously determined factors (that is, outside the economic system).

Realistically, growth relationships are also assumed by many EGT models. For instance, establishing permanent growth requires a linear model in differential equation form. This implies that within the modelling framework, something is assumed to grow without limit. For the neoclassical growth assumption, productivity grows exogenously while endogenous growth assumption is that growth results from accumulation and scale. On the other hand, EGT theorists explain the process through scale impact on productivity positively. The positive relationship between scale and productivity is expected to offset or outweigh the impact of the diminishing return. More importantly, it shows how technological progress takes place through innovation (such as new products, processes, and markets) resulting from economic activities. In addition, many innovations arise from investment in R&D undertaken by profit-seeking firms and this investment is affected by economic policies such as education, trade, taxes competition, and intellectual property via high private cost and low benefits from investment in R&D.

EGT is characterized by two different theories, namely: AK and innovation-based. AK theory is the first version of endogenous growth theory with no clear distinction between the accumulation of capital and technological progress. Physical and human capital are not accounted for separately in the model of the theory. Frankel (1962) proposes the early version of this theory where there is an assumption of the constant or increasing marginal product of capital in the aggregate production function. Explicitly, as a firm accumulates more capital, some proportion of this capital is intellectual capital that produces technological progress, and this technological progress, in turn, counterbalance the marginal diminished return to capital. The AK theory argues that the long-run growth rate relies on the economy's saving rate and, as the saving rate increases, there will be a perpetually high growth rate. A similar analysis was done by Romer (1986) with improvement on Frankel's model by using a more general production structure with an assumption that saving is being created by intertemporal utility maximisation rather than the fixed saving rate in Frankel's model.

On the other hand, innovation-based theory distinguishes between intellectual capital (as a source of technological progress) and physical and human capital. The accumulations of physical and human capital are done through saving and education while innovation arises from the accumulation of intellectual capital. Romer (1990) introduces one version of innovation-based theory with an assumption that aggregate output is an increasing function of the degree of product variety. By this, innovation promotes output growth through the creation of new varieties of products. Another version of this theory is the 'Schumpeterian' theory developed by Grossman and Helpman (1991) and Aghion and Howitt (1992). This theory focuses on the improvement of innovation quality that makes old products outdated through the process of 'creative destruction[16]'. Aggregate output depends on a variety of intermediate products. The innovation-based theory argues that output can only grow rapidly when a large portion of the output is directed towards research and development rather than saving.

Apart from different theories in endogenous growth, there are many models but for this study, the review would be limited to models with public capital or government

[16] Term developed by Schumpeter (1942).

spending. The fundamental models under this theory are Barro (1990), and Devarajan, Swaroop, and Zou (1996). These models are discussed as follow:

Barro's Model

As explained earlier, most of the recent economic growth models argue that long-run growth no longer depends on exogenous changes in technology or population (Barro, 1990). The majority of these models are found in theories of technological progress (Romer, 1986; Agbion and Howitt, 1992; Grossman and Helpman, 1991) and population change (Becker and Barro, 1988; Becker, Gary, Murphy, Kevin and Tamura, 1990). These models exhibit either constant or increasing returns in the accumulated capital (Lucas, 1988; Romer, 1990; and Rebelo, 1991). Endogenous growth models rely on two propositions: divergence of private and social returns to investment that makes the decentralised choices lead to suboptimal saving rates and economic growth (Arrow 1962 and Romer, 1986) and absence of externalities where there is Pareto optimal in the privately determined choices of saving and growth (Rebelo, 1991). Barro's model is built on these two propositions.

The endogenous growth models that rely on the assumption of constant returns to capital utilised a representative with the infinite-lived household in a closed economy to maximise overall utility presented as:

$$U = \int_0^{\infty} u(c)e^{-\rho t}dt \tag{2.23}$$

The models considered the instantaneous utility function presented as follows:

$$u(c) = \frac{c^{1-\pi} - 1}{1 - \pi} \tag{2.24}$$

The household-producer production function is

$$y = f(k) \tag{2.25}$$

The solution of the three equations above implies that the consumption growth rate is given by

$$\frac{\dot{c}}{c} = \frac{1}{\pi}.(f' - \rho) \tag{2.26}$$

Where f' represents the marginal product of capital, ρ is the constant rate of time preference, and π measures the marginal utility. Following Rebelo (1991) assumption of constant returns to capital, the household-producer production is presented as:

$$y = Ak \tag{2.27}$$

In this model, viewing capital as a combination of human and non-human capital is more intuitive. According to Becker and Barro (1988) schooling, training and the cost of raising children are forms of human capital investment. The capital inputs (human and physical) in the production function are not necessarily a perfect substitute. When these capital inputs are introduced separately in the production process, the production function may exhibit marginal diminishing returns. However, if the capital inputs are jointly introduced into the production, the production function may exhibit a constant return to scale. Therefore, Barro extended the Ak model to include two sectors. The extended model assumed that the economy is at steady-state growth where consumption, capital, and output grow at the rate of per capita growth. Explicitly, the extended model was modified to include the public sector[17]. Private production now uses public service[18]. Unlike human and non-human capital in the original production function, the extended model has private and public capital jointly (thus exhibiting constant returns to scale) and otherwise, if they entered separately (that is, diminishing return). Given the assumption of a constant return to scale, the production function is presented as follows:

$$y = \chi(k, g) = k \cdot \theta \frac{g}{k} \tag{2.28}$$

The χ satisfies the conditions for positive and diminishing marginal products, such that $\theta' > 0$ and $\theta'' < 0$ (though previous studies such as Arrow and Kurz (1970), utilized stock of public capital while Barro (1990) adopted the flow of public service in the production process which allows it to determine growth from endogenous factor (technological progress). From equation 2.28, variable k captures the representative producer's capital quantity (that is per capita amount of aggregate capital) and g represents per capita quantity of government spending on goods and services. Barro's model clarifies the role of government and the private sector in the model. In essence, rental income of public capital is omitted from the national accounts, thus government

[17] Assumption of no user charges and congestion effects.
[18] This captures the productive role of government in the growth process.

only purchases the flow of output from the private sector which government makes available to the households that are used in the private sector production process. It further accounts for partial non-rivalry of the public services in the model. The private and public capital are not close substitutes due to difficulty in the introduction of user fees (non-excludability-national defence) or user fee undesirability (non-rivalry). Thus, equation 2.29 assumes that government spending is financed instantly by flat-rate income tax:

$$g = T = \delta y = \delta \cdot k \cdot \chi\left(\frac{g}{k}\right) \tag{2.29}$$

From equation 2.29, g represents the aggregate government expenditure and T captures the aggregate revenue. The δ is the tax rate and the government constraint is subjected to a balanced budget. This implies that the government can neither accumulate assets by running a surplus budget nor issue debt by relying on deficit finance. Considering the marginal product capital of the production function, the growth rate of consumption can be summarized as:

$$\lambda = \frac{\dot{c}}{c} = \frac{1}{\pi} \cdot \left[(1-\delta) \cdot \chi\left(\frac{g}{y}\right) \cdot (1-\eta) - \rho \right] \tag{2.30}$$

The growth rate λ can only be constant when δ and $\frac{g}{y}$ grow at a constant rate which is not different from the analysis in Ak model since k and y start from initial points of $k(0)$ and $y(0)$. Also, the economy does not pass through any transitional dynamics and is always at a steady-state growth position where all variables grow at a constant rate of λ. Now considering different sizes of governments[19], there are two effects of the tax rate on growth. First, when there is an increase in the tax rate, the growth rate declines. Second, when the tax rate increases the marginal product of capital increases. The first effect dominates when the size of government is large while the second effect dominates when the size of government is small. Under Cobb-Douglas technology[20], the conditions

[19] Different values for aggregate expenditure per output and tax rate.

[20] Where $\frac{y}{k} = \chi\left(\frac{g}{k}\right) = A \cdot \left(\frac{g}{k}\right)^{\alpha}$ in the case of η (the elasticity of output) = α such that $0 < \alpha < 1$

.

$\delta = \frac{g}{y}$ and $\frac{g}{k} = \left(\frac{g}{k}\right) \cdot (\chi' - 1)$ suggest that the derivative of λ with respect to $\frac{g}{y}$ is (given that η is constant):

$$\frac{d\lambda}{d\left(g/y\right)} = \frac{1}{\theta}\left(\frac{g}{k}\right) \cdot (\chi' - 1) \tag{2.31}$$

Therefore, as g/y increases, the growth rate also increases given that $\frac{g}{k}$ is relatively small such that $\chi' > 1$. On the other hand, a decline in g/y leads to a reduction of growth rate given that $\frac{g}{k}$ is relatively large such that $\chi' < 1$. Thus, in a Cobb-Douglas technology, the maximisation of growth rate depends on the size of the government given that there is a natural condition for productive efficiency[21].

This model dealt with the role of government extensively in the endogenous growth theory with the conclusion that an economy can only experience a positive growth rate over some range of time, only if such economy is adequately productive compared to the time preference rate. On the other hand, it would record a negative growth rate when such an economy is not sufficiently productive relative to the rate of time preference.

Devarajan et al.'s Model

This model improves on Barro's model by categorising government expenditure in two, namely: productive and unproductive. Unlike Barro that focuses on the aggregate government expenditure. This categorisation is to unravel the challenges associated with the public sector-growth relationship. The studies on government-growth nexus (such as Landau (1983); Aschauer (1989) and Barro (1990) could not establish a clear-cut relationship as most of their findings are mixed (positive and negative relationship). Thus, Devarajan et al.'s model demonstrates how a shift in the mix (that is, productive and unproductive expenditure) affect the long-run growth rate in the economy. Thus, the

[21] Where $\chi' = 1$, given that $\alpha = \eta = \chi' \cdot \left(g/y\right)$. Therefore, it means that $\alpha = g/y = \delta$. This implies that growth rate is maximised when government sets its share of output equal to the share it would accrue when the flow of public services is assumed to be competitively supplied as inputs in the production process.

aggregate production function has three arguments, namely: the stock of private capital (k), productive expenditure (g_1) and unproductive expenditure (g_2). Applying the functional form of constant elasticity of substation (CES) to the relationship between government and growth, we have:

$$y = f(k, g_1, g_2) = \left[\beta_1 k^{-\alpha} + \beta_2 g_1^{-\alpha} + \beta_3 g_2^{-\alpha} \right]^{-\frac{1}{\alpha}} \tag{2.32}$$

Where $\beta_1 > 0$, $\beta_2 \geq 0$, $\beta_1 + \beta_2 + \beta_3 = 1$, $\alpha \geq -1$

There is also an assumption that the government finances its public investment through a flat-rate income tax[22], δ such that:

$$\delta y = g_1 + g_2 \tag{2.33}$$

The two types of government expenditure can be expressed as:

$$g_1 = \chi \delta y \text{ and } g_1 = (1-\chi)\delta y \tag{2.34}$$

Assuming that the decisions of government on δ and χ are given, thus the representative household chooses consumption, c, and capital, k, to maximise his welfare:

$$U = \int_0^{\infty} u(c) e^{-\rho t} dt \tag{2.35}$$

Such that:

$$\dot{k} = (1-\delta) y - c \tag{2.36}$$

Where ρ represents the rate of time preference. The utility of the household is in isoelatsic form as presented below:

$$u(c) = \frac{c^{1-\phi} - 1}{1-\phi} \tag{2.37}$$

Solving equations 2.32-2.37 yield the growth rate of consumption:

$$\frac{\dot{c}}{c} = \frac{\beta_1 (1-\delta) \left\{ \beta_1 + (g/k)^{-\alpha} \left[\beta_2 \chi^{-\alpha} + \beta_3 (1-\chi)^{-\alpha} \right] \right\}^{-(1+\alpha)/\alpha} - \rho}{\phi} \tag{2.38}$$

[22] Note that the model follows the assumption that there is no deficit or surplus for government and the role of tax is not captured (see Easterly, 1989; Easterly and Rebelo, 1993).

By assuming that steady-state growth rate of consumption (λ) and tax rate[23] (δ) are constant, it then implies that g/k is constant. Thus, equations 2.32-2.34 yield:

$$g/k = \left\{\left[\delta^{\alpha} - \beta_2 \chi^{-\alpha} - \beta_3 (1-\chi)^{-\alpha}\right] / \beta_1\right\}^{1/\alpha} \tag{2.39}$$

Equations 2.38 and 2.39 yield:

$$\lambda = \frac{\beta_1 (1-\delta)\left\{\beta_1 \delta^{\alpha} / \left[\delta^{\alpha} - \beta_2 \chi^{-\alpha} - \beta_3 (1-\chi)^{-\alpha}\right]\right\}^{-(1+\alpha)/\alpha} - \rho}{\phi} \tag{2.40}$$

From equation 2.40, the relationship between the steady-state growth rate and the share of government expenditure directed to g_1 is

$$\frac{d\lambda}{d\chi} = \frac{\beta_1 (1-\delta)(1+\alpha)[\beta_1 \delta^{\alpha}]^{-(1+\alpha)/\alpha}\left[\beta_2 \chi^{-(1+\alpha)} - \beta_3 (1-\chi)^{-(1+\alpha)}\right]}{\phi\left[\delta^{\alpha} - \beta_2 \chi^{-\alpha} - \beta_3 (1-\chi)^{-\alpha}\right]^{-1/\alpha}} \tag{2.41}$$

Thus, the productive expenditure is the public expenditure component in which an increase in its share raises the steady-state growth rate of the economy. In addition, the shift in the composition of the expenditure depends on some conditions[24] before the growth rate can increase. However, if the initial share (α) is very large, a shift in more productive expenditure may not increase growth rate. Intuitively, there is a condition that the shift in the mix in favour of g_1 can enhance long-run growth rate in the economy when a relative portion of public expenditure is directed towards g_1 and g_2 less than their relative output elasticities (that is, β_2 and β_3 are the associated output elasticities to g_1 and g_2, respectively). It further implies that allocating resources from g_2 to g_1 will increase the steady-state growth rate only if the condition holds. A situation where the output elasticity of g_1 is greater than output elasticity of g_2 is not enough to establish that a shift to g_1 will raise the steady-state growth rate but requires relative budget shares to be lower than output elasticities. In the case that the two types of expenditure are substitutes, there is a likelihood of an increase in the share to the higher coefficient to

[23] Note that $\delta = g/y$

[24] $(1+\alpha)\left[\beta_2 \chi^{-(1+\alpha)} - \beta_3 (1-\chi)^{-(1+\alpha)}\right] > 0$; $\frac{d\lambda}{d\chi} > 0$ if $\frac{\chi}{1-\chi} < \left(\frac{\beta_2}{\beta_3}\right)^{\sigma}$ where $\sigma = 1/1+\alpha$, the elasticity of substitution.

enhance growth. However, when the elasticity of substitution is low, an increase in the share of g_1 may not increase the growth rate. In addition, more allocation to productive expenditure will raise the growth rate even when the total expenditure remains unchanged.

Extension of the model to infinite components of government expenditure does not add something intuitively but makes it cumbersome and any shift to productive expenditure will have the same effect on the steady-state growth rate as established above. Also, the introduction of the unimportant component of government expenditure will enter the production function as zero without altering the previous outcome. Finally, the decision of the government is assumed to be given rather than derived, within the framework of the model. Thus, the government's objective function is not captured in the model. In summary, the model provides an answer to how components of government expenditure (i.e., productive) affect growth through its budget share relative to output elasticities rather than the sign of the exponent in the production function.

2.3.Methodological Literature Review

This section examines different methodological approaches adopted by previous studies and their implications for findings. It also explores the strengths and weaknesses of these approaches. For ease of appreciation, this section is subdivided into four categories, namely: short-run evidence, long-run evidence, simulation, and calibration exercise, and others.

2.3.1. Short-run Evidence

There have been several developments in the short-run modelling approach for measuring the growth effects of fiscal policy. These approaches include Ordinary Least Square (OLS), Instrumental Variables (IV), Fixed-Effectss (FE), Random-Effect (RE), Structural Threshold Regression (STR), Two-Stage Least Squares (TSLS), System Generalized Method of Moments (SGMM), Least Square Dummy Variable (LSDV), and Vector Autoregressive (VAR). In exploring the growth effects of fiscal policy, some studies rely on either government expenditure or taxation or fiscal deficit to measure the role of fiscal policy. Most earlier and few recent studies employed OLS to examine the role of taxation or expenditure on growth. These studies include Landau (1983), Laudau

(1985), Koester and Kormendi (1989), Martin and Fardmanesh (1990), Easterly and Rebelo (1993), Marsden (1993), Mendoza, Milesi-Ferreti and Asea (1997), Folster and Henrekson (1999), Alesina,Ardagna, Perotti and Schiantarelli (2002), Burdekin, Denzau, Keiil, Sitthiyot and Willett (2004), Mendizabal (2006), and Aisen and Veiga (2008). Despite the theoretical assumption of maximum likelihood solution and Gauss-Markov conditions, there are a lot of issues with OLS at time series or panel levels such as outlier, not normally distributed data, and endogeneity among others. In the panel form, OLS disregards the panel structure of data by ordinarily pooling data together on the units. Heterogeneity issue arising from cross-section is ignored. It further assumes that the coefficients for all units are treated as the same in all time-periods without accounting for possible heterogeneity.

Several studies have utilised panel fixed effects to examine the role of fiscal policy. These studies include Cashin(1995), Deverajan, Swaroop and Zou (1996), Miller and Russek (1997), Folster and Henrekson (2001), Dar and AmirKhalkhali (2002), Adam and Bevan (2005), Gupta, Clement, Baldacci and Mulas-Granados (2005), Angelopoulus, Economides and Kammas (2007), Colombier (2009), Afonso and Furceri (2010), and Bergh and Karlsson (2010). These studies largely focused on OECD countries. The availability of data promotes the adoption of panel data where effects are captured using the available information demonstrating changes with countries over a period of time. The methodological approach treats omitted variables that are responsible for growth variation among countries as a constant within the individual country. The influence of these variables on growth is assumed to be captured by country fixed effect. This approach ignores relevant information about cross-section. For instance, the small change happening in government size within the sample countries over time is always captured by fixed effects which may falsely show that the change is significantly thus, implying negative growth effects from government size. At times, the estimates from within-country variation and cross-country variation are not significantly different.

Also, the dynamic fixed-effects models are established to be biased and/or inefficient due to the presence of the lagged dependent variable and omitted variable bias associated with the country-specific effects. This bias is caused by the time and cross-section

natures of the panel as well as regressors' homogeneity. That is, the differenced dependent variable (in the case of growth rate) is correlated with the differenced error term even if the current error term is not serially correlated. Thus, by design, the lagged dependent variable is correlated with the average of the common cross-section time-series effect. Since the latter average contains a cross-section time-series effect which is correlated with the lagged dependent variable, the current common cross-section time-series effect is also correlated with a mean of lagged dependent variable. This correlation renders both within estimator fixed effect and LSDV estimator inconsistent most especially when N is large and T is small.

In addressing the methodological problems above, some studies explore instrumental variables and least square dummy variable (Laudau, 1985; Kneller, Bleaney and Gemmell, 1999; Agell, Ohlsson, and Thoursie, 2006; Bond, Leblebicioglu and Schiantarelli, 2010), and two-stage least squares and generalized method of moments (Egen and Skinner, 1992; Agell, Lindh, and Ohlsson, 1999; Gupta, Clements, Baldacci and Mulas-Granados 2005; Baum, Checherita-Westphal, and Rother, 2013; and Bojanic 2013). The least dummy variable is another form of fixed effect that accounts for an intercept dummy variable for each unit or individual. In essence, it incorporates dummy variables as regressors to capture the individual effects in the model. This method does not address the problems of endogeneity. The use of generalised least squares (GLS) of random effects for a dynamic model produces the same result as LSDV estimation of a fixed effect. Despite the inclusion of the dummy variables and quasi-demeaning process, the dependent variable will still be correlated with residuals and thus the estimators are rendered biased and inconsistent.

To overcome the inherent methodological challenges of LSDV and GLS in estimating unbiased, consistent and efficient estimators for the growth effects of fiscal policy, two-stage least squares and generalized method of moments (Egen and Skinner, 1992; Agell, Lindh, and Ohlsson, 1999; Gupta, Clements, Baldacci and Mulas-Granados 2005; Baum, Checherita-Westphal, and Rother, 2013; Kourtellos, Stengos and Tan, 2013; and Bojanic, 2013; Ehrhart, Minea, and Villieu, 2014) were adopted. Many studies have also ascertained that growth regressions are characterised by many concerns (Islam, 1995; Temple, 1999). For instance, Caselli, Esquivel, and Lefort (1996) identified two main

sources of a challenge with the methodology of empirical studies on growth which are incorrectness of country-specific effects treatment (capturing technological differences and variation in preferences which lead to omitted variables bias). Most independent variables might be endogenous to growth and issues of reverse causality and simultaneity can also result in estimation bias. Instrumental variable estimator, the generalised method of moments (GMM) accounts for the endogeneity arising from the correlation between regressors and the effects. According to Arrelano and Bond (1991), there should be no second-order serial correlation for the remainder disturbances of the difference equation while the first-order autocorrelation is assumed to be in the first-differenced dynamic panel data models. It also allows for the inclusion of other drivers of growth as instruments to address the potential correlation between the lagged dependent variable and the remainder disturbance term. These instruments are validated through Sargan's test and Hansen's test. In addition, the differenced GMM is extended by Blundell and Bond (1998) to allow the use of lagged differenced of regressand as instruments for equations in first differences.

However, instrumental variable or GMM does not eliminate all issues related to endogeneity; only those associated with individual effects are eliminated. Another possible endogeneity bias arises when the growth equation is first differenced and there is a need for careful selection of valid instruments that will be correlated with the first-differenced growth and uncorrelated with common cross-section time-series effect. This approach only captures the short-run dynamics of the growth effect of fiscal policy while the long-run equilibrium relationship (which is critical in the growth framework) is neglected.

Further, a number of studies tried to model the short-run shocks of fiscal policy to growth using vector autoregressive (VAR) and structural autoregressive (SVAR) models. Exploring the empirical characterisation of the dynamic effects of changes in government spending and taxes on output, Blanchard and Perotti (2002) utilise the structural vector autoregressive modelling technique. Specifically, neoclassical and Keynesian traditions establish a short-run shock of fiscal policy on the output. There have been many recent developments in modelling short-run shocks through SVAR for country-specific and cross-country studies. Some studies have tried to capture the effects

of different events through conflict, war episodes, and natural disaster and the possible mechanism through these events affect the responses of output to fiscal policy in the short-run and long-run (see Romer and Romer, 2010; Ramey, 2011; and Barro and Redlick, 2011). This VAR approach addresses the endogeneity issue extensively relative to previous studies.

Unlike previous methods that capture a simple relationship, this approach captures causal effects and prediction (Gemmell and Au, 2013). This method is commonly applied to the public expenditure aspect of the fiscal policy while those studies which apply it to taxation are faced with either non-robustness of result or counter-intuitive results (see Auerbach and Gorondnichenko, 2012; Fielding, Parkyn and Gardiner, 2011). Thus, Gemmell and Au (2013) argue that endogeneity of tax revenue and tax rate measurements are complicated to address in the literature since the capacity of the SVAR method to capture feedback effects of tax revenue from other variables in the VAR, needs an endogenous revenue variable instead of measurement of tax rate in marginal or average term. In addition, the model is restrictive as it imposes convergence to a 'no impact' long-run equilibrium. Therefore, the important information on long-run fiscal policy effects in the data is lost. Although, this model is only testing for temporary shock rather than permanent change and such fiscal policy development will not account for long-run responses.

2.3.2. Long-run Evidence

Many challenges have been identified with short-run models; thus, many studies have tried to explore the model that is capable of capturing both short-run and long-run effects of fiscal policy on growth. The recent studies examine these effects using a panel data approach and mostly focused on the effect of tax rather than expenditure (that is most SVAR studies) on growth. Several studies applied the non-stationary heterogeneous panel to examine the effect of fiscal policy on growth. These studies include Kneller, Bleaney and Gemmell (1999), Romero-Avila and Strauch (2008), Arnold (2008), Gemmell, Kneller and Sanz (2011, 2014), Minea and Villieu (2012), Bal and Rath (2014), Eggoh and Khan (2014), Gomez-Puig and Sosvilla-Rivero (2017).

Considering the panel autoregressive modelling technique applied by recent studies, the approach allows these studies to take advantage of the long dataset (in terms of period and cross-section) by capturing short-run and long-run dynamics. The asymptotics of large N, large T dynamic panels are different from the asymptotics of traditional large N, small T dynamic panels (see Blackburne and Frank, 2007). The short panel such as fixed- or random-effects estimators as well as instrumental-variable estimators, pooled individual groups and only accounted for differential intercepts across the groups. This approach is applied to address the problem of heterogeneity adequately which is common to fiscal policy-growth studies. One of the relevance of this approach is that the assumption of homogeneity of slope parameter is always unsuitable (Im, Pesaran and Shin, 2003). This method can be sub-divided into three namely: differenced fixed effects (DFE), mean group (MG) and pooled mean group (PMG) estimators.

The DFE and MG estimators impose homogeneity assumptions on all slope coefficients and error variances across countries in the short-run. The implication is that short-run parameter homogeneity will yield unreliable estimates of the long-run responses thereby affecting the speed of convergence towards long-run equilibrium. However, PMG allows for homogenous long-run slope coefficients which are more efficient relative to other categories. In addition, PMG uses short-run parameter heterogeneity to estimate very reliable long-run responses of the estimate thus aiding the convergence of the short-run to the long-run equilibrium (Pesaran et al., 1999). However, the PMG estimator is only efficient when the time series is long because of the degree of freedom.

A cross-section growth regression faces the simultaneity problem between growth and fiscal policy variable as well as the control variables (Slemrod, 1995). The time and individual fixed effects used by studies to capture country-specific and time-varying features (such as political changes, conflicts, institutional quality, natural disasters among others) which affect fiscal policy and per capita GDP are not sufficient. The issue can be complicated in the growth framework where persistence fiscal time series, as well as long lags, are associated with fiscal policy and growth thus resulting in serial correlation in the residual process. There is a need for an adequate methodological approach such as ARDL because of its robustness in addressing such problems (see Pesaran, 1997 and Pesaran and Shin, 1999).

2.4.Empirical Literature Review

This section gives a detailed review of the literature on the growth effects of taxes and expenditures. Given the extensive discussions on the theoretical underpinnings of the role of taxes (or expenditures) in the growth in the previous section, we now proceed to examine different issues that emerged from the empirical evidence. Thus, this section is sub-divided into four, focusing on *first-generation* studies, *second-generation* studies, *third-generation* studies, and *fourth-generation* studies taking a cue from Gemmell (2001).

2.4.1. First-generation Studies

The studies under this generation are those before the development of endogenous growth models of Romer (1986, 1987) and fundamental extension by Barro (1990). These studies tried to provide possible explanations for the role of government through either expenditure or tax in growth of an economy. They are developed based on the public choice trepidations over the government growth between the 1960s and 1970s. These studies in these periods are marred by some deficiencies such as poor specification, use of limited dataset unreliable econometric approaches and support of little or no theory. Some of these studies are Landau (1983, 1985); Leffler (1978); Ram (1986); Saunder (1985); Katz, Mahler, and Franz (1983) among others. All these challenges lead to unreliable results which are non-robust or non-comparable (see Gemmell, 2001). Given the extensive work and development in this area both theoretically and empirically, this study will not pay more attention to this generation.

2.4.2. Second-generation Studies

This generation improves on the shortcomings of *first-generation* studies. Specifically, these are guided by the emerging endogenous growth theory and the modification of the neoclassical model. These studies examine extensively the role of fiscal policy in the growth process. Starting with a study by Koester and Kormendi (1989) which focuses on taxation, aggregate activity and economic growth reveals the negative effect of tax rates on economic growth but vanishes when the endogeneity of average tax rate was controlled for. Also, marginal tax rates have negative effects on the level of economic activity. Therefore, tax rates serve as a drag on economic growth.

Similarly, a study by King and Rebelo (1990) on the effect of public policy on economic growth and its emerging neoclassical implications show the incentive to accumulate capital can induce large differences in long-run growth rates through national taxation. Substantial national taxation in small open economies may have a positive effect or a negative effect on growth. This implies that the structure of the tax system significantly determines the growth rate in an economy either by experiencing "development traps", negative growth or "growth miracles", positive growth (King and Rebelo, 1990). This outcome is with a neoclassical framework suggesting the presence of Growth Laffer Curve (GLC) in small open economies.

Also, taxes are negatively related to GDP growth rate but may result in higher growth when their benefits with respect to deficits reduction are considered. On the other hand, when the impacts of government expenditures on the deficit are considered, the positive relationship between government expenditures and GDP growth turns negative. In addition, when deficits are contracted and deficit-reducing tax rises with a reduction in expenditure, the growth is impacted positively. A balanced budget expansion of taxes and expenditures is negatively related to GDP growth which suggests that the level of development in countries determines the effect of fiscal variables on GDP growth (Martin and Fardmanesh, 1990).

Further, a landmark contribution from Barro (1990) on how government spending works in the growth model, shows that the predicted long-run growth effects are associated with the combination of taxes and expenditures. This further implies that the long-run growth effect relies majorly on the types of taxes and expenditures explored by the government. Engen and Skinner (1992) establish strong and negative impacts of government spending and taxation on output growth. An increase in the balanced budget of government spending and taxation reduces long-term growth. This may be due to the distortionary effect of the tax on the factor inputs. Thus, they argue that the measurement of the tax base is more relevant relative to the ratio of tax revenue to GDP. In providing further explanation for the role of fiscal policy in the growth process, Easterly and Rebelo (1993) reveal a strong relationship between the level of development and fiscal structure. Although, poor countries explore international taxes to generate the needed

revenue while developed countries rely heavily on income taxes. The fiscal policy is driven by the scale of the economy in terms of population but isolating the effect of taxation on growth is observed to be challenging.

Considering a formal/informal sector model with different taxes applied across sectors, government consumption spending (a measure of high taxes on the formal sector) affects growth (Easterly, 1993) Contrarily, there is evidence that countries with lower taxes recorded higher growth in investment, productivity, employment, and government services and also experienced a higher growth rate with no discrimination (Marsden, 1993). Also, a study by Agell, Lindh, and Ohlsson (1997) reveals the possibility of establishing a clear-cut relationship from observations of public sector size to economic growth though it requires rigorous empirical proof. Thus, the disaggregated level of analysis was favoured compared to cross-country analysis for a better understanding of how the public sector works in the growth framework. Similarly, Razin and Yuen (1995) show that the growth effects of changes in capital income tax rates may be highly magnified by cross-border capital flows and cross-border spill-overs of policy effects. From productive and unproductive public spending dichotomy, Government transfers, consumption and total outlay influence growth negatively whereas educational expenditure is growth-enhancing, but government investment does not affect private productivity growth. The impact of government spending also works through total factor productivity but not through the marginal productivity of labour and capital (Hansson and Henrekson, 1994).

In an endogenous framework for a two-sector model with public capital, taxation is divided into three components, namely, income tax, capital tax, and wage tax. Examining the tax from its components suggests that the various taxes are growth-reducing as earnings by individuals and private capital accumulation are discouraged. An equal percentage of tax changes also show that wage taxes have a larger influence on the growth rates compared to capital consumption taxes (Devereux and Love, 1994). Considering the effect of government spending and taxes on economic growth, the increase in the provision of public capital and the transfer payment plays important role in enhancing growth, however, distortionary taxes levied on individuals and companies have growth-inhibiting effects. The spending of government directed towards the

provision of infrastructure creates an enabling environment for private investment growth which may compensate for the distortionary effect of taxes imposed on individuals and businesses (Cashin, 1995).

Exploring the role of the composition of public expenditure on economic growth was also considered. The findings reveal that not only the physical productivity of different components of public expenditure improves growth but also, the initial shares. Also, an increase in the share of current expenditure has positive and significant growth effects. On the other hand, there is a negative relationship between the capital component of public expenditure and per-capita growth. This suggests that the developing-country governments have been misallocating public expenditures more to capital expenditures relative to current expenditures (Deverajan, Swaroop and Zou, 1996). This is puzzling as many studies suggested capital investment transmission mechanisms for meaningful growth in developing countries. Though, most public investments in the developing countries were classified as unproductive which crowd out productive private or public investment thereby, possibly resulting in long-run growth reduction (Barro, 1990; Devarajan et al., 1996; Milesi-Ferretti and Roubini, 1998). The ineffectiveness of tax policy in altering long-run growth from Harberger's superneutrality conjecture shows that as taxes reduce, growth increases and when factor income taxes fall or consumption taxes rise, investment rate increases. In a situation where human capital accumulation is taxed market activity, the growth and investment effect of tax decline are stronger (Mendoza et al., 1997).

A State-level analysis by Miller and Russek (1997) on the role of fiscal structures in the growth process, the distortionary taxes (as classified by Barro, 1990) may exert a large influence on the equilibrium behaviour both along with the transitional dynamics and the balanced growth path. Also, capital income taxation plays a significant role along with the convergence of the balanced growth path. Distortionary taxes may exert a great impact on the equilibrium behaviour both along with the transitional dynamics and the balanced growth path. For instance, capital income taxation plays a significant role along with the convergence of the balanced growth path (Ortigueira, 1998). The government needs to identify the components of tax that are beneficial for long-run growth. The key objective of the government is to raise enough revenue from taxes to finance the public

investment, but low and high tax rates may be detrimental to long-run growth through private capital distortion when it is not well managed by the government. For instance, low tax rate puts the government at a disadvantage in providing public goods for private firms to thrive. On the other hand, the high tax rate provides the government with high revenue and its distortion of private capital accumulation can be minimized when the public investment is huge.

Contrary to a previous finding by Agell et al. (1997), their study in 1999, shows that the re-estimated growth equation results based on theoretically valid instruments, the growth effect of the public sector is not statistically significant with small point-estimates. This supports the argument that cross-country growth regressions are not likely to provide a valid answer to the role of the public sector in the growth process. However, Folster and Henrekson (1999) establish a robust negative growth effect of large public expenditures in rich countries. In conclusion, De la Fuente (1997) highlighted different ways through which fiscal policy can impact growth in OECD countries. First, the government plays a significant role in the growth process through public investment in infrastructure and other assets. Second, the crowding-out effect on private investment via a reduction in disposable income and the incentive to save. Third, distortion of productivity level due to negative externality effect of government. These studies reviewed above overlook the critical role of government budget constraint (GBC) as well as the significance of implicit (tax or debt) financing options.

2.4.3. Third-generation Studies

The studies in this category account for the implicit or explicit role of government budget constraint when analysing the effects of fiscal variables by considering at least two of tax/ expenditure/deficit effects jointly rather than separately (see Gemmell 2001). These studies come up with convincing evidence on the role of fiscal policy in predicting growth outcomes. A robust outcome from a study by Kneller, Bleaney, and Gemmell (1999) establishes that distortionary taxation is growth-retarding while non-distortionary is not growth-retarding and productive government expenditure is growth-enhancing while non-productive expenditure is not. These implicit financing options give a clearer picture to the government on which fiscal structure to explore in the growth process.

Similarly, Besci (2000) explains that tax policy should be in agreement with expenditure policy to avoid miscalculation of tax revenue. Also, tax rates reduction could enhance labour income and private capital thereby increasing productivity (that is, the higher the productivity of public capital, the likelihood that tax revenues will fall). The growth effect of fiscal policy crucially relies on budgetary regimes. Also, the public deficit in an economy does not necessarily mean a lower growth rate and growth-maximising income tax rate is within the range of the elasticity of output with respect to public capital (Greiner and Semmler, 2000). Improving on their earlier study, Bleaney Gemmell and Kneller (2001) found that a mixture of finances such as non-productive expenditure, and non-distortionary taxation, productive expenditure spur economic growth while distortionary taxation has a drag effect on the economic growth. Also, the budget surplus enhances growth in line with Ricardian equivalence as well as consumption taxation.

Further, the initial decline in revenues resulting from a permanent tax cut can be strengthened by an upward review of the tax base due to a dynamic Laffer effect and a non-trivial margin for substituting debt for taxes on labour and capital income. Therefore, higher welfare gain can arise from the highest feasible decrease in labour income tax rates relative to the highest feasible decline in capital income tax rates (Novales and Ruiz, 2002). Similarly, public spending negatively impacted profit and business investment. This is in line with pressures created by government employment for the private sector. Also, different types of taxes negatively influenced profits while government spending magnitude is larger (Alesina, Ardagna, Perotti and Schiantarelli, 2002). In a robust study by Gemmell and Kneller (2003) on fiscal policy, growth and convergence in Europe, the change in the overall share of taxes or spending in GDP or the annual budget surplus/deficit is not a good guide to whether growth effects of fiscal policy are likely to be positive or negative. The homogeneity across countries also matters in growth regression with fiscal policy. According to Heijman and Van Ophem (2005), high total tax revenue is associated with a lower tax rate and declines against it at its higher levels (Laffer curve). Under the Laffer effect, there may be a switch between official and unofficial sectors and all countries' marginal tax rates may be below their optimum.

Exploring the deficit component of fiscal policy, Adam and Bevan argue that there should be a threshold effect of a deficit level of around 1.5% of GDP in developing economies. The findings also reveal the associated growth payoff with deficit reduction but later vanishes during fiscal contraction. The growth payoff quantity relies on deficit change funded through either borrowing change or seigniorage change and its inclusion in the budget. The evidence further shows that high debt stocks escalate high deficit consequences. However, the implications of the escalated high deficit for the tax structure and growth outcomes were ignored in the analysis. This is very important for the developing countries in adjusting their fiscal policy framework for the positive growth effect of the tax.

From the expenditure view, Gupta, Clements, Baldacci, and Mulas-Granados (2005) reveal that strong budget positions are growth-enhancing in the short and long terms. Countries that spend largely on wages experienced a low growth rate while those with a larger allocation to capital and non-wage goods and services experienced faster output expansion. However, the generation faces some shortcomings such as limited evidence for public expenditure relative tax, conceptual and measurement challenges with respect to suitable tax rates and challenges in dichotomizing demand-side and supply-side effects of fiscal policy (see Romer and Romer, 2010). These studies reviewed under this generation are constrained with limited data available for robust outcomes. In addition, the studies do not consider the decomposition of public expenditure and APFOs.

2.4.4. Fourth-generation Studies

The studies in this category address some of the challenges raised in the *third-generation studies* and also explore the improvement in the dataset for robust empirical outcomes. Exploring the effect of the composition of optimal public spending on economic growth, Chen (2006) argues that the cross-country growth differentials are not explained by high productive public service share and a low public consumption share. However, these two adjustment terms only depend on optimal choices of the government in exploring them to promote growth. Similarly, the expansion of government spending in high-income economies through taxes impedes growth relative to seigniorage while otherwise in developing countries. This further suggests that when the investment's return is higher in the developed countries with low default risk, seigniorage will continue to be a viable

and optimal means of financing public expenditure. In the case of developing countries, a seigniorage is an inexpensive form of government finance which may tempt them to rely heavily on it. Alternatively, a tax-financed public investment tends to increase public expenditure that can enhance growth, and this may discourage them from over-reliance on seigniorage (Bose, Holman and Neanidis, 2007). This study further shows various ways through which governments in the developed and developing countries explore to finance their expenditure thereby impacting growth.

In addition, the share of productive government expenditure promotes higher growth. This implies that the productive components of government spending are necessary for the growth process rather than focusing on aggregate government spending. This is an interesting outcome from recent studies. The growth effects of tax rates and labour income tax rates (i.e., distortionary taxes) are growth-retarding whereas there are positive effects of capital income and corporate income tax rates (non-distortionary taxes) on the economic growth (Angelopoulos, Economides and Kammas, 2007). Greiner (2008) explains that there may exist a welfare-maximising labour income tax rate even when a higher labour income tax rate always raises the balanced growth rate.

Exploring the role of public finances in long-term growth in a cross-country framework, Romero-Avila and Strauch (2008) show that government size either measured by total expenditure or revenue shares, government consumption and direct taxation affect the growth of GDP per capita negatively. Considering the implications of a balanced budget and tax smoothing in a small open economy, Angryridis (2009) shows significant welfare gain conditioned on borrowing for tax smoothing over time rather than operating a balanced budget. On the heterogeneous impact of public capital and current spending across nations, Gregoriou and Ghosh (2009) reveal that the countries with large public capital (current) spending have strong negative (positive) growth effects.

In the analysis of Colombier (2009) on the growth effects of fiscal policies, there is a stable positive growth effect of public infrastructure and education. More so, government size is not growth-retarding for OECD countries. Astonishingly, Colombier (2009) establishes that there are no growth effects of taxation contrary to the endogenous growth theory proposition. Revisiting the Laffer curve using the US and EU as a case

study, Trabandt and Uhlig (2011) suggest that the US can increase its tax revenues to their maximum through 30% and 6% increase in labour and capital taxes, respectively. EEU-14 can get maximum tax revenue with 8% and 1% while individual European countries need 54% of a labour tax cut and 79% of a capital tax cut and the consumption tax Laffer curve fails to peak. The contribution of Gemmell, Kneller, and Sanz (2011) to the timing and persistence of fiscal policy impacts on growth shows positive growth effects associated with productive public spending changes which are approximately counteracted by tax changes with negative effects. The higher tax rate may have a significant negative effect on the growth rate; however, it is largely counterpoised by a significant positive growth effect of the productive government expenditure accompanied by high tax rate resulting in a small net effect. The result further shows relative short timeframes between fiscal policy changes and the full estimated impact on GDP growth empirically over the years.

However, Teles and Mussolini (2014) argue that there is non-existence of positive and significant impact of productive expenditures on growth without interactions while the existence holds under interaction which depends on various fiscal variables. Nutahara (2015) shows that the labour tax rate is smaller than the Laffer curve peak while the capital tax rate is higher than the Laffer curve peak. The consumption tax rate is detrimental to the total tax revenue. Also, total tax revenue can be maximised through an increase in the labour tax rate while reducing the capital tax rate. In the analysis of the dynamic Laffer curves, population growth and public debt overhangs, the findings of Tsuchiya (2016) show that population growth positively impacts the long-run government budget in two ways. First, higher population growth in the economy suggests tax-cut while satisfying its long-run government's budget constraint. Second, an economy with a higher population repays its debt within the shortest period. Also, a decline in population growth experienced in developed countries may be detrimental to government budgets in those countries. However, the dynamic Laffer curve effect does not hold at the presence of a low initial outstanding debt level and incorporating public debt overhang episodes.

Providing a further explanation on how fiscal policy can stimulate growth, Gemmell (2011) reveals that the estimated long-run effects of fiscal policy are attained very

quickly, and consistent with short-run SVAR models. The short-run effects are persistent since fiscal injections are always reversed thus resulting in growth-retarding tax changes simultaneously with growth-enhancing expenditure policies, observed impacts on long-run GDP level are mostly small. Also, through public goods and services financing, productivity and private investment are enhanced, and this is important for long-run growth. In addition, a short-run response mostly works through aggregate demand while long-run growth operates through alteration of aggregate supply conditions (Gemmell, Misch and Moreno-Dodson, 2012).

Focusing on the deficit aspect of fiscal policy, Minea and Villieu (2012) show an endogenously estimated threshold around a debt-to-GDP ratio of 115% above which the negative debt-growth link changes sign. However, the adoption of the fiscal mix for successful debt reduction shows that raising tax revenues is important for debt reduction in countries with large adjustment needs. Therefore, there is a need for the effort to establish a balance between expenditure savings and revenue-raising measures especially when the debt challenge is huge by preventing inefficient across-the-board expenditure cuts. Also, higher taxation may not affect efficiency as well as minimize distortions, specifically in countries with high tax ratios (Baldacci, Gupta, Mulas-Granado and Devereux, 2012).

Baum, Checherita-Westphal, and Rother (2013) explain that there is a significant and positive impact of debt on growth in the short-run though declines to about zero and insignificance below public debt-to-GDP ratio to about 67% and the high debt-to-GDP ratio has a negative impact on economic activities. The utilization of debt and framework for raising funds for its repayment determine the extent to which growth will be impacted. The inability to design financing options for debt repayment as well as inefficient utilization of debt for public investment will generate a huge decline in growth. This is due to the non-efficiency of the debt in creating an enabling environment for private investment expansion thus growth continues to retard. From multiple regimes' perspectives, there is strong evidence in support of threshold effects of debt suggesting that higher public debt is associated with lower growth for low-democracy regime countries and otherwise for the high-democracy regime (Kourtellos, Stengos, and Tan, 2013).

Similarly, Eberhandt and Presbitero (2013) examine heterogeneity and non-linearity in the relationship between debt and growth. Their findings show the evidence of systematic differences in the debt-growth relationship across countries while otherwise for within-country and support linear specification rather than polynomial. In addition, a study by Gomez-Puig and Sosvilla-Rivero (2017) shows that only Belgium experienced the detrimental effect of debt on growth before the SGDP debt ceiling is met. Also, debt reduction does not have a positive impact on EMU countries' growth. The speed of fiscal adjustment needs to be reduced in Greece and Spain relative to other countries in the sample. Egert (2015) shows a negative relationship between central government debt and growth may result from debt levels as low as 20% of GDP while general government debt is significantly higher at about 50%. This implies that public debt may be associated with poor economic performance at fairly moderate public debt levels.

Using Bolivia as a case study, Bojanic (2013) considers the composition of expenditures and economic growth. He observes that the defence expenditures, decentralised expenditures, and expenditures in the Santa Cruz department capture the best ways for the government to promote the country's growth. Also, expenditures on additional areas such as education and other promising departments, have the potential for generating significant growth. More so, Gemmell, Keneller, and Sanz (2016) argue that the reallocation of total spending towards infrastructure and education has a positive effect on long-run output levels while reallocation of expenditure towards social welfare has negative effects on output in the long-run. Also, there is statistical robustness of GDP growth effects of modest size from changes in marginal income tax rates at both the personal and corporate levels. Also, the effects of the tax on GDP growth works largely through impacts on factor productivity rather than factor accumulation (Gemmell, Keneller and Sanz, 2014).

Comparing the growth- and welfare-maximising rate of tax, the growth-maximising rate of tax can lie above, below or on the welfare-maximising equivalent. There are even relatively large differences in growth- and welfare-maximising tax rates translate into relatively small differences in growth rates, and, in some cases, welfare levels (Misch,

Gemmell, and Kneller, 2014). Apart from the financing options explore by the studies, Go, Robinson and Thierfelder (2016) try to explore the role of natural resource revenue and spending strategies in the growth process. The findings reveal that Niger can spend the interest earned on revenue in a sovereign wealth fund on one hand and can borrow to finance its expenditure and repay with expected revenue from a natural resource on the other hand. The benefits of significant mineral revenue rely on the productivity and supply responses of spending.

Dioikitopoulos (2018) argue that a fiscal rule needs to be pro-cyclical to output for government investment financing and simultaneously has to control for the debt level adjusting taxation for policy design to elude debt explosion and poor economic activity. Economies with significantly low capital and high debt levels also need a tax rate that is adjusted for non-monotonicity during the process of recovery. This implies that, given the initial capital stock threshold, taxes need to adjust negatively to expand private investment thus reducing debt with a higher tax base. A recent study by Oyinlola and Adedeji (2022) demonstrate that taxes at aggregate and disaggregated levels significantly amplify growth (in terms of inclusiveness). More so, tax revenue can improve the resource pools of the government to finance expenditure on education and health.

2.5.The Gap in the Literature

Put together, there is mounting evidence on tax and growth relationship at aggregated and disaggregated levels in the literature as presented in sections 2.2 and 2.4. However, the critical effects of APFOs on the tax-growth relationship in the developing region especially SSA has received little attention. As noted above, other financing options are very essential in explicating the tax-growth relationship in developing countries with reference to SSA countries. Thus, this study relied on Ehrhart et al. (2014) and further extended their unbalanced budget constraint to capture receipt on natural resources. This is demonstrated under theoretical frameworks. In essence, this study provides insights on the effect of APFOs (public debt, seigniorage and natural resource rents) on the relationship between tax and economic growth in selected countries in the SSA region. Relying on our elaborate theoretical framework (presented in section 3.1), the study further explores different scenarios under the assumptions of high and low public

financing options and their implications for optimal tax levels that can maximise long-run economic growth in these countries. These scenarios were carried out using a simulation approach in line with the above assumptions.

To address the empirical aspect at the country level, two-stage least squares, three-stage least squares was employed to analyse the effects of APFOs on tax and economic growth nexus. The methodological approach was deployed due to the following reasons. First, there are major concerns about the reliability of growth regression's results at cross-section and panel analysis due to inconsistencies such as omitted variables bias and the inability to capture the technological difference. These concerns have been documented by several studies (see for instance, Gemmell et al., 2014; Gemmell and Au, 2013; Gemmell, 2001; Caselli et al., 1996). Second, regressors in the growth equations are highly endogenous and inherent simultaneity issues can produce inefficient and biased estimates. Thus, methods such as ordinary least squares, autoregressive distributed lags among others may produce biased results. Finally, this study should be of interest to the policymakers in the selected countries as it provides information on how these APFOs can be effectively harmonised with tax to facilitate public spending for growth enhancement.

CHAPTER THREE

METHODOLOGY

3.0.Overview

This chapter focuses on methodology for the examination of tax and economic growth in the selected sub-Saharan African countries. It describes how APFOs affect the nature of tax and growth relationship in these countries. It starts by developing an endogenous growth model with different APFOs. From the theoretical models, the nature of growth effects of these financing options is established. This partially addresses the objectives of the study from a theoretical point of view. Other objectives will be addressed through methodological and empirical approaches. It equally considers issues related to the sources and measurements of data. The methodological approach and its procedures were detailed sequentially in the body of the work.

3.1.Methodology

3.1.1. Theoretical Framework

In analysing the role of government through public expenditure as well as resource mobilisation in financing such expenditure, we explore the endogenous growth theory. It has been discussed that the government finances its expenditure through tax revenue, seigniorage as well as debt accumulation. However, in the context of SSA countries, the rent receipts from natural resources are included as a different source of revenue for public investment. We shall allow our analysis to reflect that revenue can be earned from this source. Thus, we consider a closed economy with an infinitely lived representative economic agent and two public authorities that include a Government and a Central Bank.

The representative economic agent (REA)

The REA (household and private investor) is assumed to generate funds from its productivity and interest-bearing bond (i.e., public debt). The REA also relies heavily on its private capital, K_t and productive public spending, G_t, at each time, t, to produce the level of output, Y_t, where the elasticity of output, ρ, with respect to its private capital lies between zero and one (i.e. $0 < \rho < 1$). Thus, the production function follows the form of Barro (1990)[25], which is presented as:

$$Y_t = f(K_t, G_t) = (K_t^{\rho} G_t^{1-\rho}), \quad 0 < \rho < 1 \tag{3.1}$$

The variables are expressed in per capita terms to normalise the system with respect to population in the production function to 1. Public investment is equivalent to public spending with a flow dimension even though there is a stock dimension which, however, does not alter the property of our results (see Agénor, 2011; Marrero, 2004; Futagami et al., 1993). Public spending is financed by tax revenue and thus the spending was introduced into the production function as a public productive input (Futagami and Mino, 1992). Therefore, the REA faces the budget specified in equation 3.2.

The budget constraint of our REA is given as:

$$r_t B_t + (1-\tau)Y_t + T_t + (1-\varphi)V_t = C_t + \left(\dot{K}_t + \delta K_t\right) + \dot{B}_t + \left(\dot{M}_t + \pi_t M_t\right) \tag{3.2}$$

From the left-hand side of equation 3.2, the REA can hold government bonds[26] (B_t) with real interest rate returns (r_t). Specifically, household and private investors buy government bond and receive interest rate on it. The interest rate on bond serves as part of income to the representative economic agent. Hence, $r_t B_t$ forms part of an income earns by the REA. Another household's income component is transfer (T_t). This captures the transfer resulting from the inflation tax on private money (i.e., the profits of the banking sector in

[25] Under the output elasticity condition, the production function exhibits decreasing returns to scale for the presence of a competitive equilibrium given that public spending is exogenously determined for households but under the equilibrium condition, public spending is determined endogenously for the production function to exhibit constant returns to scale as well as the existence of long run endogenous growth path.

[26] In the equilibrium, the private bonds are not held thus, only government is a debtor.

the economy). This transfer is seen by households as lump-sum[27]. REA also earns from disposable income (income after tax), $(1-\tau)Y_t$[28]. It also assumed that REA[29] received a share of resource rents, $(1-\varphi)V_t$. All these components of income form the total earnings of REA. From the right hand side of equation 3.2, the REA also incurs private expenses. The total earnings are used to finance private expenditures. Specifically, all earnings are spent on any of the following: private investment, $(\dot{K}_t + \delta K_t)$[30], the purchase of new bonds $(\dot{B}_t)$ and private consumption (C_t). Hence, equation 3.2 shows that household earning is equal to private spending. In the model (equation 3.2), we further assumed that the household holds a real money balance, $\dot{M}_t$ where $M_t = M_t P_t^{-1}$ (i.e., the real money stock), M_t measures the nominal money stock and P_t captures the price level. πM measures the depreciation of real money stock per unit of time[31].

Furthermore, the REA maximises the present value of the discounted intertemporal utility function (in equation 3.3) given the REA budget constraint in Equation (3.2), and the instantaneous utility function captured in Equation (3.4). The REA functional utility is therefore presented as:

$$W = \int_0^{\infty} U(C_t) e^{-\beta t} dt\,,\ \beta > 0 \tag{3.3}$$

The REA functional utility is made up of instantaneous and intertemporal utility functions. For the economy to converge to the balanced endogenous growth path, we utilize the

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[27] In equilibrium $T = (1-\eta)\left(\dot{M}_t - \pi M_t\right)$.

[28] Thus, it is implicitly stated that the REA earns the income Y_t at equilibrium; but it pays a flat tax rate on total output to the government, τY_t.

[29] We allow the government to transfer or share part of the natural resource rents with the REA such that the government keeps the share $0 \leq \varphi \leq 1$ and the REA gets the proportion $1-\varphi$.

[30] Let δ be the rate at which capital depreciates with the condition that $\delta > 0$ and $\dot{K}_t \equiv \frac{dK_t}{dt}$.

[31] $\pi = \dot{P}_t P_t^{-1}$ is the inflation rate in the economy and nominal interest rate is captured by $R_t = \pi_t + r_t$.

instantaneous utility function with constant elasticity of substitution[32] presented as in equation (3.4):

$$U(C_t) = \begin{cases} \dfrac{C_t^{1-\sigma} - 1}{1-\sigma} & \sigma \neq 1 \\ \ln(C_t) & \sigma = 1 \end{cases} \tag{3.4}$$

This utility functional form is known as the *constant-relative-risk-aversion (CRRA)* utility. This is because the coefficient of relative risk aversion for this utility function is σ but it is independent of C_t. The boundary of intertemporal utility, U is necessary for the existence of an optimal level of welfare maximisation.

Further, the demand for money is motivated through the money-constraint of households on their investment as well as consumption. This is done through the cash-in-advance (CIA) constraint. Following the argument of Stockman (1981), the qualitative impact on the model does not influence the CIA results when public expenditure is subjected to the CIA constraint. Thus, the CIA constraint is presented as:

$$\phi\left[C_t + \left(\dot{K}_t + \delta K_t\right) + G_t + V_t\right] = M_t \tag{3.5}$$

The coefficient ϕ in the standard CIA model above is a constant parameter. When the nominal interest rate increases, the REA is motivated to save more proportion of their real money balances as well as explore an e-payment approach for their purchases. By this, ϕ may be negatively related to nominal interest rate[33]. There is also a possibility of high money velocity at periods of high interest rate. Thus, Mendizabal (2006) explained that a high money growth rate is accompanied by a higher inflation rate and nominal interest rates. If the opportunity cost of holding money increases, money velocity increases while real money balance declines.

[32] $\dfrac{1}{\sigma} = -U_{CC} C_t (U_C)^{-1}$ is the elasticity of substitution of the isoelastic instantaneous utility function.

[33] That is, for $\phi(R), \phi_R(R) \leq 0$.

Subsequently, the relationship between money velocity and interest rate can be expressed in a function[34]. This allows for the generalization of CIA technology which is close to the micro-foundation of transaction cost model by Minea and Villieu (2009). The specification at equilibrium[35] provides common real demand balances which depend on real income and nominal interest rate[36]. Combining Equation (3.5) and Definition ix in Appendix I will yield

$$M = \phi Y \tag{3.6}$$

Under strict CIA technology, ϕ turns to constant parameter when $\phi_R(R_t) = 0$.

The role of Government in the model

A specific public financing feature of SSA is accounted for in our model through seigniorage where the monetary block of the model was relied on. Since Equation (3.6) is equivalent to transaction money demand where M_t accounts for cash and bank deposit available for payment on consumption and investment goods and this is routed through a banking system that generates nominal money stock, M_t. The monetary authority (i.e., the Central Bank) plays a significant role in determining the nominal high-powered money stock H_t. The high-powered money is related to nominal money stock through a money multiplier. The high-powered money serves as an avenue through which government generates revenue from seigniorage to finance its expenditure. If more preference is given to money generated by private banks, then it implies that the multiplier effect is high. This further suggests that the variation between money stock demand (i.e., for transaction purposes) and high-powered money stock is high. Therefore, the Central Bank is only interested in the seigniorage share of the total money stock.

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[34] $\phi = \phi(R_t), \phi_R \leq 0$ where coefficient ϕ is the inverse of the velocity of money in circulation.

[35] $Y_t = C_t + (\dot{K}_t + \delta K_t) + G_t + V_t$ is the output-expenditure identity in a closed economy.

[36] $M = \phi Y$ when $\phi_R(R_t) \neq 0$

Further, given that the money multiplier is constant, the monetary policy of the Central Bank sees nominal money growth rate and base money as exogenous, $\omega = \dot{H}_t H_t^{-1} = \dot{M}_t M_t^{-1}$[37]. Both private banks and the monetary authority play key roles in the transfer of seigniorage to the household (collected from money supply) and the government (collected from the monetary base) respectively, without incurring any costs[38]. In addition, the revenue generated from natural resources is exogenously determined. The government share is collected through monetary authority and may be spent or channelled to the economy through the public spending or investment while the household may receive a direct share of the rent from the government (monetary authority) at the ratio $1-\varphi$, where $0 \leq \varphi \leq 1$ in terms of transferred income but indirectly from the acceleration effect that increased public investment would have on income[39]. However, if the government faces challenges of raising adequate resources from taxes, natural resource rent and seigniorage to fund its public expenditure then it raises the remaining revenue through borrowing[40]. Therefore, the government faces the budget constraint as presented below:

$$G_t - \left(\tau Y_t + \eta\omega M_t + \varphi V_t\right) + r_t B_t = \dot{B}_t \tag{3.7}$$

The left-hand side of equation 3.7 captures budget deficit whereas the right-hand side represent bond issued by government. The study relies on the unbalanced budget constraint of Ehrhart et al. (2014) rather than Barro's (1990) balanced budget constraint. This is because the intertemporal government budget constraint may not suggest a constant public debt in the long run, however, with the no-Ponzi condition, its growth rate must be less than the real interest rate. This means that the government aims at targeting a long-run debt-to-GDP ratio of $\theta = BY_t^{-1}$ at steady-state. From an endogenous growth model, the effect of

[37] Represents high powered money growth rate which is the growth rate of money supply where the multiplier is a constant.

[38] Captured by $T = (1-\eta)\left(\dot{M}_t - \pi M_t\right)$- government transfer and $\omega H_t P_t^{-1} = \omega\eta M_t$,seigniorage revenue accruing to government.

[39] That is, the household benefits from increased output due to increased government spending on public investment from the revenue of resource rent. Intuitively, the new resource rent pumped into the economy at the present moment was not made up of the past output of the economy. This is going to be constituent of the successive output/income of the economy, which in a continuous time arrangement alters the income of the REA repeatedly but indirectly.

[40] The inadequate finance resulted into budget deficits which requires borrowing plus interest rate.

permanent debt on economic growth can be explored. At steady-state, all variables grow at the same rate thus growth rate of public debt equals the balanced growth rate, γ^*. Notice that equation (3.7) is an extension of the Ehrhart et al. (2014) government constraint as the sources of government revenue have been expanded.

Equilibrium at steady state in the economy

The REA utility function in Equation (3.3) is maximised subject to the constraints in Equations (3.1-3.2) and (3.4-3.5) based on initial capital and transversality condition[41]. Given the nature of growth models, the variables are constructed in an intensive form (that is in terms of private capital stock). Therefore, the solution for the derivation of long-run growth requires setting $\dot{c} = \dot{m} = \dot{b} = \dot{R} = 0$: C, K, B, G, M and S grow constantly at γ* such that equations 3.8 and 3.9 (see workings 9 and 10 in Appendix I) are presented as follows:

$$\gamma^* = \left[\frac{\rho(1-\tau)g^{1-\rho}}{1+\phi R^*} - \delta - \beta \right] \frac{1}{\sigma} \tag{3.8}$$

$$g^* = \left[\tau + \eta\omega\phi + \nu + \theta s^* \right]^{1/\rho} \tag{3.9}$$

From equation 3.8, $s^* = \gamma^* - r^* = \beta - (1-\sigma)\gamma^*$ while the nominal interest rate at the steady-state is captured by $R^* = \omega + s^*$. The first relation in the equation is referred to as the Keynes-Ramsey relation $\gamma^* = \frac{1}{\sigma}(r - \beta)$. Assuming that $\phi = 0$ given the transaction cost constraint, then the net return of investment will be equal to the real interest rate (i.e., $r = \frac{\rho(1+\tau)g^{1-\rho}}{1+\phi R} - \delta$). The explicit derivation that suggests that the steady-state can be captured by two relations between g and γ is further presented in Appendix I. At $\phi > 0$, the nominal rate ($R = \omega + s$) requires that transaction cost on new capital goods $(1+\phi R)$ is used to deflate the return on capital. In addition, equation 3.9 implies the budget constraint faced by the government (see equation 3.6) such that $g^{\rho} = \eta\omega\phi + \tau + \nu + \theta(\gamma - r)$ (see

[41] See the process in Appendix I for solution to the equations.

the process in Appendix I) where $\theta = \frac{b}{g^{1-\rho}}$ in the long run. The real money demand from the CIA constraint is captured by $m = \phi g^{1-\rho}$ and $c^* = g^{*1-\rho} - \gamma^* - g^* - \delta$ in the steady-state. By combining Equations (3.8)-(3.9), we derive the long-run growth rate in an implicit form as presented below:

$$\gamma^* = \left[\frac{\rho(1-\tau)\left(\tau + \eta\omega\phi + \nu + \theta s^*\right)^{\frac{1-\rho}{\rho}}}{1+\phi R} - \delta - \beta \right] \frac{1}{\sigma} \tag{3.10}$$

The augmented Growth Laffer curve (The growth effect of taxes): The effect of APFOs

To demonstrate augmented Growth Laffer Curve (GLC), equation (3.10) depicts the nature of the relationship between tax rate and economic growth which exhibits an inverted U-shaped curve as found by Barro (1990), Devarajan, et al. (1996) and Milesi-Ferretti and Roubini (1998) in their endogenous growth model with public spending. From the equation above, taxes have both distortionary and productive effects. The term, $(1-\tau)$ shows that taxes are distortionary in the sense that a higher tax rate on private capital stock discourages accumulation of private capital thereby reducing the component of private capital goods in the total output. Consequently, total output declines thereby decreasing the long-run economic growth rate. On the flipped side, the second term of the numerator suggests the productive effect of taxes. At a higher tax rate, the government generates high revenue to finance its public expenditure which promotes accumulation of private capital and long-run economic growth. This suggests that private investment benefits from the favourable investment climate created by public investment which increases total productivity of the economy in the long-run. From Equation (3.10), the optimal growth rate is adversely affected because the increased tax rate lowers growth rate much more quickly in $-\rho\tau$ than it is accelerated by public capital spending in $(\tau + \eta\omega\phi + \nu + \theta s^*)^{\frac{1-\rho}{\rho}}$ since the government has to service debt from the revenue on taxes while it has already lowered the share of private capital stock in production. This nature of the relationship is termed *Growth Laffer Curve (GLC)***.**

Applying the implicit function approach, the optimal tax ($\hat{\tau}$) that maximises[42] long-run economic growth rate is presented in Equation (3.11) below:

$$\frac{\partial \gamma}{\partial \tau} = \hat{\tau} = (1-\rho) - \rho(\eta\omega\phi + \nu + \theta s) \tag{3.11}$$

Equation (3.11) gives more insight into the discussion on GLC in the context of SSA. The public debt captured by θ, seigniorage (i.e., tax revenue on money growth) measured by $\eta\omega\phi$, and the revenue from natural resources represented by ν influence the nature of the GLC (taxes and economic growth) as well as the optimal tax rate ($\hat{\tau}$) that maximises GLC. Thus, the accumulation of public debt over time tends to increase the tax rate as indicated by positive signs of the debt parameter in Equation (3.11). Explicitly, t*he accumulation of public debt over time tends to increase the growth maximising tax rate such that the government must tax higher on private capital stock in order to service the debt, as reflected in Equation (3.11)* $-\rho(+\theta s) = -\rho\theta s$. Under the no-Ponzi condition, the government is not allowed to issue debt and roll it over forever. At the steady-state, the new revenue from deficits is lower than the cost of debt (i.e., debt burden). Therefore, government faces the challenges of either reducing productive spending or increasing distortionary tax which negatively affects long-run growth[43]. This suggests that irrespective of the value of tax rate, public debt effects on GLC remain negative as an increase in public debt leads to downward movement on the GLC.

In addition, the optimal tax that maximises GLC is an increasing function of public debt. Thus, government can only minimize the distortive nature of the tax by increasing the tax rate. However, the growth effect of seigniorage is ambiguous in the model. This is because high revenue from seigniorage through high money growth rate provides government with needed resources for financing the public expenditure thereby spurring long-run growth (the numerator of Equation 3.12). On the other hand, the higher money growth causes high

[42] All the maximisation processes are presented in Appendix I.

[43] The focus of this study is to examine how the impact of debt changes the nature of the relationship between debt and long run growth thus the study does not argue for the presence of long run debt as this has been explored extensively from welfare approach by Minea and Villieu (2012); Angyridis (2009); Futagami et al. (2008); and Gosh and Mourmouras (2004).

transaction cost which is growth-reducing for public investment (denominator of Equation 3.10). Thus, this shows an inverted-U shaped curve of the seigniorage in relation to long-run growth. The optimal money growth rate for long-run growth is presented as:

$$\frac{\partial \gamma}{\partial \omega} = \hat{\omega} = \frac{\alpha(R)(\tau + \nu + R\varphi) - 1}{\frac{\phi_R}{\phi} - (\eta\phi - \theta)\alpha(R)} \tag{3.12}$$

The effect of seigniorage on the GLC depends on the differences between money growth and its optimal level. The finding from the model shows that seigniorage is a substitute for instruments of government financing options. Although, consistently increasing seigniorage may be detrimental to growth-maximising tax rate (i.e., $\frac{\partial \hat{\tau}}{\partial \omega} < 0$). Thus, increased resources from seigniorage through a high money growth rate suggests that the optimal tax should be reduced.

Focusing on the growth effect of natural resource rents on GLC in Equation (3.10), the result shows that revenue from natural resource plays a significant role in promoting the long-run growth rate. This is indicated by the positive sign of ν in the model. Higher revenue from natural resources provides government with more resources to finance its public investment which spurs private capital accumulation thereby increasing the growth rate. In addition, high natural rents reduce the tax-maximising rate. In essence, government is motivated to reduce the tax rate as long as the revenue from natural resources covers such reduction. The growth-maximising resource rent growth rate is captured by Equation (3.13) below.

$$\frac{\partial \gamma}{\partial \nu} = \hat{\nu} = -\theta s - \tau - \eta\omega\phi \tag{3.13}$$

Like the observation from the seigniorage result, revenue from natural resources shows an inverted-U shaped curve in relation to growth. This curve shows the positive effect of an increase in natural resource revenue as government generates more revenue from a high price of natural resources at the international market or increases in the quantity of natural resources. On the other hand, the negative effect may result from a significant decline in the price of natural resources or its quantity. In addition, Equation (3.13) shows that resource rent is a substitute with respect to other financing options explored by the government. As

either tax rate or seigniorage increases, government does not rely more on the natural resource revenue as indicated by the negative signs. Another observation from the model is that if the debt increases while the sum of revenue from other sources for the government are unchanged, the government will have to raise more revenue from natural resources. Given that $\hat{v}$ is the ratio of natural resource revenue to output, thus the government will always target the optimal ratio from natural resources; and if it earns any more than this ratio, it should endeavour to sterilize the excess in some reserves in order not to distort the economy. This sterilisation process makes it possible for the government to adjust v as $\theta s(\gamma)$ changes where other revenues are held constant.

From the foregoing discussions, public debt plays a significant role in the government decision-making process on public investment financing. The effect of debt can be productive and unproductive in the long-run. The public debt results in unproductive public spending when the interest rate payments on debt lead to the crowding-out effect of productive expenditures in the government budget constraint. In Barro's (1990) model, public debt is assumed to always be equal to zero given balance budget constraint, however, unbalanced budget constraint reveals an interesting story as debt may be constant and positive in the long-run. In the long-run, all public expenditures are not always productive while tax revenue is used to finance productive spending as well as interest rate payment on public debt. At times, interest rate payment may take a larger share from the available government resources thereby leaving small resources for productive spending which may not generate a positive economic growth rate in the long-run. Given that government explores other sources as indicated in equation (3.14), the debt service is always higher than new revenues generated in the long-run thus crowding out productive public investment. This is because debt cannot be the most effective way of government finance in the steady-state since the permanent stream of new revenue is always smaller than the permanent stream of new spending arising from debt servicing in the long-run. As government continues to raise more resources from tax, seigniorage and natural resource rents larger proportion of it goes to debt servicing as clearly demonstrated in equation 3.14.

$$\hat{\theta} = -\frac{(\tau + \eta\omega\phi + \nu)}{s} \tag{3.14}$$

In conclusion, the focus of the study is to examine the mechanism through which debt, natural resource revenue, and seigniorage affect the relationship between taxes and long-run economic growth (GLC). Both seigniorage-financing and natural resource revenue-financing options at growth-maximising rate are less distortive relative to tax-financing options. This is because the effects of the former in crowding-out accumulation of private capital is little relative to that of the latter. The augmented endogenous model shows an inverted-U shape for taxes, seigniorage, and resource revenue in relation to long-run economic growth. Thus, these government financing options depend on preferences with respect to their thresholds.

3.1.2. Simulation Approach

The reactions of tax and growth to APFOs will be explicitly determined under the theoretical models at the steady-state using equations 3.10-3.14. These equations can be simplified further for our simulation analysis under a logarithmic instantaneous household utility ($\sigma = 1$) and CIA technology assumption $\phi(R) = \phi$ as demonstrated below:

$$\gamma^* = \left[\frac{\rho(1-\tau)\left(\tau + \eta\omega\phi + \nu + \theta s^*\right)^{\frac{1-\rho}{\rho}}}{1 + \phi R} - \delta - \beta \right] \frac{1}{\sigma} \tag{3.15}$$

Recall that $\phi = \phi(R)$ (see Appendix I in working 1), thus, the equation about can be rewritten explicitly as:

$$\gamma^* = \left[\frac{\rho(1-\tau)\left(\tau + \eta\omega\phi(R^*) + \nu + \theta s^*\right)^{\frac{1-\rho}{\rho}}}{1 + R^*\phi(R^*)} - \delta - \beta \right] \frac{1}{\sigma} \tag{3.16}$$

This is further simplified as:

Recall that $s^* = \gamma^* - r^* = \beta - (1-\sigma)\gamma^* = \beta$ and $R^* = \omega + s^* = \omega + \beta - (1-\sigma)\gamma^* = \omega + \beta$ given the value of σ above.

$$\gamma^* = \left[\frac{\rho(1-\tau)\left(\tau + \eta\omega\phi(\omega+\beta) + \nu + \beta\theta\right)^{\frac{1-\rho}{\rho}}}{1+(\omega+\beta)\phi(\omega+\beta)} - \delta - \beta \right] \qquad (3.10')$$

Optimal tax that maximises steady-state growth:

$$\frac{\partial \gamma^*}{\partial \tau} = \hat{\tau} = (1-\rho) - \rho\left[\eta\omega\phi + \nu + \beta\theta\right] \qquad (3.11')$$

Optimal resource rents that maximise steady-state growth:

$$\frac{\partial \gamma}{\partial \nu} = \hat{\nu} = -\theta\beta - \tau - \eta\omega\phi \qquad (3.12')$$

Optimal seigniorage that maximises steady-state growth:

$$\frac{\partial \gamma}{\partial \omega} = \hat{\omega} = \frac{\alpha(R)(\tau + \nu + R\varphi) - 1}{\frac{\phi_R}{\phi} - (\eta\phi - \theta)\alpha(R)}$$

Recall from Appendix I (working 13) that $\frac{1}{\eta\phi}\left[\frac{(\phi+\phi_R R)}{(1+\phi R)}\frac{\rho}{1-\rho}\right] = \alpha(R)$. Thus, optimal seigniorage can simplify to:

$$\hat{\omega} = \frac{\eta(1-\varepsilon)(1+\phi\beta) - \varepsilon(\tau + \nu + \beta\theta) - 1}{\eta\phi(2\varepsilon - 1)} \qquad (3.13')$$

Optimal debt that maximises steady-state growth:

$$\hat{\theta} = -\frac{\left(\tau + \eta\omega\phi + \nu\right)}{\beta} \qquad (3.14')$$

The above equations are simulated with respect to these countries and determine how these countries can harmonise these APFOs to achieve long-run economic growth.

3.1.3. Model Specification

Our theoretical framework analyses explicitly, the nature of the relationship between taxes and long-run economic growth (GLC). In addition, theoretical models provide useful

information on how public debt, seigniorage, and total natural resource rents affect the nature of the relationship between taxes and economic growth in the context of selected SSA countries. Kneller et al. (1999) and Gemmell (2001) argued that growth regressions with fiscal variables do not address properly the issue of government budget constraint by examining the growth effect of fiscal variables individually. Therefore, this study considers this by jointly accounting for the growth effects of taxes and APFOs. To lay strong model foundation, we start with a baseline model as presented by Barro (1990) where single financing option was considered. The variants of the model in line different public financing options are presented as follows:

A case of tax only: $\gamma_t = \delta_0 + \tau TAX_t + \pi H_t + \varepsilon_t$ (3.17)

A case of public debt only: $\gamma_t = \delta_0 + \theta PD_t + \pi H_t + \varepsilon_t$ (3.19)

A case of seigniorage only: $\gamma_t = \delta_0 + \omega_t SEG_t + \pi H_t + \varepsilon_t$ (3.20)

A case of total natural resource rent only: $\gamma_t = \delta_0 + \nu TNRR_t + \pi H_t + \varepsilon_t$ (3.21)

Equations 3.17-3.21 are different baseline models from arising from the assumption that government relies on one of the public financing options. However, this study focuses on the influence of APFOs on tax and growth nexus. In line with Ehrhart et al. (2014) approach, we employ the representations in our theoretical model in equation (3.10) to specify our models under the following scenarios.

(i) The effect of public debt on taxes and economic growth nexus:

$\gamma_t = \delta_0 + \tau TAX_t + \sigma_1 (TAXPD)_t + \theta PD_t + \pi H_t + \varepsilon_t$ (3.22)

(ii) The effect of seigniorage on taxes and economic growth nexus:

$\gamma_t = \delta_0 + \tau TAX_t + \mu_1 (TAXSEG)_t + \omega SEG_t + \pi H_t + \varepsilon_t$ (3.23)

(iii) The effect of total natural resources on taxes and economic growth nexus:

$$\gamma_t = \delta_0 + \tau TAX_t + \psi_1 (TAXTNRR)_t + vTNRR_t + \pi H_t + \varepsilon_t \quad (3.24)$$

To determine the threshold effects of taxes under different alternative public financing options:

(i) Under public debt

$$\gamma_t = \delta_0 + \tau TAX_t + \sigma_1 (TAXPD)_t + \theta PD_t + \beta TAX_t^2 + \sigma_2 (TAX^2 PD)_t + \pi H_t + \varepsilon_t \quad (3.25)$$

(ii) Under seigniorage

$$\gamma_t = \delta_0 + \tau TAX_t + \mu_1 (TAXSEG)_t + \omega SEG_t + \beta TAX_t^2 + \mu_2 (TAX^2 SEG)_t + \pi H_t + \varepsilon_t \quad (3.26)$$

(iii) Under total natural resource rents

$$\gamma_t = \delta_0 + \tau TAX_t + \psi_1 (TAXTNRR)_t + vTNRR_t + \beta TAX_t^2 + \psi_2 (TAX^2 TNRR)_t + \pi H_t + \varepsilon_t \quad (3.27)$$

The priori expectations of the algebraic signs of the coefficients to be estimated as stated above are as follows:

$$\tau \succ / \prec 0 ; \theta \succ / \prec 0 ; \omega \succ / \prec 0 ; v \succ / \prec 0 ; \pi \succ / \prec 0 ; \sigma_1 \prec 0 ; \sigma_2 \succ / \prec 0 ; \mu_1 \succ / \prec 0 ; \quad \beta \prec 0 ;$$

$$\mu_2 \succ / \prec 0 ; \ \psi_1 \succ / \prec 0 ; \ \psi_2 \succ / \prec 0$$

The dependent variable in equations (3.17-3.27) represents the log of GDP per capita (γ_t) over time. This metric measures economic growth. TAX_t measures different taxes as a ratio of GDP. A stepwise approach would be applied in the introduction of taxes into the models. The growth effect of tax depends on APFOs available to the government to mobilise resources for its public investment. From the theoretical explanation, the growth effect of taxes can be productive and distortive depending on how government utilises the resources raised from them. If the government introduces a higher tax rate, the accumulation of private capital will be discouraged thereby affecting economic growth negatively. On the other hand, a higher tax rate creates an avenue for the government to raise more revenue to finance

its spending which indirectly promotes private capital accumulation and promote growth in the long-run (Barro, 1990; Devarajan, et al., 1996; Milesi-Ferretti and Roubini, 1998; Kneller et al., 1999; Misch et al., 2013; Gemmell et al., 2016).

The PD_t captures public debt as a ratio of GDP. The effect of debt on the relation between tax and economic growth suggests that accumulation of debt over time tends to reduce the long-run economic growth. High debt negatively affects capital accumulation through higher long-term interest rates thus reducing the long-run growth (see Gale and Orzag, 2003; Kumar and Baldacci, 2010). In addition, high debt may serve as an impediment to the framework of either countercyclical or procyclical fiscal policies which may generate higher volatility and therefore continue to escalate the problem of low economic growth (See Woo, 2009; Agbion and Kharroubi, 2008). Theoretically, the new revenue from deficits is lower than the cost of debt (i.e., debt burden). Therefore, government faces the challenges of either reducing productive spending or increasing distortionary tax which negatively affects long-run growth.

The variable SEG_t represents seigniorage (i.e., growth rate of money as described in our CIA constraint in the previous section). When resources generated from seigniorage are judiciously utilised for expansion of public investment by government, this has spill-over effect on the private sector through positive externality (the expansion of private capital accumulation). As private capital benefits from positive externality of public investment, the long-run growth increases. On the other hand, seigniorage may have a distortionary effect on the private banks' asset mix and input mix of the firms with respect to their intermediate and un-intermediate capital accumulation (see Basu, 2001; Haslag and Young, 1998; Roubini and Sala-i-Martin, 1995).

On the growth effect of natural resource rents ($TNRR_t$), government explores this source of revenue to finance its public expenditure. This has two effects on long-run growth. High resource revenue may motivate the government to invest massively in the provision of public goods which fosters the expansion of the private sector's output (See Raheem et al.,

2018). However, earnings from natural resources can discourage resource mobilisation from tax to finance government expenditure that may result in reduction of intermediate capital goods (that might benefit the private sector) and further reduces the long-run growth (See Ndikumana and Abderrahim, 2010).

In capturing the nature of relationship between taxes and growth postulated by our theoretical endogenous model, linear and non-linear approaches were explored via tax (TAX_t) and squared tax (TAX_t^2). The mechanism through which debt, seigniorage, and resource revenue affect the tax and economic growth was captured through the interactive terms in equations (3.22-3.27). More so, this study tested for the presence of GLC through the three mechanisms explained above. The nonlinear model also allows us to compute the minimum threshold value for taxes. H_t captures the control variables which include inflation rate, investment, population growth, domestic credit to the private sector, foreign direct investment, government final consumption expenditure, growth of terms of trade, and trade openness. Inflation rate captures the economic uncertainty and instability which influence the performance of aggregate economy (Kremer, Bick and Nautz, 2013; Hajamini, 2019).

On the other hand, trade openness measures the level of domestic economic accessibility to foreign businesses which influences economic growth (Vinayagathasan, 2013; Zahonogo, 2017). Foreign direct investment can promote economic growth depending on how it enhances technological progress and export competitiveness as well as improvement in employment skills (Ndoricimpa, 2014, Oyinlola and Adedeji, 2020). On government final consumption, Deveranja et al. (1996) points out that a high level of recurrent expenditure enhances economic growth in developing countries. On the other hand, Seleteng et al. (2013) shows negative impact of government spending on economic growth. Investment and population growth are positively related to economic growth (Solow, 1956; Jacques Esso, 2012; Mijiyawa, 2013). An increase in growth of terms of trade can enhance or inhibit economic growth depending on degree of risk aversion (Mendoza et al., 1997). Also, De

Gregorio and Guidotti (1995) established a positive relationship between credit to the private sector and economic growth.

3.1.4. Data Issues and Measurement

The variables used in this study are selected based on their theoretical importance, economic relevance, and their uses and findings in the previous empirical literature. Given our objective and following existing literature, GDP per capita (in logarithmic form), γ_t, is used as a key metric for measuring economic growth rate in the three countries. Changes in GDP per capita captures the expansion and contraction of output per individual in the economy. This measure of economic growth rate has been widely used in theoretical and empirical studies on growth such as Barro (1990), Deverajan et al. (1996), Bruno and Easterly (1998), Agell et al. (1999). Adam and Bevan (2005), Remero-Avila and Strauch (2008), Bojanic (2013) among others. Data on GDP per capita (constant US dollars, $) is sourced from World Development Indicators (2018).

Further, the study utilised total tax as a percentage of GDP (TTAX). This captured the aggregate revenue generated from all taxes collected. This is sub-divided into two, namely, direct taxes (DTAX) and indirect taxes (ITAX). Direct tax is levied on the income, wealth, and profit of individuals and companies. In the context of this study, a direct tax is the aggregation of personal income tax, capital gain tax, and corporate tax. This is measured as a percentage of GDP. In addition, indirect tax is levied on goods and services. This includes value-added tax, tax on goods and services, and excise duty. It is measured as a percentage of GDP. The measurement of tax as a percentage of GDP has been widely used in the existing literature. Some of the renowned studies that have applied these tax measures are Colombier (2009), Gemmell (2011), Misch et al. (2014), Gemmell et al. (2014), Dioikitopoulos (2018) among others. The three measures of tax employed are robust as they captured all aspects of taxation at aggregate and disaggregated levels. These measures are sourced from International Centre for Tax and Development Government Revenue Dataset (2018). Another variable utilised in the study is public debt (PD). There are different measures of debt but in the context of this study, we explore public debt which is defined

as the gross general government debt as a percentage of GDP (International Monetary Fund, 2012). This is relevant to the study because the study focuses on the role of public sector in the economy. Hence, public debt is also measured as a percentage of GDP and sourced from the Historical Public Debt database of the International Monetary Fund.

On total natural resource rents (TNRR), they are grouped into five by the World Bank definition namely; oil, natural gas, coal (hard and soft), forest, and mineral. Therefore, total natural resource rents are the aggregation of all rents received from the sales of oil, natural gas, coal, forest, and mineral. This is measured as a percentage of GDP. Data on this indicator is also sourced from World Development Indicators (2018). In the literature, different measures have been explored to calculate seigniorage (SEG) for countries. Some studies used change in monetary base or base money (Fielding and Mizen, 2001; Buiter, 2007; Aisen and Veiga, 2008; Blackburn et al., 2008; and Ehrhart et al., 2014). Also, Click (2000) used a change in M1 to GDP. In the case of this study, we computed seigniorage using a change in base money in percentage of GDP. The data for base money is sourced from the countries' Central Banks. However, change in money supply in percentage of GDP was used for the Republic of Congo due to data unavailability.

The control variables drawn from the literature are inflation rate (INF), investment (gross fixed capital formation as a percentage of GDP)-INV, population growth (POPG), domestic credit to the private sector (as a percentage of GDP)-DOM, foreign direct investment net inflows (as a percentage of GDP)-FDI, government final consumption expenditure (as a percentage of GDP)-GOVT, growth of terms of trade (GTOT), and trade openness (ratio of export and import to GDP)-TOP. These control variables are sourced from World Development Indicators (2018). Also, the instruments (final consumption as a percentage of GDP; Exports of goods and services as a percentage of GDP, Net ODA received as a percentage of GNI; Life expectancy at birth, total; Personal remittances received as a percentage of GDP; School enrollment, primary as a percentage of gross; Total debt service as a percentage of exports of goods, services and primary income; GDP, labour force participation) are sourced from World Development Indicators (2018).

Given the small size of the dataset (1990-2016), the study explores a quadratic approach for interpolation. This helps to expand our observations in quarterly form and still preserves the nature of the original data. This approach fits a local quadratic polynomial for each observation in the data and utilises this polynomial to generate observation for the quarterly structure without distortion (Gregory and Delbourgo, 1982; Liu et al., 2014). It takes a set of three adjacent points from the original data and fits a quadratic in such a way that the mean, median, standard deviation, skewness, and kurtosis of the quarterly data are the same as the original data. The exceptional characteristic of retaining the nature of original data in the transformed data justifies the application of this approach for the study.

3.1.5. Estimation Procedure

Our estimation procedure is structured into three phases. The first phase examines the pre-tests such as descriptive statistics, stationarity test, and cointegration test. The second phase focuses on the model estimation while the final phase deals with diagnostic tests to ascertain the robustness of our estimates.

(i) Preliminary Analysis

This focuses on the descriptive statistics for the series thus reporting their mean, standard deviation, skewness, kurtosis, and the Jacque-Bera test for normality. The essence of this is to verify the distributional properties of the series before applying formal econometric tests.

Descriptive Statistics

Descriptive statistics are employed to unravel the nature of the distribution from which the data is generated. In this case, the Jarque-Bera would be used to examine the normality, and this will be reinforced by the values of the skewness and kurtosis of the series. The skewness measures the symmetry of the distribution while kurtosis measures the tail shape of the distribution. A symmetrical distribution such as normal distribution, the Jarque-Bera test examines if a sample has an excess kurtosis and a skewness equal to zero or not. The test statistic is given as:

$$JB = \frac{n}{6}\left[S^2 + \frac{(K-3)}{4} \right] \tag{3.23}$$

Where n is the number of observations, S is the skewness, and K is the kurtosis. The excess kurtosis is captured by $EK = K - 3$, since the kurtosis of the normal distribution is equal to 3. A positive excess kurtosis is a distribution with thick tails and has a higher peak. In that case, it is referred to as **leptokurtic**, and if otherwise, it is **platykurtic** while a normal distribution is termed **mesokurtic**. Therefore, the sample kurtosis can be calculated as follows:

$$K = \frac{1}{n}\frac{\sum_{i=1}^{n}\left(x_i - \bar{x}_i\right)^4}{\left(\hat{\sigma}^2\right)^2} \tag{3.24}$$

The sample skewness can be expressed as:

$$S = \frac{1}{n}\frac{\sum_{i=1}^{n}\left(x_i - \bar{x}\right)^3}{\left(\hat{\sigma}^2\right)^{3/2}} \tag{3.25}$$

Where $\hat{\sigma}^2$ is expressed as:

$$\hat{\sigma}^2 = \frac{1}{n}\sum_{i=1}^{n}\left(x_i - \bar{x}\right)^3 \tag{3.26}$$

Therefore, the hypotheses of the Jarque-Bera test are:

$H_0: S = EK = 0$

$H_1: S \neq EK \neq 0$

The null hypothesis is that the distribution is normal. If otherwise, that indicates a non-normal distribution.

Stationarity Tests (Unit Root Tests)

After checking the statistical properties of the series above, it is necessary to go further to test the stationarity of the time series variables. The importance of verifying the presence of unit roots in our series is to prevent the occurrence of spurious regression problems. Conceptually, a time series variable is said to contain a unit root if its mean, variance, and covariance are variants with respect to time. Explicitly, the series has a different mean at

each point in time and as its sample size increases, the variance also increases. This implies that the variable is not stationary. On the other hand, a time series variable does not contain a unit root if its mean, variance, and covariance are all invariant with respect to time. By implication, it suggests that the series returns to its mean and as its sample increases, the variance remains constant over time. This implies that the variable is stationary[44]. It is necessary to test for the order of integration of each variable in the model to determine the stationarity of the series and if not stationary, the number of times the variable can be differenced to have a stationary series. There are many stationarity tests for verifying the presence of a unit root. Thus, this study uses two prominent tests: The Augmented Dickey-Fuller (ADF) unit root test and the Phillip-Perron (PP) unit root test.

The augmented Dickey-Fuller unit root test was proposed by Dickey and Fuller (1981) to test the null hypothesis that a series contains a unit root against the alternative hypothesis of stationary. Thus, the three possible forms of the ADF test are captured in the following equations:

$$\Delta x_t = \theta x_{t-1} + \sum_{i=1}^{n} \lambda_t \Delta x_{t-i} + \mu_t \qquad \mu_t \sim IID(0, \sigma^2) \tag{3.27}$$

$$\Delta x_t = \gamma + \theta x_{t-1} + \sum_{i=1}^{n} \lambda_t \Delta x_{t-i} + \mu_t \qquad \mu_t \sim IID(0, \sigma^2) \tag{3.28}$$

$$\Delta x_t = \gamma + \delta T + \theta x_{t-1} + \sum_{i=1}^{n} \lambda_t \Delta x_{t-i} + \mu_t \qquad \mu_t \sim IID(0, \sigma^2) \tag{3.29}$$

Where x_t is the dependent variable under consideration and μ_t is a white-noise disturbance term. T captures the non-stochastic time trend in the equation (v) which implies that x_t is stationary around a linear trend under the alternative hypothesis (Nelson and Plosser, 1982). The three forms of the ADF imply that either non-stochastic time trend or the constant can be zero and both can also be equal to zero. This approach is appropriate for testing the unit roots when the form of the data-generating process is unknown. In other words, the test

[44] A stochastic process is said to be stationary if its mean and variance are constant overtime and the value are auto-covariance between the two-time period depends only on the distance between the two time periods and not the actual time at which the covariance is computed (Gujarati, 2003).

suggests that the disturbance term, μ_t, follows an individually independently distributed process. However, if this assumption fails to hold, it then means that the limiting distributions and the critical values generated may not hold.

On the other hand, the Phillips-Perron (PP) test was developed by Phillips and Perron (1988). This test was built on the ADF test procedure which fairly adjusted some assumptions about the distribution of errors. The PP test regression is given by the equation below:

$$\Delta x_{t-1} = \theta x_{t-1} + \mu_t \tag{3.30}$$

$$\Delta x_{t-1} = \gamma + \theta x_{t-1} + \mu_t \tag{3.31}$$

$$\Delta x_{t-1} = \gamma + \delta T + \theta x_{t-1} + \mu_t \tag{3.32}$$

The test uses non-parametric statistical methods to take care of serial correlation in the disturbance term without the inclusion of lagged difference terms. The PP statistics modified the ADF t statistics that consider the less restrictive nature of the error process. The choice for the use of these tests is due to their complementary advantage for the validity of our results.

(ii) Two-stage Least Squares

This study employs Two-stage Least Squares (TSLS). This method has been widely utilised to examine the role of fiscal variables in the economic growth process for panel data (see Oyinlola et al. 2020a; Ehrhart et al., 2014). Concerning economic growth model with public sector, Kneller et al. (1999), Gemmell (2001), and Gemmell et al. (2014) argued that taxes and other financing options have potential simultaneity. This evidence corroborates the conclusions in our theoretical framework. Specifically, the increase or decrease in the APFOs is associated with either increase or decrease in tax level that maximises growth rate. Additionally, the independent variables (especially, the APFOs) may also be endogenously related to economic growth coupled with reverse causality. Exploring

ordinary least squares to such a model may result in inefficient estimates. Several econometric methods have been explored in the literature largely at cross-sectional and panel levels to address these challenges (such instrumental variable, panel ARDL, GMM, 2SLS, among others). Thus, equations (3.17-3.22) are estimated using TSLS to address our concerns earlier identified.

Furthermore, the application of the approach provides a comparative basis for in-depth analysis. In addition, this approach addresses most of these problems using different instruments which may include lagged dependent and independent variables. The validity of the instrumental variables is determined by Hansen's test. These estimators allow for more instruments to increase the efficiency of the estimates. The key assumption of our regression equation is that the independent variables (taxes, alternative financing options, and control variables) should not be correlated with the error term. By construct, our models violated this assumption which result in biased and inconsistent estimates from OLS and weighted LS. The independent variables are correlated and there is a possibility of measurement errors.

Also, the regressors in the models are likely to be correlated with the residuals. To address these challenges in our models, the instrumental variables approach was explored. The approach allows for the inclusion of other variables termed *instruments* that are correlated with independents variables but uncorrelated with disturbance terms. Thus, the study uses the following instruments (final consumption, debt service, life expectancy, export, primary school enrollment, personal remittances, aid, GDP, labour force participation, and their lags where necessary) that are uncorrelated with the error terms. The instruments remove the potential correlation between regressors and the error terms (Hansen et al., 2008). To increase the precision of our estimates, the number of instruments is greater than the number of regressors in our model. This makes models (3.22-3.27) to be *overidentified*. The instruments employed fulfilled two conditions:

Instrument relevance: $corr(Z_i, X_i) \neq 0$

Instrument exogeneity: $corr(Z_i, \varepsilon_i) \neq 0$

Where X_i and Z_i represent our vectors of dependent variables (presented in equations 3.22-3.27) and instruments, respectively.

The first condition holds when change in the instrument is linked to change in X_i and the second condition holds when the part of the change in X_i captured by the instruments is exogenous. Since these instruments fulfilled these conditions, we can conclude that they are relevant and exogenous. This is captured in the *J-statistics* from the Hansen test for single-equation model. Since our instruments satisfy the two conditions, TSLS is employed for estimation.

In TSLS, there are two different stages in the estimation procedure. First, the first stage determines parts of the dependent (log of GDP per capita) and independent variables (taxes, APFOs, and control variables) that can be associated with our instruments. This stage requires the estimation of OLS regression of each variable in the models (3.17-3.22) on the set of instruments. This stage is formalised as follows:

$$X_i = \eta_0 + \eta_1 Z_i + \mu_i \tag{3.33}$$

Where η_0, η_1 and μ_i represent vectors of constant term, slope, and disturbance term, respectively. Equation (3.33) gives the required decomposition of X_i. Since Z is exogenous, this is a component of X predicted by Z ($\eta_0 + \eta_1 Z_i$) and is uncorrelated with ε_i in equations (3.17-3.22). Another component of X is μ_i which is the problematic component of X that is correlated with μ_i. Hence, the TSLS uses $\eta_0 + \eta_1 Z_i$ component of independents variables and remove the problematic component (μ_i). It may be difficult to calculate the unknowns in equation 3.33. Hence, the first stage of TSLS uses OLS to estimate equation 3.33 as presented below:

$$\hat{X}_i = \hat{\eta}_0 + \hat{\eta}_1 Z_i + \mu_i \quad (3.34)$$

The second stage of the TSLS uses predicted values of the independent variables from equation 3.34 in estimating equations (3.22-3.27).

Given the nonlinear equations (3.23, 3.25 and 3.27) above, it is important to compute net or overall effect and minimum policy thresholds for tax under the APFOs. Asongu and Odhiambo (2020), Boateng et al. (2018), and Brambor et al. (2006) argued that computation of net or overall effect for quadratic or non-linear determines the overall relevance of variables of interest on the dependent variable. Thus, this study computes the net effect of taxes to evaluate the relevance of the taxes in enhancing economic growth under APFOs (public debt, seigniorage, and total natural resource rents. The effect is computed as follows:

$$NE_{tax} = \left[2 \times (\beta \times \bar{\tau}) + \tau \right] \quad (3.35)$$

Where NE_{tax} captures the net effect of taxes, β represents the conditional effect of facilitating tax in the growth process (the coefficients of tax squared in the baseline equations); $\bar{\tau}$ is the mean value of taxes; τ is the unconditional effect of tax (the coefficients of tax in the baseline equations). The parameter (2) is generated from the quadratic derivation.

Additionally, the net effects of APFOs are also computed as follows

$$NE_{APFOs} = \left[2 \times (\xi \times \overline{APFOs}) + APFOs \right] \quad (3.36)$$

Where ξ captures the conditional effects of APFOs $(\sigma_1, \mu_1, \text{and } \psi_1)$ whereas APFOs capture the unconditional effects and $\overline{APFOs}$ is the average value of APFOs.

On policy threshold, this allows us to determine the thresholds at which taxes are important for economic growth under the APFOs. The approach has been documented in the literature (Adeniyi et al., 2021; Asongu and Odhiambo, 2020; Ashraf and Galor, 2013; Batuo, 2015, Cummins, 2000). Hence, the policy thresholds are computed as follows:

$$T_{tax} = \frac{\tau}{2 \times \beta} \tag{3.37}$$

Where T_{tax} is the minimum threshold tax that guarantees positive economic growth.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.0.Overview

This chapter deals with empirical analysis and discussions of results. Specifically, section 4.1 examines the effect of APFOs on tax and economic growth nexus using econometric approaches. Also, section 4.2 focuses on the structure of parameters and the simulated effect of APFOs on the relationship between tax and economic growth across selected sub-Saharan African countries.

4.1.Econometric Approach

4.1.1. Preliminary Analysis

Descriptive Analysis

This sub-section provides discussion on statistical properties of the variables employed in our analysis across the three countries (South Africa, Nigeria, and the Republic of Congo). Given the time series characteristics of our variables, Tables 4.1a-b present the descriptive statistics to capture individual statistical properties of the variables. Among the three countries, South Africa has the highest average value for GDP per capita (GDPPC) while Nigeria has the lowest average value. This result indicates that average income per individual in South Africa is more than three times average income per individual in Nigeria. More so, the average income per individual in the Republic of Congo is almost twice of Nigeria. Clearly, this analysis reveals that the level of income is abysmally low in Nigeria. Moreover, the result further reinforces the poor economic performance and low standard of living especially in Nigeria.

Considering the degree of volatility, GDPPC is highly stable for the Republic of Congo relative to the other two countries as indicated by the values of their standard deviation. This further suggests a huge disparity between minimum and maximum values of GDPPC, especially for South Africa and Nigeria. Also, the values of skewness are positive across the three countries which means that the tail of the distribution is biased towards the right as well as fatter. Also, the values of the kurtosis are less than the threshold value of 3 ($k<3$) across the countries which suggests that GDPPC is *leptokurtic.* This implies that the peak of GDPPC distribution is high. This further corroborates the pattern observed in the previous statistical properties of the variable.

On total tax (TTAX), South Africa has the highest average value while Nigeria has the lowest value. The mean values also show that South Africa mobilises more domestic revenue through tax relative to Nigeria and the Republic of Congo. For instance, South Africa's tax is more than three and two times of Nigeria and the Republic of Congo, respectively. The rationale for this huge disparity can be attributed to the overreliance of the two countries (Nigeria and the Republic of Congo) on other sources. In terms of volatility, total tax is relatively unstable in Nigeria and the Republic of Congo as shown in the values of the standard deviation. This further implies that there is a huge disparity between minimum and maximum values of tax in Nigeria and the Republic of Congo. It is also important to note that South Africa had a strong tax system since 1990 compare to Nigeria and the Republic of Congo which are still struggling to develop their tax systems.

Skewness remains positive across the countries except for Nigeria. This indicates that the tail of the distribution of total tax is fatter on the right side for South Africa and the Republic of Congo while the tail is fatter on the left side of the distribution for Nigeria. In addition, the kurtosis of total tax is less than 3 across the countries suggesting that total tax is also *leptokurtic*. Thus, the peak of the distribution for total tax is high. Focusing on the disaggregated taxes (direct and indirect taxes), South Africa has the highest average value compared to Nigeria and the Republic of Congo. Also, the standard deviation shows that Nigeria has a more stable direct tax while indirect tax is relatively stable in Republic of Congo. This gives insight into variation in disaggregated taxes across the three countries.

The skewness remains positive for the three countries under the indirect tax. However, the skewness is only positive for South Africa and the Republic of Congo while negative for Nigeria under direct tax. On kurtosis, the indirect tax is *leptokurtic* (k<3), *platykurtic* (k>3), and *mesokurtic* (k=3) for South Africa, Nigeria, and the Republic of Congo, respectively. On the other hand, direct tax is *leptokurtic* across the three countries.

Furthermore, the statistics of public debt (PD) reveal that the Republic of Congo has the highest average value relative to the other two countries. Historically, the Republic of Congo incurred high debt in the past as well as growing debt recently, relative to South Africa. This has resulted in a huge debt crisis in the country. In the case of Nigeria, the public debt has consistently declined significantly over time. Moderate reliance of South Africa on public debt manifests in the lowest average value recorded. More so, huge debt accumulation is associated with resource-dependent countries such as Nigeria and the Republic of Congo in some periods. This further reinforces the argument in the literature that resource-dependent countries explore more debt compared to less-resourced dependent countries since they have the resources to leverage in paying the debt[45]. Also, the series is highly volatile for Nigeria and the Republic of Congo compared to South Africa given the value of the standard deviation. This high volatility in public debt for the two countries can be attributed to periods of high public debt and low public debt. The statistics of the skewness reveal that public debt is negatively skewed for South Africa and the Republic of Congo while positively skewed for Nigeria. More so, the series is also *leptokurtic* for the three countries as the values of the kurtosis are less than the threshold value of 3.

Additionally, the descriptive statistics also indicate that the Republic of Congo has the highest average value of seigniorage relative to the other two countries. In other words, this suggests that the Republic of Congo generates more revenue from seigniorage to finance its expenditure compared to the other two countries. In addition, the standard deviation reveals that seigniorage is more stable in Nigeria relative to South Africa and the Republic of Congo. This also implies that there is a wide disparity between the minimum and maximum

[45] Though it mostly results in debt crisis given African countries experience.

values of seigniorage in the two countries compared to Nigeria. The skewness values indicate that the series is positively skewed for South Africa while negatively skewed for Nigeria and the Republic of Congo. More so, the statistics of the kurtosis show that the series is *leptokurtic*, *platykurtic,* and *mesokurtic* for South Africa, Nigeria, and the Republic of Congo, respectively.

On total natural resource rents (TNRR), the average value shows that the Republic of Congo and Nigeria explore more revenue from the source relative to South Africa. This is expected as the Republic of Congo and Nigeria depend largely on revenue from natural resources (especially crude oil). Moreover, the volatility of total natural resource rents is very high for Nigeria and the Republic of Congo compared to South Africa as indicated by high standard deviation. Due to unstable international commodity prices, it is expected that revenue from natural resources will be highly unstable as evident in Nigeria and the Republic of Congo. This may also explain the unstable financing pattern in these countries. The statistics of the skewness also reveal that total natural resource rents are positively skewed for South Africa and Nigeria while negatively skewed for the Republic of Congo. This implies that the tail of the distribution for total natural resource rents is fatter and biased towards the right for Nigeria and South Africa but biased towards the left for the Republic of Congo. In addition, the kurtosis of total natural resource rents is *platykurtic*, *mesokurtic*, and *leptokurtic* for South Africa, Nigeria, and the Republic of Congo, respectively.

In addition, the average value of investment (INV) is higher for Nigeria and the Republic of Congo compared to South Africa. This suggests that the level of domestic investment in Nigeria and the Republic of Congo is very high compared to South Africa. More so, the investment is highly volatile in Nigeria and the Republic of Congo relative to South Africa given the wide difference between the minimum and maximum values as well as the standard deviation. The statistics of the skewness indicate that investment is positively skewed for all the countries. Also, the kurtosis values show that the series is *leptokurtic* for South Africa and Nigeria while *platykurtic* for the Republic of Congo. Also, the mean value of population growth (POPG) is higher for Nigeria and the Republic of Congo compared to South Africa. In terms of volatility, population growth is more stable in Nigeria relative to

South Africa and the Republic of Congo. Also, the series is positively skewed for all these countries. The series is also *leptokurtic* for all these countries.

On government final consumption expenditure (GOVT), the average value is very high in South Africa and the Republic of Congo compared to Nigeria. However, the series is highly unstable for the Republic of Congo and Nigeria. The series is also positively skewed and *leptokurtic* for all the countries. Also, Nigeria has the highest average value of inflation rate relative to South Africa and the Republic of Congo. Unlike South Africa and the Republic of Congo, Nigeria is battling with consistent increase in the price of goods. Moreover, the country has the highest standard deviation among the countries suggesting high uncertainty in the economy. This is further corroborated by the huge disparity between the minimum and maximum values. The series is positively skewed for South Africa and Nigeria while negatively skewed for the Republic of Congo. The summary statistical also reveals that the series is *platykurtic* for South Africa and Nigeria while *leptokurtic* for the Republic of Congo.

The mean value of growth rate of terms of trade (GTOT) is relatively high for the Republic of Congo and Nigeria[46] while South Africa has the lowest. By the nature of the series, the volatility is very high across the countries, but the Republic of Congo has an extremely high and unstable growth rate of terms of trade. More so, the series is positively skewed for South Africa and the Republic of Congo while negatively skewed for Nigeria. Also, the statistics of the kurtosis reveal that the series is *platykurtic* across the countries. The statistics of foreign direct investment (FDI) reveal that the Republic of Congo has the highest average value compared to Nigeria and South Africa. This suggests that the Republic of Congo received more foreign direct investment than the two countries. In addition, the series is highly unstable for the Republic of Congo compared to Nigeria and South Africa. Also, the series is positively skewed across the countries. The statistics of kurtosis reveal that the series is *platykurtic* across the countries.

[46] The negative mean value is due to deficit in the terms of trade recorded in most years under consideration.

On domestic credit to the private sector (DOM), the descriptive statistics reveal that South Africa has the highest mean value while the Republic of Congo has the lowest average value. The standard deviation also shows that the series is highly unstable for South Africa compared to Nigeria and the Republic of Congo. More so, the series is negatively skewed for South Africa and Nigeria while positively skewed for the Republic of Congo. The statistics of kurtosis indicate that the series is *leptokurtic*, *platykurtic*, and *mesokurtic* for South Africa, Nigeria, and the Republic of Congo, respectively. The descriptive statistics also reveal that the Republic of Congo has the mean value of trade openness (TOP) among the countries. Also, the series is highly unstable for the Republic of Congo relative to South Africa and Nigeria. This arises from huge differences between the minimum and maximum values. Also, the series is positively skewed while negatively skewed for Nigeria and the Republic of Congo while positively skewed for South Africa. The statistics of the kurtosis show that the series is *leptokurtic* for South Africa and Nigeria while *platykurtic* for the Republic of Congo. The p-values of the Jarque-Bera test shows that the sampled data for the variables follows the non-normal distribution. However, this does not affect the parameters from our estimated models as our methodological approaches (Two-stage Least Squares) adequately address non-normality challenges. According to Brown (1990), the Monte Carlos study reveals the robustness of Two-stage Least Squares (TSLS).

Table 4.1a: Summary of Descriptive Statistics

	Mean	Minimum	Maximum	Std. Dev.	Skewness	Kurtosis	Jarque-Bera test
	South Africa						
GDPPC (US$)	4628.426	2306.282	8017.189	1639.360	0.485	1.936	9.327 (0.009)
TTAX (%)	24.764	22.729	27.611	1.490	0.472	1.994	8.558 (0.014)
ITAX (%)	10.861	9.556	12.257	0.699	0.501	2.206	7.355 (0.025)
DTAX (%)	13.903	12.622	16.382	0.977	0.591	2.569	7.125 (0.028)
PD (%)	39.099	26.073	50.099	6.727	-0.227	1.838	7.002 (0.030)
SEG (%)	2.191	-7.480	17.532	6.311	0.391	2.249	5.284 (0.071)
TNRR (%)	5.191	2.149	13.475	2.230	1.643	6.453	102.237 (0.000)
INV (%)	18.295	15.084	23.717	2.160	0.424	2.421	4.743 (0.093)
POPG (%)	1.657	1.216	2.500	0.423	0.950	2.461	17.545 (0.000)
GOVT (%)	19.280	17.746	21.067	0.854	0.264	2.051	5.312 (0.070)
INF (%)	7.075	-1.203	15.440	3.573	0.493	3.467	5.362 (0.069)
GTOT (%)	6.685	-344.439	993.557	206.037	3.150	15.940	932.134 (0.000)
FDI (%)	1.250	-0.270	6.330	1.347	1.752	6.523	111.138 (0.000)
DOM (%)	128.366	74.553	162.526	21.124	-0.533	2.486	6.293 (0.043)
TOP (%)	53.030	37.352	74.214	9.308	0.001	2.163	3.149 (0.207)
	Nigeria						
GDPPC (US$)	1324.934	248.918	3260.773	962.913	0.571	1.795	12.388 (0.002)
TTAX (%)	7.588	4.151	11.130	1.813	-0.093	1.998	4.676 (0.097)
ITAX (%)	2.265	1.212	4.172	0.649	1.033	3.580	20.704 (0.000)
DTAX (%)	5.324	2.228	8.645	1.816	-0.153	1.905	5.818 (0.055)
PD (%)	59.181	6.047	201.791	56.052	0.921	2.876	15.336 (0.001)
SEG (%)	0.463	-11.643	11.643	3.590	-0.907	7.898	122.754 (0.000)
TNRR (%)	27.837	3.957	65.592	13.786	0.508	3.287	5.011 (0.082)
INV (%)	29.073	13.973	54.914	11.765	0.296	1.884	7.179 (0.028)
POPG (%)	2.575	2.488	2.681	0.072	0.198	1.403	12.186 (0.002)

Table 4.1b: Summary of Descriptive Statistics (continued)

	Mean	Minimum	Maximum	Std. Dev.	Skewness	Kurtosis	Jarque-Bera test
GOVT (%)	4.218	0.437	10.119	3.139	0.445	1.597	12.420 (0.002)
INF (%)	18.805	4.896	76.426	17.707	1.900	5.401	90.911 (0.000)
GTOT (%)	-80.436	-1829.78	570.403	369.700	-3.194	15.380	873.255 (0.000)
FDI (%)	1.845	0.024	6.370	1.199	1.894	7.087	139.698 (0.000)
DOM (%)	9.957	4.640	20.367	3.724	1.070	3.580	22.136 (0.000)
TOP (%)	37.960	19.633	53.938	8.712	-0.191	2.538	1.613 (0.446)
	Republic of Congo Rep.						
GDPPC (US$)	2566.610	2252.085	2944.884	189.014	0.374	1.907	7.894 (0.019)
TTAX (%)	9.103	5.611	12.354	1.753	0.006	1.960	4.866 (0.088)
ITAX (%)	5.781	3.525	9.033	1.177	0.510	3.069	4.701 (0.095)
DTAX (%)	3.322	1.233	5.453	0.944	0.360	2.841	2.445 (0.295)
PD (%)	131.412	19.068	267.582	70.544	-0.007	1.785	6.646 (0.036)
SEG (%)	3.796	-27.297	35.664	12.706	-0.258	3.103	1.243 (0.537)
TNRR (%)	45.423	22.140	63.736	10.212	-0.309	2.450	3.082 (0.214)
INV (%)	26.254	15.993	54.606	8.223	1.630	5.392	73.587 (0.000)
POPG (%)	2.873	2.437	3.457	0.268	0.537	2.861	5.272 (0.072)
INF (%)	3.370	-4.826	10.361	3.308	-0.064	2.873	0.147 (0.929)
GOVT (%)	16.857	9.357	28.843	5.176	0.853	2.716	13.463 (0.001)
GTOT (%)	156.707	-751.836	4563.598	847.573	4.369	21.856	1943.583(0.000)
FDI (%)	7.211	-35.293	53.728	12.650	1.129	6.873	90.460 (0.000)
DOM (%)	8.703	2.073	23.221	5.649	0.900	3.053	14.586 (0.001)
TOP (%)	127.837	55.936	167.325	27.508	-1.385	4.055	39.524 (0.000)

Source: Author's computation. Note that the values in parenthesis are p-values.

Unit Root Tests

This sub-section further examined the statistical properties of our variables. Thus, Tables 4.2-4.3 presents the unit root tests for three countries to ascertain the stationarity of the variables. The study utilises two tests which are Augmented Dickey-Fuller (ADF) and Philip-Perron (PP) tests. Starting with dependent variables, log of GDPPC (LGDPPC), the t-statistic of ADF test shows that the series is not stationary at level under none, constant, and trend for the three countries. This is expected as this series is trending or non-stationary due to a consistent increase in its mean. This also necessitates the use of logarithm form of the series in this analysis. More so, it ensures that the series follows a linear trend. Taking the first difference of LGDPPC, the series becomes stationary under none, constant, and trend for three countries. Thus, the null hypothesis of the unit root is rejected.

Furthermore, total tax (TTAX) is not stationary at a level under none and constant for the three countries. However, the series turns out to be stationary for South Africa and the Republic of Congo when a linear trend is included at level. When the series is differenced once, it becomes stationary for the countries. Considering the disaggregated taxes, direct tax (DTAX) has a unit root at level under none and constant. The inclusion of linear trend makes the series to be stationary for South Africa and Nigeria. Taking the first difference of DTAX, the series turns out to be stationary across the three countries. Indirect tax (ITAX) is non-stationary at level under none. Nevertheless, the series becomes stationary at level with the inclusion of constant and linear trend for South Africa and the Republic of Congo. By taking the first difference of the series, it becomes stationary under none, constant and linear trend for all the countries.

Public debt (PD) remains non-stationary at level under none, constant and linear trend across the countries except for Nigeria under none. This series is first differenced to make it stationary for countries under none, constant and trend. Therefore, the null hypothesis of unit root is rejected. Moreover, total natural resource rent (TNRR) is not stationary at level under none. With the inclusion of constant, the series turns to be stationary for the Republic of Congo. Accounting for the linear trend, the series is also stationary for Nigeria and South Africa. Taking the first difference of the series, it becomes stationary across the countries.

Also, seigniorage (SEG) is stationary at level under none for three countries. However, the series is stationary under constant for South Africa and Nigeria. The series is stationary when a linear trend is included for Nigeria only. Under the first difference, the series is stationary across the three countries.

On domestic credit to the private sector (DOM), there is unit root at level except under trend for South Africa only. Thus, the series is differenced once, and it becomes stationary across the countries. More so, foreign direct investment (FDI) is stationary at level under none, constant, and trend for South Africa and the Republic of Congo while it is only stationary for Nigeria under none and constant. The first difference of the series shows that there are no unit roots in the variable across the countries which makes it stationary. Also, government final consumption expenditure (GOVT) has a unit root at level for South Africa and Nigeria. In the case of the Republic of Congo, the series is stationary when constant and linear trend are accounted for. The first difference of the series reveals that it is stationary across the countries.

Growth of the terms of trade (TOT) is stationary at level and first difference. Expectedly, inflation is also statistically significant and stationary at level and first difference. Investment (INV) is stationary at level for Nigeria and the Republic of Congo. After taking the first difference of the series, it becomes stationary. Also, the population growth (POPG) is only stationary at level for South Africa. The trending pattern of the series in Nigeria and the Republic of Congo may account for its non-stationarity at level. However, the first difference of the series turns out to be stationary across the three countries. On the trade openness (TOP), the series is not non-stationary at level for the countries except for the Republic of Congo. When the first difference of the series is considered, it turns out to be statistically significant and stationary across the countries.

The distribution theory that is associated with ADF relied on the assumption of statistically exogenous error terms and constant variance. More so, ADF accounts for higher-order serial correlation via lagged difference terms. On the other hand, Phillip-Perron (PP) test corrects t-statistic to account for serial correlation. Thus, the PP test is just an augmented form of

ADF through a less restrictive error process. Since ADF and PP tests reinforce each other, we also consider the PP tests as presented for the countries in Tables 4.2-4.4. The PP test results support the findings under ADF with just slight differences. In conclusion, all series for the estimations are stationary and do not have unit roots across the variables. Since non-stationary series can result in spurious regression, this problem is circumvented due to the stationarity of the variables at most with the first difference. This necessitates the next step which specifically focuses on model estimation as discussed in the next section.

Table 4.2: Unit Root Tests for South Africa

	Level			First difference		
	Augmented Dickey-Fuller test statistics (ADF)					
Variable	None	with constant	with constant and trend	None	with constant	with constant and trend
LGDPPC	0.422	-1.488	-1.965	-4.114***	-4.126***	-4.1316***
TTAX	0.507	-2.245	-3.622**	-3.289***	-3.336**	-3.309*
DTAX	0.611	-2.037	-3.439**	-3.489***	-3.557***	-3.539**
ITAX	0.104	-3.002**	-3.724**	-3.434***	-3.413***	-3.379*
PD	-0.513	-2.360	-2.431	-2.406**	-2.312	-2.285
TNRR	-0.658	-1.891	-2.454	-4.790***	-4.762***	-4.737***
SEG	-2.914***	-3.020**	-3.060	-5.953***	-5.936***	-5.917***
DOM	0.547	-2.259	-3.079	-3.642***	-3.734***	-3.870**
FDI	-1.954**	-3.655***	-3.862**	-4.614***	-4.593***	-4.581***
GOVT	0.727	-1.416	-2.313	-4.116***	-4.175***	-4.204***
GTOT	-4.077***	-4.075***	-4.034***	-4.328***	-4.303***	-4.274***
INF	-1.595	-3.055**	-2.926	-5.446***	-5.449***	-5.644***
INV	-0.2501	-2.3672	-2.936	-3.081***	-3.064**	-2.935
POPG	-1.738*	-2.965**	-2.674	-2.603***	-2.888**	-3.272*
TOP	0.593	-1.842	-3.394*	-3.949***	-4.047***	-4.067***
	Phillip-Perron test statistics (PP)					
LGDPPC	0.651	-1.260	-1.527	-4.175***	-4.180***	-4.186***
TTAX	0.741	-1.590	-2.507	-4.737***	-4.659***	-4.631
DTAX	0.648	-1.575	-2.543	-4.757***	-4.703***	-4.682***
ITAX	0.335	-2.225	-2.648	-4.584***	-4.539***	-4.534***
PD	0.286	-1.774	-1.770	-3.520***	-3.458***	-3.492**
TNRR	-0.772	-1.952	-2.365	-6.436***	-6.337***	-6.268***
SEG	-2.591***	-2.563	-2.566	-5.059***	-5.026***	-4.985***
DOM	0.878	-2.516	-2.478	-4.877***	-4.746***	-4.726***
FDI	-1.840*	-2.677*	-2.764	-9.213***	-9.851***	-10.618***
GOVT	0.708	-1.426	-2.165	-4.731***	-4.717***	-4.605***
GTOT	-2.670***	-2.664*	-2.641	-7.154***	-7.576***	-8.428***
INF	-1.384	-2.309	-2.168	-4.826***	-4.803***	-4.690***
INV	-0.608	-2.145	-2.896	-4.120***	-4.112***	-4.075***
POPG	-1.791*	-1.586	-0.798	-1.553	-1.906	-2.276
TOP	0.422	-1.403	-1.959	-5.125***	-5.235***	-5.248***

Source: Author's computation

Note that ***, **, and * represents levels of significance at 1%, 5%, and 10%, respectively.

Table 4.3: Unit Root Tests for Nigeria

	Level			First difference		
	Augmented Dickey-Fuller test statistics (ADF)					
Variable	None	with constant	with constant and trend	None	with constant	with constant and trend
LGDPPC	0.652	-1.138	-2.115	-2.623***	-2.732*	-2.610
TTAX	0.412	-1.525	-3.351*	-4.530***	-4.579***	-4.576***
DTAX	0.599	-0.831	-3.3981*	-6.215***	-6.272***	-6.305***
ITAX	-0.319	-1.961	-2.040	-3.636***	-3.619***	-3.626**
PD	-1.698*	-1.663	-3.001	-5.020***	-5.441***	-5.429***
TNRR	-1.424	-1.328	-5.283***	-6.075***	-6.145***	-6.115***
SEG	-3.931***	-3.962***	-4.037***	-7.957***	-7.922***	-7.885***
DOM	0.058	-2.056	-3.704**	-3.228***	-3.301**	-3.278*
FDI	-1.412	-3.353**	-3.588**	-4.317***	-4.294***	-4.273***
GOVT	-0.445	-1.324	-1.129	-3.789***	-3.787***	-3.839**
GTOT	-2.789***	-2.950**	-3.296*	-4.989***	-4.963***	-4.945***
INF	-1.469	-2.491	-3.279*	-3.488***	-3.471***	-3.440**
INV	-2.595***	-1.535	-2.734	-3.455***	-4.090***	-4.226***
POPG	-0.163	-2.402	-1.631	-1.592	-1.533	-1.309
TOP	-0.740	-2.491	-2.518	-4.517***	-4.509***	-4.560***
	Phillip-Perron test statistics (PP)					
LGDPPC	1.083	-0.515	-2.277	-4.849***	-4.738***	-4.687***
TTAX	0.443	-1.017	-2.086	-4.974***	-4.973***	-4.942***
DTAX	0.298	-1.323	-2.828	-4.921***	-4.905***	-4.735***
ITAX	-0.332	-1.756	-1.792	-6.356***	-6.294***	-6.696***
PD	-1.330	-1.184	-2.550	-5.029***	-5.047***	-5.011***
TNRR	-1.926**	-2.199	-3.559**	-4.982***	-4.958***	-4.915***
SEG	-3.481***	-3.483***	-3.524**	-5.460***	-5.408***	-5.349***
DOM	0.177	-1.602	-2.552	-4.589***	-4.631***	-4.610***
FDI	-1.407	-2.710*	-2.843	-4.932***	-4.895***	-4.849***
GOVT	-0.379	-1.254	-1.253	-4.811***	-4.704***	-4.714***
GTOT	-2.582***	-2.561	-2.469	-7.821***	-7.725***	-7.676***
INF	-1.292	-2.011	-2.395	-4.934***	-4.917***	-4.899***
INV	-3.804***	-2.145	-2.649	-4.494***	-4.640***	-4.691***
POPG	0.188	-0.761	-2.682	-2.088**	-2.129	-1.088
TOP	-0.663	-2.446	-2.674	-5.278***	-5.232***	-5.278***

Source: Author's computation

Note that ***, **, and * represents levels of significance at 1%, 5%, and 10%, respectively.

Table 4.4: Unit Root Tests for the Republic of Congo

	Level			First difference		
	Augmented Dickey-Fuller test statistics (ADF)					
Variable	None	with constant	with constant and trend	None	with constant	with constant and trend
LGDPPC	-0.109	-1.652	-2.525	-3.218***	-3.187**	-3.210*
TTAX	-0.241	-2.430	-2.294	-9.573***	-9.524***	-9.598***
DTAX	-0.340	-1.918	-1.950	-4.559***	-4.537***	-4.677***
ITAX	-0.586	-3.606***	-3.509**	-5.769***	-5.741***	-5.766***
PD	-1.038	-0.776	-2.170	-3.737***	-3.802***	-3.852**
TNRR	-0.218	-4.144***	-4.300***	-6.081***	-6.035***	-5.990***
SEG	-2.486***	-2.552	-2.951	-4.990***	-4.977***	-4.873***
DOM	-0.824	-1.776	-1.305	-3.294***	-3.266**	-3.889**
FDI	-3.249***	-3.673***	-3.719**	-4.119***	-4.050***	-3.967***
GOVT	-1.234	-3.106**	-4.422***	-5.419***	-5.404***	-5.414***
GTOT	-3.536***	-3.705***	-3.682**	-5.135***	-5.108***	-5.084***
INF	-1.694*	-3.153**	-3.193*	-4.400***	-4.382***	-4.385***
INV	-0.952	-3.290**	-3.253*	-3.142***	-3.093**	-3.102
POPG	-0.307	-1.565	-1.382	-4.867***	-4.852***	-5.183***
TOP	0.538	-2.689*	-2.628	-6.102***	-6.180***	-6.294***
	Phillip-Perron test statistics (PP)					
LGDPPC	-0.004	-1.263	-2.061	-4.582***	-4.557***	-4.309***
TTAX	0.094	-2.117	-1.859	-6.249***	-6.176***	-8.664***
DTAX	-0.255	-1.959	-2.093	-5.110***	-5.071***	-5.259***
ITAX	-0.191	-2.582*	-2.558	-9.459***	-9.358***	-12.188***
PD	-1.046	-0.704	-1.889	-5.034***	-4.920***	-4.873***
TNRR	-0.759	-3.305**	-3.418**	-4.142***	-4.085***	-4.121***
SEG	-3.242***	-3.111**	-3.198*	-5.875***	-6.130***	-6.473***
DOM	-0.246	-0.897	-0.630	-4.465***	-4.432***	-3.983***
FDI	-2.515***	-2.715*	-2.642	-2.715***	-2.692*	-2.756
GOVT	-0.615	-2.366	-3.190*	-4.945***	-4.904***	-4.810***
GTOT	-2.613***	-2.624*	-2.603	-11.255***	-11.119***	-11.180***
INF	-1.971**	-2.419	-2.409	-5.559***	-5.493***	-5.461***
INV	-0.444	-1.904	-1.794	-4.500***	-4.457***	-4.555***
POPG	-0.329	-1.343	-1.312	-1.950**	-1.942	-1.914
TOP	0.283	-2.307	-2.299	-4.621***	-4.554***	-4.432***

Source: Author's computation

Note that ***, **, and * represents levels of significance at 1%, 5%, and 10%, respectively.

4.1.2. The Effects of Public Debt on Tax-Economic Growth Nexus

In addressing our first objective, this section focuses on the effects of public debt on the relationship between tax and economic growth under linear and non-linear approaches in South Africa, Nigeria, and the Republic of Congo. In other words, we examine the extent to which public debt accumulation influences the effect of tax on economic growth of these countries under linear and nonlinear approaches. This is important as these countries are faced with challenges of APFOs in facilitating their economic growth over years.

Table 4.5 presents the effect of public debt on tax and economic relationship using linear approach. Starting with the coefficients of public debt (PD), they are positive and statistically significant at 1% for South Africa under the aggregated and disaggregated taxes. On average, this result suggests that a 1% increase in public debt will result in approximately 0.09% increase in economic growth. Thus, public debt serves as a positive significant predictor of economic growth in the country. Comparatively, the coefficients of public debt are largely positive and statistically significant under aggregated and disaggregated taxes for Nigeria. Models 4 and 5 reveal a positive effect of public debt on economic growth as a 1% increase in public debt amplifies economic growth by 0.08%, on average. On the other hand, in model 5 where indirect tax is considered, the coefficient shows a negative effect of public debt as a 1% increase dampened economic growth by 0.005%. This result indicates that public debt enhances economic growth, but its effect remains small. Furthermore, the result for the Republic of Congo reveals positive and statistically significant coefficients of public debt. This implies that public debt as a crucial public financing option has the potential to facilitate economic growth. For instance, a 1% increase in public debt facilitates economic growth by 0.02%, on average. The results for the countries are consistent with observed patterns in the trend analysis. These suggest that public debt positively influences the growth process but remains very weak across the countries adjudged by the small coefficients.

The evidence from the three countries supports the finding by Makhoba et al. (2021) and Megersa (2015) that there are some levels of debt that are positively related to economic growth. Generally, the results do not support the argument that debt is always bad as

portrayed by some studies (such as Yusuf and Mohd, 2021; Mhlaba and Phiri, 2019; Ncanywa and Masoga, 2018) due to exclusion of proposition in the theoretical government budget constraint. The findings by these existing studies may be inadequate given the argument by Kneller et al. (1999), Gemmell (2001), and Gemmell et al. (2014) that most studies do not rely on government budget constraint, thus, addressing fiscal variables such as debt, independently provide inefficient result. Our results further corroborate the recent study on developing countries by Ehrhart et al. (2014) and Le Van et al. (2018) that explore theoretical government budget constraint. It is important to note that efficient utilisation of debt at a moderate level will foster economic growth. In this study, we jointly account for other fiscal variables such as tax and government final consumption expenditure. Thus, our models provide more reliable and valid estimates.

Focusing on total tax (TTAX) and its disaggregation (indirect tax-ITAX and direct tax-DTAX), the results for South Africa show positive and statistically significant coefficients. From the result, increasing the total tax by 1% leads to 0.14% increase in economic growth. In addition, an increase in indirect tax by 1% results in 0.32% in economic growth while a 1% increase in direct tax facilitates growth by 0.22%. Though the positive effect of indirect tax is relatively higher than direct tax. Unlike other financing options, taxes provide consistent and stable revenue to government as well as enhance financing capacity to provide public infrastructures that are growth-enhancing. On a comparative basis, the result for Nigeria indicates that total tax and direct taxes have a positive and statistically significant influence on economic growth while indirect tax negatively impacts economic growth. For instance, a 1% increase in total tax and direct tax results in an approximately 0.18% increase in economic growth.

On the other hand, increasing indirect tax by 1% leads to 0.4% decrease in economic growth. At a disaggregated level, direct tax is growth-enhancing while indirect tax is growth-inhibiting. More so, the result for the Republic of Congo reveals that the coefficients of total tax and its disaggregation are all positive and statistically significant. This result suggests that a 1% increase in total tax, indirect tax, and direct tax will enhance economic growth by 0.46%, 0.78%, and 0.91%, respectively. Thus, taxes have the potential to generate enormous

income for the government to spur economic growth through improvement in public investment. The results across the countries suggest that the effect of tax is relatively high in South Africa and the Republic of Congo compared to Nigeria. Our results support the argument by Oyinlola and Adedeji (2022), Gemmell et al. (2016), Gemmell (2001), and Deverajan et al. (1996) that tax can be growth-enhancing.

The next discussion focuses on the effect of public debt on the tax-economic growth relationship across the countries as captured by the interaction of public debt and taxes. The results for South Africa reveal that the coefficients of taxes and public debt interactions are negative and statistically significant. Also, the results suggest that the accumulation of public debt reduces the effectiveness of tax impact on economic growth. For example, a 1% increase in public debt reduces the growth effect of total, indirect and direct taxes by approximately 0.004%, 0.009%, and 0.008%, respectively. Similar results are obtained for Nigeria except for indirect tax. The results in models 4 and 5 imply that increasing the level of public debt by 1% inhibits the growth effect of tax by approximately 0.002%. On the other hand, model 5 indicates that public debt enhances the growth effect of indirect tax in the case of Nigeria. In other words, a 1% increase in public debt improves the growth effect of indirect tax by 0.003%. Furthermore, the coefficients of public debt for the growth effects of tax are all negative and statistically for the Republic of Congo. For instance, if the public debt is increased by 1%, growth effects of total tax, indirect tax, and direct tax will decrease by 0.002%, 0.003%, and 0.007%, respectively. Thus, the result confirms that huge accumulation of public debt undermines the efficacy of taxes in improving economic growth. This is expected as tax revenue is allocated between interest repayment and public investment.

Comparatively, the effect of public debt on tax and economic growth relationship is more pronounced in South Africa relative to the other two countries. South Africa mobilises more revenue from taxes compared to Nigeria and the Republic of Congo which implies that the share of tax revenue allocated between interest repayment and competing public investments needed for growth will be substantial. In the case of Nigeria and the Republic of Congo, tax revenue is not the major revenue source for interest repayment and financing

public investment, thus, the effect may not be as high as observed for South Africa. This evidence is critical for understanding public financing behaviour and economic growth in sub-Saharan Africa. Thus, the estimates from this study provide useful information on how APFOs work to spur economic growth compared to existing studies (such as Yusuf and Mohd, 2021; Mhlaba and Phiri, 2019; Ncanywa and Masoga, 2018, Saibu, 2018).

Table 4.5: The effect of public debt on tax-economic growth nexus (Linear Approach)

	Dependent Variable: LGDPPC								
	South Africa			Nigeria			Republic of Congo		
Variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
PD	0.0825*** (0.0139)	0.0809*** (0.0112)	0.0975*** (0.0159)	0.0104*** (0.0042)	-0.0054*** (0.0013)	0.0065*** (0.0025)	0.0173*** (0.0056)	0.0180*** (0.0067)	0.0249*** (0.0063)
TTAX	0.1404*** (0.0109)			0.1751*** (0.0553)			0.4629*** (0.1110)		
ITAX		0.3244*** (0.0216)			-0.4224*** (0.0686)			0.7475*** (0.2055)	
DTAX			0.2243*** (0.0200)			0.1768*** (0.0005)			0.9133*** (0.3164)
TTAXPD	-0.0038*** (0.0005)			-0.0022*** (0.0007)			-0.0018*** (0.0006)		
ITAXPD		-0.0086*** (0.0010)			0.0030*** (0.0009)			-0.0031*** (0.0012)	
DTAXPD			-0.0078*** (0.0010)			-0.0020*** (0.005)			-0.0069*** (0.002)
INV	0.0925*** (0.0117)	0.0976*** (0.0109)	0.0944*** (0.0131)	-0.0072 (0.0096)	-0.0428*** (0.0032)	-0.0101 (0.0069)	0.0114 (0.0075)	0.0158 (0.0113)	0.0154* (0.0081)
POPG	0.3782*** (0.0790)	0.3917*** (0.0895)	0.2979*** (0.0959)	2.1906*** (0.3216)	3.5761*** (0.0905)	2.3615*** (0.2127)	1.0133*** (0.3162)	0.9869*** (0.2339)	1.5775*** (0.2560)
DOM	0.0010 (0.0020)	0.0007 (0.0020)	0.0032*** (0.0023)	-0.0040 (0.0153)	0.0151* (0.0090)	0.0021 (0.0134)	-0.0163 (0.0417)	0.0048 (0.0113)	0.0498 (0.0387)
INF	-0.0703*** (0.0108)	-0.0692*** (0.0126)	-0.0604*** (0.0122)	-0.0015 (0.0019)	-0.0057*** (0.0015)	-0.0026 (0.0016)	-0.0527 (0.0377)	-0.0525* (0.0298)	-0.0189 (0.0324)
GOVT	0.1553*** (0.0185)	0.1456*** (0.0166)	0.1571*** (0.0200)	0.0761*** (0.0225)	-0.0262 (0.0174)	0.0620*** (0.0172)	0.0040 (0.0313)	-0.0033 (0.0121)	-0.0247 (0.0293)
FDI	-0.0487*** (0.0169)	-0.0446*** (0.0176)	-0.0557*** (0.0150)	-0.0809** (0.0398)	-0.0540*** (0.0215)	-0.0790** (0.0334)	0.0020 (0.0086)	-0.0004 (0.0052)	0.0119 (0.0105)
TOP	0.0098*** (0.0039)	0.0109*** (0.0041)	0.0097*** (0.0034)	0.0069 (0.0046)	-0.0003 (0.0015)	0.0056* (0.0033)	0.0044 (0.0043)	0.0038 (0.0030)	-0.0039 (0.0033)
GTOT	0.00017 (0.0001)	0.00017 (0.0001)	0.00012 (0.0001)	0.000014 (0.00009)	0.00006*** (0.00004)	0.00005 (0.00007)	-0.0001 (0.0001)	-0.00007 (0.00009)	-0.0002 (0.0001)
Observation	108	108	108	108	108	108	108	108	108
J-statistic	12.911	8.6162	18.482	11.322	10.033	9.9420	1.6147	12.655	1.5811
Prob (J-statistic)	0.1149	0.3757	0.0179	0.1841	0.2628	0.2691	0.9906	0.1243	0.9913
Instrument Rank	19	19	19	19	19	19	19	19	19

Source: Author's computation

Note that the values in parenthesis are robust standard errors. ***, **, and * represents levels of significance at 1%, 5%, and 10%, respectively.

Further discussion focuses on the effects of the control variables on economic growth across the three countries. The coefficients of investment are all positive and statistically significant for South Africa. This shows that domestic investment exerts a positive influence on economic growth. Thus, increasing the level of domestic investment by 1% leads to an increase in economic growth by 0.09% on average. Domestic investment is essential to productivity expansion as this improves capital accumulation needed to enhance economic growth. In the case of Nigeria, domestic investment exerts a negative influence on economic growth but is only statistically significant in model 2. This simply reveals that domestic investment is not large enough to drive economic growth. For example, a 1% increase in domestic investment reduces economic growth by approximately 0.02% on average. Economically, high investment is largely linked with high savings but for a country such as Nigeria, low per capita income may be associated with a low saving rate as the huge poor population will most likely expend their income on consumption. Thus, low saving behaviour implies low investment thereby having a drag effect on economic growth.

However, the coefficients of domestic investment are all positive but statistically significant in model 9 for the Republic of Congo. This means that domestic investment influences economic growth positively but remains sub-optimal. When the level of domestic investment is increased by 1%, economic growth amplifies by 0.01% on average. Among these countries, South Africa benefits more from domestic investment as indicated by a relatively high coefficient. The positive effect of domestic investment supports the findings by Kremer et al. (2013), Mijiyawa (2013), and Thanh (2015) while the negative effect supports the evidence provided by Ogundari and Awokuse (2018).

On population growth, its coefficients are positive and statistically significant across the three countries. This suggests that population growth plays a significant role in amplifying economic growth across the countries. An increase in population growth by 1% translates to an increase in economic growth of South Africa, Nigeria, and the Republic of Congo, by 0.36%, 2.71%, and 1.19%, respectively. The effect of population growth is relatively high for Nigeria. Thus, the countries have the potential to explore their human resource endowment to enhance their productivity. In other words, these countries have huge

populations they can engage in the production process. It is high time these countries regarded their population as economic strength towards generating high and stable productivity. The results contradict the finding by Ogundari and Awokuse (2018), Oyinlola and Adedeji (2019), and Ndoricimpa (2020) who found high population as inhibition to growth. Furthermore, the domestic credit to the private sector has a positive effect but is statistically significant in model 3 for South Africa. The effect is largely positive for Nigeria and the Republic of Congo but statistically significant in model 4 for Nigeria. More so, the impact is higher in South Africa relative to Nigeria and the Republic of Congo. The availability of enough resources for business will enhance productivity. This result is similar to the finding by Oyinlola et al. (2020b).

More so, the effect of inflation is negative and statistically significant for South Africa. Similarly, inflation influences economic growth negatively for Nigeria and the Republic of Congo but only statistically significant in models 5 and 8, respectively. Expectedly, an increase in inflation rate reduces economic growth due to economic uncertainty. Inflation causes high production costs which reduce the level of productivity. Intuitively, high price discourages demand and production which lowers economic growth. Moreover, the coefficients of government final consumption expenditure are all positive and statistically significant for South Africa. This suggests that government final consumption expenditure exerts a positive influence on economic growth. On average, increasing the government final consumption expenditure by 1% causes economic growth to increase by 0.15%.

In the case of Nigeria, the coefficients of government final consumption expenditure are positive all statistically significant except in model 5. Thus, if government final consumption expenditure is increased by 1%, economic growth amplifies by 0.01% on average. On the other hand, the coefficients of government final consumption expenditure are largely negative and statistically insignificant for the Republic of Congo. The results indicate that the government expenditure is non-distortionary for growth in South Africa and Nigeria while distortionary for the Republic of Congo. More so, the positive effect is more pronounced for South Africa compared to the other two countries. Like other African countries, these countries' spending is dominated by recurrent expenditure which plays a

significant role in productivity. Our results support evidence in the literature as Oyinlola and Adedeji (2019, 2020) and Adeniyi et al. (2020) found a positive impact of government final consumption expenditure on growth.

Also, the results show a negative relationship between foreign direct investment and economic growth for South Africa and Nigeria while a largely positive relationship for the Republic of Congo. This suggests that foreign direct investment serves as a drag on the economic growth in South Africa and Nigeria. For instance, when foreign direct investment is increased by 1%, economic growth for South Africa and Nigeria decline, on average, by 0.05% and 0.07%, respectively. However, foreign direct investment positively influences economic growth but is statistically insignificant for the Republic of Congo. Distinguishably, the drag effects of foreign direct investment are more pronounced for South Africa and Nigeria. Therefore, we can conclude that foreign direct investment is not growth-enhancing in most of these countries. The plausible reason may be due to larger inflows of foreign investments to the extractive sector rather real sector (Chen, et al., 2017; Guo and Clougherty, 2015).

The coefficients of trade openness are positive and statistically significant for South Africa. The coefficients are positive for Nigeria in models 4 and 6 but statistically significant for model 6. In the case of the Republic of Congo, the coefficients are positive in models 7 and 8 but statistically insignificant across the models. This implies that liberalisation of the market fosters economic connectedness of the South African economy to the global market which tends to facilitate economic growth relative to Nigeria and the Republic of Congo. This evidence supports the findings reported by Zahonogo (2017), and Hossain and Mitra (2013). The effect of growth of terms of trade is positive but statistically insignificant across the models for South Africa. The effect remains positive for Nigeria but statistically significant in Model 2. However, the effect is negative and statistically significant across models for the Republic of Congo. It is important to note that the impact is relatively high for South Africa. This is expected as the country promotes its export, especially within SADC compared to Nigeria.

For the Republic of Congo, the country's import is relatively high, especially for final products which may not foster economic growth. Hence, enhancing the growth of export with a reduction in import growth tends to boost the level of productivity in the economy. The evidence is supported by the finding by Ndoricimpa (2020). Also, the results reveal that all instruments irrespective of their ranks remain valid as indicated by statistically insignificant values of *J*-statistic. This implies that all instruments used in our analysis are strong and give adequate information about the variations in endogenous regressors. Thus, our estimates from the models are reliable.

The next phase of our analysis focuses on the effect of public debt on the relation between tax and economic growth across the three countries using a non-linear approach (as reported in Tables 4.6). Specifically, the results for South Africa reveal negative effect of public debt in models 1 and 2 while positive effect in model 3. Also, all the coefficients are statistically insignificant across the model. This result deviates from earlier findings. This plausible reason may be due to the sensitivity of the variable to model specification. However, the coefficients of public debt are largely positive and statistically significant for Nigeria. This reinforces the previous finding that public debt has a greater role to play in enhancing economic growth in Nigeria. Thus, accumulation of moderate public debt may enhance the country's capacity to reduce the public investment deficit, and in turn, is beneficial to productivity. Similarly, the effect of public debt remains positive and statistically significant for the Republic of Congo. According to Oyinlola and Adedeji (2022), many SSA countries are still facing serious financial constraints given the huge infrastructure deficit. Thus, public debt has a crucial role to play to augment the huge financing gap in public investment with judicious utilisation and management of borrowing.

Furthermore, the coefficients of tax and its disaggregation remain positive and statistically significant across the models for South Africa. This result suggests that economic growth is enhanced by 0.41%, 0.79%, and 0.76%, for a 1% increase in total tax, indirect tax, and direct tax, respectively. Mobilising resources through taxes provide more resources to the country to expand its public goods that can facilitate productivity. This result further supported earlier finding under the linear specification. Thus, South Africa is one of the highest tax

collectors in Africa, it is expected that such revenue option should promote its economic growth. On the other hand, total tax and direct tax influence economic growth positively while indirect tax substantially reduces economic growth in Nigeria. This result points to the fact that tax revenue is very essential to improving the country's resource paucity as well as creating enabling environment through massive public investment for high and stable economic growth. However, the mixed results suggest that the country needs to pay attention to non-distortionary tax. More so, the results for the Republic of Congo reveal a strong positive effect of total tax and disaggregated taxes on economic growth. These results ascertain the need for these countries to diligently explore taxes and ensure their efficient utilisation for high, stable, and sustainable economic growth. These results contradict the findings of Widmalm (2001), Tobing (2011), Yilmaz (2013), and Oyinlola et al. (2020a) that taxes dampened growth but support the most recent evidence of positive effect of taxes by Oyinlola and Adedeji (2022).

The study further tests for the presence of growth laffer curve to ascertain the implications of consistently increasing the tax rates on economic growth across the countries. The results show the presence of growth laffer curve at aggregate and disaggregated taxes for South Africa as indicated by negative and statistically significant coefficients of squared taxes (TTAXS, ITAXS, and DTAXS). A similar result is reported for Nigeria. Specifically, the coefficients of total tax squared and direct tax squared are negative suggesting the presence of growth laffer curve. However, the sign of indirect tax squared is positive which implies the absence of growth laffer curve. Subsequently, the results show the presence of growth laffer curve for aggregated and disaggregated taxes for the Republic of Congo. By implication, these results suggest that tax can be growth-enhancing or retarding. There is a threshold of tax rate that will maximise economic growth. Determining the tax rate that maximises economic growth is an important way to address resource paucity in the countries. These findings give more insight into the issue of tax mobilisation in these countries. This evidence supports our theoretical propositions and arguments by Ehrhart et al. (2014) and Barro (1990). More so, our findings provide more evidence for the relationship between tax and economic growth than existing studies such as Oyinlola and Adedeji (2022) and Oyinlola et al. (2020a).

Table 4.6: The effect of public debt on tax-economic growth nexus (Nonlinear Approach)

	Dependent Variable: LGDPPC								
	South Africa			Nigeria			Republic of Congo		
Variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
PD	-0.0681 (0.2948)	-0.1689 (0.3223)	0.1221 (0.2042)	0.0446* (0.0236)	-0.0225*** (0.0054)	0.0249** (0.0125)	0.0395*** (0.0065)	0.0419*** (0.0034)	0.0491*** (0.0037)
TTAX	0.4062*** (0.1240)			1.5281* (0.8080)			0.9616*** (0.3036)		
ITAX		0.7932** (0.3932)			-2.1445*** (0.5486)			2.6327*** (0.1816)	
DTAX			0.7565*** (0.1372)			1.0338*** (0.4065)			2.5597*** (0.2410)
TTAXS	-0.0090** (0.0005)			-0.0883* (0.0502)			-0.0438*** (0.0172)		
ITAXS		-0.0364 (0.0305)			0.4517*** (0.1444)			-0.2145*** (0.0205)	
DTAXS			-0.0316*** (0.0088)			-0.0781** (0.0367)			-0.3163*** (0.0368)
TTAXPD	0.0031 (0.0229)			-0.0114* (0.0062)			-0.0088*** (0.0015)		
ITAXPD		0.0271 (0.0516)			0.0209*** (0.0057)			-0.0147*** (0.0013)	
DTAXPD			-0.0213 (0.0298)			-0.0081* (0.0047)			-0.0286*** (0.0025)
TTAXSPD	-0.00004 (0.0005)			0.0007 (0.0004)			0.0005*** (0.0001)		
ITAXSPD		-0.0012 (0.0021)			-0.0048*** (0.0015)			0.0012*** (0.0001)	
DTAXSPD			0.0008 (0.00011)			0.0005 (0.0044)			0.0041*** (0.0005)
INV	0.0864*** (0.0125)	0.0958*** (0.0125)	0.0969*** (0.0129)	-0.0174*** (0.0070)	-0.0286*** (0.0049)	-0.0196*** (0.0059)	0.0154* (0.0154)	0.0016 (0.0012)	0.0080*** (0.0260)
POPG	0.5639*** (0.1194)	0.4340*** (0.1200)	0.5154*** (0.1131)	0.5606 (1.2020)	4.1368*** (0.1889)	1.9221*** (0.3649)	0.6050** (0.2958)	-0.0405 (0.0943)	0.6033*** (0.1083)
DOM	0.0025 (0.0026)	0.0005 (0.0026)	0.0044 (0.0027)	-0.0186 (0.0116)	-0.0150* (0.0089)	-0.0233 (0.0197)	-0.0109 (0.0069)	-0.0104*** (0.0040)	0.0018 (0.0084)
INF	-0.0786*** (0.0123)	-0.0769*** (0.0158)	-0.0722*** (0.0126)	0.0004 (0.0026)	-0.0062*** (0.0010)	-0.0052** (0.0026)	-0.0536** (0.0231)	-0.0232*** (0.0064)	0.0176*** (0.0066)

GOVT	0.0785* (0.0404)	0.1168*** (0.031)	0.0587* (0.0311)	0.1181*** (0.0261)	0.0398** (0.0190)	0.0775*** (0.0244)	0.0061 (0.0069)	0.0103** (0.0052)	-0.0132 (0.0135)
FDI	-0.0476** (0.0212)	-0.0401** (0.0182)	-0.0364** (0.0171)	-0.2226*** (0.0809)	-0.0463*** (0.0132)	-0.1880*** (0.0545)	-0.0026 (0.0026)	-0.0018 (0.0020)	-0.0022 (0.0029)
TOP	0.0138*** (0.0047)	0.0101** (0.0044)	0.0143*** (0.0041)	-0.0063 (0.0049)	-0.0063*** (0.0023)	-0.0059 (0.0073)	0.0068** (0.0068)	0.0013 (0.0009)	0.0078*** (0.0017)
GTOT	0.0002 (0.0001)	8.10E-05 (0.0002)	0.0002 (0.0001)	0.0001** (0.0001)	0.00001 (0.00005)	0.0001 (0.00009)	0.00001 (0.00004)	0.00003 (0.00002)	0.0001 (0.0001)
Observation	108	108	108	108	108	108	108	108	108
J-statistic	7.7060	5.6259	6.1461	8.8551	4.4012	4.5833	6.6198	5.3243	9.0052
Prob(J-statistic)	0.2604	0.4664	0.4070	0.1819	0.4931	0.4688	0.9484	0.3776	0.1089
Instrument Rank	19	19	19	19	19	19	27	18	18

Source: Author's computation.

Note that the values in parenthesis are robust standard errors. ***, **, and * represents levels of significance at 1%, 5%, and 10%, respectively.

Shifting attention to the role of public debt in tax and economic growth nexus across the three countries. For South Africa, these results reveal positive influence of public debt on the growth effect of taxes except for direct tax. However, the coefficients of public debt are statistically insignificant. This result largely deviates from our earlier finding. In the case of Nigeria, the effect of public debt on the growth effect of taxes is largely negative. This further reinforces the result under linear specification. Expectedly, interest repayment due to public debt accumulation reduces the share of tax revenue available for public investment which lowers productivity. Thus, higher public debt dampened the growth effects of tax. A similar result is observed under aggregated and disaggregated taxes for the Republic of Congo. Public debt also causes a drag effect on the growth effect of tax. This country has experienced debt crisis in the past which put the country in a difficult position. This huge debt affects the provision of public infrastructures that could benefit private investment which in turn, reduces the level of productivity.

Since we established that increasing tax beyond a threshold will result in a decline in economic growth, subsequent discussions now focus on how the introduction of public debt influences the growth laffer curve. On the growth laffer curve, public debt was found to undermine tax and economic growth relationship for South Africa as indicated by the negative coefficient. Specifically, public debt reduces the growth impacts of total and indirect taxes while improving the growth effect of direct tax when taxes go beyond their threshold. However, the effect of public debt on the growth laffer curve is largely positive but statistically insignificant for Nigeria. More importantly, public debt increases the growth effects of both total and direct taxes at the sub-optimal levels when they are above the tax rate threshold level. On the other hand, public debt significantly undermines the growth effect of indirect tax when this tax is raised beyond its threshold level. Different results emerge in the case of the Republic of Congo as public debt positively and significantly influences the growth laffer curve.

This evidence indicates mixed result across the countries as well as depict their financing choices. The economic intuitions behind these results can be attributed to the following factors within the countries' context. First, South Africa generates the highest revenue from

taxes, thus, increasing taxes above their threshold in the presence of high debt will discourage investments and lower incentive to work resulting in low economic growth. This is similar to the present economic challenges facing the country. Second, Nigeria receives one of the lowest revenues from taxes in sub-Saharan Africa which suggests that increasing the existing low tax rate in the presence of high debt may not largely influence because interest repayment depends more on other major sources of revenue. Third, the situation in the Republic of Congo is similar to Nigeria as the tax rate is also exceptionally low. Oftentimes, the payment of interest on debt may not significantly influence tax revenue as the countries exploit seemingly easy revenue options for their interest payment. Thus, the effect of public debt on the growth laffer curve depends on the extent to which countries explore their tax potential and share in the total revenue pool. This finding also reveals that the effect of public debt on the growth impact of disaggregated taxes varies across countries. These findings provide more insightful information at the country level.

Considering our control variables, the coefficients of investment are all positive and statistically significant across the models for South Africa. This further lends support to our earlier findings that an increase in investment promotes capital accumulation for the expansion of productivity. However, the results reveal negative impact of investment on economic growth for Nigeria. This may suggest that the level of investment in the country is not large enough to drive productivity. More so, the negative impact may be explained by capital dilution given the high growing population in the country. On the other hand, the effect of investment on economic growth is positive but statistically significant in models 7 and 8 for the Republic of Congo. Thus, investment plays a significant role in amplifying economic growth in the country. Among the countries, the effect of investment is more pronounced for South Africa. Also, the coefficients of population growth remain positive and statistically significant across the models for South Africa. A similar result is reported for Nigeria except that population growth is not statistically significant in model 4. More so, the coefficients of population growth are positive and statistically significant across the models except for model 8.

On domestic credit to the private sector, there is a little twist to the discussion as its coefficients turn out to be statistically insignificant for South Africa. Though the signs of domestic credit to the private sector remain positive. In addition, the coefficients of domestic credit to the private sector are negative but statistically significant model 5 for Nigeria. This slightly deviates from the earlier finding which is largely positive. Apart from sensitivity to model specification, the results still show that access to funding by the private sector is still exceedingly difficult. More so, poor funding lowers productivity thereby dampening the overall economic growth in Nigeria. The effect of DOM is largely negative but statistically significant in model 2 for the Republic of Congo. This result shows a slight deviation from our linear models. The fact remains that access to funding by the private sector is still challenging which has not translated to improvement in the economic growth of the country.

Inflation which measures the economic uncertainty is predominately negative and statistically significant across the countries. This result also affirms that high inflation is detrimental to an economy as it will raise production costs hence, forcing the firms to reduce their productivity. Also, government final consumption expenditure continues to exert a positive influence on economic growth across the countries. Notably, recurrent expenditure dominates aggregate expenditure of these countries, thus, it appears to be productive. According to Devarajan et al. (1996), allocation of expenditure towards recurrent expenditure facilitates economic growth in developing countries. Furthermore, the results show that foreign direct investment continues to exert a negative effect on economic growth across the countries. The evidence of negative effects of foreign direct investment appears to suggest that this investment has not been productive as the real sector benefits little from such.

On trade openness, the coefficients remain positive across the models for South Africa. However, the result for Nigeria deviates from earlier findings under linear specification as trade openness is low to drive productivity optimally. In the case of the Republic of Congo, the results reveal positive effects of trade openness across the model. This suggests that trade openness is essential for high economic growth in the country. Moreover, the growth

of terms of trade positively impacts economic growth across the countries but is statistically insignificant. In terms of magnitude, the effect remains very inconsequential across the three countries. We also test for the validity of our instruments using *J*-statistic. The results show that all instruments irrespective of their ranks remain valid as indicated by statistically insignificant values of *J*-statistic.

4.1.3. The Effect of Seigniorage on Tax-Economic Growth Nexus

The second objective is examined in this section. Specifically, we examine the effect of seigniorage on the relationship between tax and economic growth at aggregate and disaggregated levels across the three countries. Apart from raising capital through public debt, these countries also raised revenue from seigniorage to finance their economic growth.

Thus, Table 4.7 reported results on the effect of seigniorage across the countries using a linear approach. The results for South Africa show positive coefficients of seigniorage in model 1 while negative coefficients in models 2 and 3. Also, all the coefficients are not statistically significant across the models. Raising seigniorage revenue by 1% suggests that economic growth will decline by 0.12% in model 1 while economic growth increases by 0.12% and 0.04% in models 2 and 3, respectively. Beyond this statistical interpretation, the results point to the possibility that the revenue raised from this financing option at a given tax level assists the country to partly finance its public investment. Given the trade-off between seigniorage and tax, the effect of seigniorage appears to be sub-optimal for economic growth in South Africa.

However, the coefficients of seigniorage are all positive but statistically significant in models 4 and 5 for Nigeria. In this case, if seigniorage revenue increases by 1%, this translates to economic growth amplifying by 0.12%, 0.07%, and 0.01% in models 1, 2, and 3, respectively. Intuitively, this result suggests that Nigeria partly finances its economic growth with seigniorage revenue at a given tax level. Theoretically, seigniorage and tax are substitutes thus, it is expected that country with low tax will generate revenue from seigniorage as observed in Nigeria. In the Republic of Congo, the coefficient of seigniorage is also positive in models 7 and 8 but negative and statistically significant in model 3. This

result shows that seigniorage is largely associated with a positive impact on economic growth. We can infer from the results that Nigeria benefitted more from seigniorage revenue relative to South Africa and the Republic of Congo. This evidence aligns with the proposition by Bose et al. (2007), however, it deviates from the argument pushed by Udoh (2011) that seigniorage effect is sub-optimal in Nigeria.

The succeeding results focus on the role of aggregate and disaggregated taxes on economic growth when seigniorage is accounted for. The results strongly support a positive effect of taxes on economic growth across the countries. Specifically, increasing total tax, indirect tax and direct tax by 1% will magnify economic growth by 0.07%, 0.26%, 0.18%, respectively, for South Africa. Similarly, raising total tax and direct tax by 1% for Nigeria resulted in 0.03% and 0.06% increase in economic growth, respectively. On the other hand, when indirect is increased by 1%, economic growth falls by 0.11% but is statistically insignificant. More so, results indicate that by magnifying total tax, indirect tax, and direct tax by 1%, economic growth is enhanced by 0.24%, 0.35%, and 0.22%, respectively, for Republic of Congo. Putting together, these results show that tax appears to be a viable way to raise revenue to finance public goods which can foster high and stable economic growth. In addition, tax is mostly non-distortionary across the countries, thus, these countries especially Nigeria and the Republic of Congo may leverage their tax potential to mobilise more resources for their economic growth.

The next discussion now examines the critical role of seigniorage in tax and economic growth relationship across the countries. In the case of South Africa, the results indicate a positive effect of seigniorage on total tax and economic growth nexus but statistically insignificant. At the disaggregated level, seigniorage negatively influence this relationship but remain statistically insignificant. These results show an indication that seigniorage complements total tax in the provision of public goods which facilitates economic growth but at sub-optimal level. However, seigniorage discourages mobilisation of tax needed for economic growth at disaggregated level but remain very weak. The implication of this result is that country does not depend largely on revenue from seigniorage to support the existing tax revenue to finance the expenditures for economic growth.

Table 4.7: The effect of seigniorage on tax-economic growth nexus (Linear Approach)

	Dependent Variable: LGDPPC								
	South Africa			Nigeria			Republic of Congo		
Variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
SEG	-0.1187 (0.1161)	0.1211 (0.2282)	0.0352 (0.1299)	0.1174*** (0.0406)	0.0722** (0.0361)	0.0117 (0.0347)	0.0198 (0.0496)	0.0829 (0.0550)	-0.0927** (0.0422)
TTAX	0.0721*** (0.0159)			0.0285* (0.0170)			0.2398*** (0.0324)		
ITAX		0.2550** (0.1068)			-0.1062 (0.0651)			0.3537*** (0.0779)	
DTAX			0.1810*** (0.0516)			0.0621*** (0.0244)			0.2226 (0.1734)
TTAXSE	0.0057 (0.0045)			-0.0190*** (0.0065)			-0.0037 (0.0055)		
ITAXSE		-0.0085 (0.0201)			-0.0192* (0.0112)			-0.0163* (0.0182)	
DTAXSE			-0.0007 (0.0092)			-0.0076 (0.0091)			0.0272** (0.0135)
INV	0.0536** (0.0224)	0.0536* (0.0319)	0.0346 (0.0224)	-0.0230*** (0.0041)	-0.0322*** (0.0047)	-0.0188*** (0.0048)	0.0094** (0.0044)	0.0161*** (0.0060)	0.0390** (0.0202)
POPG	0.3541*** (0.1223)	0.3223* (0.1665)	0.6331*** (0.1422)	3.0741*** (0.1169)	3.3137*** (0.0775)	2.9066*** (0.1497)	1.3902*** (0.1401)	1.3152*** (0.1894)	1.6884*** (0.1541)
DOM	0.0004 (0.0053)	0.0071 (0.0049)	0.0035 (0.0069)	-0.0321*** (0.0081)	-0.0133 (0.0111)	-0.0231** (0.0116)	0.0124 (0.0182)	0.0217 (0.0249)	0.0020 (0.0232)
INF	-0.0240 (0,.0198)	0.0097 (0.0181)	-0.0418 (0.0310)	-0.0070*** (0.0019)	-0.0099*** (0.0018)	-0.0041 (0.0031)	-0.0024 (0.0129)	-0.0004 (0.0182)	0.0210 (0.0160)
GOVT	0.2341*** (0.0325)	0.1467** (0.0746)	0.1778*** (0.0439)	0.0907*** (0.0129)	0.0395 (0.0280)	0.0882*** (0.0167)	-0.0089* (0.0046)	-0.0093* (0.0053)	-0.0088 (0.0084)
FDI	-0.00005 (0.0161)	0.0866 (0.0687)	0.0014 (0.0169)	-0.1177*** (0.0220)	-0.0650*** (0.0161)	-0.1380*** (0.0328)	0.0135*** (0.0028)	0.0151*** (0.0038)	0.0088** (0.0037)
TOP	0.0111** (0.0047)	0.0022 (0.0060)	0.0102* (0.0054)	-0.0065*** (0.0025)	-0.0053* (0.0031)	-0.0038 (0.0032)	-0.0851*** (0.0189)	-0.1399*** (0.0262)	-0.0663*** (0.0224)
GTOT	0.0005*** (0.0002)	0.0006*** (0.0001)	0.0008** (0.0004)	0.0001** (0.0001)	0.00003 (0.00004)	0.0002*** (0.0001)	-0.0001 (0.0001)	-0.0003 (0.0002)	0.00001 (0.0001)
Observation	108	108	108	108	108	108	108	108	108
J-statistic	14.4751	5.6641	10.2338	13.8208	11.7989	8.8937	13.5521	3.6336	5.3300
Prob(J-statistic)	0.1064	0.1291	0.1151	0.1289	0.1074	0.1796	0.2588	0.7261	0.5022
Instrument Rank	20	14	17	20	18	17	22	17	17

Source: Author's computation.

Note that the values in parenthesis are robust standard errors. ***, **, and * represents levels of significance at 1%, 5%, and 10%, respectively.

More so, the problem of hyperinflation may be another plausible explanation for the result. Thus, Selcuk (2001) and Soydan (2003) argue that efforts to increase seigniorage revenue may be detrimental to the economy as this may amplify inflation level. In Nigeria, the result suggests negative effect of seigniorage on growth effects of taxes. In essence, increasing the revenue from seigniorage discourages the country from exploring tax to finance expenditures needed for high and stable economic growth. This evidence corroborated the argument in the literature by Udoh (2011) that seigniorage and tax revenue are not complementary in some countries. However, it could be that seigniorage revenue is suboptimal due to low inflation tax arising from low per capita income of the teeming population and the country's non-reactiveness toward strong tax mobilisation. Also, the results obtained in the case of the Republic of Congo suggest a negative effect of seigniorage on growth effects of total and indirect taxes but a positive effect on the growth effect of direct tax. This is an indication that seigniorage influences the growth effect of tax based on tax measures. Thus, the effectiveness of seigniorage is enhanced when the country pays more attention to direct tax relative to the indirect tax in this country.

On the control variables, investment continues to exert a positive effect on economic growth in South Africa and the Republic of Congo while it exerts a negative influence on economic growth in Nigeria. Thus, the effect of investment is not responsive to the alternative financing measures. As investment remains optimal for economic growth for South Africa and the Republic of Congo, it is not enough to propel economic growth in the case of Nigeria. Also, population growth has a positive and significant effect on economic growth across the countries. More so, the effect is significantly high for Nigeria and the Republic of Congo as expected given their high population growth. The result further reveals positive effect of domestic credit to the private sector on economic growth but is not statistically significant for South Africa and the Republic of Congo. This suggests that domestic credit has the potential to spur economic growth in these countries if optimally explored. However, domestic credit to the private sector remains less optimal for economic growth in Nigeria. Thus, domestic credit available to businesses is not large enough to improve economic growth in the country. As argued under the methodology that it is essential to account for inflation when analysing the effect of seigniorage. Thus, the results show that inflation is

negatively related to economic growth across the countries but majorly significant for Nigeria and the Republic of Congo. This evidence supports the findings of Barro (2013) and Eggoh and Khan (2014).

In addition, government final consumption expenditure continues to exert a positive influence on economic growth for South Africa and Nigeria. This points to the fact recurrent expenditure is essential for growth in these countries. However, the result for the Republic of Congo changes from the observed pattern under public debt. Specifically, the coefficient of government final consumption expenditure turns out to be mostly negative and statistically significant across countries. This suggests that the level of expenditure is not sufficient for economic growth. This little twist in the result may be attributed to a change in public financing options. On foreign direct investment, the results show a negative but not statistically significant effect in model 1 but positive effects in models 2 and 3 for South Africa. In the case of Nigeria and the Republic of Congo, foreign direct investment continues to dampen economic growth as previously observed. Thus, foreign direct investment will be less productive in these countries as its larger share continues to flow to the extractive sector. Trade openness is positively and significantly related to economic growth in all models for South Africa. This is expected as the country explores the trade potential with neighbouring countries in the Southern African region. Thus, more exposure to trading activities especially in export tends to increase the level of productivity.

However, trade openness is less productive in the case of Nigeria given the negative coefficients across the models. Indeed, Nigeria is exposed to international trade but the consuming nature of the country (that is, high import) tends to undermine the benefit that should accrue to the country. Specifically, high reliance on imports implies that exportation of productive activities dampens economic growth. The same pattern is observed in the result of the Republic of Congo as trade openness reduces economic growth. In addition, growth of terms of trade is positively and significantly associated with economic growth for South Africa and Nigeria. However, growth of terms of trade reduces economic growth in models 7 and 8 but positively influences economic growth in model 9 for the Republic of

Congo. Though, all the coefficients are statistically insignificant. Testing the validity of the instruments, *J*-statistic reveals that all the instruments are strong and valid.

The subsequent discussion focuses on the nonlinear models across the countries as presented in Tables 4.8. This allows us to give more insights into the complementarity nature of these financing options. On seigniorage, the result significantly changes relative to linear specification for South Africa. The coefficients are now positive and statistically significant across the models. Judging by the magnitude, the growth effect of seigniorage is also remarkably high. For instance, a 1% increase in seigniorage leads to an increase in economic growth by 4.2%, 2.98%, and 2.24% in models 1, 2, and 3, respectively. The improvement in the result may be attributed to the specification form. This suggests that seigniorage revenue is essential for funding the public infrastructures needed for high productivity.

In addition, the result for Nigeria slightly changes as the effect of seigniorage is only positive in models 4 and 6. Also, the coefficients are statistically significant in models 5 and 6. Though the results still reveal that seigniorage is largely positive. Thus, we can infer from the result that seigniorage revenue majorly enhances economic growth. Similar to the result of linear specification, the effect of seigniorage remains mostly positive but only statistically significant in model 7 for Republic of Congo. This may suggest that seigniorage is still a useful financing source for this country. Thus, we can conclude that seigniorage matters for economic growth as it assists these countries to augment their financial pool.

More so, aggregated and disaggregated taxes continue to exert a positive and significant effect on economic growth for South Africa and the Republic of Congo. This suggests that taxes are a viable way for the countries to address their resource paucity. Tax mobilisation may unlock economic growth potential of these countries. However, the result for Nigeria shows a largely positive effect but remains statistically insignificant. The message from these results still establishes that tax mobilisation is very crucial to high, stable, and sustainable economic growth in these countries. We further test for the presence of the growth laffer curve under this financing option. The results reveal the presence of growth

laffer curve (as indicated by negative coefficient of taxes squared) at aggregated and disaggregated taxes for South Africa and the Republic of Congo. However, the evidence is weak in the case of Nigeria under this financing option. These results still indicate that raising tax above its threshold for the sake of revenue mobilisation may be detrimental to economic growth. Since the tax mobilisation remains incredibly low in Nigeria and the Republic of Congo, these countries have the opportunity to generate more taxes to address the growing public investment deficit required for stable economic growth. It is important to note that direct and indirect taxes have proved to be viable options for raising more revenue for these countries.

Shifting attention to the effect of seigniorage on tax and growth relationship under linear and nonlinear taxes (as captured by the interaction terms). This is important to ascertain if the seigniorage complements or undermines the effectiveness of taxes on economic growth. Given the reality and theoretical proposition, countries do not depend on only one financing option to achieve stable economic growth. When tax is linear, increasing the seigniorage revenue lowers tax revenue which in turn dampens economic growth in South Africa. Similar results are reported in the case of Nigeria and the Republic of Congo but are mostly statistically insignificant. In terms of direction, the results corroborate earlier findings under linear model specification. Apart from hyperinflation, seigniorage serves as the easiest way of raising revenue which may make tax mobilisation unattractive. For instance, if seigniorage does not generate the required revenue given low tax, there would be a setback in the provision of public goods needed for economic growth.

When tax is nonlinear, seigniorage appears to support the growth laffer curve at aggregated and disaggregated taxes for South Africa. This suggests that seigniorage revenue complements tax rate that maximises economic growth. Also, seigniorage positively influences the growth laffer curve in models 1 and 3 but is statistically insignificant in Nigeria. However, it negatively and significantly influences the growth laffer curve in model 2. For the Republic of Congo, seigniorage positively affects the growth laffer curve in models 1 and 2 but is statistically significant in model 2. However, seigniorage exerts a negative effect on the growth laffer curve in model 2. Notably, these results establish that

seigniorage revenue largely enhances the effectiveness of tax rate that maximises economic growth across the countries. Though the effects are still minimal across these countries. Hence, these countries can benefit from tax-maximising rate and seigniorage revenue to finance public infrastructure and social capital. This is an efficient way to address resource and economic growth challenges. This result further provides useful insights into how countries can leverage their fiscal and monetary policies to raise huge revenue for government spending. Though Udoh (2011) argued that political elites undermine the potential to explore enough resources from seigniorage and tax in Africa.

Table 4.8: The effect of seigniorage on tax-economic growth nexus (Nonlinear Approach)

	Dependent Variable: LGDPPC								
	South Africa			Nigeria			Republic of Congo		
Variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
SEG	4.2349* (2.2485)	2.9791* (1.7534)	2.2422* (1.2072)	0.3862 (0.2868) `	-0.3707* (0.2228)	0.1937* (0.1937)	1.2658* (0.6988)	0.2430 (0.3059)	-0.1156 (0.7750)
TTAX	0.2010*** (0.0386)			0.0300 (0.2004)			1.4271*** (0.4853)		
ITAX		0.5740*** (0.0930)			-0.2665 (0.2282)			1.0452*** (0.4021)	
DTAX			0.3612*** (0.0677)			0.0180 (0.1440)			0.6494 (1.3048)
TTAXS	-0.0038*** (0.0012)			-0.0024 (0.0137)			-0.0752** (0.0303)		
ITAXS		-0.0210*** (0.0043)			0.0392 (0.0392)			-0.0691* (0.0039)	
DTAXS			-0.0154*** (0.0028)			-0.0022 (0.0138)			-0.0069 (0.2158)
TTAXSE	-0.3322* (0.1775)			-0.0966 (0.0862)			-0.2801* (0.1519)		
ITAXSE		-0.5213* (0.3059)			0.3388* (0.1804)			-0.0700 (0.1049)	
DTAXSE			-0.3224* (0.1745)			-0.0763 (0.0532)			0.0342 (0.4416)
TTAXSSE	0.0065* (0.0035)			0.0054 (0.0064)			0.0150* (0.0081)		
ITAXSSE		0.0229* (0.0133)			-0.0681** (0.0345)			0.0045 (0.0087)	
DTAXSSE			0.0116* (0.0063)			0.0064 (0.0057)			-0.0004 (0.0606)
INV	0.0715*** (0.0188)	0.0453* (0.0240)	0.0771*** (0.0128)	-0.0273*** (0.0054)	-0.0262*** (0.0051)	-0.0230*** (0.0063)	-0.0027 (0.0062)	0.0156*** (0.0051)	-0.0065 (0.0063)
POPG	0.5144*** (0.1151)	0.6125*** (0.1607)	0.3481*** (0.1196)	3.2088*** (0.2588)	3.3621*** (0.1080)	3.2632*** (0.1111)	0.5473 (0.3933)	1.0115*** (0.2607)	1.7480*** (0.3670)
DOM	0.0077** (0.0033)	0.0069** (0.0034)	0.0076*** (0.0024)	-0.0344*** (0.0098)	-0.0187* (0.0111)	-0.0278*** (0.0107)	0.0374 (0.0293)	0.0273 (0.0188)	-0.0198 (0.0515)
INF	-0.0472*** (0.0161)	-0.0383** (0.0185)	-0.0304*** (0.0104)	-0.0102*** (0.0036)	-0.0099*** (0.0013)	-0.0116*** (0.0028)	-0.0138 (0.0384)	-0.0798*** (0.0238)	0.0637** (0.0297)

GOVT	0.1248*** (0.0334)	0.0617 (0.0531)	0.1548*** (0.0452)	0.0760*** (0.0165)	0.0542** (0.0259)	0.0781*** (0.0147)	-0.0141 (0.0159)	-0.0080 (0.0105)	0.0079 (0.0426)
FDI	0.0076 (0.0269)	0.0231 (0.0414)	-0.0220* (0.0124)	-0.0827*** (0.0230)	-0.0836*** (0.0168)	-0.0792*** (0.0198)	0.0012 (0.0078)	-0.0121** (0.0052)	-0.0049 (0.0080)
TOP	0.0084 (0.0076)	0.0169*** (0.0057)	0.0114** (0.0054)	-0.0066 (0.0051)	-0.0076** (0.0032)	-0.0133*** (0.0041)	-0.0014 (0.0070)	0.0087*** (0.0033)	0.0064 (0.0063)
GTOT	0.0005** (0.0002)	0.0005*** (0.0002)	0.0005*** (0.0001)	0.0003** (0.0001)	0.00003 (0.0001)	0.00003 (0.0001)	-0.0001 (0.0001)	-0.0002* (0.0001)	-0.0001 (0.0003)
Observation	108	108	108	108	108	108	108	108	108
J-statistic	6.5667	8.2638	15.7327	5.0997	5.3841	10.3136	3.4330	7.4902	4.4669
Prob(J-statistic)	0.3628	0.2194	0.1075	0.2772	0.7158	0.2437	0.4881	0.3797	0.1072
Instrument Rank	19	19	23	17	21	21	17	20	15

Source: Author's computation

Note that the values in parenthesis are robust standard errors. ***, **, and * represents levels of significance at 1%, 5%, and 10%, respectively.

Additionally, investment continues to positively influence economic growth in South Africa as established earlier. On the other hand, there are slight changes in the case of Nigeria as investment positively influences economic growth in model 5 only. Also, results for the Republic of Congo are mixed depending on the tax measures but only statistically significant in model 8. Population growth is also positively and significantly related to economic growth in most of the models across the countries. Domestic credit to the private sector is positively associated with economic growth in South Africa while negatively associated with economic growth in Nigeria. In the case of the Republic of Congo, domestic credit to the private sector is largely positive but statistically insignificant. Moreover, inflation serves as a drag on economic growth across the models for the countries.

Government final consumption expenditure positively and significantly influences economic growth in South Africa and Nigeria. However, the effect of government final consumption expenditure mostly reduces economic growth in the Republic of Congo. On foreign direct investment, its effect is mixed for South Africa but negative across the models for Nigeria. More so, it continues to dampen economic growth in the case of the Republic of Congo. The effect of trade openness is mostly positive and statistically significant for South Africa and the Republic of Congo while mostly negative in the case of Nigeria. The effect of growth of terms of trade is positive across the models for South and Nigeria but remains inconsequential. On the other hand, growth of terms of trade exerts a negative influence on economic growth in Republic of Congo. Testing for instruments' validity, the results suggest that all instruments are strong and valid.

4.1.4. The Effect of Total Natural Resource Rents on Tax-Economic Growth Nexus

The last section deals with the third objective which examines the extent to which total natural resource rents influence the relationship between tax and economic growth across the countries under linear and nonlinear approaches. Beyond the two financing options considered above these countries also rely on the revenue from total natural resources. Thus, Table 4.9 reports results from a linear approach across the countries. The coefficients of total natural resource rents are all positive and statistically significant across the models for South Africa. This suggests that revenue from natural resources plays a significant role in

financing economic growth. For instance, increasing total natural resource rents by 1% causes economic growth to increase by 0.92%, 0.75%, and 0.78% in models 1, 2, and 3, respectively. Undoubtedly, South Africa depends largely on revenue from the mining sector which accounts for the highest proportion of its total natural resource rents. This further augments resources from other sources available for public goods and social capital that are necessary for economic growth.

For Nigeria, the coefficient of total natural resource rents is positive but statistically insignificant in model 4 while negative and statistically significant in models 5 and 6. For instance, a 1% increase in total natural resource rents results in 0.02% increase in economic growth in model 4 while it leads to 0.01% and 0.02% decline in economic growth in models 5 and 6, respectively. This result suggests that revenue from natural resource rents serves as a drag on economic growth in the country. Total natural resource rents are dominated by volatile oil revenue. Given the low tax performance in the country, an unstable pattern of dominant revenue component (i.e., oil revenue) may explain poor funding of public infrastructure and social capital which in turn undermine economic growth in the country. The country's experience has also shown that revenue from natural resources especially oil dampens the expected stable economic growth patterns in the country.

However, the coefficients of total natural resource rents are all positive and statistically significant across the models for the Republic of Congo. Increasing total natural resource rents by 1% causes economic growth to amplify by 0.06%, 0.05%, and 0.09% in models 1, 2, and 3, respectively. This signifies that revenue from this financing source matters for financing public goods and social capital that are necessary for economic growth. Similar to Nigeria, the Republic of Congo's total natural resource rent is dominated by oil revenue. As explained in the background, the Republic of Congo earns the highest revenue from natural resources, thus, huge resources from this financing source appear to enhance the provision of public investment needed for economic growth. The evidence from South Africa and the Republic of Congo supports the argument by Raheem et al. (2018) and Chambers and Guo (2009) that natural resource rents are essential to economic growth. However, the evidence provided by Oyinlola et al. (2020a) tends to support findings for

Nigeria. Furthermore, the results reveal a positive and significant effect of aggregate and disaggregated taxes on economic growth for South Africa. However, the results show a positive effect of total and direct taxes but statistically insignificant while indirect tax exerts a negative and significant influence on economic growth. The little twist to the result for Nigeria may be attributed to the choice of alternative financing options. Generally, we can still deduce from the results that taxes are a useful revenue source for these countries to raise more resources for economic growth. Our results for taxes remain consistent across the alternative financing options except for some slight changes.

Further discussion examines the effect of total natural resource rents on tax and economic growth relationship across the three countries. The results reveal that total natural resource rents weaken the growth effect of taxes in South Africa and Republic of Congo. It is expected that countries pay little attention to taxes when there are other seemingly easy sources of revenue (such as natural resource rents). This evidence portrays reality in South Africa and the Republic of Congo. Hanusch and Baskaran (2019) established a positive benefit from natural resources arising from the mining sector in South Africa. This has shifted more attention of the government to the sector source for revenue. Also, the Republic of Congo depends largely on its total natural resource rents as indicated under the background of the study. Oftentimes, these countries tend to get distracted from improving fundamental revenue source (such as tax) thus undermining the growth effect of taxes. As the country continues to concentrate on revenue from natural resources, tax revenue available for a huge financial gap in public infrastructure and social capital coupled with low productivity maybe low.

Table 4.9: The linear effect of Total natural resource rents on tax-economic growth nexus

	Dependent Variable: LGDPPC								
	South Africa			Nigeria			Republic of Congo		
Variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
TNRR	0.9180*** (0.1416)	0.7482*** (0.1294)	0.7813*** (0.1271)	0.0249 (0.0208)	-0.0136* (0.0080)	-0.0165 ** (0.0073)	0.0572*** (0.0111)	0.0525*** (0.0148)	0.0945*** (0.0065)
TTAX	0.2459*** (0.0206)			0.0787 (0.0639)			0.3858*** (0.0578)		
ITAX		0.4974*** (0.0472)			-0.4642*** (0.0969)			0.5104*** (0.1200)	
DTAX			0.4691*** (0.0475)			0.0107 (0.0005)			1.3879*** (0.1348)
TTAXTR	-0.0312*** (0.0055)			-0.0022 (0.0021)			-0.0052*** (0.0013)		
ITAXTR		-0.0586*** (0.0115)			0.0077** (0.0034)			-0.0055* (0.0030)	
DTAXTR			-0.0431*** (0.0081)			0.0016 (0.0011)			-0.0239*** (0.0024)
INV	0.0170 (0.0170)	0.0310** (0.0153)	-0.0062 (0.0230)	-0.0313*** (0.0076)	-0.0355*** (0.0056)	-0.0114 (0.0076)	0.0236*** (0.0057)	0.0146*** (0.0032)	0.0052 (0.0033)
POPG	0.0323 (0.1471)	-0.1638 (0.1546)	0.0981 (0.1611)	2.9562*** (0.2754)	3.6318*** (0.0860)	3.0217*** (0.1731)	0.8990*** (0.1518)	0.8714*** (0.1847)	0.5536*** (0.1071)
DOM	0.0016 (0.0030)	0.0043 (0.0026)	-0.0039 (0.0042)	-0.0284*** (0.0093)	0.0005 (0.0084)	-0.0301*** (0.0087)	0.0109 (0.0100)	0.0303** (0.0123)	0.0102 (0.118)
INF	-0.0342*** (0.0108)	-0.0151 (0.0163)	-0.0559*** (0.0195)	-0.0104*** (0.0036)	-0.0099*** (0.0014)	-0.0035* (0.0019)	-0.0445*** (0.0147)	-0.0712*** (0.0167)	0.0373*** (0.0116)
GOVT	0.1088*** (0.0426)	0.1518*** (0.0384)	0.1485*** (0.0466)	0.0771*** (0.0158)	-0.0075 (0.0206)	0.1054*** (0.0182)	0.00002 (0.0096)	0.0182* (0.0096)	-0.0023 (0.0098)
FDI	-0.0639*** (0.0220)	-0.0488** (0.0213)	-0.0780*** (0.0259)	-0.1129** (0.0472)	-0.0827*** (0.0244)	-0.0926*** (0.0303)	-0.0060** (0.0030)	-0.0012 (0.0030)	-0.0069** (0.0032)
TOP	-0.0145* (0.0075)	0.0225*** (0.0074)	-0.0180** (0.0081)	0.0072* (0.0043)	-0.0022 (0.0017)	0.0069** (0.0031)	0.0055*** (0.0017)	0.0056*** (0.0020)	0.0041** (0.0019)
GTOT	-0.00004 (0.0002)	0.00006 (0.0002)	-0.0001 (0.0003)	0.0002*** (0.0001)	0.00006 (0.000006)	0.0001** (0.0001)	0.0001 (0.00001)	0.00003 (0.0001)	0.0002** (0.0118)
Observation	108	108	108	108	108	108	108	108	108
J-statistic	6.6028	12.4473	7.2244	10.686	11.450	11.846	1.9804	7.8899	10.3901
Prob(J-statistic)	0.5800	0.1323	0.5126	0.1529	0.1775	0.2955	0.9215	0.4443	0.3198
Instrument Rank	19	19	19	18	19	21	17	19	20

Source: Author's computation

Note that the values in parenthesis are robust standard errors. ***, **, and * represents levels of significance at 1%, 5%, and 10%, respectively.

In the case of Nigeria, the result shows a negative effect of total natural resource rents on the growth effect of total tax but is statistically insignificant. This implies that total natural resource rents appear to discourage total tax which reduces available revenue for public investment thus dampening economic growth. Though, the effect remains very weak. Under the disaggregated taxes, the result reveals positive effects but is only statistically significant in model 5. This suggests that total natural resource rents enhance the growth effect of indirect taxes. Total natural resource rents serve as a substitute in most cases in this country. Thus, it may be challenging for developing countries such as Nigeria and the Republic of Congo to boost their tax revenue for economic growth when they focus more on the natural resource rents.

On control variables, investment positively influences economic growth in models 1 and 2 but is only statistically significant in model 2 while negatively influences economic growth in model 3 in South Africa. On the other hand, investment continues to serve as a drag on economic growth in Nigeria but is only statistically significant in models 4 and 5. In this regard, the results remain consistent for Nigeria as the level of investment necessary to trigger huge capital accumulation that would be beneficial to economic growth is not large enough. For the Republic of Congo, investment amplifies economic growth but is statistically significant in models 7 and 8. Furthermore, population growth largely influences economic growth in South Africa but is statistically insignificant. However, population growth positively and significantly facilitates economic growth in Nigeria and the Republic of Congo. This may be due to earlier reasons identified. Also, the effect of domestic credit to the private sector on economic growth for South Africa is dominated by positive coefficients but statistically insignificant. However, the effect is dominated by a negative and significant effect on economic growth in Nigeria. In the case of Republic of Congo, the effect is all positive but only statistically significant in model 8.

More so, the effect of inflation on economic growth is still negative across the countries. The effect of government final consumption expenditure on economic growth is dominated by positive coefficients across the countries. This further supports previous evidence that recurrent expenditure is very essential to economic growth in these countries. Moreover,

foreign direct investment dampens economic growth across the countries. The result of trade openness is mixed across the countries. The negative effect is prominent for South Africa while the positive effect is noticeable for Nigeria and the Republic of Congo. The effect of growth of terms of trade on economic growth is similar to trade openness. Similarly, all the values of *J*-statistics are statistically insignificant implying that all instruments provide adequate information about the variations in endogenous regressors.

The next discussion focuses on the nonlinear approach as presented in Tables 4.10. The result reveals a negative effect of total natural resource rents on economic growth in models 1 and 3 for South Africa but is statistically insignificant. However, the effect is positive in model 2. The results deviate from the findings under linear approach. In other words, the direct effect of total natural resource rents is majorly negative and statistically insignificant. This suggests that total natural resource rent is not optimal to facilitate economic growth in South Africa. Also, the total natural result rent exerts a positive influence on economic growth in models 4 and 9 but is only statistically significant in model 9 for Nigeria. On the other hand, the effect is negative and statistically significant in model 2. The mixed results are dominated by positive effects unlike findings under the linear approach. This suggests that total natural resource rent appears to facilitate public investment needed for economic growth given the tax measures. As the top earner of total natural resource rents, the Republic of Congo continues to enjoy positive and significant effects of total natural resource rent on economic growth. Total natural resource rents provide the country with huge resources to finance public goods and social capital and this, in turn, increases the level of productivity in the economy.

In addition, the effect of aggregated and disaggregated taxes on economic growth is still positive and statistically significant across the models for South Africa. This result reaffirms the important role of tax in providing the countries with stable revenue which may guarantee stability in the public investment as well as economic growth. More so, the result slightly changes for Nigeria as only indirect tax dampens economic growth. In sum, countries need to explore their tax potential to raise more revenue needed to finance their economic growth. Hence, Oyinlola et al. (2020a) argues that revenue raised from tax forced the government

to be committed to providing necessary public infrastructure that will facilitate growth, unlike other sources which make government less accountable.

We subsequently consider if there is a need for an optimal tax that will maximise economic growth across the countries. The results show the presence of the growth laffer curve at aggregated and disaggregated taxes across the countries except in model 5 for Nigeria. The results simply suggest that increasing taxes beyond their threshold levels to raise more revenue may be detrimental to economic growth. In essence, a higher tax rate may discourage private investments which may reduce the level of productivity in the economy. Thus, results across the APFOs strongly support optimal taxes for high, stable, and sustainable economic growth.

The succeeding discussion examines the effect of total natural resource rent on the relation between tax and economic growth to ascertain if total natural resource rent complements taxes to facilitate economic growth. In the case of South Africa, the results show more positive effect compared to result under public debt and seigniorage. The total natural resource rents augment the total and direct taxes which enhances economic growth. It is expected that total natural resource rents should assist the government to generate more revenue as taxes may not be enough to finance public goods. Thus, revenue from sector such as mining should supplement revenue from taxes in South Africa to achieve high and stable economic growth.

On the other hand, total natural resource rents largely undermine the growth effects of taxes except in model 5 for Nigeria. This is expected due to over-reliance on revenue from natural resources such as crude oil. The unstable nature of total natural resource rents creates uncertainty around government spending which is reflected in unstable economic growth. Also, we examine if the natural resource rents deform the growth laffer curve. In other words, if countries double their taxes, does total natural resource rent boost resources available for economic growth. Expectedly, the results for South Africa show that total natural resource rent deforms the growth laffer curve in models 1 and 3 while improving

the growth laffer curve in model 2. Intuitively, tax performance is high in the country, hence, high tax rate will lower economic growth which total natural resource rent cannot augment.

Table: 4.10: The nonlinear effect of Total natural resource rents on tax-economic growth nexus in South Africa

	Dependent Variable: LGDPPC								
	South Africa			Nigeria			Republic of Congo		
Variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
TNRR	-4.4771 (2.9991)	2.3577* (1.3300)	-0.5679 (2.6918)	0.0249 (0.0631)	-0.0534*** (0.0147)	0.0817** (0.0393)	0.1145*** (0.0069)	0.1082*** (0.0103)	0.1428*** (0.0068)
TTAX	0.3084*** (0.0599)			0.5029 (0.6821)			1.3299*** (0.1063)		
ITAX		1.1182*** (0.1534)			-2.0589*** (0.5946)			2.0197*** (0.2099)	
DTAX			0.6730*** (0.1374)			1.0671*** (0.4100)			3.9807*** (0.2598)
TTAXS	-0.0004 (0.0027)			-0.0283 (0.0427)			-0.0643*** (0.0078)		
ITAXS		-0.0638*** (0.00132)			0.3738*** (0.1398)			-0.1468*** (0.0259)	
DTAXS			-0.0163*** (0.0061)			-0.0855*** (0.0327)			-0.4839*** (0.0473)
TTAXTR	0.4003* (0.2405)			-0.0052 (0.0171)			-0.0215*** (0.0024)		
ITAXTR		-0.4785* (0.26614)			0.0509*** (0.0155)			-0.0302*** (0.0057)	
DTAXTR			0.1156 (0.3695)			-0.0289** (0.0123)			-0.0755*** (0.0055)
TTAXSTR	-0.0086* (0.0048)			0.0003 (0.0011)			0.0011*** (0.0002)		
ITAXSTR		0.0249* (0.0159)			-0.0103*** (0.0039)			0.0022*** (0.0007)	
DTAXSTR			-0.0046 (0.0125)			0.0023** (0.0010)			0.0098*** (0.0011)
INV	-0.0025 (0.0292)	0.0641*** (0.0147)	0.0191 (0.0326)	-0.0277*** (0.0044)	-0.0350*** (0.0021)	-0.0266*** (0.0064)	0.0023 (0.0014)	0.0065*** (0.0023)	-0.0037** (0.0017)
POPG	-0.0365 (0.1452)	-0.0345 (0.1702)	0.0839 (0.1198)	2.3785** (0.9945)	4.2187*** (0.2369)	2.0826*** (0.4533)	0.1587* (0.0822)	0.1971** (0.0815)	0.0199 (0.0798)
DOM	0.0003 (0.0041)	0.0012 (0.0022)	-0.0004 (0.0049)	-0.0281*** (0.0099)	-0.0004 (0.0053)	-0.0296*** (0.0107)	0.0106*** (0.0035)	0.0153*** (0.0044)	-0.0092** (0.0045)
INF	-0.0154 (0.0181)	-0.0414*** (0.0144)	-0.0486*** (0.0155)	-0.0036* (0.0019)	-0.0090*** (0.0009)	-0.0087*** (0.0031)	-0.0050 (0.0051)	-0.0022 (0.0075)	0.0175*** (0.0053)

GOVT	0.0719* (0.0414)	0.1518*** (0.0295)	0.1125*** (01125)	0.0900*** (0.0249)	0.0012 (0.0115)	0.0848*** (0.0156)	0.0005 (0.0037)	-0.0006 (0.0051)	-0.0005 (0.0034)
FDI	-0.1133*** (0.0332)	-0.0518*** (0.0166)	-0.0940*** (0.0167)	-0.1281*** (0.0411)	-0.0833*** (0.0167)	-0.0920*** (0.0304)	0.0027*** (0.0008)	0.0006 (0.0010)	0.0002 (0.0015)
TOP	-0.0169** (0.0079)	-0.0113 (0.0072)	-0.0132* (0.0078)	-0.0098*** (0.0033)	-0.0036*** (0.0014)	-0.0121** (0.0047)	0.0005 (0.0008)	-0.0007 (0.0009)	0.0001 (0.0011)
GTOT	-0.0002 (0.0002)	0.00001 (0.0002)	-0.0002 (0.0002)	0.0001* (0.00005)	0.00004 (0.00004)	0.0001 (0.00005)	0.00004** (0.00002)	0.00003* (0.00002)	0.00005 (0.00003)
Observation	108	108	108	108	108	108	108	108	108
J-statistic	2.7127	2.6148	5.8675	14.3143	13.6700	11.9026	12.517	14.875	11.642
Prob(J-statistic)	0.9746	0.8554	0.4382	0.1591	0.2518	0.1038	0.2520	0.1883	0.1130
Instrument Rank	22	19	19	23	24	20	23	24	20

Source: Author's computation. Note that the values in parenthesis are robust standard errors. ***, **, and * represents levels of significance at 1%, 5%, and 10%, respectively.

In the case of Nigeria, total natural resource rents predominately improve the growth laffer curve across the models. This implies that there is tax-maximising rate that will foster economic growth, as well as total natural resource rent, appears to augment the revenue pool. By implication, the country has the lowest tax level, increasing the tax level does push the tax beyond its optimal level, hence, it may not hamper economic growth. More so, the total natural resource rents support available resources needed for high and stable economic growth in the country. A similar result is observed in the case of the Republic of Congo.

Similar to Nigeria in terms of low tax performance, doubling tax level does not reduce economic growth because tax has not gone beyond its threshold and natural resource rent will further improve the available resources. Hence, this will enhance economic growth through high public investment and social capital. These findings shed more light on how these countries can address the challenge of resource paucity. Our findings provide more reliable estimates relative to existing studies such as Raheem et al. (2018), Oyinlola et al. (2020a), Oyinlola and Adedeji (2022), Ndoricimpa (2020), as they only focus on a single public financing option. In reality, countries explore APFOs to generate huge revenue for the growing government spending. On the control variables, their results are remarkably similar to results under APFOs. Also, a test for the validity of instruments using *J*-statistic shows that all instruments are valid as indicated by statistically insignificant values of *J*-statistics. This suggests that all the instruments are strong and adequately explain the variations in endogenous regressors.

4.1.5. Computation of net effects and policy thresholds for taxes.

This section examines the overall effects of total, indirect, and taxes on economic growth under the APFOs (public debt, seigniorage, and total natural resource rents) for the three countries. Hence, we computed the net effects of taxes from a nonlinear approach based on the argument in the literature that net effect (overall effect) must be calculated for quadratic regression (Asongu and Odhiambo, 2020 and Boateng et al., 2018). The result of net effects reported in Table 4.11 shows that the net effects of total tax on economic growth under public debt are -0.04%, 0.19%, and 0.16% for South Africa, Nigeria, and the Republic of Congo, respectively. This result suggests that aggregate tax reduces the overall economic

growth by 0.04% when South Africa accumulates more public debt. Intuitively, South Africa relies heavily on tax revenue, thus, high public debt will reduce the available resources for public goods and social capital that are essential to stable economic growth.

However, the results show that aggregate tax improves overall economic growth by 0.19% and 0.16% in Nigeria and the Republic of Congo, respectively, when these countries incur more public debt. The plausible explanation for this can be attributed to little reliance on tax in these countries to finance economic growth. At the disaggregated level, the results for South Africa show that indirect tax amplifies overall economic growth by 0.003% while direct tax reduces overall economic growth by 0.12%. The positive overall effect of direct tax outweighs the negative overall effect of indirect tax. On the other hand, indirect tax reduces overall economic growth by 0.1% while direct tax improves overall economic growth by 0.2% in Nigeria. This suggests that the positive net effect of direct tax outweighs the negative effect of indirect. In the case of the Republic of Congo, both indirect and direct taxes improve overall economic growth. Put together, the findings suggest that taxes tend to dampen overall economic growth in a high tax performance country when there is high public debt while taxes enhance overall economic growth in low tax performance countries.

Shifting our focus on the net effect of taxes on overall economic growth under seigniorage across the countries. The result shows that the net effect of total tax on economic growth is 0.13% for South Africa. Seigniorage appears to play a complementary role, unlike public debt. Effective management of seigniorage increases the available resources needed for overall economic growth in the country. Thus, it is expected that for a high tax performance country, an increase in total tax level should facilitate economic growth given additional resources from seigniorage. However, the result indicates that the net effects of total tax on economic growth are negative in Nigeria. An increase in total tax dampens overall economic growth by 0.006% given the seigniorage level. By implication, the poor tax performance and distraction from seigniorage revenue may explain the reason why total tax does not facilitate overall economic growth. On the other hand, the net effect of total tax on overall economic growth is positive in the Republic of Congo. Given the seigniorage level, economic growth is amplified by 0.06% when total tax increases. Despite low tax

performance, seigniorage appears to support the effect of total tax on economic growth in the country. At the disaggregated level, the results support the evidence at the aggregated level. Hence, we can conclude that seigniorage serves as a complement and substitute for tax depending on how the country manages the revenue sources to improve its economic growth potential.

The next discussion focuses on the overall effect of total, indirect and direct taxes on economic growth under total natural resource rents. From the results, the net effect of total tax on overall economic growth is positive across the countries. Specifically, the net effect of tax improves economic growth by 0.29%, 0.07%, and 0.18% for South Africa, Nigeria, and the Republic of Congo, respectively. This suggests that total natural resource rents serve as a complement that may improve the tax performance on overall growth. Increasing total natural resource rents coupled with high tax performance should provide the government with much-needed resources to address the increasing need for public goods and social capital. This is evident in the result of South Africa relative to Nigeria and the Republic of Congo. Hence, the challenges of a huge financing gap can be resolved if these countries explore this approach and ensure discipline in the utilisation of the available revenue to improve their economic growth.

At a disaggregated level, indirect tax has a negative net effect on economic growth while direct has a positive effect on economic growth for South Africa. This implies that the combination of direct tax and total natural resource rents do not distort economic growth while indirect with total natural resource rent distorts economic growth. A similar result is observed in the case of Nigeria. However, the combination of direct and indirect taxes with total natural resource rents appears to be efficient in unlocking the economic growth potential in the Republic of Congo.

On the other hand, the net effects of APFOs are considered under different taxes across the three countries. The results indicate that the net effect of public debt improves economic growth under total and indirect taxes in South Africa. The country has been cautiously managing its deficit, which has resulted in low debt over the years. In addition, the net effect

of public debt undermines economic growth under most taxes in Nigeria. Similarly, the net effect of public debt weakens economic growth in the Republic of Congo. In the case of Nigeria and the Republic of Congo, public debt remains a critical issue as they accumulate huge public debt. This hinders the availability of resources for public investment needed for high productivity. Additionally, the net effect of seigniorage is negative, suggesting that seigniorage undermines growth under total taxes in South Africa. However, seigniorage appears to foster economic growth under disaggregated taxes. In the case of Nigeria, the overall effect of seigniorage is positive under all the taxes. This implies that seigniorage potential supports the government by expanding the availability of resources required for long-term economic growth. In the case of the Republic of Congo, the overall effect of seigniorage is largely negative, implying that this financing option undermines long-term growth. On the overall effect of total natural resource rents, it significantly enhances economic growth in South Africa and Nigeria. However, the net effect is largely negative in the Republic of Congo. This can be attributed to the unproductive nature of this public financing source.

Table 4.11: Computation of Net Effects of Total Tax and APFOs

Public Debt									
	South Africa			Nigeria			Republic of Congo		
	TTAX	ITAX	DTAX	TTAX	ITAX	DTAX	TTAX	ITAX	DTAX
Average value of tax	24.764	10.861	13.903	7.588	2.265	5.324	9.103	5.781	3.322
Unconditional effect of tax	0.406	0.793	0.757	1.528	-2.145	1.034	0.962	2.633	2.560
Conditional effect of tax	-0.009	-0.036	-0.032	-0.088	0.452	-0.078	-0.044	-0.215	-0.316
Net effects	-0.040	0.003	-0.122	0.188	-0.098	0.202	0.164	0.153	0.458
Seigniorage									
Average value of tax	24.764	10.861	13.903	7.588	2.265	5.324	9.103	5.781	3.322
Unconditional effect of tax	0.201	0.574	0.361	0.030	-0.267	0.018	1.427	1.045	0.649
Conditional effect of tax	-0.004	-0.021	-0.015	-0.002	0.039	-0.002	-0.075	-0.069	-0.007
Net effects	0.013	0.118	-0.067	-0.006	-0.089	-0.005	0.058	0.246	0.604
Total natural resource rents									
Average value of tax	24.764	10.861	13.903	7.588	2.265	5.324	9.103	5.781	3.322
Unconditional effect of tax	0.308	1.118	0.673	0.503	-2.059	1.067	1.330	2.020	3.981
Conditional effect of tax	0.0004	-0.064	-0.016	-0.028	0.374	-0.086	-0.063	-0.147	-0.484
Net effects	0.289	-0.268	0.220	0.073	-0.366	0.157	0.176	0.322	0.766
APFOs under Taxes									
Unconditional effect of public debt	-0.068	-0.169	0.122	0.045	-0.023	0.025	0.040	0.043	0.049
Conditional effect of public debt	0.003	0.027	-0.021	-0.011	0.021	-0.008	-0.009	-0.015	-0.029
Net effects	0.167	1.942	-1.520	-1.257	2.463	-0.922	-2.325	-3.899	-7.573
Unconditional effect of seigniorage	-0.119	0.121	0.035	0.117	0.072	0.012	0.020	0.083	-0.093
Conditional effect of seigniorage	0.006	-0.009	-0.001	-0.019	-0.019	-0.008	-0.004	-0.016	0.027
Net effects	-0.093	0.082	0.031	0.099	0.054	0.005	-0.010	-0.038	0.112
Unconditional effect of TNRR	0.918	0.748	0.781	0.025	-0.014	-0.017	0.057	0.053	0.095
Conditional effect of TNRR	-0.031	-0.059	-0.043	-0.002	0.008	0.002	-0.005	-0.006	-0.024
Net effects	0.596	0.135	0.335	-0.005	0.022	0.004	-0.397	-0.492	-2.085

Source: Author's computation

To further shed more light on the role of APFOs in tax and economic growth relationship, we determine the minimum thresholds at which an increase in taxes across the countries will enhance economic growth as presented in Table 4.12. Under public debt, the net effect of total tax is negative likewise the conditional effect used in its computation for South Africa suggests that amplifying the conditional effect of total tax can be detrimental to economic growth. More so, the net effect is not reversed implying that an increase in total tax above the threshold level will hamper the economic growth. Specifically, South Africa can only achieve positive economic growth at the minimum total tax rate of 22.6% given its public debt level.

However, the net effect of total tax is positive whereas the conditional effect is negative which implies that increasing the conditional effect of total tax can enhance economic growth in Nigeria given its public debt level. Additionally, increasing the tax level beyond the threshold can enhance economic growth. Unlike South Africa, Nigeria can achieve positive economic growth at a minimum total tax rate of 8.7% given its debt level. Similarly, the net of total tax is positive while the conditional effect remains negative revealing that increasing the conditional effect of total tax can facilitate economic growth in the Republic of Congo given its public debt level. Moreover, if the country increases the total tax rate above the threshold level, economic growth would still be enhanced. Thus, the country requires a minimum total tax rate of approximately 11% to achieve optimal economic growth given its public debt level. The threshold levels for countries are reliable and can enhance policy formulation as their values are within the range of minimum and maximum limits as presented in Table 4.1. Thus, these countries must ensure that they consistently maintain a minimum value of required total tax rates to achieve positive economic growth. The disaggregated taxes also follow a similar pattern observed under the total tax rate.

Under seigniorage, the net effect of total tax is positive while the conditional effect is negative. This shows that the conditional effect of total tax can enhance economic growth in South Africa unlike the finding under public debt. Furthermore, increasing the total tax rate beyond the threshold level can improve economic growth. Given seigniorage, the country needs a minimum total tax rate of 26.4% to achieve positive economic growth. This

suggests that South Africa will need more tax revenue to finance its economic growth given its seigniorage level. In the case of Nigeria, the net and conditional effects are negative. This means that increasing that total tax rate may dampen the economic growth given the country's seigniorage level. In essence, increasing the total tax rate beyond the threshold of 6.3% will reduce economic growth of the country. By implication, seigniorage level may not allow the country to generate enough revenue due to high population with low per capita income. For Republic of Congo, the net effect is positive while the conditional effect is negative. This implies that the country needs a minimum total tax of 9.5% for it to positively influence economic growth given the seigniorage level. Thus, we can conclude that South Africa and the Republic of Congo can enhance their economic growth given the minimum threshold levels of total tax under seigniorage while Nigeria cannot positively facilitate its economic growth beyond the threshold of total tax. A similar pattern is observed under the disaggregated taxes across the countries.

Considering the last public financing option, we also compute the minimum threshold values for taxes under total natural resource rents. Both net and conditional effects of total tax are positive implying that increasing the total tax beyond the threshold will spur economic growth in South Africa. However, the huge threshold falls outside the range of minimum and maximum which is counterintuitive and does not make economic sense. Thus, disaggregated taxes that provide useful information would be examined in the case of South Africa. The net and conditional effects of indirect tax are negative. This simply denotes that increasing indirect tax beyond 8.8% may reduce economic growth. However, the net effect of direct is positive while the conditional effect is negative indicating that a minimum threshold direct tax of 20.6% is needed to achieve positive economic growth. Given that major revenue from natural resources comes from mining, the country requires at least a direct tax of 20.6% and at most indirect tax of 8.8% to maintain stable provision of public goods and social capital to achieve stable economic growth.

In the case of Nigeria, the net effect of total tax is positive whereas the conditional effect of total tax is negative. This shows that increasing the total tax level beyond the minimum threshold may enhance economic growth given the total natural resource rents. As a

resource-dependent country, the required minimum tax for positive economic growth is 8.9%. This implies that the country can increase the tax level to generate more revenue for its public investment needed for economic growth. The result for disaggregated taxes is similar to findings at aggregated tax level. Thus, Nigeria has the potential to mobilise resources through taxes to finance and maintain stable economic growth. In the Republic of Congo, the net effect of total tax is also positive while the conditional effect of total tax is negative. This reveals that amplifying the total tax level above the minimum threshold appears to foster positive economic growth given its total natural resource. As a resource-dependent country, such as Nigeria, the Republic of Congo needs a minimum total tax rate of 10.5% to maintain positive economic growth. Hence, the country can boost government revenue by increasing its total tax above 10.5% coupled with huge revenue derived from natural resources. A similar pattern is observed at the disaggregated taxes.

From the foregoing, it is apparent that South Africa cannot increase its total tax level under public debt due to interest payment which may erode huge resources needed for the provision of public goods and social capital. This may partly explain economic growth challenges facing the country. However, resource-dependent countries such as Nigeria and the Republic of Congo accumulate more public debt due to high budget deficit and unstable commodity prices. Hence, increasing the tax level in these countries may be beneficial to their economic growth. In the presence of seigniorage, threshold tax enhances economic growth of South Africa and the Republic of Congo while it is not advisable for Nigeria to increase its tax level. Given the total natural resource rents, these countries especially Nigeria and the Republic of Congo can carefully explore tax to accrue more resources to finance their economies.

Table 4.12: Computation of minimum threshold values for Total Tax and its Components

Public Debt									
	South Africa			Nigeria			Republic of Congo		
	TTAX	ITAX	DTAX	TTAX	ITAX	DTAX	TTAX	ITAX	DTAX
Unconditional effect of tax	0.406	0.793	0.757	1.528	2.145	1.034	0.962	2.633	2.560
Conditional effect of tax	0.009	0.036	0.032	0.088	0.452	0.078	0.044	0.215	0.316
Minimum Threshold Value	**22.567**	**10.896**	**11.970**	**8.653**	**2.374**	**6.618**	**10.977**	**6.137**	**4.046**
Seigniorage									
Unconditional effect of tax	0.201	0.574	0.361	0.030	0.267	0.018	1.427	1.045	0.649
Conditional effect of tax	0.004	0.021	0.015	0.002	0.039	0.002	0.075	0.069	0.007
Minimum Threshold Value	**26.447**	**13.667**	**11.727**	**6.250**	**3.399**	**4.091**	**9.489**	**7.563**	**47.058**
Total Natural Resource Rents									
Unconditional effect of tax	0.308	1.118	0.673	0.503	2.059	1.067	1.330	2.020	3.981
Conditional effect of tax	0.0004	0.064	0.016	0.028	0.374	0.086	0.063	0.147	0.484
Minimum Threshold Value	**385.500**	**8.763**	**20.644**	**8.885**	**2.754**	**6.240**	**10.488**	**6.879**	**4.113**

Source: Author's computation

4.2. Simulation Analysis

4.2.1. Structure of parameters for simulation analysis

The sub-section deals with measurements and justifications for the parameters used in simulating equation 10' in our theoretical framework. The parameters for the simulation are reported in Table 4.13. The values for policy parameters (that is, public debt, seigniorage, and natural resource rent) are estimated using the countries' datasets. This allows us to account for the financing characteristics of the countries in the model. Apart from policy parameters, other parameters are sourced from Barro (1990) and Ehrhart et al. (2014) as used for developing countries. The values for other parameters are usually difficult to determine at the regional or country level, thus, theoretical studies rely largely on values from Barro (1990).

Table 4.13: Definitions of parameter for theoretical simulation analysis

S/N	Parameter		Definition	Value	Source
	β		Discount rate	0.05	Barro (1990); Ehrhart et al. (2014)
	δ		Private capital depreciation	0.1	Barro (1990); Ehrhart et al. (2014)
	ρ		Elasticity of output	0.8	Barro (1990); Ehrhart et al. (2014)
	ϕ		Reciprocal of money velocity	0.5	Barro (1990); Ehrhart et al. (2014)
	σ		Coefficient of relative risk aversion	1.5	Barro (1990); Ehrhart et al. (2014)
	η		Money multiplier	0.2	Barro (1990); Ehrhart et al. (2014)
	θ	θ_s	Ratio of public debt to output for South Africa	0.02	Estimated
		θ_n	Ratio of public debt to output for Nigeria	0.002	
		θ_c	Ratio of public debt to output for the Republic of Congo	0.001	
	ν	ν_s	Ratio of total natural resource rents to output for South Africa	0.06	Estimated
		ν_n	Ratio of total natural resource rents to output for Nigeria	0.001	
		ν_c	Ratio of total natural resource rents to output for the Republic of Congo	0.001	
	ω	ω_s	Ratio of seigniorage to output for South Africa	0.01	Estimated
		ω_n	Ratio of seigniorage to output for Nigeria	0.02	
		ω_c	Ratio of seigniorage to output for the Republic of Congo	0.001	

Source: Author's compilation

Note: the subscript n, s, and c represent South Africa, Nigeria, and the Republic of Congo. Also, the absolute value of estimated parameters for θ, ν, and ω are used in the simulation because positive level of these APFOs is expected, and the results are presented in Appendix II.

4.2.2. Simulation Effects of Public Debt on Tax-Economic Growth Nexus

To complement our econometric approach, we simulate the effect of public debt on the relationship between tax and economic growth for the countries under consideration. The baseline theoretical model developed by Barro (1990) was first examined where these conditions hold: $\theta = 0$; $\omega = 0$; $\nu = 0$. Hence, the government is assumed to finance its economic growth with only tax. Substituting zero for public debt, seigniorage and natural resource rents will reduce equation 3.10' to Barro's model. More so, the result shows the presence of growth laffer curve indicating that there is a nonlinear relationship between tax and economic growth. In other words, there is a particular tax threshold (tax-maximising rate) that will guarantee high and stable economic growth in the long-run. In the absence of APFOs, South Africa, Nigeria, and the Republic of Congo will achieve an economic growth rate of 9.57% with an optimal tax rate of 40% as reported in Figures 4.1-4.3. This result illustrates that financing public investment to ensure high, stable, and sustainable economic growth requires huge tax revenue.

Furthermore, the extension of Barro's model by Ehrhart et al. (2014), where scenario analysis was carried out to examine how APFOs influence the growth effect of tax. Thus, Ehrhart et al. (2014) assumed that governments in the developing region do not maintain a balanced budget as proposed by Barro (1990). In essence, we tested the propositions of Ehrhart et al. (2014) on these three countries by factoring in the role of public debt and seigniorage. The assumption is that $\nu = 0$ across these countries. Thus, Figures 4.1-4.3 present simulation results of public debt on tax-economic growth nexus across the three countries. Following Reinhart and Rogoff's (2010) categorization of public debt, the study used low public debt (30%), medium public debt (60%), and high public debt (75%) for the simulation.

For South Africa, the result shows that public debt accumulation reduces long-run economic growth. Given a tax-maximising rate (optimal tax rate) of 40%, the long-run economic growth stood at 8.47% compared to 9.57% in Barro's model as public debt[47] increases to

[47] It is important to note that seigniorage is fixed using its estimated values while total natural resource rents are assumed to be zero.

30%. As public debt increases to 60%, the tax-maximising rate increases to 45% with long-run economic growth further declining to 7.50%. At high public debt of 75%, the optimal tax rate remains at 45% but long-run economic growth reduces to 7.08%. This result points to the fact that accumulation of public debt inhibits long-run economic growth. Extending the model of Ehrhart et al. (2014), this study account for total natural resource rents[48]. Different scenarios emerge under the augmented model. At a tax-maximising rate of 40%, a public debt of 30% results in the long-run economic growth of 10.09%. In response to public debt of 60%, the long-run economic growth declines to 8.96%. More so, the long-run economic growth decreases to 8.45% as public debt increases to 75% given the tax-maximising rate of 40%. We can infer from the results that as the country accumulates more public debt, long-run economic growth diminishes.

In Nigeria, the simulation result indicates that high public debt also lowers the long-run economic growth. From the model of Ehrhart et al. (2014), a tax-maximising rate remains at 40% as public debt increases to 30%. Correspondingly, the long-run economic growth was 8.50% relative to 9.57% of Barro's model. More so, as public debt rises to 60%, the tax-maximising rate upsurges to 45% with long-run economic growth further declining to 7.53%. As high public debt increases to 75%, the tax-maximising rate remains at 45% while long-run economic growth further declines to 7.10%. This analysis is similar to the findings of South Africa. It further reinforces the fact that public debt accumulation dampens long-run economic growth.

Similarly, an extension of the model by Ehrhart et al. (2014) reveals that public debt reduces long-run economic growth. At the tax-maximising rate of 40%, a public debt of 30% corresponds to the long-run economic growth of 8.53%. As public debt increases to 60%, the tax-maximising rate also rises to 45% with corresponding long-run economic growth declining to 7.56%. Additionally, the long-run economic growth further declines to 7.13% as public debt increases to 75% while the tax-maximising rate stood at 45%. The simulating effect of public debt is higher for Nigeria relative to South Africa.

[48] In this case, seigniorage and total natural resource rents are fixed using their estimated values.

Furthermore, stimulating the effect of public debt on long-run economic growth for the Republic of Congo indicates that accumulation of public debt decreases long-run economic growth. Under Ehrhart et al.'s model, a tax-maximising rate remains at 40%. At public debt of 30%, the long-run economic growth stood at 8.39% relative to baseline economic growth of 9.57% as in Barro's model. In addition, as public debt rises to 60%, the tax-maximising rate upsurges to 45% with long-run economic growth further declining to 7.44%. As public debt increases to 75%, the tax-maximising rate remains at 45% whereas long-run economic growth further declines to 7.02%. Likewise, the augmented model shows that public debt also shrinks long-run economic growth. At the tax-maximising rate of 40%, a public debt of 30% generates long-run economic growth of 8.42%. As public debt increases to 60%, the tax-maximising rate also increases to 45% with corresponding long-run economic growth declining to 7.46%. Moreover, the long-run economic growth further decreases to 7.04% when public debt increases to 75% while the tax-maximising rate remains at 45%.

From the above, several conclusions can be drawn from our results. First, the accumulation of public debt pushes the growth laffer curve downward. In other words, incurring high public debt reduces the long-run economic growth but at varying levels across the theoretical models. Second, the effect of public debt on growth laffer curve is marginally underestimated under Ehrhart et al.'s model relative to the augmented model. This suggests that accounting for additional key financing options matters a lot. Third, the tax-maximising rate amplifies as the level of public debt increases. In essence, higher public debt creates a dilemma for the government as the focus will be on servicing the public debt as well as maintaining public spending which may necessitate a high tax rate. These results corroborate evidence by Le Van et al. (2018), Megersa (2015), Saibu (2015) and Ehrhart et al. (2014).

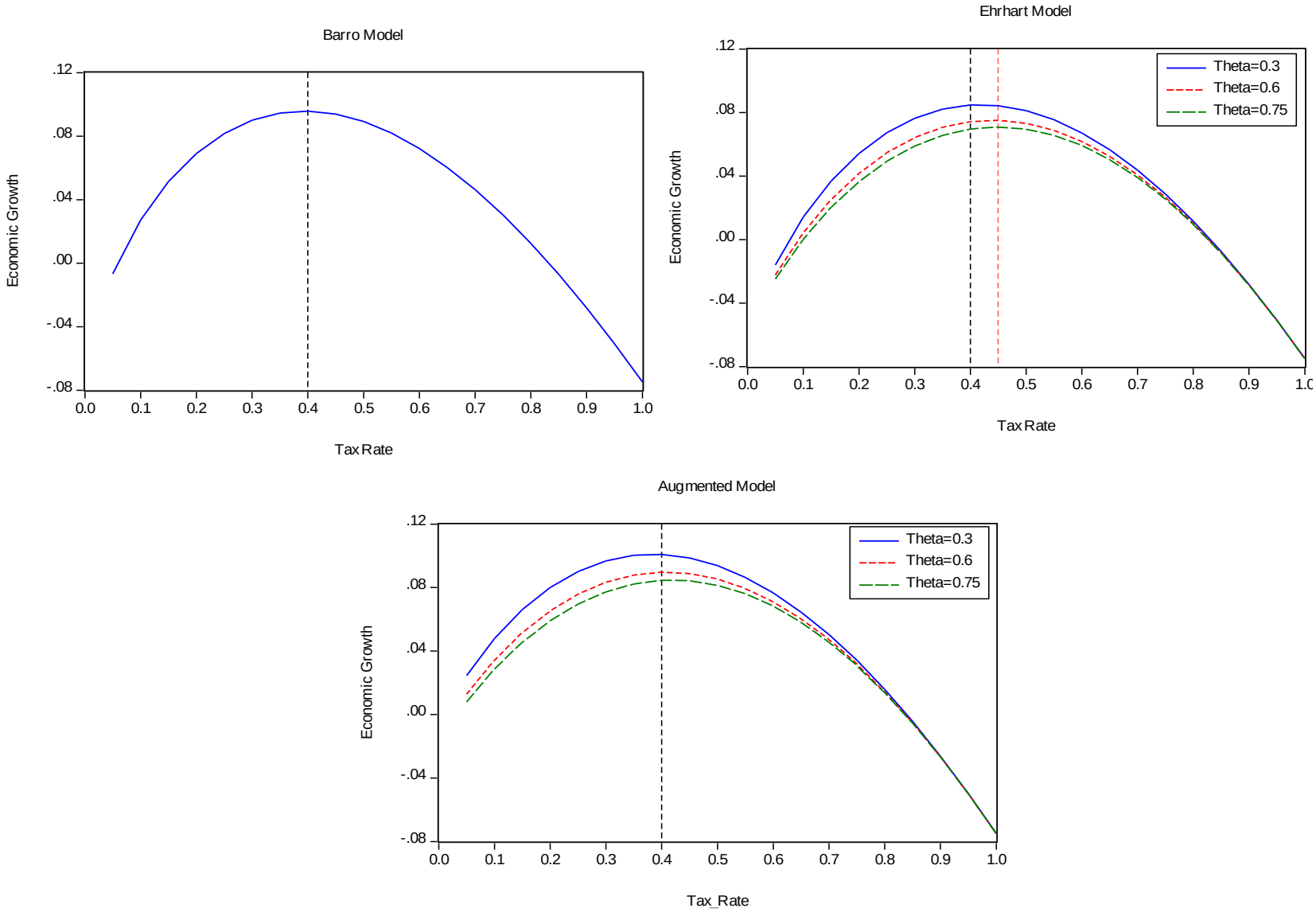

Figure 4.1: Simulation of Public Debt effect on Tax-Economic Growth nexus for South Africa

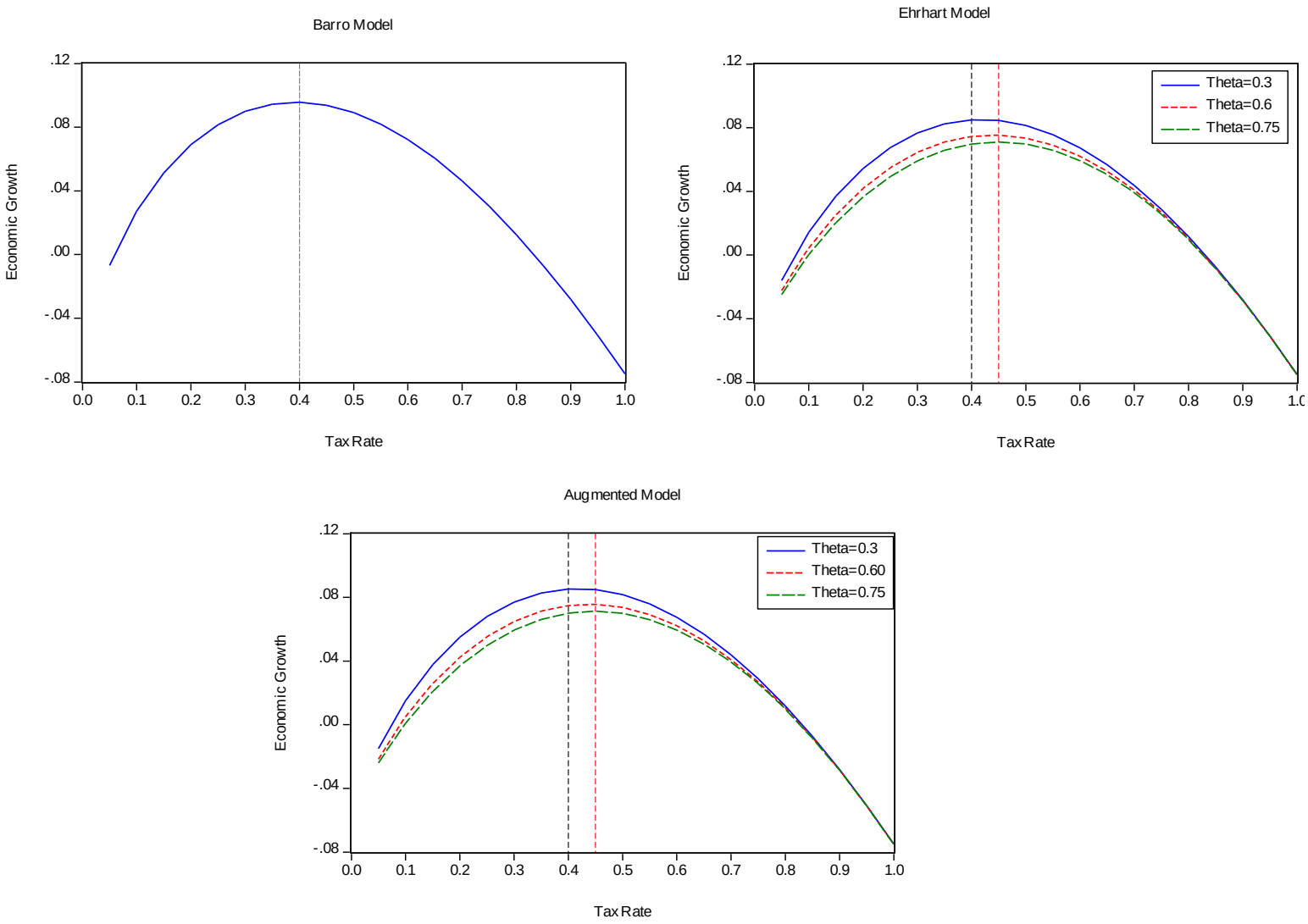

Figure 4.2: Simulation of Public Debt effect on Tax-Economic Growth nexus for Nigeria

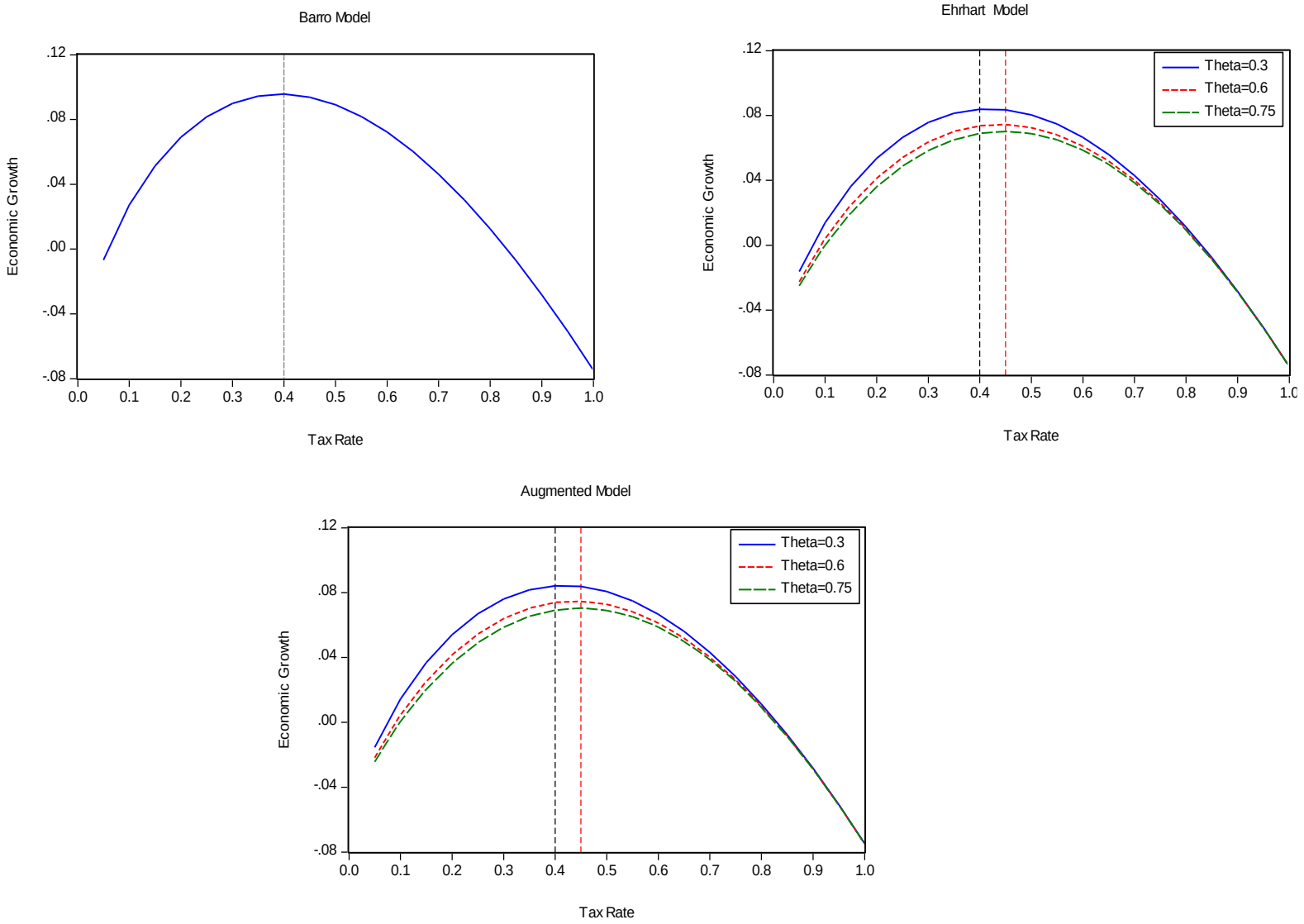

Figure 4.3: Simulation of Public Debt effect on Tax-Economic Growth nexus for the Republic of Congo

4.2.3. Simulation Effects of Seigniorage on Tax-Economic Growth Nexus

The sub-section further considers the effects of seigniorage[49] on the relation between tax and economic growth. The result from the baseline model remains unchanged as the government finances its economic growth with tax only. In the case of seigniorage, a similar simulation analysis is conducted to ascertain how seigniorage influences long-run economic growth at tax-maximising rate. Figures 4.4-4.6 present simulation results of seigniorage on tax and economic growth nexus across the three countries. Following Ehrhart et al. approach, three classifications of seigniorage are considered: no seigniorage (0%), moderate seigniorage (5%), and high seigniorage (10%).

In South Africa, the result from Ehrhart et al.'s model shows that when seigniorage is zero, the tax-maximising rate is 40% with corresponding long-run economic growth of 9.63% relative to Barro's estimate of 9.57%. As the seigniorage increases to 5%, the tax-maximising rate remains at 40%. Long-run economic growth further responds to the seigniorage increase by increasing to 10.14%. At high seigniorage of 10%, the tax remains at 40% as long-run economic growth increases to 10.84%. As seigniorage increases, it provides government with additional revenue to support tax in financing long-run economic growth.

More so, the extension of the model by Ehrhart et al. (2014) shows that the tax-maximising rate declines to 35% when seigniorage is zero with associated long-run economic growth of 11.45%. Furthermore, as seigniorage increases to 5%, the tax-maximising rate remains at 35% while long-run economic growth further increases to 12.02%. More so, the long-run economic growth climbs to 12.79% responding to increment in seigniorage to 10% as the tax-maximising rate does not change. We can deduce from the results that as the country increases the seigniorage, long-run economic growth increases given that all other parameters in the model remain stable. Comparatively, the augmented shows that long-run

[49] It is also important to note that public debt is fixed using its estimated values while total natural resource rents are assumed to be zero for Ehrhart et al.'s model. In the augmented model, public debt and total natural resource rents are fixed using their estimated values.

economic growth is high as the tax-maximising rate declines compared to the finding in Ehrhart et al.'s model.

In the case of Nigeria, the simulation result reveals that an increase in seigniorage improves the long-run economic growth at a given tax-maximising rate. Specifically, Ehrhart et al.'s model show that the tax-maximising rate remains at 40% as seigniorage is zero. Also, the associated long-run economic growth is 9.58% which is very close to the baseline value. In addition, when seigniorage moves to 5%, the tax-maximising rate is unchanged but long-run economic growth increases to 10.08%. When seigniorage increases to 10%, the tax-maximising rate does not respond to the change while long-run economic growth further increases to 10.78%. As seigniorage increases, the tax-maximising rate remains stable at 40% while long-run economic growth consistently increases. From the augmented model, tax-maximising rate remains constant at 40% irrespective of seigniorage level. However, increasing the seigniorage level from 0% to 5% causes long-run economic growth to increase from 9.61% to 10.12%. Similarly, as seigniorage increases to 10%, long-run economic growth rises to 10.81%. The simulating effect of seigniorage for the tax-maximising rate in the augmented model is similar to Ehrhart et al.'s model. However, the effect on long-run economic growth is relatively high in the augmented model.

The next focus is on the simulation effect of seigniorage on long-run economic growth for the Republic of Congo. The result indicates that an increase in seigniorage enhances long-run economic growth. From Ehrhart et al.'s model, the tax-maximising rate remains at 40% across the seigniorage levels. However, at a seigniorage of 0%, the long-run economic growth was 9.57% as in the baseline model. In addition, as seigniorage level increases to 5%, long-run economic growth climbs to 10.08%. As seigniorage increases to 10%, long-run economic growth further amplifies to 10.77%. This result suggests that seigniorage facilitates long-run economic growth. Additionally, the augmented model shows that seigniorage promotes long-run economic growth. Irrespective of the seigniorage level, the tax-maximising rate is 40%. Hence, tax does not respond to changes in seigniorage revenue. On the other hand, a seigniorage of 0% causes long-run economic growth of 9.60%. Increasing the seigniorage to 5%, long-run economic growth increases to 10.11%. More so,

the long-run economic growth further increases to 10.80% when seigniorage increases to 10%.

From the above, several conclusions can be drawn from our results. First, seigniorage moves the growth laffer curve upward. This suggests that seigniorage increases long-run economic growth but at different levels across the theoretical models. In essence, it provides government with additional revenue to fund the public investment which fosters long-run economic growth. Second, the estimated long-run economic growth under augment is high relative to estimates in Ehrhart et al.'s model. Third, the tax-maximising rate is stable across the models except for South Africa where the tax-maximising rate declines with an increase in seigniorage under the augmented model.

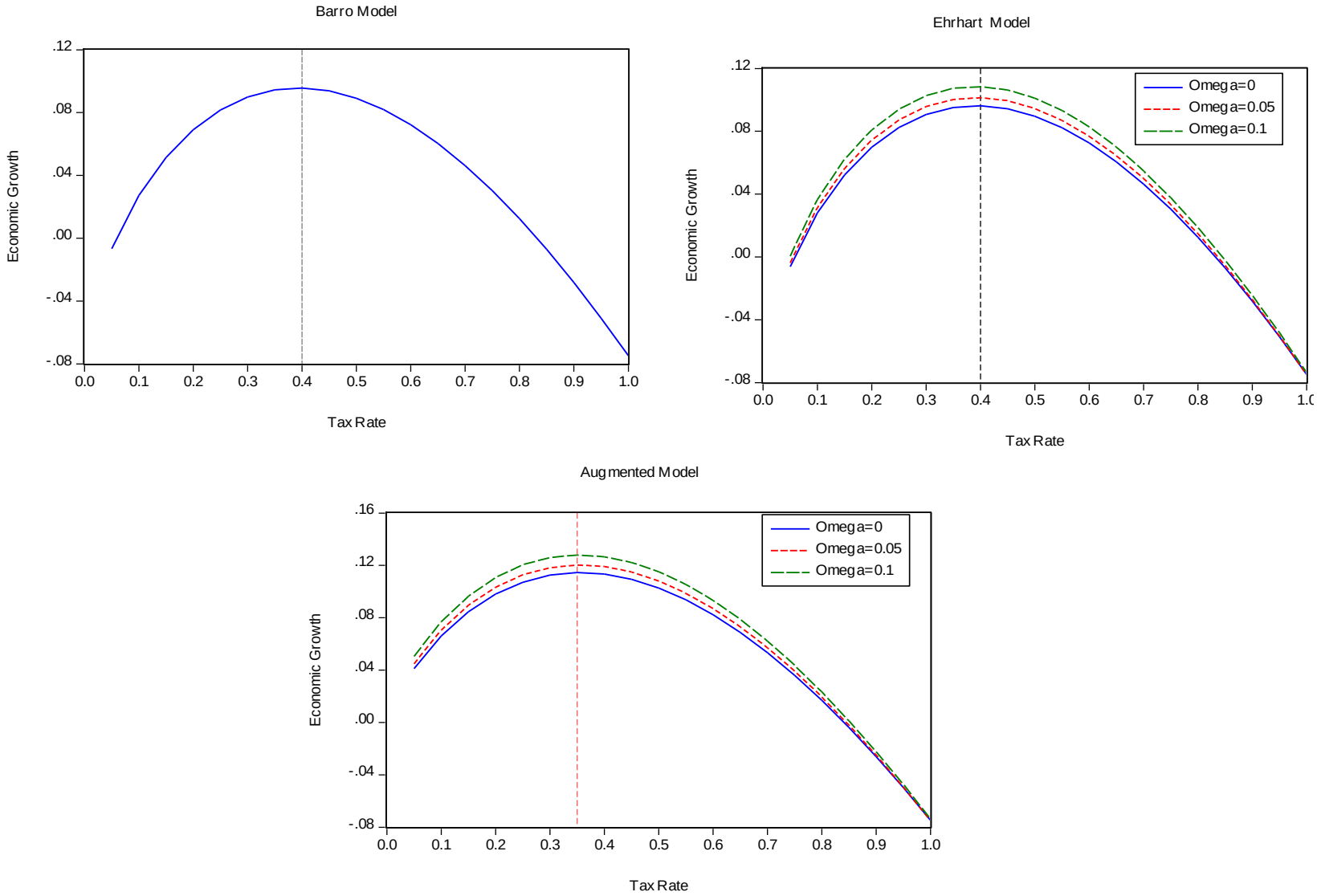

Figure 4.4: Simulation of Seigniorage effect on Tax-Economic Growth nexus for South Africa

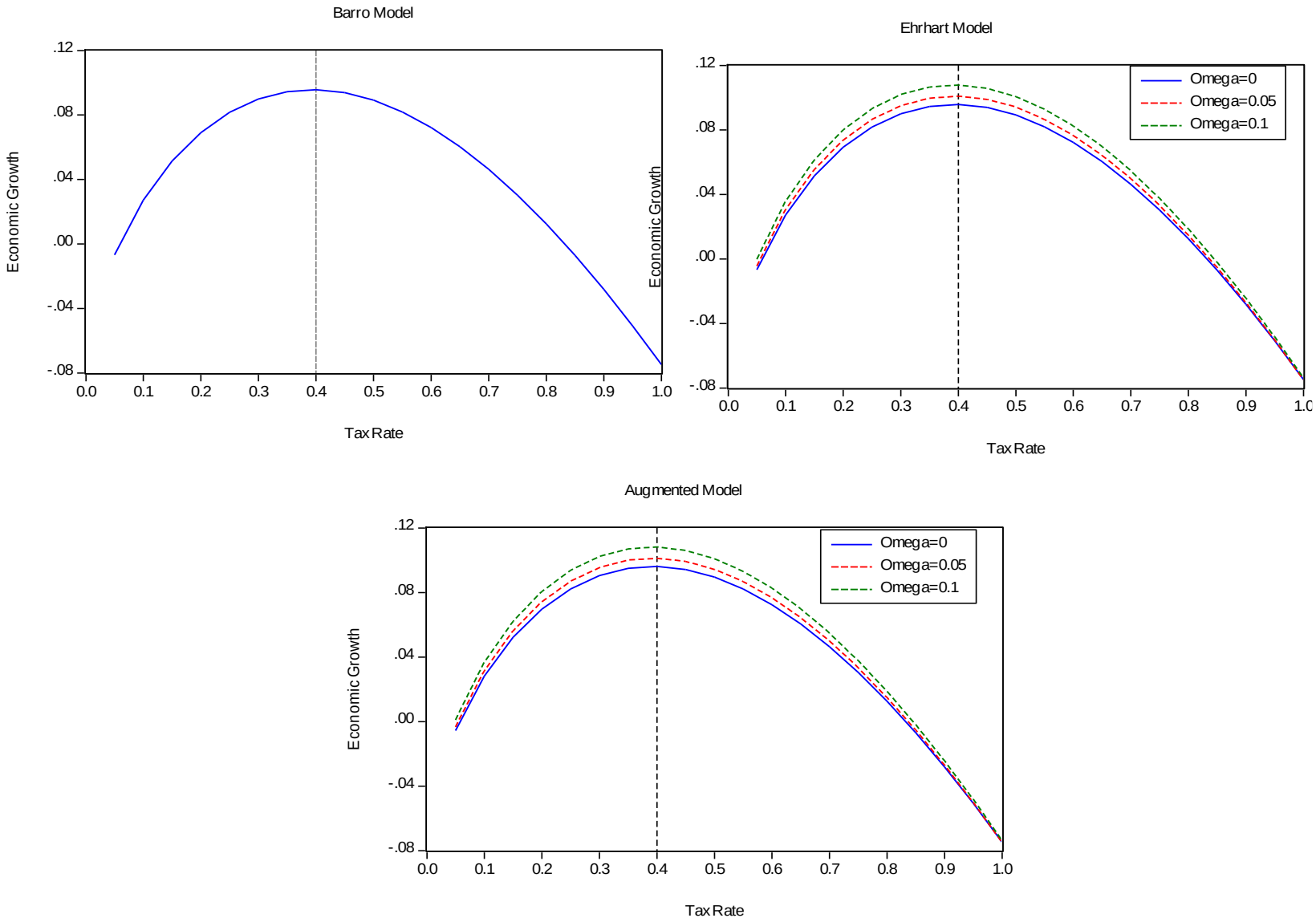

Figure 4.5: Simulation of Seigniorage effect on Tax-Economic Growth nexus for Nigeria

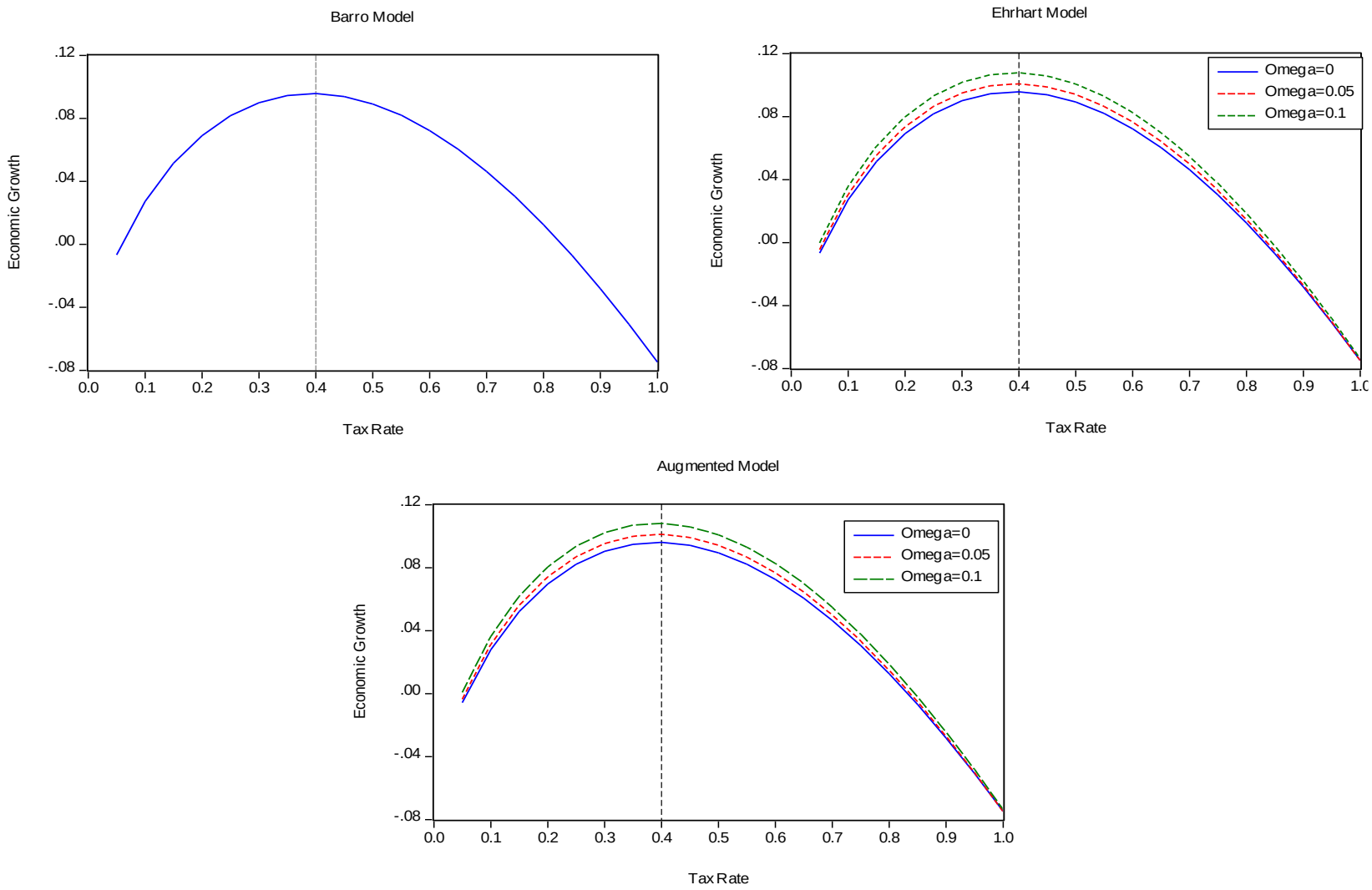

Figure 4.6: Simulation of Seigniorage effect on Tax-Economic Growth nexus for the Republic of Congo

4.2.4. Simulation Effects of Total Natural Resource Rents on Tax-Economic Growth Nexus

In this sub-section, we examine the role of total natural resource rents in the relation between tax and economic growth. Here, the focus is on the augmented model since Barro (1990) and Ehrhart et al. (2014) assumed that $v = 0$. Figure 4.7 presents simulated effects of total natural resource rents on tax-economic growth relationship across the three countries. Following Lee and Gueye's (2015) definition, we classified total natural resource rents into three: no natural resource rents (0%), moderate natural resource rents (10%), and high natural resource rents (20%).

Starting with South Africa, the result from the augmented model shows that in the absence of total natural resource rents, the tax-maximising rate is 40% with corresponding long-run economic growth of 6.61%. In addition, when total natural resource rent increases to 10%, the tax-maximising rate declines 35%. Hence, long-run economic growth further responds to the increase in total resource natural rents by magnifying to 9.43%. As total natural resource rent increases to 20%, the tax-maximising rate falls drastically to 25% with long-run economic growth of 12.44%. Deduction from the results shows that high total natural resource rents discourage tax mobilisation while it fosters economic growth given that all other parameters in the model remain unchanged.

For Nigeria, the result shows that an increase in total natural resource rents enhances long-run economic growth at a given tax-maximising rate. In the augmented model, the tax-maximising rate is 40% when total natural resource rents are zero. More so, the corresponding long-run economic growth is 6.55%. In addition, when total natural resource rents increase to 10%, the tax-maximising rate declines to 35% with an increase in long-run economic growth to 9.36%. A further increase in total natural resource rents to 20%, resulted in a decline in the tax-maximising rate to 25%. Hence, long-run economic growth increases to 12.34%. The simulated effect of total natural resource rents clearly shows that both tax and long-run economic growth are influenced by the level of natural resource rents.

Next, we consider the simulated effect of total natural resource rent on long-run economic growth for the Republic of Congo. The result also supports earlier evidence on Nigeria and South Africa as an increase in total natural resource rents promotes long-run economic growth but a lower tax-maximising rate. When total natural resource rents are 0%, the tax-maximising rate is also 40% with a long-run economic growth of 6.55%. However, as total natural resource rents increase to 10%, the tax-maximising rate decreases to 35% while the long-run economic growth increases to 9.36%. Moreover, when total natural resource rents increase to 20%, the tax-maximising rate declines to 25%. Correspondingly, long-run economic growth further magnifies to 12.43%. It could be observed that both Nigeria and the Republic of Congo's results are nearly the same. This result suggests that total natural resource rent facilitates long-run economic growth but a low tax-maximising rate.

From the above, several conclusions can also be drawn from our results. First, total natural resource rents move the growth laffer curve upward. This implies that total natural resource rent magnifies long-run economic growth but at different levels in the augmented model. Second, the tax-maximising rate declines as total natural resource rents increase. As revenue from natural resources increases, the government has more revenue to finance its public spending as well as reduce over-dependence on high tax rate. Reduction in the tax rate encourages private investment and productivity expansion leading to high economic growth. Third, the effect of total natural resource rents in resource-rich countries such as Nigeria and the Republic of Congo are similar.

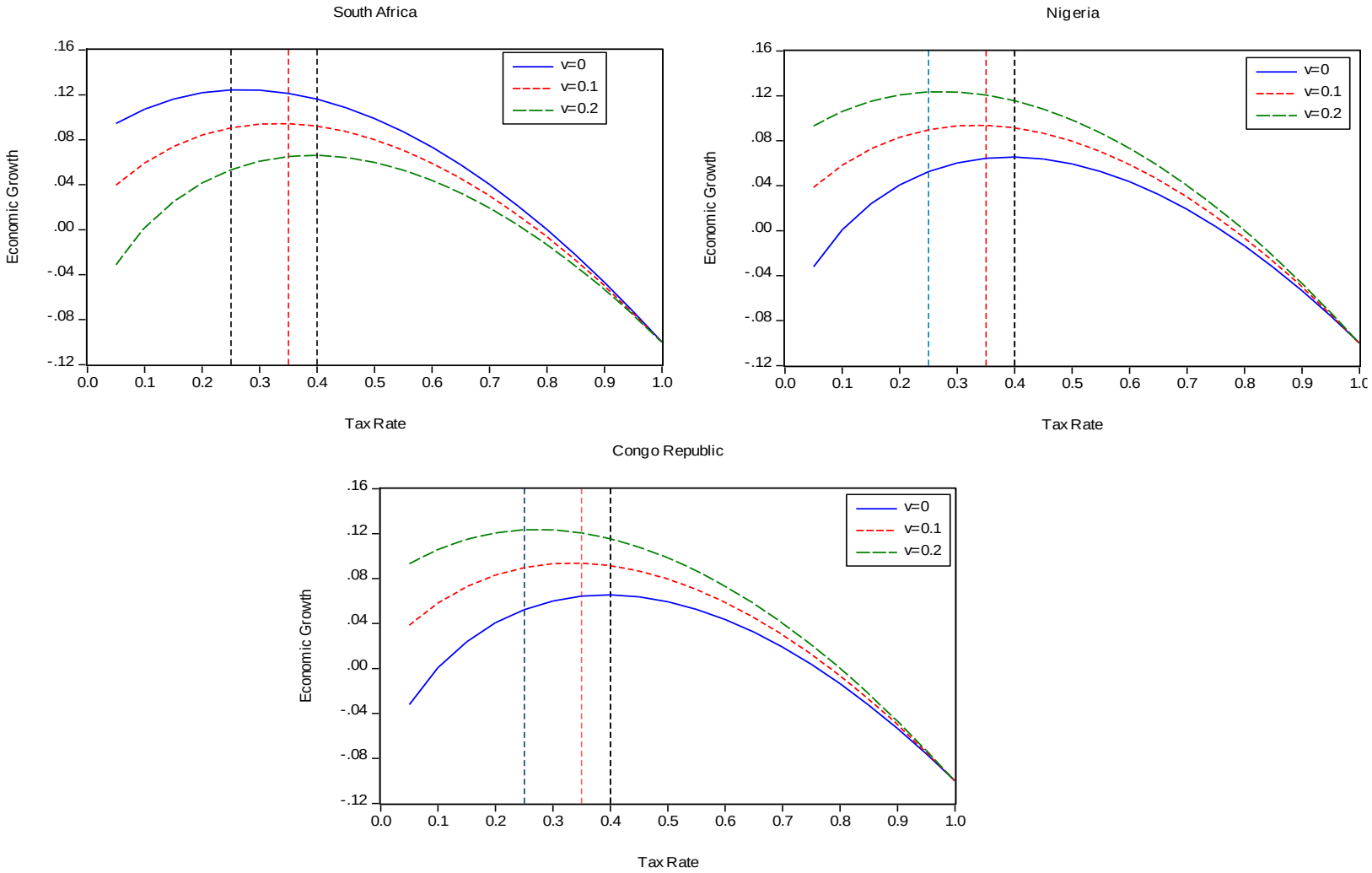

Figure 4.7: Simulation of Total Natural Resource Rents effect on Tax-Economic Growth nexus

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.0.Overview

The chapter provides a summary of key findings from the econometric and simulation approaches. Also, the conclusions drawn from the results to give insight into policy formulation in the three countries are considered. Key contributions of this study to the literature and limitations to the study are also captured in the chapter.

5.1.Summary

This study focused on three crucial objectives. Specifically, the study examined the effects of APFOs on the relationship between tax and economic growth in three selected sub-Saharan African countries. It carried out trend analysis to understand the nature and evolution of key variables of interest. Also, the literature review was based on three strands (theoretical, methodological, and empirical issues) is conducted to provide an overview of existing issues in the literature and plausible critiques of those issues. More so, it built on the framework of the endogenous growth model with the public sector to analyse the objectives. The framework provided useful analytical steps to understanding the role of public sector in the growth process relative to Keynesian and Neo-classical frameworks. On methodological approach, Two-stage Least Squares method was deployed to provide robust estimates. Moreover, the methodological approach addressed the potential endogeneity issues and reverse causality among the fiscal variables in the growth model relative to other methodological approaches. In addition, the simulation approach was employed to complement the econometric approach and test the propositions of theoretical models.

On the empirical analysis, the econometric result showed that public debt had a negative and significant effect on economic growth under a linear approach. In essence, high

public debt reduced the growth effects of taxes across the three countries. Specifically, it reduced the growth effect of total tax by 0.004%, 0.002% and 0.002% in South Africa, Nigeria and Republic of Congo, respectively. A similar pattern was observed when growth effects of direct and indirect taxes were considered. These effects are weighty for South Africa compared to Nigeria and Republic of Congo under aggregated and disaggregated taxes. However, the result from nonlinear approach indicated that the public debt influenced the growth laffer curve differently across the countries. The public debt weakly dampened the effectiveness of tax in the growth process in South Africa and Nigeria while it strongly amplifies economic growth in Republic of Congo. Furthermore, the findings from the simulation approach showed that high public debt increases the tax-maximising rate as it reduced economic growth in the three countries.

Moreover, the econometric results showed that seigniorage largely hampered the growth effect of tax in the selected countries under a linear approach. Explicitly, seigniorage had an insignificant positive influence on growth effect of total tax in South Africa. It undermined growth effect of total tax by 0.009%. On the other hand, seigniorage significantly and negatively influenced growth effect of total tax by 0.019% and 0.016% in Nigeria and Republic of Congo, respectively. Similarly, seigniorage followed the same pattern in influencing growth effects of direct and indirect taxes across the countries. The magnification effect is higher in Nigeria relative to South Africa and Republic of Congo. Nevertheless, seigniorage positively influenced the growth laffer curve in the three countries under the nonlinear approach. The effect is more pronounced in South Africa and Republic of Congo compared to Nigeria. Additionally, the results from simulation approach indicated that an increase in seigniorage reduced the tax-maximising rate but increased in South Africa when the augmented model was considered. However, seigniorage did not influence the tax-maximising rate while economic growth increased in Nigeria and Republic of Congo.

More so, the econometric results revealed that total natural resource rents had a negative and significant effect on the relation between tax and growth under a linear approach. In essence, total natural resource rents reduced the growth effect of total tax by 0.031%, 0.002% and 0.05% in South Africa, Nigeria and Republic of Congo. Though total natural resource rents dampened the efficacy of total tax in the growth process across the

countries, its effect remains weak in the case of Nigeria. Moreover, the total natural resource rents continued to undermine the growth effect of direct and direct taxes in South Africa and Republic of Congo. However, a positive effect of total natural resource rents on growth effect of direct and indirect taxes is more pronounced in the case of Nigeria. Considering the linear approach, total natural resource rents enhance the growth effect of taxes in Nigeria and the Republic of Congo but largely reduces the growth effect of taxes in the case of South Africa. In addition, the simulation result showed that the total resource rents reduced tax-maximising rate as economic growth amplifies.

Similar results were obtained under net effect computation. For the policy threshold, the minimum tax required for positive economic growth under public finance options is higher for South Africa relative to Nigeria and the Republic of Congo. Under public debt, South Africa required a minimum total tax rate of 22.6% to maintain positive growth while Nigeria and Republic of Congo needed minimum total tax rates of 8.7% and 11%, respectively. The required total tax rate for South Africa increased to 26.4% under seigniorage while it declined to 6.3% and 9.5% for Nigeria and Republic of Congo. Under total natural resource rents, the total tax rate rose to 29.4% for South Africa whereas it stood at 8.9% and 10.5% for Nigeria and Republic of Congo, respectively. This suggests that South Africa needs a high tax rate under the APFOs to maintain positive economic growth while Nigeria and Republic of Congo require a low tax rate to ensure positive economic growth.

5.2.Conclusion

From the first objective, public debt was found to largely and negatively influence economic growth across the countries from both simulation and econometric approaches. Specifically, this suggests that high public debt increases the tax rate. The available resource from taxes is shared between interest payment on debt and competing public investments and thus, reducing economic growth. Accumulation of public debt beyond a moderate level (30%-60%) may lead to debt crisis/risk. This would mean that part of tax resources of these countries is reallocated from provision of public goods and social capital to needed for stable economic growth to debt servicing and repayment. Consequently, this would result in huge financing gaps in public investment that would deteriorate economic growth. This finding supports the arguments from Le Van et al.

(2018), Megersa (2015), and Ehrhart et al. (2014). Hence, the accumulation of high public debt inhibits the growth effect of taxes.

On the second objective, the effect of seigniorage on economic growth largely depends on tax conditions across the countries. Given the tax ratios of these countries, seigniorage reduces the growth effect of taxes as this additional financing option discourages government from mobilising resources from tax options which reduces available revenue for growth-enhancing public investments. Doubling the tax ratios in these countries coupled with an increase in seigniorage facilitates economic growth in the case of South Africa while both it is not large enough to drive economic growth in Nigeria and the Republic of Congo. These results indicated that low tax performing countries such as Nigeria and the Republic of Congo, may not address the huge financing gap in public investment exploring this alternative financing option, hence, the objective of attaining high and stable economic growth would be challenging. On the other hand, high tax-performing countries such as South Africa may benefit from exploring this option as the combined resources enhanced economic growth. These findings partly support evidence by Bose et al. (2007) and Udoh (2011).

On the third objective, total natural resource rents significantly reduced the growth effect of taxes across the three countries. Expectedly, seemingly easy financing option such as revenue from natural resources does not encourage the government to aggressively mobilising resources from taxes to finance economic growth. When tax ratios are doubled, total natural resource rent enhances the growth effect of indirect tax in South Africa and Nigeria while it facilitated the growth effect of all taxes in the Republic of Congo. Thus, these findings suggest that natural resource rents might complement tax which in turn, expand the resource pools available for growth enhancement. These results also corroborate the arguments pushed by Raheem et al. (2018), Oyinlola et al. (2020a), Hanusch and Baskaran (2019), and Chambers and Guo (2009).

On the threshold analysis, the policy thresholds show the minimum tax required to achieve positive economic growth whereas simulation analysis generates the maximum tax required to achieve positive and high economic growth. The findings showed that both Nigeria and the Republic of Congo needed low tax rates to achieve positive growth

while South Africa required high tax rates to maintain positive economic growth. The reason for this is aptly captured by the countries' dependence on APFOs. Specifically, Nigeria and the Republic of Congo depend heavily on revenue from borrowing and total natural resources compared to South Africa. More so, the findings indicated that the three countries require a maximum tax rate of 40% to maintain positive, stable, and high economic growth.

5.3.Recommendations

The findings of this study have shown that APFOs significantly influenced the relationship between tax and economic growth in the three selected sub-Saharan African countries. For South Africa, the country needs to maintain moderate public debt for the reallocation of more tax revenues to public investments needed for stable economic growth. Given the strong tax system, the country should diligently raise revenue from seigniorage and total natural resources to complement available resources from tax to put the country on a sustainable growth trajectory. It is important to acknowledge the efforts of the government towards achieving a tax rate of 30%, however, other financing options (seigniorage and natural resource rents) should be looked into since they are not entirely bad for economic growth. In Nigeria, its tax rate is still far from South Africa and simulated maximum threshold. Thus, the country needs to aggressively mobilise tax revenue while moderately utilising public debt, seigniorage and total natural resource rents. These alternative financing options should serve as a complement to tax revenue not contrariwise.

More so, the experience of debt crisis should be avoided by limiting the public debt to a low or moderate level. High public debt accumulation eroded the resources needed for economic growth. Developing a strong tax system that can generate huge resources is important for the country while carefully sourcing revenue from seigniorage and total natural resources. In the case of Republic of Congo, the country needs to pay attention to huge accumulation of debt and poor tax system. Thus, it is recommended that this country should be serious with fiscal discipline by maintaining low or moderate public debt. Also, reforming the tax system to mobilise resources may reduce debt challenge in the country. A strong tax system is essential for the country while seigniorage and total natural resource rents should play complementary. From the foregoing, tax mobilisation

must be central to achieving positive and stable growth with a supporting role from alternative financing options for the countries.

5.4.Contributions to the Knowledge

This study contributes to the existing knowledge in the following ways. First, it explores the theoretical endogenous growth model with public sector by assuming unbalanced government budget constraint in the context of sub-Saharan African countries. Specifically, government budget constraint is modified to capture APFOs such as public debt, seigniorage, and total natural resources contrary to the assumption of balanced government budget constraint which does not capture reality in the sub-Saharan countries. Second, it deploys both simulation and econometric (two-stage least squares) approaches. The simulation approach allows for the determination of tax-maximising rates while the econometric approach captures the effects and assists in addressing possible endogeneity among fiscal variables. It also helps in computing net effects and minimum threshold values of taxes at aggregate and disaggregate levels. Lastly, it provides new and comprehensive empirical evidence on the issues of public financing and economic growth in sub-Saharan African countries. The evidence is compelling as different effects of APFOs on the relationship between tax and economic growth are captured by indicating the weakness and strength of the selected countries in financing their economic growth.

5.5.Limitations and suggestions for the future studies

There is limitation to the study. Specifically, the role of institutions is not captured due to the complications that arose from solving the theoretical model and testing its empirically. On suggestion, future studies may attempt to unbundle the complexity and complications associated with the endogenous growth model with public sector and institutions. Second, the model may be transformed into the framework of dynamic stochastic general equilibrium due to interlinkages among the financing options. Third, the use of data interpolation due to limited data availability. Future studies can revisit the estimation when there is long period data.

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APPENDIX I

Table A: Average GDP growth for sub-Saharan African countries between 1990-2016

Country	1990-1994	1995-1999	2000-2004	2005-2009	2010	2011	2012	2013	2014	2015	2016	Average
Benin	4.8	5.1	4.7	3.8	2.1	3.0	4.8	7.2	6.4	1.8	3.3	4.1
Botswana	4.5	6.3	3.1	4.0	8.6	6.0	4.5	11.3	4.1	-1.7	4.3	5.3
Burkina Faso	2.7	7.6	5.0	6.2	5.4	6.6	6.5	5.8	4.3	3.9	5.9	5.5
Burundi	-0.1	-2.8	1.9	3.7	5.1	4.0	4.4	4.9	4.2	-3.9	-0.6	2.6
Cabo Verde	8.2	12.1	7.2	7.1	1.5	4.0	1.1	0.8	0.6	1.0	4.7	1.9
Cameroon	-3.8	4.4	4.7	3.2	3.4	4.1	4.5	5.4	5.9	5.7	4.6	4.8
Central African Republic	-0.8	3.4	1.2	4.2	4.6	4.2	5.1	-36.4	0.1	4.3	4.8	-1.9
Chad	1.4	3.1	13.5	5.7	13.6	0.1	8.9	5.7	6.9	2.8	-6.3	4.5
Congo, DR	-8.6	-2.4	1.3	5.4	7.1	6.9	7.1	8.5	9.5	6.9	2.4	6.9
Congo, Rep.	***-0.1***	***1.8***	***4.1***	***5.1***	***8.8***	***3.4***	***3.8***	***3.4***	***6.8***	***2.6***	***-2.8***	***3.7***
Cote d'Ivoire	-0.1	5.0	-0.7	2.2	2.0	-4.4	10.7	8.9	8.8	8.8	8.0	6.1
Eswatini	6.3	3.5	2.9	3.8	3.8	2.2	5.4	3.9	0.9	2.3	1.3	2.8
Ethiopia	0.6	4.7	5.5	10.7	12.6	11.2	8.6	10.6	10.3	10.4	9.4	10.4
Gabon	3.2	1.8	0.6	0.5	7.1	7.1	5.3	5.6	4.3	3.9	2.1	5.1
Gambia	2.6	3.6	4.4	2.6	5.9	-8.1	5.2	2.9	-1.4	4.1	1.9	1.5
Ghana	4.1	4.4	4.6	6.1	7.9	14.0	9.3	7.3	2.9	2.2	3.4	6.7
Kenya	1.6	2.9	2.6	4.6	8.4	6.1	4.6	5.9	5.4	5.7	5.9	6.0
Lesotho	5.9	2.9	2.9	4.3	6.4	6.6	5.9	2.2	2.8	2.7	3.2	4.3
Madagascar	0.0	3.2	2.6	3.7	0.6	1.6	3.0	2.3	3.3	3.1	4.0	2.6
Malawi	1.3	7.0	1.9	6.7	6.9	4.9	1.9	5.2	5.7	2.8	2.5	4.3
Mali	2.6	5.2	5.8	4.8	5.4	3.2	-0.8	2.3	7.0	6.0	5.8	4.1
Mauritania	0.9	4.4	2.8	4.1	4.8	4.7	5.8	6.1	5.6	0.4	1.8	4.2
Mauritius	5.5	4.8	4.7	4.2	4.4	4.1	3.5	3.4	3.7	3.6	3.8	3.8
Mozambique	3.4	9.3	7.5	7.5	6.5	7.4	7.3	7.0	7.4	6.7	3.8	6.6
Namibia	3.5	3.6	5.2	3.6	6.0	5.1	5.1	5.6	6.4	6.1	1.1	5.1
Niger	0.0	3.7	2.8	4.5	8.4	2.3	11.8	5.3	7.5	4.3	4.9	6.4
Nigeria	***2.6***	***2.0***	***6.6***	***6.8***	***8.0***	***5.3***	***4.2***	***6.7***	***6.3***	***2.7***	***-1.6***	***4.5***
Rwanda	-11.5	15.0	7.9	9.0	7.3	8.0	8.6	4.7	6.2	8.9	6.0	7.1
Senegal	0.9	4.5	4.2	3.8	3.6	1.5	5.1	2.8	6.6	6.4	6.4	4.6
Seychelles	4.5	5.3	-1.7	5.1	6.0	7.9	1.3	6.0	4.5	4.9	4.5	5.0
Sierra Leone	-2.8	-2.5	8.5	5.1	5.3	6.3	5.2	5.7	4.6	-2.1	6.1	4.4
South Africa	***0.2***	***2.6***	***3.6***	***3.6***	***3.0***	***3.3***	***2.2***	***2.5***	***1.8***	***1.2***	***0.4***	***2.1***
Sudan	2.8	6.0	6.2	8.0	3.5	-2.0	0.5	4.4	2.7	4.9	4.7	2.7
Tanzania	2.5	4.0	6.4	6.3	6.3	7.7	4.5	6.8	6.7	6.2	6.9	6.4
Togo	-1.0	4.2	1.9	1.3	6.1	6.4	6.5	6.1	5.9	5.7	5.6	6.1
Uganda	6.0	7.7	6.1	8.2	5.6	9.4	3.8	3.6	5.1	5.2	4.8	5.4
Zambia	-0.8	3.4	5.5	8.1	10.3	5.6	7.6	5.1	4.7	2.9	3.8	5.7
Zimbabwe	2.8	1.1	-4.7	-3.7	9.7	4.2	6.7	2.0	2.4	1.8	0.8	3.9

Table B: Average GDP per capita growth for sub-Saharan African countries between 1990-2016

Country	1990-1994	1995-1999	2000-2004	2005-2009	2010	2011	2012	2013	2014	2015	2016	Average
Benin	1.3	1.9	1.6	0.8	-0.7	0.1	1.9	4.2	3.4	-1.0	0.5	1.2
Botswana	1.6	3.8	1.2	1.9	6.7	4.6	3.2	10.1	2.8	-3.2	2.4	3.8
Burkina Faso	0.0	4.6	2.0	3.0	2.2	3.5	3.3	2.7	1.3	0.9	2.9	2.4
Burundi	-2.2	-3.9	-0.8	0.4	1.8	0.7	1.2	1.7	1.0	-6.9	-3.7	-0.6
Cabo Verde	5.4	9.6	5.5	5.7	0.2	2.7	-0.2	-0.5	-0.7	-0.2	3.4	0.7
Cameroon	-6.5	1.6	2.0	0.4	0.6	1.3	1.7	2.6	3.1	2.9	1.9	2.0
Central African Republic	-3.4	0.8	-0.9	2.3	3.5	3.4	4.6	-3.7	-0.3	3.7	3.7	2.1
Chad	-1.9	-0.4	4.1	2.1	9.8	-3.2	5.3	2.2	3.4	-0.5	-9.2	1.1
Congo, DR	-11.9	-4.9	-1.6	2.0	3.6	3.4	3.6	4.9	5.9	3.4	-0.9	3.4
Congo, Rep.	***-2.8***	***-1.1***	***1.1***	***1.7***	***5.5***	***0.6***	***1.1***	***0.9***	***4.2***	***0.1***	***-5.2***	***1.0***
Cote d'Ivoire	-3.6	1.8	-3.0	-0.1	-0.3	-6.6	8.0	6.2	6.1	6.1	5.3	3.5
Eswatini	3.6	1.6	2.3	3.1	3.1	1.6	4.7	3.1	0.2	1.5	0.4	2.1
Ethiopia	-2.8	1.5	2.5	7.7	9.5	8.1	5.6	7.5	7.2	7.4	6.5	7.4
Gabon	0.4	-0.8	-1.8	-2.4	3.4	3.2	1.3	1.7	0.6	0.5	-1.0	1.4
Gambia	-1.0	0.4	1.1	-0.4	2.8	-10.9	2.1	-0.2	-4.3	1.0	-1.1	-1.5
Ghana	1.2	1.8	2.1	3.5	5.2	11.3	6.7	4.8	0.6	-0.1	1.1	4.2
Kenya	-1.7	0.0	-0.2	1.7	5.5	3.3	1.8	3.1	2.7	3.1	3.3	3.3
Lesotho	3.6	1.2	3.0	4.4	6.1	6.2	5.3	1.5	2.1	1.9	2.4	3.6
Madagascar	-2.9	0.0	-0.5	0.8	-2.2	-1.2	0.2	-0.4	0.6	0.4	1.2	-0.2
Malawi	-0.2	4.7	-0.6	3.8	3.8	1.9	-1.0	2.3	2.8	0.0	-0.3	1.4
Mali	0.2	2.5	2.7	1.4	2.1	0.1	-3.7	-0.6	4.0	2.9	2.7	1.1
Mauritania	-1.6	1.8	0.0	3.1	1.8	1.7	2.7	3.0	2.5	-2.4	-1.0	1.2
Mauritius	4.3	3.7	3.9	3.8	4.1	3.9	3.2	3.1	3.6	3.4	3.8	3.6
Mozambique	0.2	6.2	4.4	4.6	3.6	4.5	4.3	4.0	4.4	3.7	0.9	3.6
Namibia	0.7	1.5	3.6	1.8	4.1	3.2	3.2	3.8	4.5	4.2	-0.7	3.2
Niger	-3.2	0.1	-0.9	0.6	4.3	-1.6	7.6	1.2	3.4	0.4	1.0	2.3
Nigeria	***0.02***	***-0.5***	***5.9***	***4.0***	***5.2***	***2.5***	***1.5***	***3.9***	***3.5***	***0.0***	***-4.2***	***1.8***
Rwanda	-7.9	10.2	4.8	6.5	4.6	5.3	6.0	2.2	3.6	6.1	3.3	4.4
Senegal	-2.0	2.0	1.7	1.1	0.8	-1.3	2.2	0.0	3.7	3.4	3.4	1.7
Seychelles	3.0	3.6	-2.2	3.9	3.0	10.8	0.3	4.1	2.9	2.6	3.1	3.8
Sierra Leone	-3.0	-3.1	4.3	2.1	3.0	3.9	2.6	8.1	2.3	-2.3	3.8	3.0
South Africa	***-2.2***	***0.8***	***2.3***	***2.2***	***1.6***	***1.7***	***0.6***	***0.9***	***0.2***	***-0.3***	***-1.1***	***0.5***
Sudan	0.2	3.2	3.3	5.1	0.8	7.3	11.8	1.9	0.2	2.4	2.2	3.8
Tanzania	-0.8	1.4	3.6	3.4	3.3	4.5	1.4	3.6	3.6	3.0	3.7	3.3
Togo	-3.2	3.1	-0.8	-1.4	3.3	3.6	3.7	3.4	3.2	3.1	2.9	3.3
Uganda	2.6	4.6	2.8	4.8	2.3	6.0	0.6	0.3	1.6	1.6	1.0	1.9
Zambia	-3.3	0.7	2.8	5.2	7.1	2.4	4.3	1.8	1.5	-0.2	0.7	2.5
Zimbabwe	0.7	2.1	-7.0	-4.5	8.1	2.5	4.7	0.2	0.6	0.1	-0.8	6.5

APPENDIX II

Derivation Of the Augmented Endogenous Growth Model with APFOs

(A) Definitions for the model resolution

$\pi = \dot{P}_t P_t^{-1}$ (Inflation rate) (i)

$R_t = \pi_t + r_t$ (Nominal interest rate) (ii)

$M_t = M_t P_t^{-1}$ (Real money stock) (iii)

$T = (1-\eta)\left(\dot{M}_t - \pi M_t \right)$ (Transfer to household) (iv)

Def. iv is the transfer from commercial banks due to money supply growth

$\omega = \dot{H}_t H_t^{-1} = \dot{M}_t M_t^{-1}$ (v)

Def. v represents high powered money growth rate which is the growth rate of money supply where the multiplier is a constant

$\omega H_t P_t^{-1} = \omega \eta M_t$ (Seigniorage revenue to government) (vi)

$\theta = BY_t^{-1}$ (vii)

Def. vii captures the steady-state ratio of public debt to output that is desirably maintained by the government in order not to distort the economy's balanced growth path.

$\phi = \phi(R_t), \phi_R \leq 0$ (viii)

The coefficient ϕ in def. viii is the inverse of the velocity of money in circulation.

$Y_t = C_t + (\dot{K}_t + \delta K_t) + G_t + V_t$ (ix)

Def. ix is the output-expenditure identity in a closed economy

$\frac{1}{\sigma} = -U_{CC} C_t (U_C)^{-1}$ (x)

Def. x is the elasticity of substitution of the isoelastic instantaneous utility function

$M = \dot{M} + \pi M$ (Real money stock/balance) (xi)

$d = \dot{B}_t / Y$ (New bonds to output ratio) (xii)

$\gamma^* = g^{*1-\rho} - c^* - g^* - \delta$ (Output growth relation of Definition ix) (xiii)

$\frac{V}{Y} = \nu$ (Natural resource rents to output ratio) (xiv)

$A = \dot{B}_t + M_t$ (Total wealth in the economy) (xv)

$Z = \dot{K}_t + \delta K_t$ (Total investment in the economy) (xvi)

(B) Solving the Models

$$H_c = U(C_t) + \lambda_{1t}\left[r_t B_t + (1-\tau)\,(f(K_t, G_t)) + T_t + (1-\varphi)V_t - C_t - Z - \pi M_t\right] + \lambda_{2t}(Z - \delta K_t) + q_t(A_t - B_t - M_t + \mu_t\left[M_t - \phi(C_t - Z_t + G_t + V_t)\right]$$

(A1)

From the current-valued Hamiltonian function above, μ_t and q_t capture the multiplier of static constraint. λ_{1t} and λ_{2t} represent the costate variables that are related to K_t and A_t, respectively.

Optimizing equation A1:

For our FOC (note that that time scripts are dropped for simplicity),

$$/B: \lambda_1 r - q = 0 \Rightarrow q = r\lambda_1 \quad \text{(A2.1)}$$

$$/M: -\lambda_1\pi - q - \mu = 0 \Rightarrow \mu = \lambda_1\pi + q \quad \text{(A2.2)}$$

$$/C: U_c - \lambda_1 - \phi\mu = 0 \Rightarrow U_c = \lambda_1\left(1 + \phi\,\mu/\lambda_1\right) \quad \text{(A2.3)}$$

$$/Z: -\lambda_1 + \lambda_2 - \phi\mu = 0 \Rightarrow \lambda_2 = \left(\phi\frac{\mu}{\lambda_1 + 1}\right)\lambda_1 \Rightarrow \frac{\lambda_2}{\lambda_1} = \left(\phi\frac{\mu}{\lambda_1 + 1}\right) \quad \text{(A2.4)}$$

$$/V: \lambda_1(1-\varphi) - \phi\mu = 0 \Rightarrow \varphi = 1 - \phi\,\mu/\lambda_1 \quad \text{(A2.5)}$$

$$/A: \dot{\lambda}_1 = \beta\lambda_1 - q \quad \text{(A2.6)}$$

$$/K: \dot{\lambda}_2 = \beta\lambda_2 - \left[\lambda_1(1-\tau)F_k - \lambda_2\delta\right] \Rightarrow \frac{\dot{\lambda}_2}{\lambda_2} = \beta + \delta - \lambda_1/\lambda_2\,(1-\tau)\,F_k \quad \text{(A2.7)}$$

Since by Def. (ii), $R = \pi + r$, from A(2.1) and A(2.2)

$$R = \frac{q}{\lambda_1} + \frac{\mu - q}{\lambda_1} = \frac{\mu}{\lambda_1}$$

Rewriting A2.3, 2.4, 2.6 and 2.7, we have:

$$/C: U_c = \lambda_1(1+\phi R) \quad \text{(A3.1)}$$

$$/Z: \frac{\lambda_2}{\lambda_1} = (1+\phi R) \quad \text{(A3.2)}$$

$$/A: \frac{\dot{\lambda}_1}{\lambda_1} = \beta - r \quad \text{(A3.3)}$$

$$/K: \frac{\dot{\lambda}_2}{\lambda_2} = \beta - \delta - \frac{(1-\tau)F_K}{1+\phi R} \quad \text{(A3.4)}$$

$$/V: \varphi = 1 - \phi R \quad \text{(A3.5)}$$

From the FOC in A2.5 which optimises resource rent, all the revenue from resource rents accrues to government only as indicated by $\varphi = 1$. This implies that the household does not directly share in the revenue. Further, the constraint on consumption shows that there is always a wedge between the marginal utility of consumption and the shadow price of wealth (λ_1) caused by nominal interest rate. Similarly, the standard CIA constraint on investment creates a wedge between real wealth return ($_r$) and the investment return, $\frac{(1-\tau)F_K}{1+\phi R}$ in equations A3.3 and A3.4, respectively, because it is difficult to purchase capital goods directly while accumulating wealth. In a situation where $\phi > 0$, real rate of return on investment needed is deflated by the financing cost $\phi R + 1$. However, if $\phi = 0$ which implies that $\lambda_1 = \lambda_2$ the wedge created by CIA constraint would be eliminated, evident in A3.4. This yields Ramsey relation presented in Eqn. A4.

From A3.1, Eqn. 4, and def. 8 (see working 1, W1)

$$\frac{\dot{C}}{C} = -\left[\frac{\dot{\lambda}_1}{\lambda_1} + \frac{(\phi_R R + \phi)\dot{R}}{1+\phi R}\right]\frac{1}{\sigma} \quad \text{(A4)}$$

Considering the Goods market equilibrium, the IS curve is generated by equation A5. From Eqn. 1 and Def. 9(see Workings, W2)

$$\frac{\dot{K}}{K} = \left(\frac{G}{K}\right)^{1-\rho} - \left(\frac{C}{K}\right) - \left(\frac{G}{K}\right) - \left(\frac{V}{K}\right) - \delta \quad \text{(A5)}$$

In addition, money market equilibrium establishes that:

From def. 5 and def. 12 (working 3, W3)

$$\frac{\dot{M}}{M} = \omega - \pi \qquad \text{(A6)}$$

In equilibrium, money market constraint is given by:

From Eqn. 5 and def. 9

$$M = \phi Y \qquad \text{(A7)}$$

Recall that the long-run public debt as a ratio of output (measures the deficit) is:

$d = \dot{B}_t \big/ Y$ (Such that $\theta = B \big/ Y$)

The extended government budget constraint with revenue from natural resources is presented in equation A8:

From Eqn. 6

$$\frac{\dot{B}}{B} = r + \frac{G - (\tau Y + \eta\omega M + \varphi V)}{B}$$

Subject to $\frac{\dot{B}}{B} = r + \frac{GK^{-1}}{BK^{-1}} - \frac{\tau YK^{-1}}{BK^{-1}} - \frac{\eta\omega MK^{-1}}{BK^{-1}} - \frac{\varphi VK^{-1}}{BK^{-1}}$ (A8)

From the intensive form of the variables, we derive endogenous growth solution for consumption, government, and debt as follow:

Using j=$\frac{J}{K} \forall J \in \{C, G, M, B\}$:

Thus, combining Eq. A3.3, A4, and A5 give Eq. A9.1 which is the growth solution of consumption (also known as the Keynes-Ramsey relation at the steady-state):

$$\frac{\dot{c}}{c} = \frac{\dot{C} \big/ \dot{K}}{C \big/ K} = \left[r - \beta - \frac{(\phi_R R + \phi)\dot{R}}{(1 + \phi R)} \right] \frac{1}{\sigma} - (g^{1-\rho} - c - g - \delta - v) \qquad \text{(A9.1)}$$

Subsequently, we derived the differential equation for real interest rate in Eq. A9.2. This captures the real interest rate at the steady-state. By combining Eq. A3.3, A3.3, and A3.4 (see working 4, W4), the real interest rate in the long-run is given as:

$$\dot{R} = \frac{(r + \delta)(1 + \phi R) - \rho(1 - \tau)g^{1-\rho}}{\phi + \phi_R R} \qquad \text{(A9.2)}$$

For convenience, the growth rates of public debt and real money balance are presented in equation A9.3 and A.9.4 respectively:

$$\frac{\dot{b}}{b} = \frac{dg^{1-\rho}}{b} - (g^{1-\rho} - c - g - \delta) \qquad \text{(See working 5, W5)} \qquad \text{(A9.3)}$$

$$\frac{\dot{m}}{m} = \frac{\dot{M}}{M} - \frac{\dot{K}}{K} = \omega + r - R - (g^{1-\rho} - c - g - \delta) \qquad \text{(See working 6, W6)} \qquad \text{(A9.4)}$$

$$m = \frac{\phi Y}{K} = \phi g^{1-\rho} \qquad \text{(See working 7, W7)} \qquad \text{(A9.5)}$$

From Eqn. 6

$$g - v - (d + \gamma) g^{1-\rho} = \eta \omega m - rb \qquad \text{(See working 8, W8)} \qquad \text{(A9.6)}$$

(C) Workings

From A3.1, Eqn. 4 and def. 8:

$C^{-\sigma} = \lambda_1 (1 + \phi R)$ where $\phi = \phi(R)$

$$\Rightarrow \lambda_1 = C^{-\sigma}(1 + \phi R)^{-1}$$

$$\therefore \dot{\lambda}_1 = -\sigma C^{-\sigma-1}(1 + \phi R)^{-1}\dot{C} + (-1)C^{-\sigma}(\phi + \phi_R R)\dot{R}(1 + \phi R)^{-2}$$

$$\dot{\lambda}_1 = C^{-\sigma}(1 + \phi R)^{-1}\left[-\sigma C^{-1}\dot{C} - (\phi + \phi_R R)\dot{R}(1 + \phi R)^{-1}\right]$$

$$\therefore \frac{\dot{\lambda}_1}{\lambda_1} = \frac{C^{-\sigma}(1 + \phi R)^{-1}}{C^{-\sigma}(1 + \phi R)^{-1}}\left[-\sigma C^{-1}\dot{C} - (\dot{R}(\phi + \phi_R R))(1 + \phi R)^{-1}\right]$$

$$\frac{\dot{\lambda}_1}{\lambda_1} = \frac{-\sigma \dot{C}}{C} - \frac{(\phi_R R + \phi)\dot{R}}{(1 + \phi R)}$$

$$-\sigma \frac{\dot{C}}{C} = \frac{\dot{\lambda}_1}{\lambda_1} + \frac{(\phi_R R + \phi)\dot{R}}{(1 + \phi R)}$$

The equation below yields Eqn. A4 in B

$$\therefore \frac{\dot{C}}{C} = -\left[\frac{\dot{\lambda}_1}{\lambda_1} + \frac{(\phi_R R + \phi)\dot{R}}{(1 + \phi R)}\right]\frac{1}{\sigma}$$

From Eqn. 1 and def. 9

$$\text{Y=K}^{\rho} G^{1-\rho} = C + (\dot{K} + \delta K) + G + V$$

$$\dot{K} = K^{\rho} G^{1-\rho} - C - G - \delta K - V$$

The equation below yields Eqn. A5 in B

$$\frac{\dot{K}}{K} = \left(\frac{G}{K}\right)^{1-\rho} - \frac{C}{K} - \frac{G}{K} - \frac{V}{K} - \delta$$

From def. 5 and def. 12

$$\overline{M} = \dot{M} + \pi M$$

$$\frac{\overline{M}}{M} = \frac{\dot{M}}{M} + \pi$$

$$\frac{\dot{M}}{M} = \frac{\overline{M}}{M} - \pi \text{, where } \frac{M}{M} = \omega$$

The equation below yields Eqn. A6 in B

$$\frac{\dot{M}}{M} = \omega - \pi = \omega + r - R \qquad \text{where } \pi = R - r$$

From A3.3, A3.4, and A5.2

$$\frac{\lambda_2}{\lambda_1} = \phi R + 1$$

$$\therefore \lambda_1 = (\phi R + 1)^{-1} \lambda_2$$

$$\dot{\lambda_1} = (\lambda_{1R} . \dot{R}) \lambda_2 + (\lambda_{1\lambda 2} . \dot{\lambda_2}) R$$

$$\therefore \dot{\lambda_1} = -\lambda_2 (\phi + \phi_R R) \dot{R} (1 + \phi R)^{-2} + \dot{\lambda_2} (\phi R + 1)^{-1}$$

$$\dot{\lambda_1} = (\phi R + 1)^{-1} \lambda_2 \left[\frac{\dot{\lambda_2}}{\lambda_2} - \frac{(\phi + \phi_R R) \dot{R}}{(1 + \phi R)} \right] = \beta - r$$

$$\beta - r = \beta + \delta - \frac{\rho(1-\tau) g^{1-\rho}}{1 + \phi R} - \frac{(\phi + \phi_R R) \dot{R}}{(1 + \phi R)}$$

$$= \frac{r + \delta + \rho(1-\tau) g^{1-\rho}}{(1 + \phi R)} = \frac{(\phi + \phi_R R)}{(1 + \phi R)}$$

The equation below yields Eqn. A9.2 in B

$$\dot{R} = \frac{(r + \delta)(1 + \phi R) - \rho(1-\tau) g^{1-\rho}}{\phi + \phi_R}$$

(5) $\frac{\dot{B}}{Y} = d$

$$\dot{B} = dY$$

$$\frac{\dot{B}}{b\dot{K}} = \frac{dY}{bK} - (g^{1-\rho} - c - g - \delta)$$

The equation below yields Eqn. A9.3 in B

$$\frac{\dot{b}}{b} = \frac{dg^{1-\rho}}{b} - (g^{1-\rho} - c - g - \delta)$$

(6) $\frac{\dot{M}}{M} = \omega - \pi$

$$\pi = -(r - R)$$

$$R = \omega + r - \frac{\dot{M}}{M}$$

The equation below yields Eqn. A9.4 in B

$$\frac{\dot{m}}{m} = \omega + r - R - (g^{1-\rho} - c - g - \delta)$$

(7) $M = \phi Y$

$$m = \frac{M}{K} = \frac{\phi Y}{K}, \quad \frac{Y}{K} = g^{1-\rho}$$

The equation below yields Eqn. A9.5 in B

$$m = \phi g^{1-\rho}$$

(8) $G + (-\varphi V - \dot{B} - \tau Y) = \eta \omega M - rB$

Divide both sides by k:

$$\frac{G}{K} - \varphi \frac{V}{K} - \frac{\dot{B}}{K} - \frac{\tau Y}{K} = \eta \omega \frac{M}{K} - r \frac{B}{K}$$

$$g - \varphi v_k - \frac{(\dot{B} + \tau Y)}{K} = \eta \omega m - rb$$

$$g - \varphi v_k - \left(\frac{\dot{B}}{K} + \frac{\tau Y}{K} \right) = \eta \omega m - rb$$

$$\frac{\dot{B}}{K} = \frac{\dot{B}}{Y} . \frac{Y}{K} = dg^{1-\rho}$$

The equation below yields Eqn. A9.6 in B

$$g - \varphi v_k - (d + \tau) g^{1-\rho} = \eta w m - rb$$

(9) Setting $\dot{c} = \dot{m} = \dot{b} = \dot{R} = 0$, where C, K, B, G, M, and V grow at constant rate of γ^* such that, $\gamma^* = g^{*1-\rho} - c^* - g^* - \delta$, then Eqn. 8.1 becomes

$$0 = -\frac{1}{\sigma}\left(\beta - r + \frac{(\phi_R R + \phi)\dot{R}}{(1+\phi R)}\right) - \gamma^* \text{ since } \dot{R} = 0$$

$$0 = \frac{1}{\sigma}(r - \beta - 0) - \gamma^*$$

$$\gamma^* = \frac{1}{\sigma}(r - \beta)$$

From A9.2

$$0 = (1+\phi R)(r+\delta) - \rho(1+\tau)g^{1-\rho}$$

$$r + \delta = \frac{\rho(1-\tau)g^{1-\rho}}{1+\phi R}$$

$$r = \frac{\rho(1-\tau)g^{1-\rho}}{1+\phi R} - \delta$$

Substituting for r in $\gamma^* = \frac{1}{\sigma}(r-\beta)$ yields $\gamma^* = \frac{1}{\sigma}\left(\frac{\rho(1-\tau)g^{1-\rho}}{1+\phi R} - \delta - \beta\right)$

(10) From A9.3. A9.5 and A9.6

$$\frac{g - \varphi v_k}{g^{1-\rho}} - \frac{(d+\tau)g^{1-\rho}}{g^{1-\rho}} = \frac{\eta\omega m - rb}{g^{1-\rho}}$$

Recall that $\mathrm{v}_k = \frac{V}{K}$

$$g^{\rho} - \frac{\varphi V}{Y} - (d+\tau) = \eta\omega\phi - \frac{rb}{g^{1-\rho}}$$

$$g^{\rho} = \eta\omega\phi + \tau + \varphi \mathrm{v} - \frac{rb}{g^{1-\rho}} + d \;;\; \mathrm{v} = \frac{V}{Y};\; g^{1-\rho} = \frac{Y}{K}$$

Recall from A9.3 that

$$\frac{dg^{1-\rho}}{b} - \gamma = 0$$

$$\gamma = \frac{dg^{1-\rho}}{b}$$

$$\gamma = d\theta^{-1} \quad \text{where} \quad \theta = \frac{b}{g^{1-\rho}}$$

$$d = \theta\gamma$$

$$g^{\rho} = \eta\omega\phi + \tau + \nu + \theta(\gamma - r)$$

$\gamma^* - r^* = s^*$ and $\gamma - r = s$

$$g = \left[\eta\omega\phi + \tau + v + \theta s^*\right]^{\frac{1}{\rho}}$$

$$\boldsymbol{d} = \gamma\boldsymbol{\Theta}$$

$$from\ \gamma^* = \frac{1}{\sigma}(r - \beta)$$

$$r = \gamma\sigma + \beta$$

$$\gamma - r = -(\sigma\gamma + \beta - \gamma)$$

$$\gamma - r = (1-\sigma)\gamma - \beta$$

But $\gamma - r = \beta - (1-\sigma)\gamma$

(11) To determine the optimal tax (τ) that maximises growth rate (γ) at steady state, equation (10) is them maximised subject to tax,

$$\gamma = \frac{1}{\sigma}\left\{\frac{\rho(1-\tau)\left[\tau + \eta\omega\phi + v + \theta s\right]^{\frac{1-\rho}{\rho}}}{(1+\phi R)} - \delta - \beta\right\}$$

$$\eta = \gamma - \frac{1}{\sigma}\{...\} = 0$$

$$\sigma\gamma - \{...\} = 0$$

$$\sigma\gamma(1+\phi R) - \left\{\rho(1-\tau)\left[\tau + \eta\omega\phi + v + \theta s\right]^{\frac{1-\rho}{\rho}} - (\delta+\beta)(1+\phi R)\right\} = 0$$

$$\sigma\gamma(1+\phi R) + (\delta+\beta)(1+\phi R) - \rho(1-\tau)\left[...\right]^{\frac{1-\rho}{\rho}} = 0 \qquad \text{(a)}$$

From (a), $\frac{\partial\gamma}{\partial\tau} = \frac{\partial\eta}{\partial\tau}.\frac{\partial\gamma}{\partial\eta} = 0$

$$\frac{\partial\eta}{\partial\tau} = \rho\left[\tau + \eta\omega\phi + v + \theta s\right]^{\frac{1-\rho}{\rho}} + \frac{(1-\rho)\rho}{\rho}(1-\tau)\left[...\right]^{\frac{1-2\rho}{\rho}}$$

$$-\frac{\partial\eta}{\partial\tau} = -\left[...\right]^{\frac{1-\rho}{\rho}}\left[\rho - \frac{(1-\rho)(1-\tau)}{\left[...\right]}\right] \qquad \text{(b)}$$

$$\frac{\partial\eta}{\partial\gamma} = \sigma(1+\phi R) - (1-\tau)\rho\frac{(1-\rho)}{\rho}(\theta s)\left[...\right]^{\frac{1-2\rho}{\rho}}$$

$$= \sigma(1+\phi R) - (1-\sigma)\theta(1-\tau)(1-\rho)\left[...\right]^{\frac{1-2\rho}{\rho}} \qquad \text{(c)}$$

Recall that $s = \gamma - r = \beta - (1-\sigma)\gamma$ and its derivative is $s' = 1 - \sigma$

$$\frac{\partial \gamma}{\partial \tau} = 0 \Rightarrow \frac{-[...]^{\frac{1-\rho}{\rho}}\left[\rho - \frac{(1-\rho)(1-\tau)}{[...]}\right]}{[\sigma(1+\phi R) + s'\theta(1-\tau)(1-\rho)[...]^{\frac{1-2\rho}{\rho}}} = 0$$

$$\therefore -[...]^{\frac{1-\rho}{\rho}}\left[\rho - \frac{(1-\rho)(1-\tau)}{[...]}\right] = 0$$

$$\rho - \frac{(1-\rho)(1-\tau)}{[...]} = 0$$

$$(1-\rho)(1-\tau) = \rho(...)$$

$$1-\tau = \frac{\rho(...)}{(1-\rho)}$$

$$\tau = 1 - \frac{\rho(...)}{(1-\rho)}$$

$$\tau = 1 - \frac{\rho(\rho + \eta\omega\phi + v + \theta s)}{(1-\rho)}$$

The equation below yields Eqn. 11

$$\hat{\tau} = (1-\rho) - \rho(\eta\omega\phi + v + \theta s)$$

(12) To determine the optimal resource rents (v) that maximise growth rate (γ) at steady state, equation (10) is them maximised subject to resource rents,

$$\frac{\partial \gamma}{\partial v} = \rho(1-\rho)(1-\tau)(1)[...] = 0$$

$$\tau + \eta\omega\phi + v + \theta s = 0$$

The equation below yields Eqn. 13 in our theoretical framework

$$\hat{v} = -\theta s - \tau - \eta\omega\phi$$

(13) To determine the optimal seigniorage (ω) that maximises growth rate (γ) at steady state, equation (10) is them maximised subject to seigniorage:

We suppress $\eta(\gamma, \omega)$ to conveniently differentiate a function $\omega\eta$,

$$\omega\eta = [\tau + \eta\omega\phi + v + \theta s]^{\frac{1-\rho}{\rho}}(1+\phi R)^{-1}$$

$$\frac{\partial \omega\eta}{\partial \omega} = \eta(\phi + \omega\phi_R)[...]^{\frac{1-\rho}{\rho}}(1+\phi R)^{-1} - [...]^{\frac{1-\rho}{\rho}}(1+\phi R)^{-2}(\phi + \phi_R R) = 0$$

$$\left[\frac{1-\rho}{\rho}(\eta\phi + \omega\phi R)[...]^{-1} - \left(\frac{\phi + \phi_R R}{1+\phi R}\right)\right] = 0$$

$$(\eta\phi+\omega\phi R)\left[...\right]^{-1}=\frac{(\phi+\phi_R R)}{(1+\phi R)}\frac{\rho}{1-\rho}$$

$$\eta\phi\left(1+\frac{\omega\phi_R}{\phi}\right)\left[...\right]^{-1}=\frac{(\phi+\phi_R R)}{(1+\phi R)}\frac{\rho}{1-\rho}$$

$$\left(1+\omega\frac{\phi_R}{\phi}\right)[...]^{-1}=\frac{1}{\eta\phi}\left[\frac{(\phi+\phi_R R)}{(1+\phi R)}\frac{\rho}{1-\rho}\right]$$

$$\frac{1}{\eta\phi}\left[\frac{(\phi+\phi_R R)}{(1+\phi R)}\frac{\rho}{1-\rho}\right]=\alpha(R)$$

$1+\frac{\omega\phi_R}{\phi}=\alpha(R)\left[...\right]$, suppressing $\alpha(R)$ to α,

$1+\frac{\omega\phi_R}{\phi}=\alpha\left[\eta\phi\omega+\theta s+\nu+\tau\right]$ where $s=R-\omega$

$$1+\frac{\omega\phi_R}{\phi}=\alpha\left[\eta\phi\omega+\theta(R-\omega)+\nu+\tau\right]$$

$$1+\frac{\omega\phi_R}{\phi}=\alpha\eta\phi\omega-\alpha\theta\omega+\alpha\left[\tau+\nu+R\phi\right]$$

$$\omega\frac{\phi_R}{\phi}-\alpha\eta\phi\omega+\alpha\theta\omega=\alpha(\tau+\nu+R\phi)-1$$

$$\omega\left[\frac{\phi_R}{\phi}-\alpha(\eta\phi-\theta)\right]=\alpha(\tau+\nu+R\phi)-1$$

The equation below yields Eqn. 12 in our theoretical framework

$$\hat{\omega}=\frac{\alpha(\tau+\nu+R\phi)-1}{\frac{\phi_R}{\phi}-\alpha(\eta\phi-\theta)}$$

(14) To determine the optimal debt (θ) that maximises growth rate (γ) at steady state, equation (10) is them maximised subject to tax,

$$\eta=\sigma\gamma(1+\phi R)+(\delta+\beta)(1+\phi R)-\rho(1-\tau)\left[\tau+\eta\omega\phi+\nu+\theta s\right]^{\frac{1-\rho}{\rho}}=0$$

Note that $\frac{\partial\eta}{\partial\gamma}=\frac{\partial\eta}{\partial\theta}.\frac{\partial\gamma}{\partial\eta}=0$

$$\frac{\partial\eta}{\partial\gamma}=\sigma(1+\phi R)+(1-\sigma)(1-\tau)(1-\rho)\left[...\right]^{\frac{1-2\rho}{\rho}}$$

$$\frac{\partial\eta}{\partial\theta}=\frac{1}{\sigma}-\left[...\right]^{\frac{1-2\rho}{\rho}}\left[\frac{\rho(1-\rho)(1-\tau)s}{\rho\left(1+\phi R\right)}\right]$$

$$\frac{\partial \gamma}{\partial \theta} = -\frac{\partial \eta}{\partial \theta} . \frac{\partial \gamma}{\partial \eta}$$

$$-\frac{1}{\sigma}[...]\frac{1}{\sigma(1+\phi R)}... = 0$$

$$-\frac{1}{\sigma}[...] = 0$$

$$[...] = 0$$

$$\frac{(1-\rho)(1-\tau)s[...]^{\frac{1-2\rho}{\rho}}}{(1+\phi R)} = 0$$

$$\therefore [...]^{\frac{1-2\rho}{\rho}} = 0$$

$$[...] = 0$$

$$[\tau + \eta\omega\phi + v + \theta s] = 0$$

$$\hat{\theta} = -\frac{(\tau + \eta\omega\phi + v)}{s}$$

APPENDIX III

Numerical Simulation Results for Augmented Endogenous Growth Model

Table C: Simulation of Public Debt effect on Tax-Economic Growth nexus for South Africa

	Barro: $\theta = 0;\ \omega = 0;\ v = 0$	Ehrhart: $\theta \neq 0;\ \omega \neq 0; v = 0$			Augmented: $\theta \neq 0;\ \omega \neq 0; v \neq 0$		
τ	γ_1	γ_1	γ_2	γ_3	γ_1	γ_2	γ_3
		$\theta = 0.3$	$\theta = 0.6$	$\theta = 0.75$	$\theta = 0.3$	$\theta = 0.6$	$\theta = 0.75$
0.05	-0.0068	-0.0160	-0.0224	-0.0248	0.0245	0.0126	0.0079
0.1	0.0272	0.0141	0.0042	0.0001	0.0479	0.0342	0.0285
0.15	0.0514	0.0368	0.0251	0.0202	0.0661	0.0516	0.0454
0.2	0.0691	0.0542	0.0417	0.0364	0.0800	0.0653	0.0590
0.25	0.0816	0.0672	0.0546	0.0492	0.0901	0.0758	0.0696
0.3	0.0899	0.0763	0.0642	0.0588	0.0968	0.0833	0.0773
0.35	0.0945	0.0821	0.0707	0.0656	0.1003	0.0878	0.0822
0.4	0.0957	0.0847	0.0742	0.0695	0.1009	0.0896	0.0845
0.45	0.0938	0.0843	0.0750	0.0708	0.0987	0.0888	0.0842
0.5	0.0892	0.0811	0.0731	0.0694	0.0938	0.0853	0.0813
0.55	0.0819	0.0754	0.0686	0.0655	0.0864	0.0793	0.0760
0.6	0.0722	0.0671	0.0616	0.0591	0.0767	0.0709	0.0682
0.65	0.0603	0.0565	0.0522	0.0502	0.0646	0.0601	0.0580
0.7	0.0463	0.0436	0.0405	0.0390	0.0504	0.0471	0.0455
0.75	0.0303	0.0286	0.0264	0.0254	0.0340	0.0318	0.0307
0.8	0.0125	0.0115	0.0102	0.0096	0.0158	0.0144	0.0138
0.85	-0.0071	-0.0075	-0.0081	-0.0084	-0.0043	-0.0050	-0.0054
0.9	-0.0282	-0.0283	-0.0285	-0.0286	-0.0262	-0.0265	-0.0266
0.95	-0.0508	-0.0508	-0.0508	-0.0508	-0.0498	-0.0498	-0.0498
1	-0.0748	-0.0750	-0.0750	-0.0750	-0.0750	-0.0750	-0.0750

Source: Author's computation

Table D: Simulation of Public Debt effect on Tax-Economic Growth nexus for Nigeria

	Barro: $\theta = 0;\ \omega = 0;\ v = 0$	Ehrhart: $\theta \neq 0;\ \omega \neq 0; v = 0$			Augmented: $\theta \neq 0;\ \omega \neq 0; v \neq 0$		
τ	γ_1	γ_1	γ_2	γ_3	γ_1	γ_2	γ_3
		$\theta = 0.3$	$\theta = 0.6$	$\theta = 0.75$	$\theta = 0.3$	$\theta = 0.6$	$\theta = 0.75$
0.05	-0.0068	-0.0159	-0.0223	-0.0248	-0.0150	-0.0216	-0.0241
0.1	0.0272	0.0143	0.0043	0.0002	0.0150	0.0049	0.0008
0.15	0.0514	0.0370	0.0252	0.0203	0.0377	0.0258	0.0209
0.2	0.0691	0.0544	0.0419	0.0365	0.0550	0.0424	0.0370
0.25	0.0816	0.0674	0.0548	0.0493	0.0679	0.0553	0.0498
0.3	0.0899	0.0766	0.0644	0.0590	0.0771	0.0648	0.0594
0.35	0.0945	0.0824	0.0709	0.0658	0.0828	0.0713	0.0661
0.4	0.0957	0.0850	0.0745	0.0698	0.0853	0.0748	0.0701
0.45	0.0938	0.0846	0.0753	0.0710	0.0849	0.0756	0.0713
0.5	0.0892	0.0814	0.0734	0.0697	0.0817	0.0736	0.0699
0.55	0.0819	0.0757	0.0689	0.0657	0.0759	0.0691	0.0660
0.6	0.0722	0.0674	0.0619	0.0593	0.0676	0.0621	0.0595
0.65	0.0603	0.0567	0.0525	0.0504	0.0569	0.0526	0.0506
0.7	0.0463	0.0438	0.0407	0.0392	0.0439	0.0408	0.0393
0.75	0.0303	0.0288	0.0266	0.0256	0.0289	0.0267	0.0257
0.8	0.0125	0.0117	0.0104	0.0097	0.0118	0.0104	0.0098
0.85	-0.0071	-0.0073	-0.0080	-0.0083	-0.0073	-0.0079	-0.0083
0.9	-0.0282	-0.0282	-0.0284	-0.0285	-0.0281	-0.0284	-0.0285
0.95	-0.0508	-0.0508	-0.0508	-0.0508	-0.0507	-0.0507	-0.0507
1	-0.0748	-0.0750	-0.0750	-0.0750	-0.0750	-0.0750	-0.0750

Source: Author's computation

Table E: Simulation of Public Debt effect on Tax-Economic Growth nexus for Republic of Congo

	Barro: $\theta = 0;\ \omega = 0;\ v = 0$	Ehrhart: $\theta \neq 0;\ \omega \neq 0; v = 0$			Augmented: $\theta \neq 0;\ \omega \neq 0; v \neq 0$		
τ	γ_1	γ_1	γ_2	γ_3	γ_1	γ_2	γ_3
		$\theta = 0.3$	$\theta = 0.6$	$\theta = 0.75$	$\theta = 0.3$	$\theta = 0.6$	$\theta = 0.75$
0.05	-0.0068	-0.0162	-0.0225	-0.0249	-0.0155	-0.0219	-0.0244
0.1	0.0272	0.0138	0.0039	-0.0001	0.0144	0.0044	0.0004
0.15	0.0514	0.0364	0.0247	0.0199	0.0369	0.0252	0.0203
0.2	0.0691	0.0536	0.0413	0.0360	0.0541	0.0417	0.0364
0.25	0.0816	0.0665	0.0541	0.0487	0.0669	0.0545	0.0491
0.3	0.0899	0.0757	0.0636	0.0583	0.0760	0.0640	0.0586
0.35	0.0945	0.0814	0.0701	0.0650	0.0817	0.0704	0.0653
0.4	0.0957	0.0839	0.0736	0.0690	0.0842	0.0739	0.0692
0.45	0.0938	0.0836	0.0744	0.0702	0.0838	0.0746	0.0704
0.5	0.0892	0.0804	0.0725	0.0688	0.0806	0.0727	0.0690
0.55	0.0819	0.0747	0.0680	0.0649	0.0749	0.0682	0.0651
0.6	0.0722	0.0665	0.0611	0.0585	0.0666	0.0612	0.0587
0.65	0.0603	0.0559	0.0517	0.0497	0.0560	0.0518	0.0498
0.7	0.0463	0.0431	0.0400	0.0385	0.0432	0.0401	0.0386
0.75	0.0303	0.0281	0.0260	0.0250	0.0282	0.0261	0.0251
0.8	0.0125	0.0112	0.0099	0.0093	0.0112	0.0100	0.0093
0.85	-0.0071	-0.0077	-0.0084	-0.0087	-0.0077	-0.0083	-0.0086
0.9	-0.0282	-0.0284	-0.0286	-0.0287	-0.0284	-0.0286	-0.0287
0.95	-0.0508	-0.0508	-0.0508	-0.0508	-0.0508	-0.0508	-0.0508
1	-0.0748	-0.0749	-0.0749	-0.0749	-0.0749	-0.0749	-0.0749

Source: Author's computation

Table F: Simulation of Seigniorage effect on Tax-Economic Growth nexus for South Africa

	Barro: $\theta = 0;\ \omega = 0;\ v = 0$	Ehrhart: $\theta \neq 0;\ \omega \neq 0; v = 0$			Augmented: $\theta \neq 0;\ \omega \neq 0; v \neq 0$		
	γ_1	γ_1	γ_2	γ_3	γ_1	γ_2	γ_3
τ		$\omega = 0$	$\omega = 0.05$	$\omega = 0.1$	$\omega = 0$	$\omega = 0.05$	$\omega = 0.1$
0.05	-0.0068	-0.0062	-0.0039	0.0004	0.0411	0.0448	0.0505
0.1	0.0272	0.0280	0.0313	0.0365	0.0661	0.0705	0.0769
0.15	0.0514	0.0523	0.0562	0.0621	0.0846	0.0895	0.0965
0.2	0.0691	0.0699	0.0744	0.0808	0.0980	0.1034	0.1107
0.25	0.0816	0.0825	0.0872	0.0940	0.1072	0.1128	0.1204
0.3	0.0899	0.0907	0.0957	0.1027	0.1126	0.1182	0.1260
0.35	0.0945	0.0952	0.1003	0.1073	0.1145	0.1202	0.1279
0.4	0.0957	0.0963	0.1014	0.1084	0.1134	0.1190	0.1266
0.45	0.0938	0.0944	0.0994	0.1062	0.1094	0.1149	0.1223
0.5	0.0892	0.0896	0.0944	0.1011	0.1028	0.1080	0.1151
0.55	0.0819	0.0823	0.0868	0.0932	0.0937	0.0986	0.1053
0.6	0.0722	0.0725	0.0767	0.0827	0.0823	0.0868	0.0931
0.65	0.0603	0.0605	0.0643	0.0699	0.0688	0.0729	0.0787
0.7	0.0463	0.0464	0.0498	0.0549	0.0533	0.0569	0.0622
0.75	0.0303	0.0304	0.0333	0.0378	0.0360	0.0390	0.0437
0.8	0.0125	0.0125	0.0149	0.0188	0.0168	0.0193	0.0234
0.85	-0.0071	-0.0070	-0.0052	-0.0019	-0.0039	-0.0020	0.0014
0.9	-0.0282	-0.0282	-0.0270	-0.0243	-0.0262	-0.0249	-0.0222
0.95	-0.0508	-0.0508	-0.0502	-0.0482	-0.0498	-0.0492	-0.0472
1	-0.0748	-0.0748	-0.0748	-0.0735	-0.0748	-0.0748	-0.0735

Source: Author's computation

Table G: Simulation of Seigniorage effect on Tax-Economic Growth nexus for Nigeria

	Barro: $\theta = 0;\ \omega = 0;\ v = 0$	Ehrhart: $\theta \neq 0;\ \omega \neq 0; v = 0$			Augmented: $\theta \neq 0;\ \omega \neq 0; v \neq 0$		
	γ_1	γ_1	γ_2	γ_3	γ_1	γ_2	γ_3
τ		$\omega = 0$	$\omega = 0.05$	$\omega = 0.1$	$\omega = 0$	$\omega = 0.05$	$\omega = 0.1$
0.05	-0.0068	-0.0067	-0.0044	-0.0002	-0.0056	-0.0033	0.0009
0.1	0.0272	0.0273	0.0305	0.0357	0.0282	0.0314	0.0366
0.15	0.0514	0.0515	0.0554	0.0612	0.0522	0.0561	0.0620
0.2	0.0691	0.0692	0.0736	0.0799	0.0698	0.0742	0.0805
0.25	0.0816	0.0817	0.0865	0.0932	0.0822	0.0870	0.0937
0.3	0.0899	0.0900	0.0950	0.1019	0.0905	0.0954	0.1023
0.35	0.0945	0.0946	0.0996	0.1066	0.0950	0.1000	0.1070
0.4	0.0957	0.0958	0.1008	0.1078	0.0961	0.1012	0.1081
0.45	0.0938	0.0939	0.0988	0.1057	0.0942	0.0992	0.1060
0.5	0.0892	0.0892	0.0940	0.1006	0.0895	0.0943	0.1009
0.55	0.0819	0.0820	0.0865	0.0928	0.0822	0.0867	0.0930
0.6	0.0722	0.0723	0.0765	0.0824	0.0725	0.0767	0.0826
0.65	0.0603	0.0603	0.0641	0.0696	0.0605	0.0643	0.0698
0.7	0.0463	0.0463	0.0497	0.0547	0.0464	0.0498	0.0548
0.75	0.0303	0.0303	0.0332	0.0377	0.0304	0.0333	0.0378
0.8	0.0125	0.0125	0.0148	0.0187	0.0126	0.0149	0.0188
0.85	-0.0071	-0.0071	-0.0052	-0.0020	-0.0070	-0.0052	-0.0019
0.9	-0.0282	-0.0282	-0.0270	-0.0243	-0.0281	-0.0269	-0.0243
0.95	-0.0508	-0.0508	-0.0502	-0.0482	-0.0508	-0.0502	-0.0482
1	-0.0748	-0.0748	-0.0748	-0.0735	-0.0748	-0.0748	-0.0735

Source: Author's computation

Table H: Simulation of Seigniorage effect on Tax-Economic Growth nexus for the Republic of Congo

	Barro: $\theta = 0;\ \omega = 0;\ v = 0$	Ehrhart: $\theta \neq 0;\ \omega \neq 0; v = 0$			Augmented: $\theta \neq 0;\ \omega \neq 0; v \neq 0$		
τ	γ_1	γ_1	γ_2	γ_3	γ_1	γ_2	γ_3
		$\omega = 0$	$\omega = 0.05$	$\omega = 0.1$	$\omega = 0$	$\omega = 0.05$	$\omega = 0.1$
0.05	-0.0068	-0.0067	-0.0045	-0.0003	-0.0058	-0.0036	0.0007
0.1	0.0272	0.0273	0.0305	0.0356	0.0280	0.0312	0.0363
0.15	0.0514	0.0515	0.0553	0.0612	0.0520	0.0559	0.0618
0.2	0.0691	0.0691	0.0735	0.0798	0.0696	0.0740	0.0803
0.25	0.0816	0.0817	0.0864	0.0931	0.0821	0.0868	0.0935
0.3	0.0899	0.0900	0.0949	0.1018	0.0903	0.0953	0.1022
0.35	0.0945	0.0945	0.0996	0.1065	0.0949	0.0999	0.1069
0.4	0.0957	0.0957	0.1008	0.1077	0.0960	0.1011	0.1080
0.45	0.0938	0.0939	0.0988	0.1056	0.0941	0.0991	0.1059
0.5	0.0892	0.0892	0.0940	0.1006	0.0894	0.0942	0.1008
0.55	0.0819	0.0819	0.0864	0.0927	0.0821	0.0866	0.0930
0.6	0.0722	0.0722	0.0764	0.0824	0.0724	0.0766	0.0825
0.65	0.0603	0.0603	0.0641	0.0696	0.0605	0.0643	0.0698
0.7	0.0463	0.0463	0.0497	0.0547	0.0464	0.0498	0.0548
0.75	0.0303	0.0303	0.0332	0.0377	0.0304	0.0333	0.0378
0.8	0.0125	0.0125	0.0148	0.0187	0.0126	0.0149	0.0188
0.85	-0.0071	-0.0071	-0.0052	-0.0020	-0.0070	-0.0052	-0.0019
0.9	-0.0282	-0.0282	-0.0270	-0.0243	-0.0282	-0.0269	-0.0243
0.95	-0.0508	-0.0508	-0.0502	-0.0482	-0.0508	-0.0502	-0.0482
1	-0.0748	-0.0748	-0.0748	-0.0735	-0.0748	-0.0748	-0.0735

Source: Author's computation

Table I: Simulation of Total Natural Resource Rents effect on Tax-Economic Growth nexus

	South Africa			Nigeria			Republic of Congo		
	γ_1	γ_2	γ_3	γ_1	γ_2	γ_3	γ_1	γ_2	γ_3
τ	$v=0$	$v=0.1$	$v=0.2$	$v=0$	$v=0.1$	$v=0.2$	$v=0$	$v=0.1$	$v=0.2$
0.05	-0.0313	0.0397	0.0945	-0.0321	0.0386	0.0932	-0.0322	0.0385	0.0931
0.1	0.0018	0.0594	0.1073	0.0009	0.0583	0.1061	0.0008	0.0582	0.1059
0.15	0.0249	0.0739	0.1162	0.0240	0.0728	0.1151	0.0239	0.0728	0.1150
0.2	0.0415	0.0841	0.1218	0.0407	0.0831	0.1208	0.0406	0.0830	0.1207
0.25	0.0533	0.0906	0.1244	0.0525	0.0898	0.1234	0.0524	0.0897	0.1234
0.3	0.0609	0.0939	0.1242	0.0602	0.0932	0.1233	0.0601	0.0931	0.1232
0.35	0.0651	0.0943	0.1214	0.0644	0.0936	0.1206	0.0644	0.0936	0.1205
0.4	0.0661	0.0920	0.1161	0.0655	0.0914	0.1155	0.0655	0.0913	0.1154
0.45	0.0643	0.0872	0.1086	0.0638	0.0866	0.1080	0.0638	0.0866	0.1080
0.5	0.0599	0.0800	0.0989	0.0595	0.0795	0.0985	0.0594	0.0795	0.0984
0.55	0.0530	0.0706	0.0872	0.0527	0.0702	0.0868	0.0526	0.0702	0.0867
0.6	0.0439	0.0590	0.0734	0.0436	0.0587	0.0731	0.0436	0.0587	0.0731
0.65	0.0326	0.0455	0.0578	0.0324	0.0453	0.0576	0.0323	0.0452	0.0575
0.7	0.0192	0.0300	0.0403	0.0190	0.0298	0.0402	0.0190	0.0298	0.0401
0.75	0.0039	0.0127	0.0211	0.0037	0.0125	0.0210	0.0037	0.0125	0.0209
0.8	-0.0134	-0.0065	0.0001	-0.0135	-0.0066	0.0000	-0.0135	-0.0066	0.0000
0.85	-0.0325	-0.0274	-0.0225	-0.0325	-0.0274	-0.0226	-0.0325	-0.0274	-0.0226
0.9	-0.0533	-0.0500	-0.0468	-0.0533	-0.0500	-0.0468	-0.0533	-0.0500	-0.0468
0.95	-0.0758	-0.0742	-0.0726	-0.0758	-0.0742	-0.0726	-0.0758	-0.0742	-0.0726
1	-0.1000	-0.1000	-0.1000	-0.1000	-0.1000	-0.1000	-0.1000	-0.1000	-0.1000

Source: Author's computation

APPENDIX IV

Parameter Estimation

South Africa

Dependent Variable: LGDPPC
Method: Least Squares
Date: 10/01/21 Time: 20:58
Sample: 1990 2016
Included observations: 27

Variable	Coefficient	Std. Error	t-Statistic	Prob.
FDI	-0.029791	0.040081	-0.743278	0.4655
INV	0.137886	0.025470	5.413650	0.0000
POPG	-0.243432	0.131097	-1.856890	0.0774
PD	0.016084	0.008832	1.820997	0.0829
C	5.632878	0.790210	7.128334	0.0000
TTAX	0.000652	0.000313	2.084304	0.0495

R-squared	0.649767	Mean dependent var	8.379003
Adjusted R-squared	0.566378	S.D. dependent var	0.355113
S.E. of regression	0.233842	Akaike info criterion	0.124789
Sum squared resid	1.148325	Schwarz criterion	0.412752
Log likelihood	4.315352	Hannan-Quinn criter.	0.210415
F-statistic	7.792013	Durbin-Watson stat	0.673238
Prob(F-statistic)	0.000279		

Dependent Variable: LGDPPC
Method: Least Squares
Date: 04/17/21 Time: 15:13
Sample: 1990 2016
Included observations: 27

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GOVT	0.135471	0.042680	3.174139	0.0048
INF	-0.051695	0.016355	-3.160883	0.0049
INV	0.118340	0.015765	7.506337	0.0000
FDI	0.001310	0.026626	0.049192	0.9613
SEI	0.011251	0.004580	2.456347	0.0233
POPG	0.152491	0.136539	1.116831	0.2773
C	3.689028	0.803986	4.588423	0.0002

R-squared	0.860307	Mean dependent var	8.379003
Adjusted R-squared	0.818399	S.D. dependent var	0.355113
S.E. of regression	0.151330	Akaike info criterion	-0.720290
Sum squared resid	0.458017	Schwarz criterion	-0.384332
Log likelihood	16.72391	Hannan-Quinn criter.	-0.620392
F-statistic	20.52853	Durbin-Watson stat	1.201615
Prob(F-statistic)	0.000000		

Dependent Variable: LGDPPC
Method: Least Squares
Date: 04/17/21 Time: 15:10
Sample: 1990 2016
Included observations: 27

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GOVT	0.108539	0.036961	2.936611	0.0082
INF	-0.060032	0.014618	-4.106774	0.0005
INV	0.067780	0.021179	3.200370	0.0045
FDI	-0.029248	0.024831	-1.177903	0.2527
TNRR	0.063826	0.019981	3.194263	0.0046
POPG	0.163692	0.126901	1.289918	0.2118
C	4.905062	0.665213	7.373665	0.0000

R-squared	0.879592	Mean dependent var	8.379003
Adjusted R-squared	0.843470	S.D. dependent var	0.355113
S.E. of regression	0.140497	Akaike info criterion	-0.868852
Sum squared resid	0.394786	Schwarz criterion	-0.532894
Log likelihood	18.72950	Hannan-Quinn criter.	-0.768954
F-statistic	24.35037	Durbin-Watson stat	2.245944
Prob(F-statistic)	0.000000		

Nigeria

Dependent Variable: LGDPPC
Method: Least Squares
Date: 10/01/21 Time: 21:04
Sample: 1990 2016
Included observations: 27

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GOVT	-0.017595	0.016757	-1.050025	0.3056
INV	-0.020022	0.004030	-4.968388	0.0001
FDI	-0.037726	0.020573	-1.833734	0.0809
PD	-0.002402	0.000870	-2.759910	0.0117
POPG	6.993535	0.649362	10.76986	0.0000
C	-10.24225	1.637821	-6.253582	0.0000

R-squared	0.989971	Mean dependent var	6.897184
Adjusted R-squared	0.987584	S.D. dependent var	0.799111
S.E. of regression	0.089044	Akaike info criterion	-1.806242
Sum squared resid	0.166506	Schwarz criterion	-1.518278
Log likelihood	30.38427	Hannan-Quinn criter.	-1.720615
F-statistic	414.6014	Durbin-Watson stat	1.497997
Prob(F-statistic)	0.000000		

Dependent Variable: LGDPPC
Method: Least Squares
Date: 04/17/21 Time: 17:00
Sample: 1990 2016
Included observations: 27

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GOVT	-0.018488	0.014799	-1.249274	0.2267
INF	-0.002669	0.001145	-2.331191	0.0309
INV	-0.029400	0.002305	-12.75261	0.0000
FDI	-0.054597	0.014659	-3.724444	0.0014
SEI	0.015444	0.005399	2.860252	0.0100
POPG	6.655506	0.586161	11.35439	0.0000
C	-8.976981	1.496722	-5.997763	0.0000
TOP	-0.005222	0.001826	-2.859286	0.0100

R-squared	0.994103	Mean dependent var	6.897184
Adjusted R-squared	0.991931	S.D. dependent var	0.799111
S.E. of regression	0.071784	Akaike info criterion	-2.189108
Sum squared resid	0.097907	Schwarz criterion	-1.805156
Log likelihood	37.55295	Hannan-Quinn criter.	-2.074939
F-statistic	457.5750	Durbin-Watson stat	1.629928
Prob(F-statistic)	0.000000		

Dependent Variable: LGDPPC
Method: Least Squares
Date: 04/17/21 Time: 16:58
Sample: 1990 2016
Included observations: 27

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GOVT	-0.004091	0.016748	-0.244276	0.8096
INF	-0.004152	0.001275	-3.255758	0.0042
INV	-0.029021	0.004103	-7.073629	0.0000
FDI	-0.059827	0.021490	-2.783999	0.0118
TNRR	0.001185	0.003214	0.368704	0.7164
POPG	6.243777	0.677280	9.218906	0.0000
C	-8.005808	1.736183	-4.611154	0.0002
TOP	-0.004149	0.002228	-1.861941	0.0782

R-squared	0.991624	Mean dependent var	6.897184
Adjusted R-squared	0.988538	S.D. dependent var	0.799111
S.E. of regression	0.085553	Akaike info criterion	-1.838156
Sum squared resid	0.139068	Schwarz criterion	-1.454205
Log likelihood	32.81511	Hannan-Quinn criter.	-1.723987
F-statistic	321.3376	Durbin-Watson stat	1.995658
Prob(F-statistic)	0.000000		

Congo Republic

Dependent Variable: LGDPPC
Method: Least Squares
Date: 10/01/21 Time: 21:09
Sample: 1990 2016
Included observations: 27

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GOVT	0.001696	0.001508	1.124852	0.2754
INF	0.000813	0.001641	0.495064	0.6265
INV	-0.001908	0.000798	-2.391928	0.0279
FDI	0.001367	0.000533	2.566873	0.0194
PD	-0.000718	9.76E-05	-7.348700	0.0000
POPG	-0.109636	0.031781	-3.449731	0.0029
C	8.280349	0.118578	69.83037	0.0000
TOP	-0.000275	0.000247	-1.112586	0.2805
DOM	0.002379	0.001483	1.604498	0.1260

R-squared	0.925358	Mean dependent var	7.847720
Adjusted R-squared	0.892183	S.D. dependent var	0.073547
S.E. of regression	0.024149	Akaike info criterion	-4.347911
Sum squared resid	0.010498	Schwarz criterion	-3.915965
Log likelihood	67.69680	Hannan-Quinn criter.	-4.219471
F-statistic	27.89372	Durbin-Watson stat	2.514873
Prob(F-statistic)	0.000000		

Dependent Variable: LGDPPC
Method: Least Squares
Date: 04/17/21 Time: 17:59
Sample: 1990 2016
Included observations: 27

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GOVT	-0.003777	0.002399	-1.574572	0.1328
INF	-0.001400	0.003014	-0.464576	0.6478
INV	-0.001565	0.001515	-1.033234	0.3152
FDI	0.002734	0.000926	2.952466	0.0085
SEI	0.001334	0.000842	1.584511	0.1305
POPG	-0.116188	0.060008	-1.936199	0.0687
C	8.306644	0.223248	37.20813	0.0000
TOP	-0.000618	0.000465	-1.327271	0.2010
DOM	0.004428	0.002734	1.619926	0.1226

R-squared	0.737965	Mean dependent var	7.847720
Adjusted R-squared	0.621505	S.D. dependent var	0.073547
S.E. of regression	0.045247	Akaike info criterion	-3.092143
Sum squared resid	0.036852	Schwarz criterion	-2.660198
Log likelihood	50.74393	Hannan-Quinn criter.	-2.963703
F-statistic	6.336650	Durbin-Watson stat	1.470144
Prob(F-statistic)	0.000573		

Dependent Variable: LGDPPC
Method: Least Squares
Date: 10/01/21 Time: 20:01
Sample: 1990 2016
Included observations: 27

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GOVT	-0.003314	0.002847	-1.163842	0.2597
INF	-0.001955	0.003191	-0.612720	0.5477
INV	-0.001730	0.001603	-1.079259	0.2947
FDI	0.003263	0.000952	3.429115	0.0030
TNRR	0.001046	0.001440	0.726448	0.4769
POPG	-0.095365	0.063807	-1.494580	0.1523
C	8.162258	0.278162	29.34353	0.0000
TOP	-0.000453	0.000488	-0.928900	0.3652
DOM	0.006228	0.003079	2.022350	0.0583

R-squared	0.709921	Mean dependent var	7.847720
Adjusted R-squared	0.580997	S.D. dependent var	0.073547
S.E. of regression	0.047607	Akaike info criterion	-2.990466
Sum squared resid	0.040796	Schwarz criterion	-2.558520
Log likelihood	49.37129	Hannan-Quinn criter.	-2.862026
F-statistic	5.506503	Durbin-Watson stat	1.328559
Prob(F-statistic)	0.001296		