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RESEARCH PAPER

Public debt, tax and economic growth in Sub-Saharan African countries

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Abstract
This study examines the effect of public debt on the relationship between tax and economic growth in sub-Saharan African countries. Grounded in the extended endogenous growth model, it employs a dynamic fixed-effects model to explore both linear and nonlinear relationships. For the full sample, the linear analysis demonstrates that tax measures contribute positively to economic growth regardless of public debt inclusion. Intriguingly, while public debt on its own has a detrimental effect on growth, its interaction with total taxes exhibits a positive influence. Conversely, the nonlinear approach reveals a negative association between public debt and growth. Moreover, the interaction term indicates that public debt weakly supports the impact of indirect taxes on economic growth while undermining the effectiveness of taxes on goods and services. However, the interactions between public debt and other tax measures are not statistically significant. When considering various country classifications based on income level, fragility, and resource endowment under the linear approach, the study uncovers that several tax measures have a positive and statistically significant direct impact on growth. Furthermore, in low-income countries, public debt has a weaker effect on economic growth compared to that in middle-income countries. Public debt tends to reduce the effectiveness of direct taxes and taxes on income, profits, and capital gains in low-income countries. Conversely, public debt enhances only the effectiveness of indirect taxes in driving economic growth in middle-income countries. Under the nonlinear approach, mixed results are observed. Specifically, public debt predominantly undermines the effectiveness of most tax measures in middle-income countries. The findings across other country classifications also reveal diverse effects of public debt on the tax–growth relationship.

Keywords Public debt · Taxes · Growth · Sub-Saharan Africa

JEL Classification H2 · H63 · O4

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Introduction

One of the key objectives of any government is to maintain consistent and high economic growth over time. Many explanations have been put forward regarding the determinants of the long-term economic growth of countries. In line with this, academics and researchers in economics have developed theoretical models and conducted numerous empirical studies to provide reliable and sophisticated explanations for these determinants. One key extension in both neoclassical and endogenous growth models is the introduction of the role of the public sector. The models of Barro (1990) and Devarajan et al. (1996) have served as the basis for most theoretical and empirical works on the role of the public sector in determining long-run growth. Specifically, the role of the public sector is captured through taxation or public expenditure.

Furthermore, several studies (such as Barro 1990; Barro and Sala-i-Martin 1992; Devarajan et al. 1996; Bajo-Rubio 2000; Bleaney et al. 2001; Misch et al. 2014; Jaimovich and Rebelo 2017, among others) have established a nonlinear relationship between taxes and growth. Additionally, the role of the public sector has been decomposed into distortionary and non-distortionary components for taxes, or productive and unproductive components for public spending. These decompositions originated from the model of Barro (1990) which predicted the long-run growth effect associated with combinations of taxes and expenditures. Therefore, the predicted long-run growth effect heavily depends on the type of public spending and taxation used to finance such spending. This is facilitated through the government budget constraint (GBC), which captures the government's role in funding its public investment.

Moreover, most previous studies have focused on developed economies from both theoretical and empirical perspectives. These studies include Agell et al. (1999), Arin and Koray (2006), Denaux et al. (2005), Angelopoulos et al. (2007), Bania et al. (2007), Arnold (2008), Colombier (2009), Arin et al. (2011), and Gemmell et al. (2013), among others. Little attention has been given to developing countries, especially the sub-Saharan African (SSA) region, regarding the nature of the relationship between taxes and economic growth in the presence of other financing sources (such as debt, aid, resource rents, seigniorage, etc.). Some studies, such as Besci (2000) and Heijman and van Ophen (2005), have established the absence of the growth Laffer curve (GLC) in developing countries. However, a more recent study by Ehrhart et al. (2014) established the presence of GLC in developing countries. Consequently, existing studies on tax and growth in developing countries remain inconclusive about the presence or absence of GLC. Nevertheless, there is no available evidence to demonstrate the nature of the relationship between tax and economic growth (linear or nonlinear) in SSA. Given the financing challenges faced by many SSA countries, the accumulation of public debt may significantly influence the relationship between taxes and economic growth in the region. Therefore, this study contributes to the literature in two distinctive ways.

First, the fundamental function of any tax system is to generate sufficient funds for the government to finance its public investments. However, many SSA countries still struggle to meet the growing size of government spending relative to revenue mobilization through taxation. Jaimovich and Rebelo (2017) emphasize the nonlinear impacts of taxation on economic growth. Higher taxes generate more revenue for the government to finance its public investment thereby creating infrastructure for private investment to thrive. On the other hand, higher taxes can distort private capital accumulation thereby undermining growth. More so, low taxes may generate insufficient revenue for public

investment which affects infrastructure provision for private capital expansion. This scenario is prevalent in most sub-Saharan African countries, where the tax revenue to GDP ratio remains significantly small. According to Coulibaly and Gandhi (2018), SSA faces the challenge of a significant reduction in investment, estimated at $230 billion a year, on average, over the next five years. This shortfall is partly attributed to low tax revenue collection, which has shown minimal improvement. Excluding natural resource sector taxes, tax revenue as a percentage of GDP marginally increased from 11% in the early 2000s to about 15% in 2015. This is relatively low compared to other emerging and developing economies, and the Organization for Economic Cooperation and Development (OECD) countries which have a ratio of 24 percent. Underperforming tax revenue can be attributed to poor tax capacity and an inefficient tax revenue mobilization framework (see Coulibaly and Gandhi 2018). Thus, this study examines the nature of the tax–growth relationship in the SSA region using Barro's (1990) growth framework model.

Second, the study extends Barro's (1990) model by introducing public debt through the GBC. Inability to generate sufficient tax revenue implies the need to explore other financing sources for government development projects in SSA countries. Due to the peculiarities of SSA countries, borrowing becomes a prevalent method for financing public investment. Heavy reliance on borrowing carries the risk of macroeconomic instability and default. The World Bank (2023) data showed that SSA's public debt-to-GDP ratio declined from about 55 percent in 2007 to 37% in 2012 but then increased to 57% of GDP in 2022. Carneiro and Kouame (2020) revealed that most SSA countries contribute to the region's rapid public debt increase. The coronavirus pandemic, coupled with low tax ratios, exacerbated the rising debt burden in SSA countries. Some of the factors that contributed to this alarming public debt rate in the SSA include exchange rate depreciation, residuals, and primary deficit. The primary deficit challenges can be partially explained by poor domestic resource mobilization, weak tax capacity, and government inefficiency. Multilateral organizations, such as the International Monetary Fund and the World Bank have issued warnings to some SSA countries about the fast pace of debt accumulation. This underscores the need to examine how the growing public debt in SSA countries may impact their tax mobilization for growth. Additionally, the study considers different country classifications due to variations in development levels, fragility exposure, and resource intensity. Thus, this study seeks to elucidate how increasing public debt may weaken the tax–growth relationship in the region.

Put together, the weak tax mobilization and the escalating public debt accumulation among SSA countries reflect the region's uneven growth. Specifically, the SSA growth rate increased from 2.5% in 1990 to 3.4% in 2000 but declined to − 2.0% in 2020, marking a period of economic instability. This trend is also observed in several countries within the region. To address the growing developmental challenges of the region, achieving a high and sustainable growth rate is imperative. Furthermore, stable financing options are essential for attaining stable and sustainable growth. Hence, this study provides a comprehensive empirical analysis of the role of public debt in the tax–growth relationship in SSA countries.

The subsequent sections of the paper are structured as follows: Section two examines the theoretical foundation of the relationship between public debt, tax, and growth. The third section outlines empirical models and estimation strategies, while the fourth section focuses on presenting and discussing results. Finally, the fifth section provides concluding remarks.

Theoretical model

To provide the basis for our empirical analysis, we relied on the endogenous growth model, which incorporates the government's role in the growth process, as proposed by Barro (1990), Barro and Sala-I-Martin (1992), and Devarajan et al. (1996). The government partakes in the growth process through spending on output thus removing the possibility of separate production functions. Moreover, government spending can improve the provision of public goods or infrastructure through increased revenue from high tax rates. However, this may have a dual effect, as it could stifle innovation from private investment while also fostering private investment by creating a conducive environment. Distinctively, we assumed an unbalanced government budget constraint because, in reality, the government finances its spending through taxes and other financing options. In the case of budget deficits, the government may resort to issuing debt with the assumption that its growth rate must be lower than that of the real interest rate, adhering to the no-Ponzi game condition. Furthermore, the government's utilization of external debt is exogenously determined, based on concessional interest rates. Under the unbalanced budget constraint, the representative household maximizes the present value of discounted intertemporal utility as presented below:

$$W = \int_0^{\infty} U(C_t)e^{\alpha t}\mathrm{d}t \quad \text{where} \quad \alpha \succ 0 \tag{1}$$

The isoelastic instantaneous utility under the endogenous growth path is given as

$$U(C_t) = \begin{cases} \dfrac{C^{1-\beta} - 1}{1-\beta}, \text{ for } \beta \neq 1 \\ \ln(C_t)\text{ , for } \beta \neq 1 \end{cases} \tag{2}$$

Given the varying population growth rates in developing countries, particularly in sub-Saharan African countries, assuming a constant population growth rate in our model may deviate from reality. Consequently, we address the challenge of scale effects associated with endogenous growth models in the production function we explore. In this context, government spending, or public capital, is represented as G and is expected to benefit citizens, taking into account the population size. Moreover, there is an anticipated positive externality resulting from both private and public capital in the production function. K represents private capital in the production process. The output (Y_t) is produced with a combination of firm's capital (K_t) and productive government spending (G_t) given that the production function exhibits constant returns to scale such that $0 \prec \rho \prec 1$, the output elasticity with respect to firm's capital. Hence, the production function of the representative agent is presented as follows:

$$Y = K_t^{\rho} G_t^{1-\rho} \tag{3}$$

The population is normalized to be one and the variables are expressed in per capita terms. Furthermore, the representative agent is assumed to obtain government bonds (B_t) with interest rate return of r_t. The revenue from real interest and output (Y) can be used for private investment ($I + \delta K$) private consumption, purchasing new bonds ($\dot{B}_t$), and paying flat-rate tax on output (τY). Given the focus of the study, we assumed real money ($\dot{M}_t$) to

be zero thus excluding the possible role of seigniorage. Hence, the budget constraint of the representative agent is given as

$$r_t B_t + (1-\tau)Y_t = C_t + (I_t + \delta K_t) + \dot{B}_t \tag{4}$$

More so, the government is faced with two types of expenditures which include productive and unproductive spending. This is expressed in terms of GDP (Y). Given that the government may run a budget deficit when revenue from tax is insufficient to finance its public spending, there is a government utilized debt option with interest rate. Thus, the government budget constraint is represented as

$$G_t + r_t B_t - \tau Y = \dot{B}_t \tag{5}$$

Maximizing Eq. 2 subject to Eqs. (3)–(5) yields a growth rate at a steady-state

$$\gamma *= \rho(1-\tau)(\tau - \alpha\phi)^{(1-\rho)/\rho} - \delta - \alpha \tag{6}$$

Equation 6 shows that the relationship between tax and economic growth is nonlinear indicating the existence of an optimal tax rate that maximizes long-run growth. In particular, a low tax rate may lead to revenue reduction, thereby hindering public investment needed for fostering economic growth. Conversely, a high tax rate may generate substantial government revenue but discourage private investment. Consequently, both low and high tax rates may not facilitate growth thus implying that there is a unique tax rate that is neither too low nor high which can ensure high, stable, and sustainable growth. Additionally, a high tax rate can diminish personal income, potentially necessitating decline in consumption. This, in turn, could compel firms to reduce their productivity, resulting in decline in economic growth. Also, a significant accumulation of debt (ϕ) is detrimental to long-run growth. High levels of debt undermine the efficacy of taxation in the growth process, as substantial government revenue from taxes must be allocated between competing government expenditures and interest payments on debt. Also, debt servicing reduces available resources required to finance growth. Therefore, firms may be discouraged when the government accumulates substantial debt, as it implies that they may be confronted with higher taxes in the future. This theoretical proposition aligns with findings from previous studies such as Ehrhart et al. (2014), Adam and Bevan (2005), and others. It is nonetheless pertinent to state that productive debt can stimulate economic growth through significant improvement in investments.

Empirical model and estimation approach

This study covered 23 sub-Saharan African countries with data spanning 2005 and 2019. Our empirical analysis hinged on the growth equation (Eq. 6) and the budget constraints outlined in Eqs. (4) and (5). To provide a robust analysis, we pursued three distinct options. First, we started by examining the argument posited by Barro (1990), which asserts that only taxes serve as the source of financing for government spending. Second, we explored the presence of nonlinearity in the relationship between tax and economic growth, often referred to as the "growth Laffer curve". Third, we delved into the influence of public debt on the connection between taxation and growth, considering both linear and nonlinear aspects. Furthermore, this study explored different countries' classifications, distinguishing between middle-income and low-income countries, fragile and non-fragile countries, and

resource-intensive and non-resource-intensive countries. Hence, our econometric specifications are presented as follows:

$$\mathrm{LGDPC}_{it} = \beta_1 \mathrm{LGDPC}_{it-1} + \beta_2 \mathrm{INV}_{it} + \beta_3 \mathrm{TAX}_{it} + H'_{it}\varphi + \pi_i + \varepsilon_{it} \tag{7}$$

$$\mathrm{LGDPC}_{it} = \beta_1 \mathrm{LGDPC}_{it-1} + \beta_2 \mathrm{INV}_{it} + \beta_3 \mathrm{TAX}_{it} + \beta_4 \mathrm{TAX}^2_{it} + H'_{it}\varphi + \varepsilon_{it} \tag{8}$$

$$\mathrm{LGDPC}_{it} = \beta_1 \mathrm{LGDPC}_{it-1} + \beta_2 \mathrm{INV}_{it} + \beta_3 \mathrm{TAX}_{it} + \alpha(\mathrm{PDE} * \mathrm{TAX})_{it} + H'_{it}\varphi + \varepsilon_{it} \tag{9}$$

$$\begin{aligned} \mathrm{LGDPC}_{it} =& \beta_1 \mathrm{LGDPC}_{it-1} + \beta_2 \mathrm{INV}_{it} + \beta_3 \mathrm{TAX}_{it} + \beta_4 \mathrm{TAX}^2_{it} \\ &+ \alpha(\mathrm{PDE} * \mathrm{TAX})_{it} + \delta(\mathrm{PDE} * \mathrm{TAX})^2_{it} + H'_{it}\varphi + \varepsilon_{it} \end{aligned} \tag{10}$$

The a priori expectations of the coefficients in Eqs. (9–10) are as follows:

$$\beta_1 > 0;\ \beta_2 > / < 0;\ \beta_3 > / < 0;\ \beta_4 < 0;\ \alpha < 0;\ \varphi > / < 0$$

where countries are indexed by i and t is the time. $\varepsilon_{it} = \theta_i + \pi_t + \sigma_{it}$ where θ_i is the time-invariant country-specific effects and π_t is time-varying effects. σ_{it} is the idiosyncratic disturbance term while ε_{it} is a two-way disturbance term.

Equations (7) and (8) depict the nature of the relationship between taxation and economic growth in linear and nonlinear forms, while Eqs. (10) and (11) examine the role of public debt in the tax–growth relationship in both linear and nonlinear forms, respectively LGDPC_{it} represents the growth rate, represented by the log of GDP per capita, while LGDPC_{it-1} reflects the log of lagged GDP per capita, accounting for the catching-up effect. The inclusion of a lagged dependent variable (LDV) in the fixed-effects model is justified for several reasons. First, LDV captures potential persistence in our data, reflecting the influence of immediate past economic growth on current growth. Second, it may address potential endogeneity issues. Third, the inclusion of LDV can control for possible correlations in cases where current economic growth is correlated with the error term. Fourth, LDV allows us to account for short-term dynamics and adjustments over time. A high initial economic growth level may enhance current growth, while a low initial level may hinder current growth (Oyinlola et al. 2020; Ehrhart et al. 2014).INV_{it} represents private investment, capturing gross fixed capital formation as a percentage of GDP. Theoretically, private investment contributes to capital accumulation through new physical capital (Solow 1956; Mankiw et al. 1992). An increase in private investment facilitates higher capital accumulation, leading to increased productivity and output levels, thereby promoting economic growth. Conversely, low private investment reduces capital accumulation thus hampering productivity and economic growth. TAX_{it} represents public investment in growth, proxied by tax-to-GDP. Public investment can be captured through either taxes or public expenditures, as argued in renowned public economics studies (Ehrhart et al. 2014; Devarajan et al. 1996; Barro 1990). Tax revenue is used to provide public goods, implying that high tax revenue may enable the expansion of public investment. Contrarily, low tax revenue may hinder the government's capacity to do the same. The impact of taxes on economic growth can vary, depending on how much the positive externality from expanded public goods offsets the decline in firm productivity resulting from high tax rates. Conversely, low tax rates may result in insufficient tax revenue, preventing the government from providing the necessary public infrastructure to enhance firm productivity and consequently

retarding economic growth. In contrast to other studies on developing countries, this study considered various taxes in order to inform policy formulation from a more robust perspective. We examined taxes at both the aggregate and disaggregated levels, including total taxes, direct taxes, indirect taxes, and tax components (taxes on goods and services, taxes on international trade, taxes on income, profits, and capital gains). Oppel et al. (2021) comprehensively defined these tax measures. Total taxes encompass all tax revenue received by the government through its agencies, categorized into direct and indirect taxes. Direct taxes include levies on income, profits, capital gains, payroll, the workforce, and property, excluding taxes from natural resources. Indirect taxes encompass sales taxes, value-added taxes, excise duties, and other taxes on goods and services, international trade, and other items. On the sub-components of taxes, taxes on income, profits, and capital gains comprise the summation of taxes on individuals' income, corporations' profits, and capital gains, excluding social contributions. Taxes on goods and services capture sales taxes, value-added taxes, and excise duties. Taxes on international trade involve taxes on imports and exports. Overall, this comprehensive approach aims to provide evidence to shape specific tax policies for long-term growth. To ascertain the threshold effect of tax, TAX_{it}^2 accounts for the nonlinearity of tax in the growth process (that is, growth Laffer curve). The nonlinearity of taxes has been emphasized in the theoretical models of public economics. Studies such as Jaimovich and Rebelo 2017; Gemmell et al. 2016; Misch et al 2013; Kneller et al. 1999; Devarajan et al. 1996; Barro 1990, have theoretically underscored the importance of a tax threshold, as taxes can be distortionary or non-distortionary. PDE_{it} represents public debt, captured by the total external debt stock as a percentage of GDP. High public debt can hinder economic growth by leading to high long-term interest rates (Kumar and Baldacci 2010; Gale and Orzag 2003). More so, it may impede the government's ability to implement either countercyclical or procyclical fiscal policies, potentially increasing volatility and exacerbating the problem of low economic growth (see Ndoricimpa 2020; Woo 2009; Kharroubi and Aghion 2008). $PDE * TAX$ and $PDE * TAX^2$ account for the influence of public debt on the growth effect of taxes. Theoretically, the new revenue from fiscal deficits is often lower than the cost of debt, reducing productivity and output. Consequently, the government faces the challenge of either reducing productive spending or increasing distortionary taxes, both of which negatively affect long-run growth. H_{it} is the vector of control variables, which play a significant role in the growth process. These variables include population, government final consumption expenditure, foreign direct investment, and trade openness, and have been used in various growth models. The working-age population serves as a proxy for labor, as explored in the literature. A high population may provide a country with a large labor force, boosting productivity and output levels, while a low population may indicate a smaller labor force for productivity (Ndoricimpa et al. 2020; Oyinlola et al. 2021). Government final consumption expenditure has both positive and negative effects on economic growth in developing countries (Devarajan et al. 1996). Barro (1990) incorporated government spending into the endogenous growth model, highlighting its potential positive impact on steady-state economic growth. However, Seleteng et al. (2013) revealed a negative effect of government spending on economic growth, indicating that the impact may vary. Foreign direct investment is another traditional determinant of growth, with its impact depending on the sector in which investments are made. It can either foster or hinder economic growth (Odhiambo 2022; Iwasaki and Suganuma 2015; Fowowe and Shuaibu 2014; Li and Liu 2005; Alfaro et al. 2001). Trade openness plays a significant role in the growth process, reflecting an economy's competitiveness and engagement with the global market. The

impact of trade openness on growth can vary depending on how a country harnesses trade opportunities (Zahonogo 2017; Law and Habibullah 2009; Mayer-Foulkes 2001). This study focused on the relevant control variables within the context of tax-growth analysis, avoiding overparameterization, consistent with the approach of studies such as Barro (1990), Barro and Sala-i-Martin (1992), Levine and Renelt (1992), and Easterly et al. (2006), who cautioned against the excessive inclusion of control variables in growth models.

Using the standard dynamic fixed-effects panel data model (DFE), we re-specified Eqs. (7)–(10) as follows:

$$\mathrm{LGDPC}_{it} = \beta_1 \mathrm{LGDPC}_{it-1} + \beta_2 \mathrm{INV}_{it} + \beta_3 \mathrm{TAX}_{it} + H'_{it}\varphi + \varepsilon_{it} \tag{7'}$$

$$\mathrm{LGDPC}_{it} = \beta_1 \mathrm{LGDPC}_{it-1} + \beta_2 \mathrm{INV}_{it} + \beta_3 \mathrm{TAX}_{it} + \beta_4 \mathrm{TAX}^2_{it} + H'_{it}\varphi + \varepsilon_{it} \tag{8'}$$

$$\mathrm{LG\ DPC}_{it} = \beta_1 \mathrm{LGDPC}_{it-1} + \beta_2 \mathrm{INV}_{it} + \beta_3 \mathrm{TAX}_{it} + \beta_4 (\mathrm{PDE} * \mathrm{TAX})_{it} + H'_{it}\varphi + \varepsilon_{it} \tag{9'}$$

$$\begin{aligned} \mathrm{LGDPC}_{it} &= \beta_1 \mathrm{LGDPC}_{it-1} + \beta_2 \mathrm{INV}_{it} + \beta_3 \mathrm{TAX}_{it} + \beta_4 \mathrm{TAX}^2_{it} + \beta_5 \mathrm{PDE} * \mathrm{TAX}_{it} \\ &\quad + \beta_6 (\mathrm{PDE} * \mathrm{TAX})^2_{it} + H'_{it}\varphi + \varepsilon_{it} \end{aligned} \tag{10'}$$

The coefficients in Eqs. (7′)–(10′) are derived using the *within estimator* (fixed-effects model). The within-transformed data is estimated using Ordinary Least Squares to yield efficient and reliable estimates. The dynamic fixed-effects (DFE) model is crucial for estimating short panel data models, as is the case in our study, given the limited time span of 15 years relative to the number of countries (23) (see Stock and Waston 2020; Ditzen 2021). The selection of DFE model is based on several advantages it offers over static panel models: First, static panel models may lead to multicollinearity and inefficient parameters due to our short time dimension. DFE models leverage the temporal dimension to account for dynamic relationships over time (Hsiao 2003), resulting in more efficient parameter estimates. Second, the inclusion of lagged dependent variables in the DFE model allows us to capture autocorrelation, which is overlooked in static panel models. This leads to more accurate estimates and addresses potential endogeneity issues (Baltagi 2008). Third, the DFE model provides consistent estimates even when there are cross-sectional effects (country-specific effects in our case), making it the most appropriate for panel data with unobserved heterogeneity. Fourth, the DFE model strikes a balance between a small T and a large N by effectively exploring the time dimension while controlling for cross-sectional effects. It accommodates variation within countries. It is worth noting that concerns related to non-stationarity are typically associated with heterogeneous panel data, especially in cases of large T and N (Pesaran et al. 1999), often referred to as "long panels". Non-stationarity issues tend to arise when dealing with long time spans (large T), necessitating unit root and cointegration tests (Ditzen 2021; Bai and Ng 2004; Hadri 2000). In the context of our study, non-stationarity is not a major concern due to the limited time dimension. Additionally, non-stationarity of variables becomes less relevant when dealing with short panel data (see Thombs 2022; Pesaran, 1997; Peseran and Smith 1995; Peseran et al. 1999; Blackburn and Frank, 2007; Kanas and Kouretas 2005; Hurlin and Mignon 2007; Im et al. 2003). Furthermore, this approach aligns with our theoretical framework, supported by insights from the public economics literature. Renowned studies in public economics,

Table 1 Variable definitions. *Source*: Authors' compilation

	Description	Source
LGDPC	Log of GDP per capita (constant US dollar, $)	World Development Indicators (WDI) 2020
LPOP	Log of population (total population ages 15–64)	World Development Indicators (WDI) 2020
INV	Gross Fixed Capital Formation (% of GDP)	World Development Indicators (WDI) 2020
FDI	Foreign direct investment, net inflows (% of GDP)	World Development Indicators (WDI) 2020
PDE	Total external debt stock as a percentage of GDP	World Development Indicators (WDI) 2020
TTAX	Total taxes as a percentage of GDP	International Centre for Tax and Development (2020)
DTAX	Direct taxes as a percentage of GDP	International Centre for Tax and Development (2020)
ITAX	Indirect taxes as a percentage of GDP	International Centre for Tax and Development (2020)
TIPC	Taxes on income, profits, and capital gains as a percentage of GDP	International Centre for Tax and Development (2020)
TGS	Taxes on goods and services as a percentage of GDP	International Centre for Tax and Development (2020)
TIT	Taxes on international trade as a percentage of GDP	International Centre for Tax and Development (2020)
GOVT	Government final consumption expenditure as a percentage of GDP	World Development Indicators (WDI) 2020
TOP	Trade as a percentage of GDP	World Development Indicators (WDI) 2020

including Ehrhart et al. (2014), Gemmell et al. (2013), Bleaney et al. (2001), Devarajan et al. (1996), Bania et al. (2007), Oyinlola et al. (2020), Oyinlola and Adedeji (2021), and Jaimovich and Rebelo (2017), have provided guidance in selecting this estimation approach. The definition of variables is presented in Table 1.

Results and discussion

Preliminary analysis

The section examines the statistical features of the variables used in our models. Tables 2a and b present the summary statistics, indicating that the average values of all variables are largely positive across different classifications. This suggests that most variables exhibit upward trends, as evident from the positive values. Exclusion of countries such as the Congo Republic, Mozambique, Sierra Leone, and Congo DR improves the mean values of the full sample. These four countries have a high debt-to-GDP ratio of above 90%, as categorized by Reinhart and Rogoff (2010). Also, the average values of the variables are higher for middle-income countries compared to those for low-income countries. Furthermore, the mean values of the variables are slightly higher in resource-intensive countries compared to those for non-resource-intensive countries. Most of the average values of the variables for non-fragile countries are higher than those for fragile countries. Among the variables, FDI exhibits the highest variability across different classifications, as indicated by the coefficient of variation (CV).[1] The mean difference among these groups is presented in Table 20 (see Appendix).

Before conducting the impact analysis, we examined the relationships between taxes and growth, public debt and growth, and taxes and public debt using scatterplots. In Fig. 1, we illustrate the relationship between total taxes and the growth rate of GDP per capita. The analysis reveals a positive correlation between total taxes and the growth rate of GDP per capita. Among the 23 countries, only Eswatini, Mauritius, and Botswana have an average total tax ratio above 15% and an average growth rate of GDP per capita above 2%. Additionally, South Africa, with the highest average tax, has a growth rate of GDP per capita of less than 1%. It is also interesting to note that Congo DR, despite its fragile nature due to ongoing conflict, has the lowest total tax and growth rate of GDP per capita. We further analyzed the relationship between types of tax (direct and indirect) and the growth rate of GDP per capita in Fig. 2. The observed relationship between direct tax and the growth rate of GDP per capita is weakly negative, while the indirect tax is positively and strongly correlated with the growth rate of GDP per capita in SSA countries. The analysis revealed that most countries relied more on indirect taxes. When considering the different components of tax, Fig. 3 indicates that taxes on income, profits, and capital gains are negatively correlated with the growth rate of GDP per capita, while taxes on goods and services and taxes on international trade are positively related with the growth rate of GDP per capita. Among the three taxes, countries appear to rely more on taxes on goods and services relative to other taxes. Hence, we infer that some taxes make more contribution to economic growth in the region.

[1] Coefficient of Variation (CV) measures the relative variability of data which assists in understanding the relative closeness of the data point to its mean.

Table 2 (a) Descriptive statistics. *Source*: Authors' computation

Variables	Obs	Mean	SD	CV	Min	Max	Obs	Mean	SD	CV	Min	Max
	Full sample						Full sample excluding four highly indebted countries					
TTAX	345	11.96	5.518	46	0.804	29.13	285	12.95	5.476	42	3.410	29.13
DTAX	345	4.027	3.111	77	0.251	15.82	285	4.393	3.266	74	0.348	15.82
ITAX	345	7.931	3.235	41	0.536	22.91	285	8.555	3.150	37	2.057	22.91
TIPC	315	4.080	3.219	79	0.251	15.48	270	4.430	3.320	75	0.655	15.48
TGS	345	4.771	2.383	50	0.190	13.64	285	5.177	2.374	46	0.666	13.64
TIT	345	2.999	2.901	97	0.223	22.14	285	3.202	3.120	97	0.223	22.14
PDE	345	60.53	47.80	79	3.742	295.0	285	53.09	37.88	71	3.742	259.9
GDPC	345	1,840	2,193	119	210.4	10,490	285	2,036	2,342	115	210.4	10,490
POP (MILLION)	345	8.77	9.19	105	0.409	43.48	285	8.72	8.43	97	0.409	38.2
INV	345	19.34	8.119	42	2.585	68.12	285	19.51	6.521	33	3.554	40.80
TOP	345	64.27	29.55	46	21.76	173.9	285	63.29	28.47	45	21.76	173.9
GOVT	345	14.15	4.953	35	2.929	30.26	285	14.71	4.784	33	4.545	30.26
FDI	345	2.802	4.439	158	−5.802	36.96	285	2.462	3.727	151	−4.475	36.96
	Low-income countries						Middle-income countries					
TTAX	195	10.07	4.364	43	0.804	24.81	135	15.16	5.746	38	6.279	29.13
DTAX	195	3.187	2.521	79	0.251	13.14	135	5.472	3.466	63	1.951	15.82
ITAX	195	6.882	2.254	33	0.536	12.87	135	9.684	3.775	39	3.790	22.91
TIPC	180	3.264	2.661	82	0.251	15.19	120	5.583	3.571	64	0.954	15.48
TGS	195	4.538	1.955	43	0.190	8.788	135	5.235	2.925	56	0.666	13.64
TIT	195	2.193	1.164	53	0.253	5.684	135	4.258	4.119	97	0.223	22.14
PDE	195	67.74	47.57	70	10.83	259.9	135	49.81	48.15	97	3.742	295.0
GDPC	195	647.8	327.9	51	210.4	1,898	135	3,714	2,525	68	892.9	10,490
POP (MILLION)	195	9.26	8.26	89	0.520	43.48	135	8.80	10.60	120	0.409	38.17
INV	195	17.62	7.481	42	2.585	40.80	135	22.57	8.111	36	11.87	68.12
TOP	195	52.00	17.94	35	21.76	121.5	135	84.28	33.12	39	32.51	173.9

Table 2 (continued)

Variables	Obs	Mean	SD	CV	Min	Max	Obs	Mean	SD	CV	Min	Max
GOVT	195	13.15	4.831	37	2.929	26.92	135	15.82	4.815	30	7.074	30.26
FDI	195	2.960	4.541	153	−0.897	36.96	135	2.772	4.494	162	−5.802	28.98
(b) Descriptive statistics												
Variables	Obs	Mean	SD	CV	Min	Max	Obs	Mean	SD	CV	Min	Max
	Resource-intensive countries						Non-resource-intensive countries					
TTAX	195	11.42	5.768	51	0.804	26.99	150	12.65	5.111	40	4.380	29.13
DTAX	195	4.251	3.656	86	0.251	15.82	150	3.735	2.191	59	0.655	12.59
ITAX	195	7.170	2.724	38	0.536	16.51	150	8.919	3.572	40	3.726	22.91
TIPC	165	4.493	3.927	87	0.251	15.48	150	3.625	2.112	58	0.655	9.752
TGS	195	4.361	2.237	51	0.190	10.39	150	5.304	2.468	47	0.666	13.64
TIT	195	2.621	2.101	80	0.253	11.65	150	3.491	3.640	104	0.223	22.14
PDE	195	62.79	52.39	83	3.742	295.0	150	57.61	41.06	71	9.383	259.9
GDPC	195	2,109	2,300	109	338.0	9,225	150	1,489	2,000	134	210.4	10,490
POP (MILLION)	195	10.80	10.54	98	0.519	43.48	150	7.06	6.7	95	0.409	30.22
INV	195	20.34	9.275	46	2.585	68.12	150	18.04	6.098	34	3.625	37.47
TOP	195	65.09	26.45	41	25.47	146.2	150	63.20	33.21	53	21.76	173.9
GOVT	195	13.79	5.537	40	2.929	30.26	150	14.62	4.042	28	7.346	26.92
FDI	195	2.760	4.294	156	−5.802	28.98	150	2.856	4.636	162	−0.447	36.96
	Fragile countries						Non-fragile countries					
TTAX	120	9.995	4.817	48	0.804	24.81	225	13.00	5.592	43	4.380	29.13
DTAX	120	3.242	2.701	83	0.251	13.14	225	4.446	3.238	73	0.655	15.82
ITAX	120	6.753	2.598	38	0.536	12.87	225	8.559	3.369	39	3.573	22.91
TIPC	90	3.590	3.250	91	0.251	15.19	225	4.276	3.192	75	0.655	15.48
TGS	120	4.360	2.095	48	0.190	8.788	225	4.990	2.500	50	0.666	13.64
TIT	120	2.270	1.066	47	0.253	5.684	225	3.388	3.447	102	0.223	22.14
PDE	120	73.70	53.40	72	10.83	295.0	225	53.51	43.03	80	3.742	259.9

Table 2 (continued)

(b) Descriptive statistics

Variables	Obs	Mean	SD	CV	Min	Max	Obs	Mean	SD	CV	Min	Max
GDPC	120	860.0	622.2	72	280.1	2,538	225	2,362	2,528	107	210.4	10,490
POP (MILLION)	120	7.06	9.04	128	50.208	43.48	225	9.68	9.15	95	0.409	38.17
INV	120	17.50	10.27	59	2.585	68.12	225	20.32	6.516	32	2.803	40.80
TOP	120	61.41	28.43	46	21.76	146.2	225	65.79	30.08	46	22.53	173.9
GOVT	120	13.59	5.570	41	2.929	27.30	225	14.45	4.576	32	7.074	30.26
FDI	120	2.759	4.738	172	−5.802	28.98	225	2.825	4.282	152	−4.475	36.96

(c) Pairwise correlation

	GDPC	TTAX	DTAX	ITAX	TIPC	TGS	TIT	PDE	INV	FDI	GOVT	TOP	POP
GDPC	1												
TTAX	0.49***	1											
DTAX	0.35***	0.86***	1										
ITAX	0.49***	0.88***	0.51***	1									
TIPC	0.34***	0.83***	0.97***	0.47***	1								
TGS	0.23***	0.60***	0.55***	0.50***	0.51***	1							
TIT	0.32***	0.46***	0.11**	0.69***	0.09	−0.27***	1						
PDE	−0.18***	−0.40***	−0.30***	−0.39***	−0.30***	−0.25***	−0.24**	1					
INV	0.28***	0.07	0.03	0.09*	0.04	0.02	0.07	−0.23***	1				
FDI	−0.05	0.03	0.09	−0.03	0.10*	0.023	−0.09	−0.12**	0.44***	1			
GOVT	0.29***	0.55***	0.42***	0.53***	0.39***	0.24***	0.38***	−0.12**	0.17***	0.04	1		
TOP	0.50***	0.30***	0.11**	0.40***	0.18***	−0.06	0.48***	−0.04	0.44***	0.32***	0.27***	1	
POP	−0.12**	0.11**	0.37***	−0.17***	0.33***	0.27***	−0.41***	−0.12**	0.03	0.03	−0.20***	−0.30***	1

Table 2 (continued)

(d) Panel unit root test result

Variable	Level, *I*(0)						First difference, *I*(1)					
	Null hypothesis: unit root with common process			Null hypothesis: unit root with individual unit root process		Null hypothesis: no unit root with common unit root process	Null hypothesis: unit root with common process			Null hypothesis: unit root with individual unit root process		Null hypothesis: no unit root with common unit root process
	LLC	BREI	HT	IPS	AF	HAD	LLC	BREI	HT	IPS	ADF	HAD
LGDPC	1.196	−7.743	0.734***	1.711	51.872	58.918***	12.148	−4.688***	−0.018***	−11.040***	55.844	4.926***
TTAX	0.803***	0.131	0.896	−2.084**	37.559	49.901***	−13.112***	−10.279***	−0.071***	−15.218***	111.127***	−3.377
DTAX	−0.403	0.424	0.872***	−0.055	17.671	59.524***	−14,030***	−13.354***	−0.115***	−15.445***	128.529***	−2.976
ITAX	−4.060***	−1.054	0.686***	−4.226***	53.307	35.100***	−14,114***	−11.065***	−0.108***	−15.527***	120.727***	−−3.678
TIPC	−1.385*	1.047	0.855***	0.264	22.278	58.457***	−14,502***	−12.410***	−0.102***	−14.055***	144.886***	−3.168
TGS	−2.459***	−0.472	0.832***	−0.987	47.388	55.814***	−15.105***	−14.379***	−0.156***	−15.480***	111.106***	−3.446
TIT	−3.574***	−1.115	0.744***	−3.826***	74.655***	37.121***	−11.365***	−7.940***	−0.105***	−15.488***	89.968***	−2.719
PDE	0.416	−1.360*	0.898	1.348	62.367**	62.498***	−10.874***	−9.809***	−0.119***	−14.279***	47.167	−1.151
LPOP	1.6672	19.416	0.611***	−3.562	20.980	57.478***	125.33	0.570	0.003***	−2.380***	81.270***	5.056***
FDI	−3.891***	−6.459***	0.609***	−6.746***	35.609	37.743***	−13.080***	−17.228***	−0.384***	−16.920***	139.773***	−3.905
INV	−2.258***	−3.370***	0.691***	−2.865***	39.539	28.957***	−15.484***	−14.122***	−0.120***	−15.176***	91.462***	−3.064
GOVT	−2.900***	−2.264***	0.766***	−2.387***	50.624	28.958***	−13.372***	−12.359***	−0.028***	−14.161***	94.867***	−2.555
TOP	−0.523	−2.549***	0.758	−2.923***	52.021	38.391***	−11.175***	−8.452***	−0.144***	−15.182***	74.512***	−1.124

***, **, *Indicate statistical significance at 1%, 5% and 10% levels respectively. All the variables are expressed either in natural logs or as a percentage of GDP. LLC, BREI, HT, IPS, ADF, and HAD are Levin, Lin, and Chu t*; Breitung t-stat; Harris-Tzavalis rho; Im, Pesaran & Shin W Stat; ADF Fisher Chi-square; Hadri Z-stat., respectively. Total tax as percentage of GDP (TTAX); Direct taxes as percentage of GDP (DTAX); Indirect tax as percentage of GDP (ITAX); Taxes on income, profit, and capital gains as percentage of GDP (TIPC), Taxes on goods and services as percentage of GDP (TGS), and Taxes on international trade as percentage of GDP (TIT). Log of GDP per capita (LGDPC); Public Debt as percentage of GDP (PDE), Log of population (LPOP), Foreign direct investment as percentage of GDP (FDI), Gross fixed capital formation as percentage of GDP (INV), Government final consumption as percentage of GDP (GOVT) and trade openness (TOP)

In Fig. 4, we present the relationship between public debt and economic growth. The analysis reveals that public debt is negatively correlated with the growth rate of GDP per capita. Debt experiences are quite similar across these countries, with a few exceptions in highly indebted countries. Moreover, only five countries (Eswatini, Botswana, Burkina Faso, Rwanda, and Uganda) maintained public debt levels of less than 60% and a growth rate of GDP per capita of 2% and above. Additionally, the pace of public debt is faster in most SSA countries. This implies that public debt has not been productive in several SSA countries. Examining the relationship between taxes and public debt shows that taxes are negatively related to public debt (see Figs. 5 and 6). With increasing public debt among SSA countries, tax mobilization may continue to underperform.

In Table 2c, correlation analysis is presented to demonstrate the relationships between the variables. The results show that there is a positive linear relationship between tax measures and economic growth. Also, public debt is positively related to economic growth. The control variables—investment, government spending, and trade openness—exhibit positive linear associations with economic growth, while foreign direct investment and population are negatively related with economic growth. When considering the correlation among independent variables, the results reveal that the linear association among the tax measures is relatively high, further justifying their separate inclusion into our estimated models. However, the results show a low correlation among the variables, indicating the possibility of the absence of autocorrelation. More so, the correlation coefficients are largely significant, suggesting that the association among the variables are not due to chance. The panel unit root tests for the variables used in our estimated models are presented in Table 2d. The results indicate that all the variables are integrated of order zero, I(0). This suggests that a static panel model or dynamic model for a short panel is the most appropriate choice. Non-stationary issues are commonly associated with heterogeneous panels; therefore, the cointegration test may be misleading when the time span of the data is short.

Public debt, tax and economic growth

The study employs dynamic fixed-effects for our short panel data. Individual effects are a critical issue in panel data analysis due to heterogeneity among the countries. The study uses the F-stat to test for the validity of the null hypothesis. Since the F-statistic is statistically significant in the tables, it suggests that the dynamic fixed-effects model provides a significantly better fit than the pooled OLS model. Moreover, the chi-square values of the Hausman tests are statistically significant, indicating that the dynamic fixed-effects models are efficient. Hence, the null hypothesis of the random effects estimator is rejected, which justifies the use of DFE model.

(a) Full sample versus Full sample excluding four highly indebted countries

To address the objectives outlined in our introductory part, we first considered the full sample (first classification-FC) and the full sample excluding four highly indebted countries (second classification-SC). Table 3 presents the effect of taxes on economic growth using a linear approach. The point estimates of the log of initial GDP per capita are positive and statistically significant across the models in both classifications. Under the different taxes explored, the point estimates of the FC are relatively higher than those of the SC. Specifically, the average point estimate of the FC is 0.52% compared to 0.47% of the SC. The initial level of growth plays a significant role in the conditional growth convergence

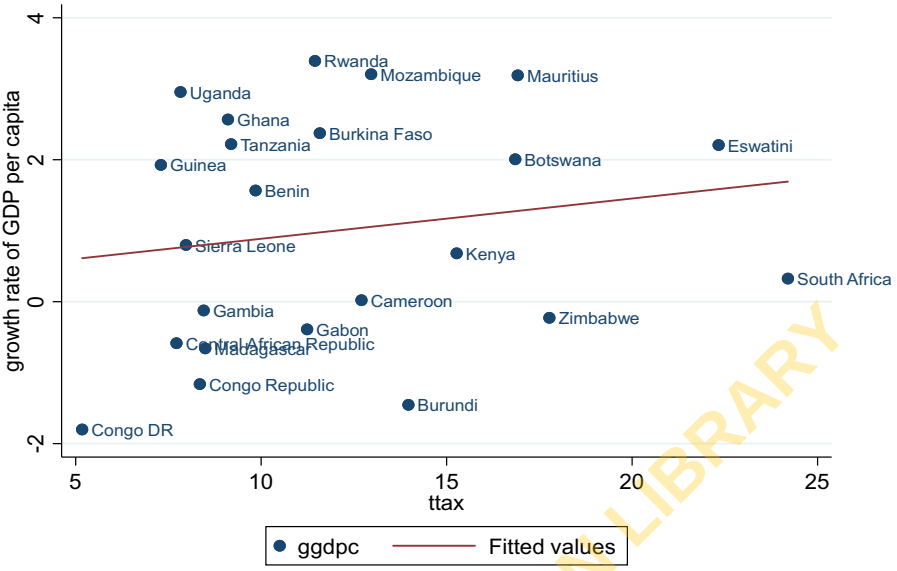

Fig. 1 Scatterplot of Growth rate of GDP per capita (%) and total tax (as % of GDP). *Source*: Computed from World Development Indicators (2020) and International Centre for Tax and Development (2020)

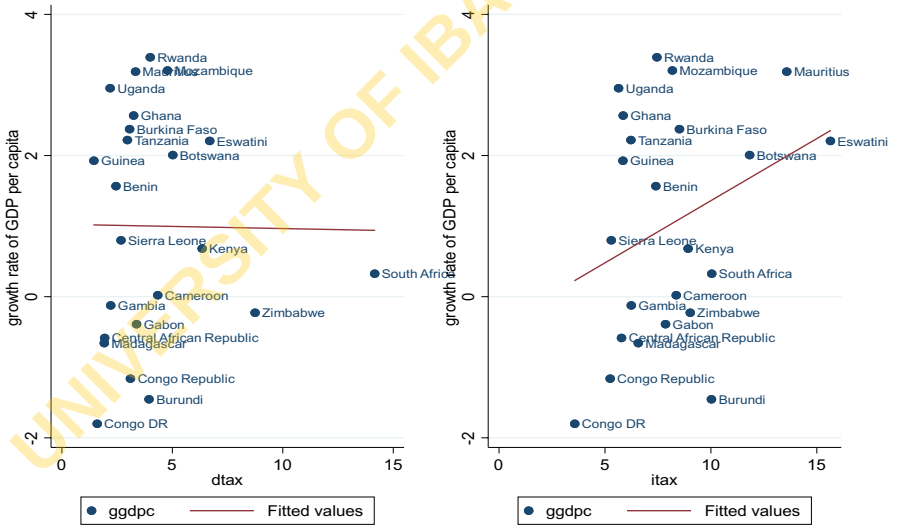

Fig. 2 Scatterplot of Growth rate of GDP per capita (%) and direct and indirect taxes (as % of GDP) *Source*: Computed from World Development Indicators (2020) and International Centre for Tax and Development (2020)

of countries in the region. Moreover, the exclusion of four highly indebted countries significantly influences the catching-up effect. Shifting our focus to the key variables of interest, different taxes positively influence growth across the models in both classifications. The coefficients of total taxes in FC are slightly lower than in SC. For instance, a 10% increase in total taxes leads to a 0.2% and 0.21% increase in the growth in the FC and SC, respectively. Disaggregated taxes (direct and indirect taxes) also positively contributed

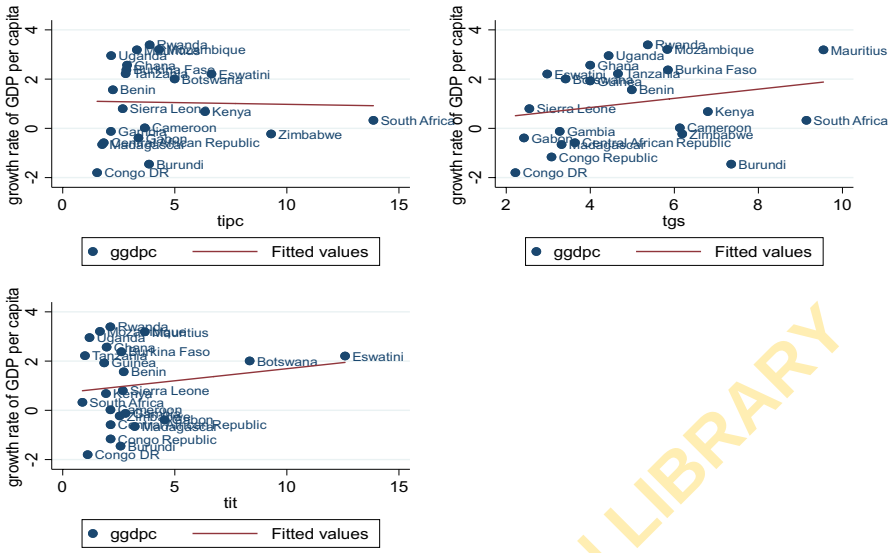

Fig. 3 Scatterplot of Growth rate of GDP per capita (%) and tax components (as % of GDP) *Source*: Computed from World Development Indicators (2020) and International Centre for Tax and Development (2020)

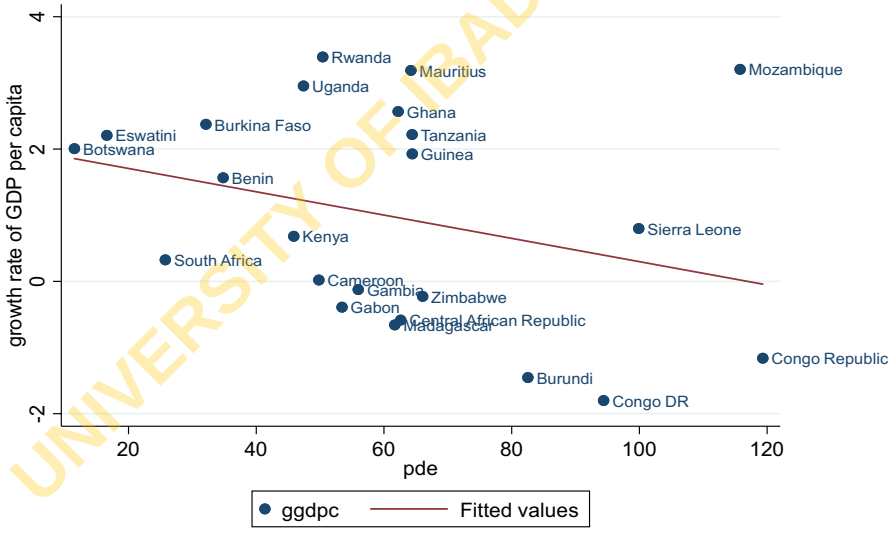

Fig. 4 Scatterplot of Growth rate of GDP per capita (%) and public debt (as % of GDP) *Source*: Computed from World Development Indicators (2020) and International Centre for Tax and Development (2020)

to economic growth in SSA countries for both FC and SC. Specifically, increasing direct taxes by 10% resulted in a 0.44% and 0.43% improvement in economic growth for FC and SC, respectively. Likewise, a 10% increase in indirect taxes amplified the economic growth of SSA countries for FC and SC by 0.18% and 0.19%, respectively.

Several deductions can be made from these results. First, taxes have the potential to generate the necessary resources for the government to finance its growth in the region. This argument aligns with the findings of Oyinlola and Adedeji (2021) and Ehrhart et al. (2014).

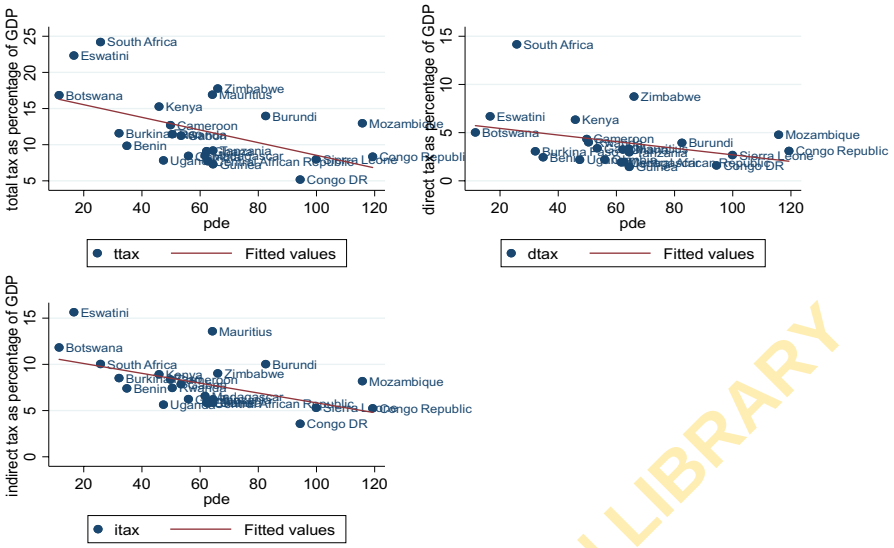

Fig. 5 Scatterplot of taxes (as a % of GDP) and Public Debt (as a % of GDP) *Source*: Computed from World Development Indicators (2020) and International Centre for Tax and Development (2020)

Second, the effect of taxes on growth remains small in terms of their magnification effect in the growth process. Third, there are negligible differences between FC and SC under different tax measures. Further decomposition of taxes into TIPC, TGS, and TIT revealed a positive relationship between these taxes and economic growth, but only in TIPC and TGS. Similarly, the difference in their effects on growth remains very small between FC and SC. The plausible reason for the small difference can be attributed to the low tax-to-GDP ratio in these countries (less than 15%). Among the control variables, only population and government final consumption expenditure are statistically significant across the models for FC and SC. While population positively influenced economic growth, government final consumption expenditure dampened growth.

Additionally, we tested for the existence of nonlinearity between taxes and economic growth, as presented in Table 4. The point estimates of the log of initial GDP per capita remained positive and significant across the models under FC and SC. Also, the results for the control variables are similar to previous results presented in Table 3. On the variables of interest, the results indicated a positive effect of total taxes on economic growth for both FC and SC. However, the coefficients of taxes squared are negative but not statistically significant. This showed that the evidence of the existence of a growth Laffer curve is weak with respect to total taxes. Notably, the effect of total taxes is higher for SC compared to FC. Looking at the disaggregated taxes (direct and indirect taxes), the result showed the existence of a growth Laffer curve for direct taxes, while the evidence for indirect taxes is weak. This suggested that the estimated tax rate that maximizes the inverted-U curve for direct taxes is positive. Also, the results of the decomposition of taxes revealed the existence of nonlinearity between TIPC and economic growth. Hence, there is strong evidence for the existence of a growth Laffer curve and a positive tax rate for only indirect taxes and TIPC. These results provide more details about the growth Laffer curve in SSA countries. Similar results were reported by Ehrhart et al. (2014), but their study only relied on government revenue to measure tax rates for developing countries. Additionally, Jaimovich and Rebelo (2017) confirmed the existence of a nonlinear relationship between taxes and

Table 3 Tax and growth (linear approach) *Source*: Authors' computation

	Full sample						Excluding four highly indebted countries					
Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
TTAX	0.0202***						0.0208***					
	(0.0035)						(0.00403)					
DTAX		0.0437***						0.0430***				
		(0.0070)						(0.0080)				
ITAX			0.0183***						0.0191***			
			(0.0051)						(0.0058)			
TIPC				0.0277***						0.0273***		
				(0.0070)						(0.0078)		
TGS					0.0266***						0.0299***	
					(0.0075)						(0.0084)	
TIT						0.0060						0.0053
						(0.0058)						(0.0063)
L.LGDPC	0.502***	0.462***	0.553***	0.495***	0.539***	0.571***	0.443***	0.414***	0.498***	0.461***	0.482***	0.525***
	(0.0415)	(0.0430)	(0.0414)	(0.0445)	(0.0420)	(0.0420)	(0.0492)	(0.0507)	(0.0487)	(0.0520)	(0.0493)	(0.0491)
LPOP	0.163***	0.184***	0.188***	0.184***	0.149***	0.232***	0.200***	0.226***	0.211***	0.211***	0.162***	0.247***
	(0.0436)	(0.0423)	(0.0449)	(0.0467)	(0.0488)	(0.0445)	(0.0499)	(0.0491)	(0.0516)	(0.0533)	(0.0553)	(0.0521)
INV	0.0012	0.0011	0.0019	0.0029	0.0027	0.0022	0.0017	0.0013	0.0032	0.0037	0.0045**	0.0039*
	(0.0016)	(0.0016)	(0.0016)	(0.0020)	(0.0016)	(0.0017)	(0.0022)	(0.0022)	(0.0023)	(0.0023)	(0.0022)	(0.0023)
GOVT	−0.008***	−0.008***	−0.0055**	−0.0061**	−0.0055**	−0.0034	−0.008***	−0.009***	−0.0060*	−0.0057*	−0.0067**	−0.0040
	(0.0027)	(0.0026)	(0.0027)	(0.0029)	(0.0027)	(0.0027)	(0.0031)	(0.0030)	(0.0031)	(0.0033)	(0.0031)	(0.0031)
FDI	−0.0007	−0.0027	0.0008	0.0022	0.0010	0.0011	0.00283	0.00026	0.0055	0.0026	0.0044	0.0061*
	(0.0024)	(0.0024)	(0.0024)	(0.0032)	(0.0024)	(0.0025)	(0.00330)	(0.0034)	(0.0034)	(0.0037)	(0.0034)	(0.0035)
TOP	0.0004	0.0003	0.0005	−0.0001	0.0006	0.0005	0.000247	0.0001	0.0001	−0.0003	0.0003	−0.00008
	(0.0006)	(0.0006)	(0.0006)	(0.0007)	(0.0006)	(0.0006)	(0.0007)	(0.0007)	(0.0008)	(0.0008)	(0.0008)	(0.0008)
Constant	0.792	0.843	0.0957	0.611	0.795	−0.611	0.672	0.583	0.154	0.493	1.001	−0.472

Table 3 (continued)

Variables	Full sample						Excluding four highly indebted countries					
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
	(0.612)	(0.602)	(0.611)	(0.664)	(0.692)	(0.605)	(0.680)	(0.669)	(0.688)	(0.733)	(0.771)	(0.690)
OBS	322	322	322	294	322	322	266	266	266	252	266	266
R-squared	0.648	0.655	0.624	0.639	0.624	0.609	0.651	0.655	0.630	0.628	0.632	0.614
No of countries	23	23	23	21	23	23	19	19	19	18	19	19
F-test	76.66	79.07	69.31	67.20	69.35	65.11	64.08	65.05	58.26	54.68	58.93	54.50
Prob > F	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Hausman test	117.63	145.40	120.87	96.97	130.35	118.38	149.06	122.35	109.16	72.14	111.81	98.99
P value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Note: LLGDPC is the lagged dependent variable (log of GDP per capita). TTAX, DTAX, ITAX, TIPC, TGS and TIT capture total tax, direct tax, indirect tax, taxes on income, profit, and capital gains, taxes on goods and services and taxes on international trade, respectively. These variables are expressed as a percentage of GDP. LPOP, INV, GOVT, FDI, and TOP are the control variables which represent log of population, gross fixed capital formation as percentage of GDP, government final consumption expenditure as a percentage of GDP, foreign direct investment (net inflows) as a percentage of GDP and trade openness, respectively. The four highly independent countries are Congo DR, Congo Rep., Sierra Leone and Mozambique. ***, **, and * denote 1%, 5%, and 10% levels of significance, respectively while values in ( ) are standard errors

economic growth. Hence, the present study provided a more detailed explanation of the growth Laffer curve or nonlinearity between taxes and economic growth in SSA countries.

The next discussion focuses on the role of public debt in the tax–growth relationship from a linear perspective under FC and SC (presented in Table 5). The coefficients of the log of initial GDP per capita remain positive and significant across the models. Moreover, the exclusion of highly indebted countries from the full sample lowered the conditional convergence of the countries in the SSA region. In addition, only population and government final consumption expenditure continued to exert a positive and negative influence on economic growth, respectively. Focusing on taxes with the inclusion of debt in the models, the results indicated that total taxes continued to exert a positive impact on economic growth for both FC and SC. Specifically, a 10% increase in total taxes enhanced economic growth by 0.18% and 0.12% for FC and SC, respectively. This showed a 0.06% growth rate difference between the FC and SC. In addition, direct taxes significantly facilitated economic growth in both classifications, but the effect is higher for FC. However, the effect of indirect taxes is stronger under FC compared to SC in terms of magnitude and level of significance. This suggests that the exclusion of four highly indebted countries significantly influenced the performance of indirect taxes. Considering the tax decomposition, the results showed that FC outperformed SC as taxes on income, profits, and capital gains and taxes on goods and services positively and significantly promoted economic growth under FC. In sum, this evidence points to the fact that some taxes can improve tax revenue mobilization to achieve strong and stable economic growth in SSA countries.

Furthermore, the coefficients of public debt are largely negative and statistically insignificant under FC. However, there is a twist to the results when the four highly indebted countries are excluded. Specifically, the coefficients are all negative but statistically significant in models 1, 3, and 5. This suggests that high debt can be detrimental to growth, though the effects are inconsequential statistically. This result contradicts the finding of Ehrhart et al. (2014), who reported a positive but not significant effect of debt on growth in developing countries. Next, the coefficients of the interaction terms (public debt and total taxes) are positive for FC and SC but only significant for SC. Moreover, this suggests that public debt enhanced the tax–growth relationship when the four countries are excluded, but this effect is very small, as it only contributed 0.002% if the public debt is increased by 10% at a given tax rate. Also, the coefficients of the interaction terms (public debt and direct taxes) are negative but statistically insignificant, while the coefficients of the interaction terms (public debt and indirect taxes) are positive and statistically significant. Further analysis shows that the effect of public debt on the tax–growth relationship is weak across other tax components under FC and SC.

The results of the nonlinear approach are presented in Table 6. Similar results are obtained for conditional convergence as reported in the previous tables. The effect of population and government final consumption expenditure continued to dominate among the control variables. Total taxes continued to exert a positive and significant effect on economic growth under FC, while the coefficient of total taxes turned out to be negative and statistically insignificant under SC. In this case, the exclusion of the four countries significantly influenced the result. Also, the coefficients of direct taxes are positive and significant under the FC but not statistically significant under the SC. Also, taxes on goods and services facilitated economic growth in both classifications. The result further revealed a weak nonlinearity between total taxes and economic growth in SSA countries. Among other tax components, the results showed strong evidence of nonlinearity or growth Laffer

Table 4 Tax and growth (nonlinear approach) *Source*: Authors' computation

	Full sample						Excluding four highly indebted countries					
Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
TTAX	0.0275***						0.0369***					
	(0.0094)						(0.012)					
TTAXS	−0.0002						−0.0005					
	(0.0003)						(0.0003)					
DTAX		0.0902***						0.103***				
		(0.0160)						(0.0200)				
DTAXS		−0.0032***						−0.0038***				
		(0.0010)						(0.0012)				
ITAX			0.0277**						0.0377**			
			(0.0129)						(0.0164)			
ITAXS			−0.0004						−0.0008			
			(0.0005)						(0.0006)			
TIPC				0.100***						0.111***		
				(0.0173)						(0.0201)		
TIPCS				−0.0047***						−0.0053***		
				(0.0010)						(0.0012)		
TGS					0.0089						0.0149	
					(0.0148)						(0.0173)	
TGSS					0.0017						0.0013	
					(0.0012)						(0.0013)	
TIT						0.0030						0.00006
						(0.0109)						(0.0124)
TITS						0.0002						0.0003
						(0.0005)						(0.0006)
L.LGDPC	0.508***	0.451***	0.558***	0.471***	0.520***	0.569***	0.444***	0.389***	0.499***	0.424***	0.470***	0.523***
	(0.0420)	(0.0424)	(0.0418)	(0.0433)	(0.0440)	(0.0424)	(0.0491)	(0.0502)	(0.0487)	(0.0507)	(0.0508)	(0.0494)
LPOP	0.152***	0.142***	0.180***	0.109**	0.164***	0.230***	0.182***	0.188***	0.200***	0.141***	0.174***	0.243***

Table 4 (continued)

Variables	Full sample						Excluding four highly indebted countries					
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
	(0.0457)	(0.0436)	(0.0460)	(0.0481)	(0.0498)	(0.0450)	(0.0515)	(0.0495)	(0.0524)	(0.0535)	(0.0565)	(0.0528)
INV	0.0010	0.0006	0.0017	0.0015	0.0031*	0.0022	0.0010	−0.00007	0.0028	0.0017	0.00489**	0.0041*
	(0.0016)	(0.0016)	(0.0017)	(0.0020)	(0.0017)	(0.0017)	(0.0023)	(0.0022)	(0.0023)	(0.0023)	(0.0023)	(0.0024)
GOVT	−0.0085***	−0.0092***	−0.0060**	−0.0076***	−0.0055**	−0.0033	−0.0091***	−0.0093***	−0.0068**	−0.0067**	−0.0066**	−0.0039
	(0.0027)	(0.0026)	(0.0028)	(0.0029)	(0.0027)	(0.0027)	(0.0031)	(0.0030)	(0.0032)	(0.0032)	(0.0031)	(0.0031)
FDI	−0.0008	−0.0039	0.0009	−0.0008	−0.0002	0.0011	0.0027	−0.0026	0.0056*	−0.0015	0.0040	0.0060*
	(0.0024)	(0.0024)	(0.0024)	(0.0031)	(0.0024)	(0.0025)	(0.0033)	(0.0034)	(0.0034)	(0.0036)	(0.0034)	(0.0035)
TOP	0.000381	0.000469	0.000425	4.82e−05	0.000626	0.000514	0.000176	0.000590	−2.79e−05	0.000202	0.000300	−0.00002
	(0.0006)	(0.0006)	(0.0006)	(0.0007)	(0.0006)	(0.0006)	(0.0007)	(0.0007)	(0.0008)	(0.0008)	(0.0008)	(0.0008)
Constant	0.896	1.473**	0.160	1.818***	0.729	−0.566	0.858	1.208*	0.256	1.659**	0.943	−0.393
	(0.625)	(0.624)	(0.617)	(0.694)	(0.693)	(0.621)	(0.692)	(0.684)	(0.692)	(0.751)	(0.773)	(0.710)
OBS	322	322	322	294	322	322	266	266	266	252	266	266
R-squared	0.648	0.667	0.625	0.665	0.627	0.610	0.654	0.669	0.632	0.658	0.634	0.614
No. of countries	23	23	23	21	23	23	19	19	19	18	19	19
F-test	67.10	72.72	60.65	65.75	61.11	56.81	56.52	60.49	51.26	54.32	51.69	47.56
Prob > F	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Hausman test	135.92	160.05	98.00	150.66	120.21	111.8	109.26	143.33	104.98	130.13	107.85	93.84
P value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Note: TTAXS, DTAXS, ITAXS, TIPCS, TGSS, are TITS denote squares of total tax, direct tax, indirect tax, taxes on income, profit, and capital gains, taxes on goods and services and taxes on international trade, respectively. ***, **, and * denote 1%, 5%, and 10% levels of significance, respectively while values in ( ) are standard errors

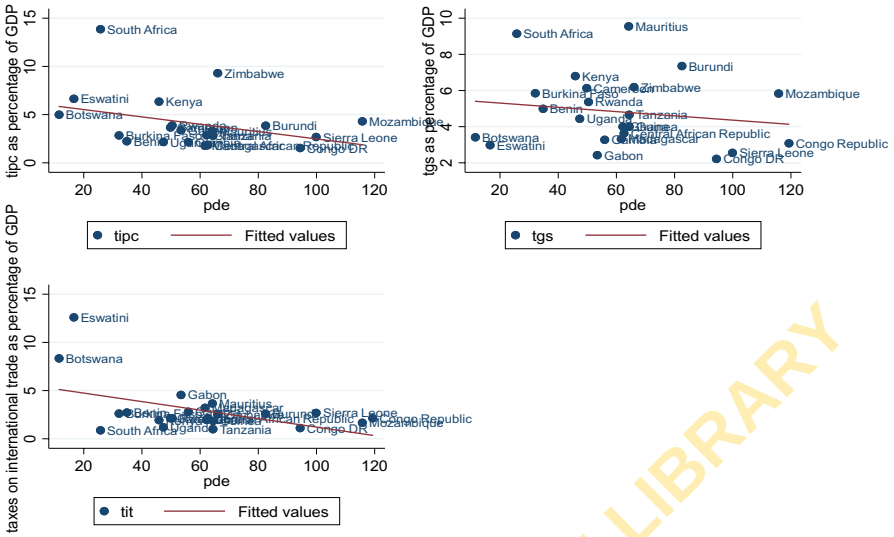

Fig. 6 Scatterplot of tax components (as a % of GDP) and Public Debt (as a % of GDP) *Source*: Computed from World Development Indicators (2020) and International Centre for Tax and Development (2020)

curves for only taxes on goods and services. The effect of public debt on economic growth remained weak under FC but negative and largely significant under SC. This finding reinforced the earlier argument under the linear approach. More so, the results showed that public debt significantly weakened the tax–growth relationship under SC. This suggests that high debt may undermine the effectiveness of taxes in the growth process. This supports the evidence reported by existing studies that public debt reduces economic growth (Ehrhart et al. 2014; Clements et al. 2003; Patillo et al. 2002). Additional results are presented in Table 19 (see Appendix), where direct and indirect taxes were jointly considered. The results indicate that both taxes facilitated economic growth. However, the growth Laffer curve does not hold in this case. More so, the effect of public debt is weak and statistically insignificant. While public debt positively affected the growth effect of direct tax, it undermined the growth effect of indirect tax.

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(b) Low-income countries versus middle-income countries

The study further explored other countries' classifications in the SSA region to provide a better understanding of the subject matter. Thus, we examined our chronological models for low- and middle-income countries. The reason for this consideration is to determine if the level of development provides more explanation for the relationship between public debt, tax and economic growth in the SSA region. Also, the World Bank (2019) recently issued a warning about growing debt in low-income countries, which has put many of them at high risk of distress. We first examined the effects of taxes and economic growth under linear and nonlinear approaches (see Tables 7 and 8 in the Appendix). The coefficients of the log of initial GDP per capita are positive and statistically significant in both low- and middle-income countries. However, conditional convergence is higher in low-income relative to that in middle-income countries. Control variables such as population, private

Table 5 Public debt, tax and growth (linear approach) *Source*: Authors' computation

	Full sample						Excluding four highly indebted countries					
Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
TTAX	0.0180***						0.0115**					
	(0.0047)						(0.0055)					
TTAXE	0.00003						0.0002**					
	(0.00004)						(0.00006)					
DTAX		0.0493***						0.0455***				
		(0.0111)						(0.0132)				
DTAXE		−0.00007						−0.00003				
		(0.0001)						(0.0001)				
ITAX			0.0126**						0.00316			
			(0.0060)						(0.00683)			
ITAXE			0.0001*						0.0004***			
			(0.00006)						(0.0001)			
TIPC				0.0427***						0.0381***		
				(0.0118)						(0.0138)		
TIPCE				−0.0002						−0.0001		
				(0.0001)						(0.0001)		
TGS					0.0228**						0.0109	
					(0.0098)						(0.0117)	
TGSE					0.00005						0.0003**	
					(0.00008)						(0.0001)	
TIT						0.0002						−0.0053
						(0.0075)						(0.0087)
TITE						0.0002						0.0004*
						(0.0001)						(0.0002)
PDE	−0.00016	0.0002	−0.0005	0.0005	−0.00006	−0.0002	−0.0017**	−0.00007	−0.0030***	0.0004	−0.0016**	−0.0006
	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0008)	(0.0006)	(0.0008)	(0.0006)	(0.0008)	(0.0005)
L.LGDPC	0.499***	0.461***	0.545***	0.490***	0.536***	0.564***	0.418***	0.416***	0.445***	0.464***	0.473***	0.506***

Table 5 (continued)

Variables	Full sample						Excluding four highly indebted countries					
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
	(0.0424)	(0.0437)	(0.0422)	(0.0451)	(0.0430)	(0.0430)	(0.0502)	(0.0511)	(0.0494)	(0.0524)	(0.0495)	(0.0504)
LPOP	0.180***	0.177***	0.216***	0.173***	0.166***	0.262***	0.216***	0.212***	0.236***	0.200***	0.169***	0.298***
	(0.0523)	(0.0512)	(0.0530)	(0.0556)	(0.0573)	(0.0544)	(0.0583)	(0.0581)	(0.0584)	(0.0624)	(0.0637)	(0.0652)
INV	0.0013	0.0010	0.0020	0.0024	0.0028*	0.0020	0.0021	0.0011	0.0033	0.0032	0.0046**	0.0034
	(0.00161)	(0.00161)	(0.00165)	(0.0021)	(0.0017)	(0.0017)	(0.0022)	(0.0023)	(0.0022)	(0.0024)	(0.0022)	(0.0024)
GOVT	−0.0082***	−0.0082***	−0.0057**	−0.0060**	−0.0053**	−0.0037	−0.0094***	−0.0086***	−0.0075**	−0.0056*	−0.0072**	−0.0036
	(0.0027)	(0.0027)	(0.0027)	(0.0030)	(0.0027)	(0.0027)	(0.0031)	(0.0031)	(0.0031)	(0.0033)	(0.0031)	(0.0031)
FDI	−0.0008	−0.0026	0.0006	0.0027	0.0001	0.0019	0.0008	0.00005	0.0024	0.0029	0.0022	0.0071**
	(0.0025)	(0.0025)	(0.0025)	(0.0032)	(0.0025)	(0.0026)	(0.0034)	(0.0035)	(0.0034)	(0.0038)	(0.0035)	(0.0035)
TOP	0.0003	0.0004	0.0004	0.0002	0.0006	0.0004	−0.00006	0.0002	0.0001	−0.000002	0.0005	−0.0003
	(0.0006)	(0.0006)	(0.0006)	(0.0007)	(0.0006)	(0.0006)	(0.0007)	(0.0008)	(0.0007)	(0.000853)	(0.0008)	(0.0008)
Constant	0.592	0.930	−0.229	0.751	0.557	−1.015	0.758	0.786	0.304	0.603	1.077	−1.091
	(0.728)	(0.726)	(0.721)	(0.792)	(0.809)	(0.742)	(0.805)	(0.812)	(0.797)	(0.871)	(0.900)	(0.874)
OBS	322	322	322	294	322	322	266	266	266	252	266	266
R-squared	0.648	0.655	0.629	0.642	0.625	0.612	0.660	0.655	0.654	0.629	0.641	0.619
No of countries	23	23	23	21	23	23	19	19	19	18	19	19
F-test	59.43	61.21	54.58	52.65	53.72	50.83	51.40	50.24	49.93	42.42	47.12	42.99
Prob > F	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Hausman test	240.09	141.70	115.84	124.04	121.33	99.07	138.15	133.20	132.84	100.75	118.74	94.42
P value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Note: PDE, TTAXE, DTAXE, ITAXE, TIPCE, TGSE, and TITE represent public debt as percentage of GDP, interaction of total tax and public debt, interaction of direct tax and public debt, interaction of indirect tax and public debt, interaction of taxes on income, profits and income gains and public debt, interaction of taxes on goods and services and public debt, and interaction of taxes on international trade and public debt, respectively. ***, **, and * denote 1%, 5%, and 10% levels of significance, respectively while values in ( ) are standard errors

investment, and trade openness positively and significantly promoted economic growth in low-income countries, while only population significantly enhanced growth in middle-income countries. Additionally, private investment facilitated economic growth in low-income countries relative to that in middle-income countries. The coefficients of government final consumption expenditure are negative and statistically significant in low-income countries, while their significance is weak in the case of middle-income countries.

Shifting attention to taxes, the coefficients of total taxes are positive and statistically significant in both groups of countries. In terms of magnitude, the effect is higher in low-income compared to middle-income countries. For instance, increasing total taxes by 10% leads to a 0.20% and 0.17% increase in economic growth in low- and middle-income countries, respectively. On disaggregated taxes, both direct and indirect taxes positively and significantly facilitated economic growth in both groups of countries. Further evidence showed that the effect of direct taxes is higher in middle-income relative to that in low-income countries, while the effect of indirect taxes is larger in low-income compared to that in middle-income countries. Specifically, the growth rate of middle-income countries is higher by 0.09% when direct taxes are increased by 10%. On the other hand, the growth rate of low-income countries is higher by 0.04% when indirect taxes are increased by 10%. Further decomposition of taxes indicated that the components of direct taxes (taxes on income, profits, and capital gains) enhanced growth in middle-income countries, while the components of indirect taxes (taxes on goods and services and taxes on international trade) promoted growth in low-income countries. This suggests that different kind of taxes determine economic growth in low- and middle-income countries.

Additionally, the results of the nonlinear approach are presented in Table 8 in the Appendix. The results showed a positive and significant influence of the log of initial GDP per capita. More so, the conditional convergence in low-income countries is higher than in middle-income countries. Also, population, private investment, and trade openness continued to exert a positive and significant influence on economic growth in low-income countries, while only population exerted a positive and significant effect on economic growth in middle-income countries. Focusing on taxes, there are major changes in the results. The effect of total taxes is positive but not statistically significant in low-income countries, while its effect is positive and statistically significant in middle-income countries. Further analysis considering disaggregated taxes revealed that only direct taxes positively and significantly influenced economic growth in low-income countries, while both direct and indirect taxes significantly promoted economic growth in middle-income countries. More so, the effect of direct taxes is higher in low-income countries, while the effect of indirect taxes is higher in middle-income countries. These results are opposite of the earlier findings under the linear approach. Thus, this significant change can be attributed to the specification approach. More so, taxes on income, profits, and capital gains promoted economic growth to a higher extent in middle-income relative to that in low-income countries. Taxes on international trade serve as a drag on economic growth but the effect is higher in middle-income countries. On the nonlinearity of tax and economic growth, there is evidence for a growth Laffer curve in only middle-income countries when total taxes are considered. In addition, there is also evidence of a growth Laffer curve in low- and middle-income countries when direct taxes are considered. Only middle-income countries have evidence for a growth Laffer curve under indirect taxes. However, when tax sub-component (TIPC) is considered, there is a growth Laffer curve in both low- and middle-income countries. Thus, we can conclude that the estimated tax rate (that is, TIPC) that maximizes the growth Laffer curve is positive in both low- and middle-income countries but depends on tax types and their components.

Table 6 Tax, public debt and growth (nonlinear approach) *Source*: Authors' computation

	Full sample						Excluding four highly indebted countries					
Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
TTAX	0.0345**						−0.0222					
	(0.0139)						(0.0219)					
TTAXS	−0.0005						0.0010*					
	(0.0004)						(0.0006)					
TTAXE	−0.0001						0.0008***					
	(0.0001)						(0.0003)					
TTAXSE	0.00001						−0.00002**					
DTAX		0.0741***						0.0403				
		(0.0235)						(0.0293)				
DTAXS		−0.0013						0.00123				
		(0.00172						(0.0020)				
DTAXE		0.0002						0.0010***				
		(0.0002)						(0.0004)				
DTAXSE		−0.00003						−0.00008***				
		(0.00002)						(0.00003)				
ITAX			0.0250						−0.0451			
			(0.0178)						(0.0286)			
ITAXS			−0.0007						0.0019*			
			(0.0007)						(0.0011)			
ITAXE			−0.0003*						0.0010**			
			(0.0002)						(0.0005)			
ITAXSE			0.00003***						−0.00003			
			(1.24e−05)						(0.00003)			
TIPC				0.0810***						0.0454		
				(0.0248)						(0.0304)		
TIPCS				−0.0016						0.00101		
				(0.0019)						(0.0022)		

Table 6 (continued)

	Full sample						Excluding four highly indebted countries					
Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
TIPCE				0.0003						0.00100***		
				(0.0002)						(0.0004)		
TIPCSE				−0.00004*						−0.0001***		
				(0.00002)						(0.00003)		
TGS					0.0722***						0.0652*	
					(0.0260)						(0.0333)	
TGSS					−0.0059**						−0.0057*	
					(0.0027)						(0.0033)	
TGSE					−0.0007***						−0.0005	
					(0.0003)						(0.0004)	
TGSSE					0.000085***						0.00007**	
					(0.00003)						(0.00004)	
TIT						−0.0141						−0.0443*
						(0.0165)						(0.0233)
TITS						0.0003						0.0018
						(0.0009)						(0.0014)
TITE						0.0001						0.0008
						(0.0003)						(0.0005)
TITSE						0.00003						−0.00002
						(0.00005)						(0.00007)
PDE	0.0005	−0.0002	0.0005	−0.00004	0.0010*	−0.0002	−0.0057***	−0.0021**	−0.0057***	−0.0018**	0.0003	−0.0012
	(0.0006)	(0.0005)	(0.0006)	(0.0005)	(0.0005)	(0.0005)	(0.0018)	(0.0008)	(0.0021)	(0.0008)	(0.0012)	(0.0009)
L.LGDPC	0.491***	0.453***	0.502***	0.463***	0.501***	0.552***	0.423***	0.378***	0.441***	0.401***	0.457***	0.484***
	(0.0439)	(0.0433)	(0.0450)	(0.0437)	(0.0444)	(0.0440)	(0.0498)	(0.0501)	(0.0507)	(0.0506)	(0.0508)	(0.0516)
	(0.000005)						(0.00001)					
LPOP	0.166***	0.159***	0.213***	0.135**	0.173***	0.265***	0.236***	0.218***	0.256***	0.179***	0.184***	0.303***

Table 6 (continued)

Variables	Full sample						Excluding four highly indebted countries					
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
	(0.0537)	(0.0516)	(0.0535)	(0.0555)	(0.0565)	(0.0551)	(0.0594)	(0.0575)	(0.0594)	(0.0612)	(0.0640)	(0.0652)
INV	0.0012	0.0005	0.0023	0.0009	0.0030*	0.0021	0.0019	−0.0002	0.0036	0.0010	0.0049**	0.0039
	(0.0016)	(0.0016)	(0.0017)	(0.0020)	(0.0016)	(0.0020)	(0.0023)	(0.0022)	(0.0023)	(0.0023)	(0.0022)	(0.0024)
GOVT	−0.0087***	−0.0091***	−0.0055**	−0.0079***	−0.0043	−0.0034	−0.0094***	−0.0098***	−0.0072**	−0.0079**	−0.0056*	−0.0031
	(0.0027)	(0.0026)	(0.0027)	(0.0029)	(0.0027)	(0.0027)	(0.0031)	(0.0030)	(0.0031)	(0.0032)	(0.0032)	(0.0031)
FDI	−0.0012	−0.0034	−0.0013	−0.0002	−0.0017	0.0018	0.0009	−0.0042	0.0018	−0.0028	0.0018	0.0067*
	(0.0025)	(0.0025)	(0.0026)	(0.0031)	(0.0027)	(0.0026)	(0.0034)	(0.0035)	(0.0035)	(0.0037)	(0.0035)	(0.0035)
TOP	0.0001	0.0005	0.0004	0.0004	0.0010	0.0004	0.0006	0.0006	0.0006	0.0003	0.0007	−0.0001
	(0.0006)	(0.0006)	(0.0006)	(0.0007)	(0.0006)	(0.0006)	(0.0008)	(0.0008)	(0.0008)	(0.0008)	(0.0008)	(0.0008)
CONSTANT	0.778	1.215	0.0589	1.450*	0.601	−0.951	0.605	0.964	0.243	1.363	0.804	−0.954
	(0.741)	(0.737)	(0.725)	(0.796)	(0.807)	(0.752)	(0.800)	(0.800)	(0.798)	(0.853)	(0.913)	(0.875)
OBS	322	322	322	294	322	322	266	266	266	252	266	266
R−SQUARED	0.651	0.669	0.638	0.673	0.639	0.614	0.670	0.682	0.658	0.674	0.646	0.625
NO OF COUNTRIES	23	23	23	21	23	23	19	19	19	18	19	19
F-TEST	48.78	52.95	46.16	48.94	46.33	41.73	43.60	45.99	41.31	41.93	39.21	35.83
PROB > F	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
HAUSMAN TEST	105.43	144.63	91.31	138.89	151.48	97.05	142.16	144.63	123.38	139.36	121.42	85.75
P value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Note: TTAXSE, DTAXSE, ITAXSE, TIPCSE, TGSSE, and TITSE represent interaction of squared total tax and public debt, interaction of squared direct tax and public debt, interaction of squared indirect tax and public debt, interaction of squared taxes on income, profits and income gains and public debt, interaction of squared taxes on goods and services and public debt, and interaction of squared taxes on international trade and public debt, respectively. Also, TTAXSE, DTAXSE, ITAXSE, TIPCSE, TGSSE, and TITSE represent interaction of squared total tax and public debt, interaction of squared direct tax and public debt, interaction of squared indirect tax and public debt, interaction of squared taxes on income, profits and income gains and public debt, interaction of squared taxes on goods and services and public debt, and interaction of squared taxes on international trade and public debt. ***, **, and * denote 1%, 5%, and 10% levels of significance, respectively while values in ( ) are standard errors

In Tables 9 and 10 (see Appendix), the role of public debt was introduced under linear and nonlinear approaches. The results from the linear approach showed that the effect of public debt on economic growth is weak in low-income countries relative to that in middle-income countries. While public debt reduced economic growth at a given total tax level in low-income countries, public debt enhanced economic growth at a given total tax level in middle-income countries. In addition, public debt reduced the effectiveness of direct taxes and taxes on income, profits, and capital gains in low-income countries, while it enhanced the effectiveness of only indirect taxes in middle-income countries. Mixed results were observed under a nonlinear relationship, but public debt largely undermined the effectiveness of most tax measures in middle-income countries.

(c) Resource-intensive countries versus non-resource-intensive countries

Resource intensity also played a significant role in financing options for growth in the region. Thus, the study further examined the comparative effect of public debt on the tax-growth nexus in resource-intensive and non-resource-intensive countries. Resource-intensive countries tend to accumulate debt relative to non-resource-intensive countries in the SSA region. Thus, this hypothesis is subjected to empirical examination to see if the effect of public debt on the tax–growth relationship is high or low in these groups of countries. Starting with baseline estimations (see Tables 11 and 12 in the Appendix), the effect of taxes on economic growth is considered using linear and nonlinear approaches. From the linear approach (Tables 11 in the Appendix), the coefficients of log of initial GDP per capita are positive and statistically significant across the models in both groups. Also, the results revealed that the catch-up effect of resource-intensive countries is lower than that of non-resource-intensive countries, judging by their coefficients. Furthermore, the coefficients of total taxes are positive and statistically significant for both groups of countries. However, the effect of total taxes on economic growth in resource-intensive countries is slightly higher by 0.001% when compared to non-resource-intensive countries. In addition, all the coefficients of other tax measures are positive and statistically significant in resource-intensive countries. On the other hand, all the coefficients of other tax measures are positive but only statistically significant for direct taxes and taxes on income, profits, and capital gains in non-resource-intensive countries. This suggests that taxes have the potential to significantly promote economic growth in resource-intensive countries, while non-resource-intensive countries can leverage direct taxes to finance their growth. From the nonlinear approach, there is evidence for the growth Laffer curve in resource-intensive countries when total taxes are considered, but the evidence is weak in the case of non-resource-intensive countries. When other tax measures are considered, the results still showed more evidence for the growth Laffer curve in resource-intensive countries relative to that in the non-resource-intensive countries.

In Tables 13 and 14 (see Appendix), we present the results for the role of public debt in the tax–growth relationship for linear and nonlinear approaches. Starting with the linear approach (in Table 13), the positive effect of taxes is more pronounced in resource-intensive countries relative to that in the non-resource-intensive countries. More so, the effect of public debt on economic growth is weak in both groups of countries. Examining the role of public debt in the tax–growth relationship, public debt retarded the effectiveness of only TIPC, while it accelerated the potency of taxes on goods and services in resource-intensive countries. On the other hand, public debt complemented the efficiency of indirect taxes and taxes on goods and services in the non-resource-intensive countries. From a nonlinear

perspective, different tax measures continued to promote economic growth in resource-intensive countries while they largely dampened growth in the non-resource-intensive countries. Additionally, public debt exerted a positive influence on economic growth in resource-intensive countries, while it largely undermined economic growth in the non-resource-intensive countries. The results further show that public debt reduced the potency of taxes in the growth process in resource-intensive countries. This implies that high public debt may erode the tax revenue required to finance growth in resource-intensive countries. However, this evidence is not robust and remained very weak in the case of non-resource-intensive countries.

(d) Fragile countries versus non-fragile countries

The final phase of the empirical analysis focuses on fragile and non-fragile countries. According to the International Monetary Fund (2018), a substantial number of countries in the SSA region are classified as countries in a fragile situation. Thus, this study attempted to provide further evidence on the relationship between public debt, tax, and economic growth in fragile and non-fragile countries. We followed the earlier chronological approach by first examining the role of tax in growth under linear and nonlinear approaches (see Tables 15 and 16 in the Appendix). From Table 15, the coefficients of logged GDP per capita are positive and statistically significant in both fragile and non-fragile countries. However, fragile countries have lower conditional convergence relative to that for non-fragile countries. Considering total taxes, the coefficients are positive and statistically significant in both groups of countries, but the effect is higher in the fragile countries. However, the other tax measures positively and significantly amplified economic growth in non-fragile countries compared to that in the fragile countries. Shifting our focus to the nonlinear approach (as presented in Table 16), most of the tax measures positively and significantly facilitated economic growth in non-fragile countries relative to that in the fragile countries. Moreover, there is more evidence for the growth Laffer curve under different tax measures for non-fragile countries. However, the evidence is frail in the case of fragile countries.

Subsequently, the role of public debt in the tax-growth nexus is examined under the linear and nonlinear approaches (Tables 17 and 18). In Table 17, public debt negatively and significantly dampened growth in non-fragile countries, but the effect is positive and not statistically significant in fragile countries. This is rather surprising, as it would be expected that public debt significantly dampens growth in fragile countries due to conflict, weak institutions, or resource dependence (World Bank, 2018). However, the coefficients of interaction terms indicated that public debt largely undermined the effectiveness of tax measures in the growth process in fragile countries, while the level of public debt appeared to complement tax measures in amplifying growth in non-fragile countries. Furthermore, the nonlinear results are presented in Table 18. Similar results are obtained on the effect of public debt on economic growth as previously reported under the linear approach. On the

interaction of public debt and tax squared, the results are mixed for both fragile and non-fragile countries.

Concluding remarks

Given the growing concerns about fast-rising public debt and a slight improvement in tax revenue mobilization in the SSA countries, this study examined the effect of public debt on the tax-growth nexus using 23 SSA countries. It employed a dynamic fixed-effects model to address the objectives. Additionally, the peculiarities of SSA countries including level of development, resource intensity, and fragility are considered. With the full sample and the exclusion of four highly indebted countries, the results indicated that tax measures largely amplify economic growth with or without the inclusion of public debt. These findings suggest that taxes have the potential to address the revenue paucity in the SSA countries. This region can leverage tax potency to address the unstable growth in the region. In addition, we tested for the presence of the growth Laffer curve. The results under this classification indicated the presence of a growth Laffer curve when different tax measures were considered, but there was no evidence of such when total taxes were examined. This indicates that some tax rates that maximize the curve are positive. When the role of public debt was accounted for under the linear approach, the findings showed that public debt largely undermined economic growth under SC (that is, the second classification). Also, the findings showed that the interaction terms (public debt and total taxes) are positive for FC (first classification) and SC but only significant under SC. Moreover, this suggests that public debt enhanced the tax–growth relationship when the four countries are excluded, but the effect remained inconsequential. Under the nonlinear approach, the findings revealed weak nonlinearity between total taxes and economic growth in SSA countries. However, the evidence from the results showed the presence of nonlinearity or the growth Laffer curve for only taxes on goods and services. In addition, the effect of public debt on economic growth was found to be weak under FC but negative and largely significant under SC. Hence, this suggests that high public debt may undermine the effectiveness of taxes in the growth process.

Exploring different classifications, the findings suggest that different tax measures amplify growth in low- and middle-income countries under the linear approach with the exclusion of debt. Similarly, mixed results are obtained with respect to tax impacts and the presence of the growth Laffer curve under a nonlinear approach with the exclusion of debt. With the introduction of public debt, the findings from the linear approach indicated that the effect of public debt on economic growth is weak in low-income countries relative to that in middle-income countries. While public debt was found to reduce economic growth at a given total tax level in low-income countries, it supported economic growth at a given total tax level in middle-income countries. Additionally, we found evidence that public debt reduced the effectiveness of direct taxes and taxes on income, profits, and capital gains in low-income countries. In the case of middle-income countries, public debt enhanced the effectiveness of only indirect taxes in the growth process. Under a nonlinear

approach, mixed results were obtained. However, public debt largely undermined the effectiveness of most tax measures in middle-income countries.

When resource-intensive and non-resource-intensive countries were considered, the findings revealed an amplifying effect of total taxes on economic growth for both groups of countries. However, the effect is slightly higher in resource-intensive countries. In addition, other tax measures were found to be promoting economic growth in resource-intensive countries, while only direct taxes and taxes on income, profits, and capital gains facilitate economic growth in non-resource-intensive countries. From the nonlinear approach, there is more evidence for the growth Laffer curve in resource-intensive countries relative to that in the non-resource-intensive countries. The effect of public debt on economic growth is weak in both groups of countries. Also, public debt retarded the effectiveness of only taxes on income, profits, and capital gains in non-resource-intensive countries, while it accelerated the potency of taxes on goods and services in resource-intensive countries. Further evidence showed that public debt complemented the efficiency of indirect taxes and taxes on goods and services in non-resource-intensive countries. From a nonlinear approach, the findings further revealed that public debt reduced the potency of taxes in the growth process in resource-intensive countries. Nevertheless, this evidence is not robust and remained very weak in the case of non-resource-intensive countries.

From analyses of fragile and non-fragile countries, we found that other tax measures significantly amplified economic growth in the non-fragile countries compared to that in fragile countries using a linear approach. According to the nonlinear approach, most of the tax measures significantly facilitated economic growth in non-fragile countries relative to that in fragile countries. More so, there is more evidence for the growth Laffer curve under different tax measures for fragile countries compared to that in non-fragile countries. The subsequent findings showed that public debt dampened growth in non-fragile countries, but the effect is weak in fragile countries. However, further findings indicated that public debt largely undermined the effectiveness of tax measures in the growth process in fragile countries, while the level of public debt appeared to complement tax measures in amplifying growth in non-fragile countries. Under the nonlinear approach, the results of the interaction of public debt and tax squared are mixed for both fragile and non-fragile countries.

From the foregoing, our analysis demonstrated the importance of taxes in promoting economic growth in SSA countries. Thus, these countries should carefully explore their tax potential and leverage productive ones to address their growth challenges. This also highlights that SSA countries should improve their capacity for tax mobilization due to the problem of resource paucity in the region. In addition, public debt should be utilized cautiously so that the growth effects of taxes are not eroded by huge interest payments. Furthermore, special attention should be given to non-resource-intensive and fragile countries in the areas of tax mobilization and the effectiveness of public debt. Finally, the accumulation of public debt should be carefully monitored in fragile and non-resource-intensive countries.

Appendix

See Tables 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19 , 20 , and 21

Table 7 Tax and growth (linear approach) *Source*: Authors' computation

	Low-income countries						Middle-income countries					
Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
TTAX	0.0198***						0.0172***					
	(0.0053)						(0.0050)					
DTAX		0.0386***						0.0472***				
		(0.0089)						(0.0144)				
ITAX			0.0187**						0.0149**			
			(0.0093)						(0.0059)			
TIPC				0.0167*						0.0850***		
				(0.0085)						(0.0151)		
TGS					0.0052						0.0441***	
					(0.0131)						(0.0083)	
TIT						0.0280**						−0.0037
						(0.0125)						(0.0060)
L.LGDPC	0.486***	0.437***	0.541***	0.501***	0.543***	0.546***	0.428***	0.411***	0.454***	0.342***	0.367***	0.469***
	(0.0576)	(0.0598)	(0.0572)	(0.0628)	(0.0579)	(0.0570)	(0.0610)	(0.0628)	(0.0613)	(0.0600)	(0.0594)	(0.0630)
LPOP	0.118*	0.160***	0.126*	0.152**	0.150*	0.207***	0.233***	0.201***	0.275***	0.126	0.246***	0.307***
	(0.0607)	(0.0583)	(0.0648)	(0.0646)	(0.0799)	(0.0629)	(0.0656)	(0.0700)	(0.0645)	(0.0804)	(0.0593)	(0.0652)
INV	0.0044*	0.0040*	0.0054**	0.0061**	0.0060**	0.0047*	−0.0018	−0.0016	−0.0015	−0.0125***	−0.0002	−0.0007
	(0.0024)	(0.0024)	(0.0024)	(0.0026)	(0.0025)	(0.0025)	(0.0021)	(0.0021)	(0.0022)	(0.0045)	(0.0020)	(0.0022)
GOVT	−0.0145***	−0.0137***	−0.0112***	−0.0099**	−0.0084**	−0.0091**	−0.0032	−0.0044	−0.0030	−0.0044	−0.0026	−0.0037
	(0.0039)	(0.0037)	(0.0040)	(0.0041)	(0.0040)	(0.0037)	(0.0043)	(0.0043)	(0.0044)	(0.0049)	(0.0040)	(0.0045)
FDI	−0.0005	−0.0017	0.0016	0.0011	0.0022	0.0032	−0.0050	−0.0065**	−0.0051	−0.0130**	−0.0078**	−0.0068**
	(0.0038)	(0.0038)	(0.0038)	(0.0041)	(0.0039)	(0.0038)	(0.0032)	(0.0032)	(0.0033)	(0.0063)	(0.0030)	(0.0034)
TOP	0.0020*	0.0018*	0.0020*	0.0016	0.0020*	0.0019*	−0.0009	−0.0009	−0.0011	−0.00001	−0.0010	−0.0013
	(0.0011)	(0.0011)	(0.0011)	(0.0012)	(0.0011)	(0.0011)	(0.0008)	(0.0008)	(0.0008)	(0.0009)	(0.0007)	(0.0008)
Constant	1.244	0.972	0.774	0.672	0.446	−0.479	0.992	1.625	0.264	3.248***	1.266	−0.151
	(0.875)	(0.834)	(0.906)	(0.925)	(1.155)	(0.890)	(0.923)	(1.022)	(0.893)	(1.138)	(0.849)	(0.901)
OBS	182	182	182	168	182	182	126	126	126	112	126	126

Table 7 (continued)

Variables	Low-income countries						Middle-income countries					
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
R-squared	0.682	0.691	0.663	0.658	0.655	0.665	0.655	0.652	0.639	0.728	0.696	0.620
No of countries	13	13	13	12	13	13	9	9	9	8	9	9
F-Test	49.72	51.84	45.52	40.89	43.92	45.92	29.85	29.47	27.87	37.16	36.01	25.62
PROB > F	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Hausman Test	198.77	47.96	69.93	35.43	62.12	129.24	98.43	95.47	90.53	55.75	145.17	82.55
P value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Note: ***, **, and * denote 1%, 5%, and 10% levels of significance, respectively while values in ( ) are standard errors

Table 8 Tax and growth (nonlinear approach) *Source*: Authors' computation

	Low-income countries						Middle-income countries					
Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
TTAX	0.0178						0.0492***					
	(0.0135)						(0.0176)					
TTAXS	0.00008						−0.0009*					
	(0.0005)						(0.0005)					
DTAX		0.0968***						0.0677***				
		(0.0241)						(0.0254)				
DTAXS		−0.0039**						−0.0014				
		(0.0015)						(0.0014)				
ITAX			−0.0045						0.0725***			
			(0.0270)						(0.0228)			
ITAXS			0.0017						−0.0021**			
			(0.0019)						(0.0008)			
TIPC				0.105***						0.125***		
				(0.0261)						(0.0231)		
TIPCS				−0.0056***						−0.0030**		
				(0.0016)						(0.0013)		
TGS					0.0137						0.0157	
					(0.0284)						(0.0166)	
TGSS					−0.0010						0.0023*	
					(0.0030)						(0.0012)	
TIT						−0.143***						−0.0298**
						(0.0443)						(0.0140)
TITS						0.0296***						0.0012**
						(0.0074)						(0.0006)
L.LGDPC	0.483***	0.435***	0.517***	0.474***	0.550***	0.504***	0.424***	0.405***	0.443***	0.338***	0.330***	0.440***
	(0.0609)	(0.0588)	(0.0628)	(0.0610)	(0.0621)	(0.0555)	(0.0603)	(0.0630)	(0.0599)	(0.0589)	(0.0615)	(0.0637)
LPOP	0.124*	0.0752	0.145**	0.0355	0.150*	0.232***	0.214***	0.202***	0.247***	0.111	0.273***	0.306***

Table 8 (continued)

Variables	Low-income countries						Middle-income countries					
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
	(0.0700)	(0.0661)	(0.0683)	(0.0703)	(0.0802)	(0.0605)	(0.0656)	(0.0700)	(0.0638)	(0.0791)	(0.0601)	(0.0643)
INV	0.0045*	0.0030	0.0059**	0.0040	0.0058**	0.0046*	−0.0024	−0.0016	−0.0022	−0.0122***	0.0003	0.00001
	(0.0024)	(0.0024)	(0.0025)	(0.0025)	(0.0027)	(0.0024)	(0.0021)	(0.0021)	(0.0021)	(0.0041)	(0.0020)	(0.0022)
GOVT	−0.0144***	−0.0153***	−0.0109***	−0.0134***	−0.0082**	−0.0066*	−0.0037	−0.0040	−0.0045	−0.0029	−0.0032	−0.0027
	(0.0040)	(0.0037)	(0.0040)	(0.0040)	(0.0041)	(0.0035)	(0.0043)	(0.0043)	(0.0043)	(0.0049)	(0.0040)	(0.0045)
FDI	−0.00054	−0.0035	0.0009	−0.0017	0.0025	0.0037	−0.0058*	−0.0071**	−0.0052	−0.0149**	−0.0082***	−0.0078**
	(0.0038)	(0.0038)	(0.0039)	(0.0041)	(0.0040)	(0.0036)	(0.0032)	(0.0032)	(0.0032)	(0.0062)	(0.0030)	(0.0034)
TOP	0.0019*	0.0022**	0.0019*	0.0019	0.0019*	0.0016	−0.0012	−0.0007	−0.0019**	0.0002	−0.0011	−0.0011
	(0.0011)	(0.0011)	(0.0011)	(0.0012)	(0.0011)	(0.0011)	(0.0008)	(0.0008)	(0.0008)	(0.0009)	(0.0007)	(0.0008)
Constant	1.185	2.228**	0.680	2.569**	0.381	−0.438	1.088	1.578	0.555	3.373***	1.234	0.107
	(0.947)	(0.953)	(0.913)	(1.037)	(1.175)	(0.851)	(0.914)	(1.023)	(0.878)	(1.117)	(0.838)	(0.897)
OBS	182	182	182	168	182	182	126	126	126	112	126	126
R-squared	0.682	0.704	0.665	0.685	0.655	0.695	0.666	0.655	0.661	0.742	0.707	0.634
No. of countries	13	13	13	12	13	13	9	9	9	8	9	9
F-test	43.25	47.78	39.89	40.17	38.23	45.93	27.17	25.90	26.52	34.45	32.82	23.60
Prob > F	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Hausman test	110.43	53.15	52.50	55.74	61.52	23.23	99.31	92.04	92.91	126.96	143.26	88.59
P value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Note: ***, **, and * denote 1%, 5%, and 10% levels of significance, respectively while values in ( ) are standard errors

Table 9 Tax, public debt and growth (linear approach) *Source*: Authors' computation

	Low-income countries						Middle-income countries					
Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
TTAX	0.0392***						0.0077					
	(0.0091)						(0.0048)					
TTAXE	−0.0002**						0.0004***					
	(0.0001)						(0.00007)					
DTAX		0.0761***						0.0295*				
		(0.0167)						(0.017)				
DTAXE		−0.0004**						0.00022				
		(0.0002)						(0.0002)				
ITAX			0.0298**						0.0035			
			(0.0143)						(0.0052)			
ITAXE			−0.0001						0.0006***			
			(0.0001)						(0.0001)			
TIPC				0.0600***						0.0706***		
				(0.0180)						(0.0171)		
TIPCE				−0.0005***						0.0002		
				(0.0002)						(0.0002)		
TGS					0.00413						0.0319***	
					(0.0164)						(0.0108)	
TGSE					−0.00001						0.0001	
					(0.0001)						(0.0001)	
TIT						0.0379*						−0.00575
						(0.0204)						(0.00748)
TITE						−0.0001						0.0001
						(0.0002)						(0.0002)
PDE	0.0008	0.0004	0.0002	0.0005	−0.0004	−0.0002	−0.0029***	0.00004	−0.0034***	0.0011	0.0001	0.0008
	(0.0006)	(0.0005)	(0.0006)	(0.0005)	(0.0005)	(0.0005)	(0.0008)	(0.0007)	(0.0008)	(0.0009)	(0.0006)	(0.0006)
L.LGDPC	0.455***	0.412***	0.539***	0.468***	0.550***	0.556***	0.280***	0.369***	0.253***	0.265***	0.323***	0.408***

Table 9 (continued)

Variables	Low-income countries						Middle-income countries					
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
	(0.0589)	(0.0603)	(0.0582)	(0.0636)	(0.0596)	(0.0575)	(0.0610)	(0.0652)	(0.0592)	(0.0615)	(0.0620)	(0.0658)
LPOP	0.0219	0.0888	0.0592	0.0835	0.108	0.153**	0.353***	0.295***	0.427***	0.278***	0.321***	0.413***
	(0.0741)	(0.0696)	(0.0798)	(0.0763)	(0.0909)	(0.0758)	(0.0680)	(0.0839)	(0.0624)	(0.0899)	(0.0688)	(0.0751)
INV	0.0033	0.0022	0.0052**	0.0041	0.0057**	0.0043*	−0.0013	−0.0008	−0.0012	−0.0124***	0.0005	−0.0003
	(0.0024)	(0.0024)	(0.0025)	(0.0026)	(0.0025)	(0.0025)	(0.0019)	(0.0021)	(0.0018)	(0.0040)	(0.0020)	(0.0022)
GOVT	−0.0177***	−0.0154***	−0.0126***	−0.0119***	−0.0088**	−0.0100***	−0.0071*	−0.0071	−0.0048	−0.0068	−0.0040	−0.0064
	(0.0040)	(0.0037)	(0.0041)	(0.0040)	(0.0041)	(0.0037)	(0.0039)	(0.0045)	(0.0037)	(0.0048)	(0.0041)	(0.0045)
FDI	−0.0016	−0.0022	0.0009	0.0009	0.0015	0.0022	−0.0089***	−0.0053	−0.0094***	−0.0126**	−0.0071**	−0.0034
	(0.0038)	(0.0037)	(0.0039)	(0.0041)	(0.0039)	(0.0037)	(0.0032)	(0.0035)	(0.0031)	(0.0060)	(0.0033)	(0.0036)
TOP	0.0026**	0.0027**	0.0023**	0.0025**	0.0021*	0.0020*	−0.0017**	−0.0016*	−0.0019***	−0.0008	−0.0015*	−0.0020**
	(0.0011)	(0.0011)	(0.0011)	(0.0012)	(0.0011)	(0.0011)	(0.0007)	(0.0009)	(0.0007)	(0.0009)	(0.0008)	(0.0009)
Constant	2.830**	2.200**	1.799	1.901*	1.086	0.325	0.555	0.664	−0.289	1.673	0.578	−1.220
	(1.105)	(1.028)	(1.156)	(1.127)	(1.344)	(1.097)	(0.894)	(1.137)	(0.801)	(1.213)	(0.917)	(0.975)
OBS	182	182	182	168	182	182	126	126	126	112	126	126
R-squared	0.698	0.707	0.668	0.676	0.658	0.669	0.732	0.666	0.753	0.758	0.709	0.644
No. of countries	13	13	13	12	13	13	9	9	9	8	9	9
F-test	41	42.94	35.69	34.14	34.13	35.86	32.73	23.94	36.67	33.10	29.28	21.68
Prob > F	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Hausman Test	52.77	70.12	40.85	47.62	42.50	97.88	161.36	100.67	148.61	147.11	132.76	86.28
P value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Note: ***, **, and * denote 1%, 5%, and 10% levels of significance, respectively while values in ( ) are standard errors

Table 10 Tax, public debt and growth (nonlinear approach) *Source*: Authors' computation

	Low-income countries						Middle-income countries					
Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
TTAX	0.0440*						−0.0044					
	(0.0260)						(0.0204)					
TTAXS	−0.0003						0.0004					
	(0.0010)						(0.0006)					
TTAXE	−0.0002						0.0014***					
	(0.0002)						(0.0004)					
TTAXSE	0.000003						−0.00004***					
	(0.00001)						(0.00001)					
DTAX		0.131***						0.0120				
		(0.0408)						(0.0350)				
DTAXS		−0.0041						0.0011				
		(0.0032)						(0.0022)				
DTAXE		−0.0005						0.0012**				
		(0.0004)						(0.0006)				
DTAXSE		0.000009						−0.00007*				
		(0.00003)						(0.00004)				
ITAX			0.0314						0.0079			
			(0.0520)						(0.0235)			
ITAXS			−0.0007						0.0001			
			(0.0037)						(0.0009)			
ITAXE			−0.0004						0.0018***			
			(0.0003)						(0.0006)			
ITAXSE			0.00003						−0.00006**			
			(0.00003)						(0.00003)			
TIPC				0.128***						0.0689*		
				(0.0433)						(0.0358)		
TIPCS				−0.0032						−0.0006		

Table 10 (continued)

Variables	Low-income countries						Middle-income countries					
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
				(0.0036)						(0.0022)		
TIPCE				−0.0002						0.0011**		
				(0.0004)						(0.0005)		
TIPCSE				−0.00003						−0.00007*		
				(0.00004)						(0.00004)		
TGS					0.0731						0.0437	
					(0.0457)						(0.0281)	
TGSS					−0.0085*						−0.0013	
					(0.0045)						(0.0031)	
TGSE					−0.0011***						−0.0003	
					(0.0004)						(0.0004)	
TGSSE					0.0001***						0.00003	
					(0.00005)						(0.00003)	
TIT						−0.176***						−0.0482*
						(0.0658)						(0.0250)
TITS						0.0347***						0.0013
						(0.0113)						(0.0014)
TITE						0.0004						0.0003
						(0.0006)						(0.0005)
TITSE						−0.00006						0.00003
						(0.0001)						(0.00007)
PDE	0.0010	0.0005	0.0006	0.0004	0.0008	−0.0008	−0.0086***	−0.0022	−0.0074***	−0.0009	0.0010	0.0001
	(0.0009)	(0.0006)	(0.0010)	(0.0006)	(0.0007)	(0.0007)	(0.0024)	(0.0014)	(0.0022)	(0.0014)	(0.0009)	(0.0010)
L.LGDPC	0.449***	0.407***	0.503***	0.439***	0.507***	0.516***	0.277***	0.350***	0.264***	0.241***	0.307***	0.370***
	(0.0618)	(0.0611)	(0.0633)	(0.0620)	(0.0624)	(0.0578)	(0.0591)	(0.0651)	(0.0582)	(0.0585)	(0.0633)	(0.0676)
LPOP	0.0178	0.0272	0.0751	0.00483	0.109	0.182**	0.432***	0.358***	0.447***	0.333***	0.324***	0.429***

Table 10 (continued)

Variables	Low-income countries						Middle-income countries					
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
	(0.0820)	(0.0783)	(0.0809)	(0.0832)	(0.0889)	(0.0730)	(0.0747)	(0.0891)	(0.0644)	(0.0891)	(0.0693)	(0.0745)
INV	0.0035	0.0016	0.0059**	0.0019	0.0063**	0.0041*	−0.0019	−0.0007	−0.0020	−0.0113***	0.0005	−0.0002
	(0.0024)	(0.0024)	(0.0025	(0.0026)	(0.0025)	(0.0025)	(0.0019)	(0.0021)	(0.0018)	(0.0038)	(0.0020)	(0.0022)
GOVT	−0.0177***	−0.0166***	−0.0117***	−0.0158***	−0.0079*	−0.0069*	−0.0064*	−0.0072	−0.0055	−0.0057	−0.0039	−0.0057
	(0.0041)	(0.0037)	(0.0042)	(0.0040)	(0.0041)	(0.0036)	(0.0038)	(0.0044)	(0.0037)	(0.0046)	(0.0041)	(0.0045)
FDI	−0.0018	−0.0036	−0.0011	−0.0014	−0.0019	0.0031	−0.0109***	−0.0079**	−0.0098***	−0.0168***	−0.0074**	−0.0050
	(0.0038)	(0.0038)	(0.0041)	(0.0040)	(0.0042)	(0.0038)	(0.0032)	(0.0036)	(0.0031)	(0.0058)	(0.0033)	(0.0035)
TOP	0.0026**	0.0029***	0.0022*	0.0028**	0.0022**	0.0017	−0.0012	−0.0017	−0.0022***	−0.0008	−0.0012	−0.0019*
	(0.0011)	(0.0011)	(0.0011)	(0.0012)	(0.0011)	(0.0011)	(0.0009)	(0.009)	(0.0007)	(0.0009)	(0.0008)	(0.0010)
Constant	2.917**	3.103***	1.794	3.233**	1.232	0.345	−0.588	−0.107	−0.676	1.044	0.611	−1.063
	(1.177)	(1.175)	(1.156)	(1.245)	(1.331)	(1.051)	(0.970)	(1.191)	(0.822)	(1.184)	(0.935)	(0.956)
OBS	182	182	182	168	182	182	126	126	126	112	126	126
R-squared	0.698	0.716	0.673	0.704	0.676	0.700	0.753	0.681	0.767	0.788	0.714	0.666
No. of countries	13	13	13	12	13	13	9	9	9	8	9	9
F-test	33.18	36.14	29.51	31.39	30.02	33.46	29.41	20.54	31.80	31.50	24.08	19.18
Prob > F	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Hausman test	47.66	38.70	52.05	66.55	52.36	46.09	170.86	88.01	183.67	168.86	141.77	94.06
P value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Note: ***, **, and * denote 1%, 5%, and 10% levels of significance, respectively while values in ( ) are standard errors

Table 11 Tax and growth (linear approach) *Source*: Authors' computation

Variables	Resource intensive countries						Non-resource intensive countries					
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
TTAX	0.0189***						0.0179**					
	(0.0035)						(0.0073)					
DTAX		0.0310***						0.0607***				
		(0.0068)						(0.0158)				
ITAX			0.0264***						0.0085			
			(0.0057						(0.00901)			
TIPC				0.0150**						0.0804***		
				(0.0064)						(0.0191)		
TGS					0.0463***						0.0094	
					(0.0088)						(0.0128)	
TIT						0.0235**						0.0008
						(0.0091)						(0.0081)
L.LGDPC	0.443***	0.424***	0.481***	0.458***	0.484***	0.482***	0.545***	0.468***	0.593***	0.454***	0.585***	0.602***
	(0.0448)	(0.0473)	(0.0449)	(0.0515)	(0.0441)	(0.0469)	(0.0767)	(0.0789)	(0.0752)	(0.0784)	(0.0779)	(0.0757)
LPOP	0.213***	0.252***	0.217***	0.254***	0.135**	0.309***	0.157*	0.133*	0.190**	0.108	0.178**	0.202**
	(0.0486)	(0.0482)	(0.0501)	(0.0577)	(0.0552)	(0.0497)	(0.0797)	(0.0773)	(0.0802)	(0.0776)	(0.0856)	(0.0799)
INV	0.0016	0.0021	0.0018	0.0039*	0.0023	0.0023	−0.0004	−0.0011	0.0002	−0.0017	0.0008	0.0004
	(0.0015)	(0.0015)	(0.0015)	(0.0022)	(0.0015)	(0.0016)	(0.0039)	(0.0037)	(0.0039)	(0.0037)	(0.0040)	(0.0040)
GOVT	−0.0046*	−0.0043	−0.0030	−0.0020	−0.0023	−0.0014	−0.0183***	−0.0185***	−0.0158***	−0.0188***	−0.0158***	−0.0147**
	(0.0025)	(0.0026)	(0.0025)	(0.0032)	(0.0025)	(0.0026)	(0.0059)	(0.0056)	(0.0060)	(0.0056)	(0.0060)	(0.0058)
FDI	−0.0056**	−0.0067***	−0.0048*	−0.0029	−0.0052**	−0.0050*	0.0086	0.0027	0.0122**	−0.0014	0.0121**	0.0128**
	(0.0025)	(0.0025)	(0.0025)	(0.0044)	(0.0025)	(0.0027)	(0.0052)	(0.0054)	(0.0050)	(0.0058)	(0.0051)	(0.0050)
TOP	0.0004	0.0006	0.0003	0.0005	0.0002	0.0005	−0.0002	−0.0007	−0.0004	0.0000004	−0.0005	−0.0006
	(0.0006)	(0.0006)	(0.0006)	(0.0009)	(0.0006)	(0.0007)	(0.0012)	(0.0011)	(0.0012)	(0.0011)	(0.0012)	(0.0012)
Constant	0.477	0.0664	0.152	−0.238	1.364*	−1.208*	0.745	1.699	0.0352	2.091*	0.294	−0.140
	(0.689)	(0.688)	(0.692)	(0.822)	(0.777)	(0.679)	(1.065)	(1.082)	(1.039)	(1.096)	(1.172)	(1.048)
OBS	182	182	182	154	182	182	140	140	140	140	140	140

Table 11 (continued)

Variables	Resource intensive countries						Non-resource intensive countries					
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
R-squared	0.706	0.693	0.694	0.669	0.704	0.667	0.637	0.660	0.622	0.667	0.621	0.619
No. of countries	13	13	13	11	13	13	10	10	10	10	10	10
F-test	55.68	52.20	52.39	39.21	55.04	46.28	30.79	34.05	28.87	35.19	28.74	28.54
Prob > F	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Hausman test	214.59	203.55	148.64	63.03	239.43	159.29	28.61	44.21	23.56	35.80	29.05	30.92
P value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Note: ***, **, and * denote 1%, 5%, and 10% levels of significance, respectively while values in ( ) are standard errors

Table 12 Tax and growth (nonlinear approach) *Source*: Authors' computation

	Resource intensive countries						Non-resource intensive countries					
Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
TTAX	0.0348***						0.0010					
	(0.0091)						(0.0224)					
TTAXS	−0.0006*						0.0005					
	(0.0003)						(0.0006)					
DTAX		0.0668***						0.107***				
		(0.0152)						(0.0400)				
DTAXS		−0.0024***						−0.0034				
		(0.0009)						(0.0027)				
ITAX			0.0457***						−0.0194			
			(0.0151)						(0.028)			
ITAXS			−0.0011						0.0010			
			(0.0008)						(0.0010)			
TIPC				0.0817***						0.0840*		
				(0.0171)						(0.0430)		
TIPCS				−0.0041***						−0.0004		
				(0.0010)						(0.0037)		
TGS					0.0563***						−0.0222	
					(0.0199)						(0.0250)	
TGSS					−0.0012						0.0026	
					(0.0021)						(0.0018)	
TIT						0.0479**						−0.0142
						(0.0206)						(0.0164)
TITS						−0.0022						0.0007
						(0.0017)						(0.0007)
L.LGDPC	0.461***	0.427***	0.497***	0.456***	0.488***	0.488***	0.549***	0.444***	0.593***	0.453***	0.545***	0.589***
	(0.0455)	(0.0464)	(0.0461)	(0.0486)	(0.0446)	(0.0471)	(0.0770)	(0.0810)	(0.0752)	(0.0797)	(0.0822)	(0.0767)
LPOP	0.182***	0.209***	0.199***	0.165***	0.138**	0.312***	0.177**	0.106	0.207**	0.106	0.214**	0.188**

Table 12 (continued)

Variables	Resource intensive countries						Non-resource intensive countries					
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
	(0.0509)	(0.0501)	(0.0515)	(0.0586)	(0.0555)	(0.0497)	(0.0837)	(0.0800)	(0.0817)	(0.0814)	(0.0888)	(0.0810)
INV	0.0013	0.0016	0.0017	0.0019	0.0021	0.0022	−0.0002	−0.0013	0.0003	−0.0017	0.0014	0.0009
	(0.0015)	(0.0015)	(0.0015)	(0.0021)	(0.0015)	(0.0016)	(0.0039)	(0.0037)	(0.0039)	(0.0038)	(0.0040)	(0.0040)
GOVT	−0.0060**	−0.0054**	−0.0043	−0.0037	−0.0022	−0.0030	−0.0184***	−0.0177***	−0.0152**	−0.0187***	−0.0144**	−0.0147**
	(0.0026)	(0.0026)	(0.0027)	(0.0031)	(0.0024)	(0.002)	(0.0059)	(0.0056)	(0.0060)	(0.0057)	(0.0061)	(0.0058)
FDI	−0.0057**	−0.0073***	−0.0049*	−0.0054	−0.0054**	−0.0049*	0.00908*	0.00129	0.0125**	−0.00131	0.0112**	0.0124**
	(0.0025)	(0.0025)	(0.0025)	(0.0042)	(0.0025)	(0.0027)	(0.0052)	(0.0055)	(0.0050)	(0.0059)	(0.0051)	(0.0050)
TOP	0.0003	0.0008	0.0002	0.0007	0.0002	0.0006	0.00004	−0.0004	−0.0001	−0.00002	−0.0005	−0.0005
	(0.0006)	(0.0006)	(0.0006)	(0.0008)	(0.0006)	(0.0007)	(0.0012)	(0.0011)	(0.0012)	(0.0011)	(0.0012)	(0.0012)
Constant	0.767	0.655	0.261	1.074	1.292	−1.307*	0.529	2.140*	−0.101	2.125*	0.0603	0.182
	(0.700)	(0.712)	(0.695)	(0.838)	(0.790)	(0.681)	(1.100)	(1.136)	(1.046)	(1.157)	(1.177)	(1.091)
OBS	182	182	182	154	182	182	140	140	140	140	140	140
R-squared	0.713	0.705	0.697	0.706	0.705	0.670	0.639	0.664	0.625	0.667	0.627	0.622
No of countries	13	13	13	11	13	13	10	10	10	10	10	10
F-test	49.94	48.19	46.32	40.60	47.99	40.90	26.95	30.13	25.43	30.54	25.66	25.14
Prob > F	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Hausman test	126.08	81.75	106.06	178.89	204.77	157.04	30.12	35.81	26.34	46.42	32.02	30.09
P value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Note: ***, **, and * denote 1%, 5%, and 10% levels of significance, respectively while values in ( ) are standard errors

Table 13 Tax, public debt and growth (linear approach) *Source*: Authors' computation

Variables	Resource intensive countries						Non-resource intensive countries					
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
TTAX	0.0228***						0.0098					
	(0.0048)						(0.0101)					
TTAXE	−0.00006						0.0001					
	(0.00005)						(0.0001)					
DTAX		0.0427***						0.0818***				
		(0.0107)						(0.0279)				
DTAXE		−0.0002						−0.0002				
		(0.0001)						(0.0002)				
ITAX			0.0287***						−0.0010			
			(0.0073)						(0.011)			
ITAXE			−0.00004						0.0002*			
			(0.00008)						(0.0001)			
TIPC				0.0475***						0.0856***		
				(0.0119)						(0.0270)		
TIPCE				−0.0004***						−0.00001		
				(0.0001)						(0.0002)		
TGS					0.0592***						−0.0218	
					(0.0104)						(0.0192)	
TGSE					−0.0002**						0.0004**	
					(0.0001)						(0.0002)	
TIT						0.0115						0.0093
						(0.0118)						(0.0116)
TITE						0.0002						−0.0003
						(0.0001)						(0.0003)
PDE	0.0003	0.0002	0.00007	0.0006	0.0005	−0.0006	−0.0014	0.000007	−0.0019	−0.0004	−0.0021*	0.0008
	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0003)	(0.0004)	(0.0012)	(0.0008)	(0.0013)	(0.0008)	(0.0012)	(0.0008)
L.LGDPC	0.437***	0.421***	0.481***	0.426***	0.465***	0.489***	0.522***	0.469***	0.546***	0.457***	0.556***	0.604***

Table 13 (continued)

Variables	Resource intensive countries						Non-resource intensive countries					
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
	(0.0461)	(0.0483)	(0.0463)	(0.0515)	(0.0452)	(0.0475)	(0.0800)	(0.0792)	(0.0804)	(0.0792)	(0.0788)	(0.0774)
LPOP	0.189***	0.227***	0.197***	0.212***	0.106*	0.297***	0.157*	0.0731	0.197**	0.0652	0.211**	0.192*
	(0.0586)	(0.0581)	(0.0606)	(0.0650)	(0.0622)	(0.0604)	(0.0948)	(0.0960)	(0.0935)	(0.0954)	(0.100)	(0.0980)
INV	0.00149	0.00181	0.0018	0.0028	0.0021	0.0018	0.0008	−0.0020	0.0016	−0.0019	0.0016	0.0003
	(0.0015)	(0.0016)	(0.0016)	(0.0022)	(0.0015)	(0.0016)	(0.0040)	(0.0039)	(0.0040)	(0.0038)	(0.0033)	(0.0040)
GOVT	−0.0040	−0.0035	−0.0027	−0.0024	−0.0018	−0.0022	−0.0174***	−0.0194***	−0.0143**	−0.0195***	−0.0124**	−0.0154**
	(0.0026)	(0.0027)	(0.0026)	(0.0031)	(0.0024)	(0.0026)	(0.0060)	(0.0057)	(0.0060)	(0.0057)	(0.0062)	(0.0060)
FDI	−0.0061**	−0.0074***	−0.0052*	−0.0048	−0.0056**	−0.0049*	0.0072	0.0012	0.0098*	−0.0024	0.0097*	0.0128**
	(0.0026)	(0.0027)	(0.0027)	(0.0041)	(0.0026)	(0.0028)	(0.0054)	(0.0056)	(0.0053)	(0.0060)	(0.0052)	(0.0051)
TOP	0.00051	0.00083	0.0004	0.0012	0.0005	0.0007	−0.0008	-0.0003	−0.0008	0.000001	−0.0008	−0.0004
	(0.0006)	(0.0007)	(0.0007)	(0.0009)	(0.0006)	(0.0007)	(0.0013)	(0.0013)	(0.0012)	(0.0012)	(0.0012)	(0.0012)
Constant	0.845	0.425	0.449	0.544	1.904**	− 1.024	1.009	2.556*	0.305	2.738**	0.113	−0.0438
	(0.837)	(0.827)	(0.856)	(0.945)	(0.889)	(0.838)	(1.309)	(1.381)	(1.272)	(1.371)	(1.387)	(1.316)
OBS	182	182	182	154	182	182	140	140	140	140	140	140
R-squared	0.709	0.697	0.694	0.693	0.714	0.673	0.641	0.663	0.631	0.669	0.635	0.622
No. of countries	13	13	13	11	13	13	10	10	10	10	10	10
F-test	43.38	40.91	40.41	33.54	44.34	36.54	24.01	26.48	22.95	27.14	23.37	22.15
Prob > F	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Hausman test	246.81	162.32	70.64	195.25	77.39	123.82	30.44	46.77	24.58	47.811	26.82	2.12
P value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.990

Note: ***, **, and * denote 1%, 5%, and 10% levels of significance, respectively while values in ( ) are standard errors

Table 14 Tax, public debt and growth (nonlinear approach) *Source*: Authors' computation

Variables	Resource intensive						Non-resource intensive					
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
TTAX	0.0689***						−0.0699*					
	(0.0146)						(0.0390)					
TTAXS	−0.007***						0.0021**					
	(0.0005)						(0.0010)					
TTAXE	−0.0003***						0.0008*					
	(0.0001)						(0.0004)					
TTAXSE	0.00001**						−0.00002					
	(0.000005)						(0.00001)					
DTAX		0.0748***						−0.0521				
		(0.0214)						(0.0737)				
DTAXS		−0.0023						0.0135**				
		(0.0016)						(0.0065)				
DTAXE		−0.0001						0.0017**				
		(0.0002)						(0.0007)				
DTAXSE		0.0000002						−0.0002***				
		(0.00002)						(0.00006)				
ITAX			0.0851***						−0.106**			
			(0.0224)						(0.0463)			
ITAXS			−0.0034***						0.0035**			
			(0.0011)						(0.0016)			
ITAXE			−0.0006***						0.0007			
			(0.0002)						(0.0008)			
ITAXSE			0.00005***						−0.00001			
			(0.00002)						(0.00004)			
TIPC				0.0794***						0.0317		
				(0.0225)						(0.0757)		
TIPCS				−0.0021						0.0059		

Table 14 (continued)

Variables	Resource intensive						Non-resource intensive					
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
				(0.0017)						(0.0072)		
TIPCE				0.00004						0.0008		
				(0.0003)						(0.0009)		
TIPCSE				−0.00002						−0.00009		
				(0.00002)						(0.00009)		
TGS					0.127***						0.0400	
					(0.0312)						(0.0481)	
TGSS					−0.0078**						−0.0065	
					(0.0033)						(0.0048)	
TGSE					−0.0008***						−0.0007	
					(0.0003)						(0.0006)	
TGSSE					0.00008*						0.0001*	
					(0.00004)						(0.00005)	
TIT						0.0288						0.0023
						(0.0295)						(0.0350)
TITS						−0.0024						−0.0001
						(0.0021)						(0.0019)
TITE						−0.0004						−0.0004
						(0.0003)						(0.0008)
TITSE						0.0001*						0.00004
						(0.00006)						(0.0001)
L.LGDPC	0.430***	0.420***	0.463***	0.435***	0.454***	0.462***	0.516***	0.445***	0.496***	0.455***	0.533***	0.595***
	(0.0461)	(0.0484)	(0.0463)	(0.0498)	(0.0452)	(0.0496)	(0.0794)	(0.0794)	(0.0825)	(0.0805)	(0.0813)	(0.0811)
PDE	0.0016***	0.0003	0.0014**	0.0003	0.0013***	−0.00001	−0.0058**	−0.0034**	−0.0050	−0.0016	0.0006	0.0008
	(0.0006)	(0.0004)	(0.0006)	(0.0005)	(0.0005)	(0.00047)	(0.0028)	(0.0015)	(0.0033)	(0.0015)	(0.0019)	(0.0014)
LPOP	0.157***	0.206***	0.188***	0.187***	0.109*	0.323***	0.236**	0.110	0.249***	0.0797	0.235**	0.192*

Table 14 (continued)

Variables	Resource intensive						Non-resource intensive					
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
	(0.0580)	(0.0585)	(0.0599)	(0.0646)	(0.0629)	(0.0613)	(0.101)	(0.0959)	(0.0936)	(0.0995)	(0.100)	(0.0987)
INV	0.0014	0.0015	0.0015	0.0016	0.0017	0.0017	0.0024	−0.0009	0.0034	−0.0013	0.0023	0.00069
	(0.0015)	(0.0015)	(0.0015)	(0.0022)	(0.0015)	(0.0016)	(0.0040)	(0.0038)	(0.0040)	(0.0039)	(0.0039)	(0.0041)
GOVT	−0.0075***	−0.0047*	−0.0060**	−0.0041	−0.0016	−0.0026	−0.0159***	−0.0186***	−0.0106*	−0.0184***	−0.0098	−0.0150**
	(0.0027)	(0.00270)	(0.0027)	(0.0031)	(0.0025)	(0.0029)	(0.0060)	(0.0056)	(0.0061)	(0.0059)	(0.0063)	(0.006)
FDI	−0.0066**	−0.0074***	−0.0057**	−0.0050	−0.0068***	−0.0053*	0.0077	−0.0059	0.0078	−0.0032	0.0088*	0.0128**
	(0.0026)	(0.0026)	(0.0026)	(0.0044)	(0.0026)	(0.0028)	(0.0053)	(0.0060)	(0.0053)	(0.0061)	(0.0052)	(0.0052)
TOP	0.0005	0.0008	0.0003	0.0008	0.0007	0.0007	−0.0001	0.0007	−0.0001	0.00049	−0.0004	−0.0006
	(0.0006)	(0.0007)	(0.0006)	(0.0009)	(0.0007)	(0.0007)	(0.0014)	(0.0013)	(0.0012)	(0.0014)	(0.0012)	(0.0013)
Constant	1.186	0.713	0.559	0.841	1.826**	−1.239	0.389	2.330*	0.349	2.572*	−0.280	0.0404
	(0.821)	(0.837)	(0.830)	(0.939)	(0.915)	(0.841)	(1.332)	(1.373)	(1.247)	(1.420)	(1.405)	(1.338)
OBS	182	182	182	154	182	182	140	140	140	140	140	140
R-squared	0.728	0.708	0.717	0.719	0.724	0.681	0.654	0.686	0.652	0.671	0.646	0.623
No. of countries	13	13	13	11	13	13	10	10	10	10	10	10
F-test	38.52	34.80	36.43	30.74	37.59	30.67	20.45	23.68	20.29	22.10	19.71	17.91
Prob > F	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Hausman test	132.46	125.66	129.83	117.73	160.90	275.77	31.69	39.60	36.49	38.84	33.65	23.65
P value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001

Note: ***, **, and * denote 1%, 5%, and 10% levels of significance, respectively while values in ( ) are standard errors

Table 15 Tax and growth (linear approach) *Source*: Authors' computation

Variables	Fragile countries						Non-fragile countries					
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
TTAX	0.0195***						0.0184***					
	(0.0066)						(0.0039)					
DTAX		0.0385***						0.0468***				
		(0.0116)						(0.0093)				
ITAX			0.0224*						0.0153***			
			(0.0116)						(0.0050)			
TIPC				0.0059						0.0636***		
				(0.0112)						(0.0100)		
TGS					0.0086						0.0365***	
					(0.0168)						(0.0072)	
TIT						0.0585***						−0.0100
						(0.0208)						(0.0051)
L.LGDPC	0.387***	0.361***	0.416***	0.445***	0.419***	0.413***	0.524***	0.478***	0.570***	0.469***	0.519***	0.585***
	(0.0850)	(0.0853)	(0.0864)	(0.103)	(0.0879)	(0.0846)	(0.0444)	(0.0471)	(0.0440)	(0.0446)	(0.0440)	(0.0450)
LPOP	−0.0071	0.0227	−0.0072	−0.111	−0.0005	0.156	0.227***	0.220***	0.262***	0.165***	0.218***	0.293***
	(0.0887)	(0.0869)	(0.0923)	(0.120)	(0.112)	(0.0983)	(0.0464)	(0.0461)	(0.0467)	(0.0469)	(0.0462)	(0.0467)
INV	0.0033	0.0029	0.0041	0.0081*	0.0046	0.0026	0.0016	0.0018	0.0020	0.0019	0.0032	0.0026
	(0.0027)	(0.0027)	(0.0028)	(0.0048)	(0.0028)	(0.0028)	(0.0020)	(0.0019)	(0.0020)	(0.0019)	(0.0019)	(0.0021)
GOVT	−0.0124**	−0.0119**	−0.0099**	−0.0125**	−0.0069	−0.0099**	−0.0019	−0.0028	−0.0003	−0.0029	−0.0011	0.0007
	(0.0049)	(0.0047)	(0.0049)	(0.0062)	(0.0049)	(0.0046)	(0.0031)	(0.0031)	(0.0032)	(0.0030)	(0.0031)	(0.0033)
FDI	−0.0034	−0.0036	−0.0030	0.0155	−0.0027	−0.0029	0.0011	−0.0021	0.0033	−0.0043	0.0013	0.0033
	(0.0044)	(0.0044)	(0.0045)	(0.0149)	(0.0046)	(0.0044)	(0.0026)	(0.0028)	(0.0027)	(0.0028)	(0.0026)	(0.0028)
TOP	0.002**	0.0029**	0.0023*	0.0036*	0.0026**	0.0020	−0.0005	−0.0010	−0.0003	−0.0009	−0.0001	−0.000
	(0.0012)	(0.0012)	(0.0013)	(0.0021)	(0.0013)	(0.0013)	(0.0006)	(0.0006)	(0.0006)	(0.0006)	(0.0006)	(0.0007)
Constant	3.886***	3.644***	3.702***	5.041***	3.627**	1.312	−0.274	0.243	−1.078*	1.098	−0.0996	−1.548**

Table 15 (continued)

Variables	Fragile countries						Non-fragile countries					
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
	(1.310)	(1.282)	(1.350)	(1.720)	(1.654)	(1.444)	(0.637)	(0.671)	(0.613)	(0.690)	(0.637)	(0.608)
OBS	112	112	112	84	112	112	210	210	210	210	210	210
R-squared	0.347	0.360	0.314	0.317	0.289	0.341	0.797	0.801	0.785	0.814	0.801	0.774
Number of countries	8	8	8	6	8	8	15	15	15	15	15	15
F-test	7.357	7.779	6.333	4.714	5.633	7.171	105.7	108.1	97.82	117.6	108.3	91.99
Prob > F	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.990
Hausman test	18.19	9.32	26.82	20.14	30.60	34.34	52.51	118.14	100.88	81.92	133.68	93.90
P value	0.011	0.231	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.990

Note: ***, **, and * denote 1%, 5%, and 10% levels of significance, respectively while values in ( ) are standard errors

Table 16 Tax and growth (nonlinear approach) *Source*: Authors' computation

Variables	Fragile countries						Non-fragile countries					
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
TTAX	0.0175						0.0599***					
	(0.0168)						(0.0126)					
TTAXS	0.00008						−0.0012***					
	(0.00006)						(0.0003)					
DTAX		0.0926***						0.0984***				
		(0.0334)						(0.0174)				
DTAXS		−0.0036*						−0.0035***				
		(0.0021)						(0.0010)				
ITAX			0.0091						0.0507***			
			(0.0335)						(0.0164)			
ITAXS			0.0010						−0.0014**			
			(0.0024)						(0.0006)			
TIPC				0.0891**						0.1070***		
				(0.0439)						(0.0162)		
TIPCS				−0.00499*						−0.00361***		
				(0.0026)						(0.0011)		
TGS					0.0233						0.0194	
					(0.0373)						(0.0142)	
TGSS					−0.0018						0.0015	
					(0.0040)						(0.0010)	
TIT						−0.141**						-0.0158
						(0.0658)						(0.0105)
TITS						0.0345***						0.0008
						(0.0109)						(0.0005)
L.LGDPC	0.383***	0.386***	0.402***	0.441***	0.429***	0.351***	0.517***	0.446***	0.573***	0.454***	0.500***	0.571***

Table 16 (continued)

Variables	Fragile countries						Non-fragile countries					
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
	(0.0890)	(0.0856)	(0.0924)	(0.101)	(0.0914)	(0.0833)	(0.0432)	(0.0467)	(0.0435)	(0.0436)	(0.0458)	(0.0457)
LPOP	−0.0019	−0.0554	0.0048	−0.170	0.0054	0.202**	0.172***	0.197***	0.233***	0.136***	0.237***	0.290***
	(0.0981)	(0.0973)	(0.0969)	(0.122)	(0.114)	(0.0951)	(0.0478)	(0.0454)	(0.0480)	(0.0465)	(0.0481)	(0.0465)
INV	0.0033	0.0027	0.0042	0.0047	0.0043	0.0019	0.0008	0.00109	0.0017	0.0018	0.0036*	0.0030
	(0.0027)	(0.0027)	(0.0028)	(0.0050)	(0.0029)	(0.0027)	(0.0019)	(0.0019)	(0.0020)	(0.0018)	(0.0020)	(0.0021)
GOVT	−0.0122**	−0.0147***	−0.0095*	−0.0158**	−0.0065	−0.0054	−0.0019	−0.0023	−0.0009	−0.0022	−0.0011	0.0007
	(0.0050)	(0.0049)	(0.0050)	(0.0063)	(0.0051)	(0.0046)	(0.0030)	(0.0030)	(0.0032)	(0.0029)	(0.0031)	(0.0032)
FDI	−0.0034	−0.0042	−0.0031	0.0073	−0.0027	−0.0023	0.00009	−0.0042	0.0033	−0.0051*	0.0010	0.0027
	(0.0045)	(0.0044)	(0.0046)	(0.0152)	(0.0046)	(0.0043)	(0.0026)	(0.0028)	(0.0026)	(0.0027)	(0.0026)	(0.0028)
TOP	0.0025**	0.0032***	0.0023*	0.0047**	0.0026**	0.0023*	−0.0010	−0.0008	−0.0008	−0.0010*	−0.0001	−0.0004
	(0.0012)	(0.0012)	(0.0013)	(0.0021)	(0.0013)	(0.0012)	(0.0006)	(0.0006)	(0.0007)	(0.0006)	(0.0006)	(0.0007)
Constant	3.836***	4.585***	3.639***	5.840***	3.450**	1.177	0.361	0.720	−0.798	1.575**	−0.233	−1.394**
	(1.374)	(1.382)	(1.364)	(1.736)	(1.709)	(1.381)	(0.646)	(0.667)	(0.619)	(0.687)	(0.643)	(0.613)
OBS	112	112	112	84	112	112	210	210	210	210	210	210
R-squared	0.347	0.379	0.315	0.353	0.290	0.404	0.810	0.813	0.790	0.825	0.803	0.777
No of countries	8	8	8	6	8	8	15	15	15	15	15	15
F-test	6.374	7.316	5.517	4.767	4.912	8.121	99.38	101.6	88.10	109.9	95.46	81.52
Prob > F	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.990
Hausman Test	9.59	24.54	51.10	36.09	88.67	35.08	147.00	82.65	95.02	160.13	126.12	68.16
P value	0.295	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.990

Note: ***, **, and * denote 1%, 5%, and 10% levels of significance, respectively while values in ( ) are standard errors

Table 17 Tax, public debt and growth (linear approach) *Source*: Authors' computation

Variables	Fragile countries						Non-fragile countries					
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
TTAX	0.0405***						0.0101**					
	(0.0114)						(0.0044)					
TTAXE	−0.0002**						0.0002***					
	(0.00009)						(0.00005)					
DTAX		0.0719***						0.0445***				
		(0.0232)						(0.0128)				
DTAXE		−0.0004*						0.00006				
		(0.0003)						(0.0001)				
ITAX			0.0472**						0.0039			
			(0.0191)						(0.0051)			
ITAXE			−0.0002*						0.0005***			
			(0.0001)						(0.00008)			
TIPC				0.119***						0.0510***		
				(0.0286)						(0.0121)		
TIPCE				−0.0013***						0.0003**		
				(0.0003)						(0.0001)		
TGS					0.0225						0.0277***	
					(0.0234)						(0.0094)	
TGSE					−0.0002						0.0001	
					(0.0002)						(0.00009)	
TIT						0.0937***						−0.0076
						(0.0345)						(0.0068)
TITE						−0.0004						0.0002
						(0.0003)						(0.0002)
PDE	0.0012	0.0007	0.0008	0.0017**	0.00005	0.0006	−0.0022***	−0.0005	−0.0033***	−0.0011***	−0.0009*	−0.0005
	(0.0007)	(0.0007)	(0.0008)	(0.0008)	(0.0006)	(0.0007)	(0.0006)	(0.0004)	(0.0006)	(0.0004)	(0.0005)	(0.0004)
L.LGDPC	0.335***	0.335***	0.383***	0.328***	0.401***	0.407***	0.478***	0.481***	0.495***	0.457***	0.516***	0.582***

Table 17 (continued)

Variables	Fragile countries						Non-fragile countries					
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
	(0.0873)	(0.0871)	(0.0888)	(0.0972)	(0.0918)	(0.0853)	(0.0452)	(0.0474)	(0.0442)	(0.0449)	(0.0448)	(0.0460)
LPOP	−0.108	−0.0330	−0.109	−0.267**	−0.0948	0.153	0.217***	0.188***	0.258***	0.136**	0.203***	0.310***
	(0.114)	(0.109)	(0.121)	(0.131)	(0.144)	(0.122)	(0.0522)	(0.0554)	(0.0504)	(0.0546)	(0.0536)	(0.0557)
INV	0.0028	0.0022	0.0040	0.0033	0.0045	0.0024	0.0022	0.0017	0.0025	0.0022	0.0032*	0.0023
	(0.0027)	(0.0027)	(0.0028)	(0.0046)	(0.0028)	(0.0028)	(0.0019)	(0.0020)	(0.0019)	(0.0019)	(0.0019)	(0.0021)
GOVT	−0.0155***	−0.0124***	−0.0128**	−0.0236***	−0.0088*	−0.0101**	−0.0040	−0.0028	−0.0024	−0.0043	−0.0011	0.0009
	(0.0050)	(0.0050)	(0.005)	(0.0065)	(0.0052)	(0.0047)	(0.0031)	(0.0032)	(0.0030)	(0.0031)	(0.0031)	(0.0033)
FDI	−0.0042	−0.0047	−0.0036	0.0184	−0.0033	−0.0038	−0.0020	−0.0035	−0.00001	−0.0067**	−0.00009	0.0040
	(0.0045)	(0.0046)	(0.0047)	(0.0140)	(0.0048)	(0.0047)	(0.0027)	(0.0030)	(0.0026)	(0.0029)	(0.0028)	(0.0029)
TOP	0.0025**	0.0031**	0.0022*	0.0043**	0.0027**	0.0018	−0.0012*	−0.0010	−0.0008	−0.0014**	−0.0001	−0.0006
	(0.0012)	(0.0012)	(0.0013)	(0.0019)	(0.0013)	(0.0013)	(0.0006)	(0.0007)	(0.0006)	(0.0006)	(0.0006)	(0.007)
Constant	5.656***	4.608***	5.389***	8.118***	5.178**	1.352	0.386	0.760	−0.346	1.751**	0.205	−1.759**
	(1.733)	(1.641)	(1.838)	(2.016)	(2.212)	(1.808)	(0.721)	(0.798)	(0.673)	(0.795)	(0.736)	(0.729)
OBS	112	112	112	84	112	112	210	210	210	210	210	210
R-squared	0.381	0.379	0.334	0.458	0.298	0.353	0.814	0.803	0.814	0.821	0.804	0.777
No of countries	8	8	8	6	8	8	15	15	15	15	15	15
F-test	6.491	6.433	5.300	6.468	4.471	5.764	90.42	84.35	90.58	94.92	84.96	71.90
Prob > F	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.990
Hausman test	57.43	50.51	28.13	107.66	27.48	48.82	233.02	134.49	79.80	208.09	73.96	55.71
P value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.990

Note: ***, **, and * denote 1%, 5%, and 10% levels of significance, respectively while values in ( ) are standard errors

Table 18 Tax, public debt and growth (nonlinear approach) *Source*: Authors' computation

Variables	Fragile countries						Non-fragile countries					
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
TTAX	0.0307						0.0235					
	(0.0330)						(0.0165)					
TTAXS	0.0009						−0.0003					
	(0.0014)						(0.0004)					
TTAXE	0.00002						0.0005***					
	(0.0003)						(0.0002)					
TTAXSE	−0.00002						−0.00001*					
	(0.00001)						(0.00001)					
DTAX		0.127**						0.0457**				
		(0.0609)						(0.0226)				
DTAXS		−0.0016						0.0002				
		(0.0055)						(0.0016)				
DTAXE		−0.0003						0.0010***				
		(0.0005)						(0.0003)				
DTAXSE		−0.00004						−0.00007***				
		(0.00006)						(0.00002)				
ITAX			0.0100						0.0044			
			(0.0656)						(0.0207)			
ITAXS			0.0032						−0.00002			
			(0.0047)						(0.0008)			
ITAXE			0.0001						0.0005			
			(0.0005)						(0.0004)			
ITAXSE			−0.00003						0.0000001			
			(0.00004)						(0.00002)			
TIPC				0.190***						0.0521**		
				(0.0654)						(0.0229)		
TIPCS				−0.0032						−0.0002		

Table 18 (continued)

Variables	Fragile countries						Non-fragile countries					
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
				(0.0049)						(0.0017)		
TIPCE				−0.0011*						0.0010***		
				(0.0005)						(0.0003)		
TIPCSE				−0.00003						−0.00007**		
				(0.00005)						(0.00003)		
TGS					0.122*						0.0336	
					(0.0680)						(0.0256)	
TGSS					−0.0105						−0.0006	
					(0.00650						(0.0028)	
TGSE					−0.0010*						−0.0002	
					(0.0006)						(0.0003)	
TGSSE					0.00009						0.00003	
					(0.00007)						(0.00003)	
TIT						−0.244**						−0.0508***
						(0.0979)						(0.0181)
TITS						0.0605***						0.0017
						(0.0165)						(0.0010)
TITE						0.0017**						0.0006
						(0.000824)						(0.0004)
TITSE						−−0.0004**						−0.0000001
						(0.0002)						(0.000006)
PDE	0.0007	0.0007	0.00006	0.0017*	0.0012	−0.0012	−0.0036***	−0.0020***	−0.0032**	−0.0020***	−0.0002	−0.0012*
	(0.0011)	(0.0008)	(0.0012)	(0.0009)	(0.0009)	(0.0009)	(0.0012)	(0.0006)	(0.0015)	(0.0006)	(0.0008)	(0.0008)
L.LGDPC	0.353***	0.361***	0.385***	0.317***	0.401***	0.397***	0.479***	0.427***	0.495***	0.434***	0.499***	0.545***
	(0.0890)	(0.0865)	(0.0927)	(0.0950)	(0.0924)	(0.0847)	(0.0443)	(0.0465)	(0.0461)	(0.0436)	(0.0464)	(0.0467)
LPOP	−0.136	−0.120	−0.121	−−0.281*	−0.0950	0.199*	0.212***	0.218***	0.258***	0.156***	0.212***	0.327***

Table 18 (continued)

Variables	Fragile countries						Non-fragile countries					
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
	(0.124)	(0.123)	(0.126)	(0.145)	(0.144)	(0.116)	(0.0537)	(0.0532)	(0.0523)	(0.0537)	(0.0542)	(0.0550)
INV	0.0027	0.0017	0.0042	−0.0006	0.0031	0.0015	0.0014	0.0013	0.0025	0.0025	0.0037*	0.0028
	(0.0027)	(0.0027)	(0.0028)	(0.0048)	(0.0030)	(0.0030)	(0.0019)	(0.0019)	(0.0019)	(0.0018)	(0.0020)	(0.0021)
GOVT	−0.0169***	−0.0157***	−0.0135**	−0.0267***	−0.0077	−0.0047	−0.0038	−0.0040	−0.0024	−0.0039	−0.0003	0.0014
	(0.0052)	(0.0050)	(0.0055)	(0.0065)	(0.0053)	(0.0047)	(0.0030)	(0.0016)	(0.0031)	(0.0030)	(0.0032)	(0.0032)
FDI	−0.0028	−0.0050	−0.0024	0.0093	−0.0044	−0.0010	−0.0014	−0.0061**	−0.00001	−0.0066**	−0.0007	0.0037
	(0.0047)	(0.0046)	(0.0049)	(0.0143)	(0.0050)	(0.0045)	(0.0027)	(0.0029)	(0.0027)	(0.0028)	(0.0028)	(0.0029)
TOP	0.0024*	0.0035***	0.0021	0.0056***	0.0029**	0.0015	−0.0011*	−0.0011*	−0.0008	−0.0016**	0.00005	−0.0005
	(0.0012)	(0.0012)	(0.0013)	(0.0020)	(0.0013)	(0.0013)	(0.0006)	(0.0006)	(0.0006)	(0.0006)	(0.0006)	(0.0007)
Constant	5.987***	5.661***	5.659***	8.264***	5.010**	1.025	0.343	0.686	−0.344	1.593**	0.151	−1.679**
	(1.824)	(1.806)	(1.883)	(2.167)	(2.206)	(1.733)	(0.723)	(0.760)	(0.683)	(0.777)	(0.746)	(0.715)
OBS	112	112	112	84	112	112	210	210	210	210	210	210
R-squared	0.392	0.411	0.340	0.501	0.318	0.436	0.823	0.825	0.814	0.837	0.806	0.788
No of countries	8	8	8	6	8	8	15	15	15	15	15	15
F-test	5.455	5.910	4.347	6.116	3.937	6.531	77.96	78.88	73.32	85.60	69.68	62.07
Prob > F	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.990
Hausman test	31.23	52.57	32.81	74.74	40.48	49.07	255.11	135.74	115.29	155.50	123.33	80.32
P value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.990

Note: ***, **, and * denote 1%, 5%, and 10% levels of significance, respectively while values in ( ) are standard errors

Table 19 Taxes (direct and indirect), public debt and growth *Source*: Authors' computation

Variables	Model 1	Model 2	Model 3	Model 4
L.lgdpc	0.465***	0.465***	0.466***	0.395***
	(0.043)	(0.044)	(0.044)	(0.047)
dtax	0.040***	0.039***	0.051***	0.054**
	(0.007)	(0.007)	(0.012)	(0.026)
itax	0.0087*	0.009*	0.005	−0.001
	(0.005)	(0.005)	(0.006)	(0.018)
dtaxs				0.0004
				(0.002)
itaxs				0.00007
				(0.0007)
pde		0.00001	−0.00005	0.0005
		(0.0003)	(0.0004)	(0.001)
dtaxe			−0.0002	0.0006*
			(0.0001)	(0.0003)
itaxe			0.00009	−0.0006***
			(0.00008)	(0.0002)
Dtaxse				−0.00006**
				(0.00002)
itaxse				0.00004***
				(0.00001)
lpop	0.169***	0.171***	0.168***	0.166***
	(0.043)	(0.051)	(0.052)	(0.052)
inv	0.001	0.001	0.001	0.001
	(0.001)	(0.002)	(0.002)	(0.002)
govt	−0.009***	−0.009***	−0.008***	−0.009***
	(0.003)	(0.003)	(0.003)	(0.003)
fdi	−0.002	−0.002	−0.002	−0.006**
	(0.002)	(0.002)	(0.002)	(0.003)
top	0.0003	0.0003	0.001	0.0007
	(0.001)	(0.001)	(0.001)	(0.0006)
Constant	1.005*	0.986	0.986	1.537**
	(0.608)	(0.720)	(0.731)	(0.731)
Observations	322	322	322	322
R-squared	0.658	0.658	0.660	0.686
Number of countries	23	23	23	23
F-test	69.95	61.97	50.89	41.30
Prob > F	0.000	0.000	0.000	0.000
Hausman test	142.14	119.67	132.47	228.78
P value	0.000	0.000	0.000	0.000

Note: ***, **, and * denote 1%, 5% and 10% levels of significance, respectively while values in () are standard errors

Table 20 Mean difference among groups *Source*: Authors' computation

Variable	Middle-income	Low-income	Diff	Resource-intensive	Nonre-source-intensive	Diff	Fragile	Non-Fragile	Diff
Dependent variable									
GDP per capita	3714.0	634.7	−3079.3*	2109.1	1489.3	−619.8***	893.1	2448.1	1555
Independent variables									
Total taxes	15.16	9.901	−5.26***	11.4	12.65	1.23	10.3	13.0	2.7
Direct taxes	5.47	3.10	−2.37***	4.25	3.74	−0.52*	3.36	4.45	1.09
Indirect taxes	9.684	6.80	−2.88***	7.17	8.92	1.75	6.93	8.57	1.65
Taxes on income, profit and capital gains	5.58	3.15	−2.43***	4.49	3.63	−0.87***	3.59	4.32	0.73
Taxes on goods and services	5.23	4.47	−0.762***	4.36	5.30	0.94	4.55	4.91	0.36
Taxes on international trade	4.26	2.19	−2.07***	2.62	3.49	0.87	2.26	3.48	1.22
Public debt	49.8	67.4	17.6	62.8	57.6	−5.2	71.10	53.7	−17.4***

Note: ***, **, and * denote 1%, 5%, and 10% levels of significance, respectively while values in) are standard errors

Table 21 Classification of countries. *Source*: International Monetary Fund (2018)

Full sample	Full sample excluding four highly indebted countries	Low-income countries	Middle-income countries	Fragile countries	Non-fragile countries	Nonresource intensive countries	Resource-intensive countries
Benin	Burundi	Burundi	Botswana	Burundi	Benin	Burundi	Burkina Faso
Botswana	Benin	Benin	Cameroon	Burkina Faso	Botswana	Benin	Botswana
Burkina Faso	Burkina Faso	Burkina Faso	Congo, Republic of the	Central African Republic	Cameroon	The Gambia	Central African Republic
Burundi	Botswana	Central African Republic	Gabon	Congo, Democratic Republic	Gabon	Kenya	Cameroon
Cameroon	Central African Republic	Congo, Democratic Republic	Ghana	Congo, Republic	Ghana	Madagascar	Congo, Democratic Republic
Central African Republic	Cameroon	Guinea	Kenya	Guinea	Kenya	Mozambique	Congo, Republic
Congo, Democratic Republic	Gabon	The Gambia	Mauritius	The Gambia	Madagascar	Mauritius	Gabon
Congo, Republic	Ghana	Madagascar	Eswatini	Zimbabwe	Mozambique	Rwanda	Ghana
Eswatini	Guinea	Mozambique	South Africa		Mauritius	Eswatini	Guinea
Gabon	The Gambia	Rwanda			Rwanda	Uganda	Sierra Leone
The Gambia	Kenya	Sierra Leone			Sierra Leone		Tanzania
Ghana	Madagascar	Tanzania			Eswatini		South Africa
Guinea	Mauritius	Uganda			Tanzania		Zimbabwe
Kenya	Rwanda	Zimbabwe			Uganda		
Madagascar	Eswatini				South Africa		
Mauritius	Tanzania						
Mozambique	Uganda						
Rwanda	South Africa						
Sierra Leone	Zimbabwe						
South Africa							
Tanzania							
Uganda							
Zimbabwe							

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