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Tax and sustainable development in sub-Saharan Africa

Beyond accountability and responsiveness

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Abstract: This paper establishes how accountability quality might mediate the effect of tax revenue on sustainable development in 41 sub-Saharan African countries for the period 1990–2019. The empirical evidence is based on three empirical strategies: generalized method of moments, instrumental variable Tobit, and quantile regressions. The following findings are revealed. First, accountability dynamics influence tax revenue in ways that have favourable net effects on sustainable development. Second, the conditional impacts between accountability dynamics and tax revenues are constantly negative, even though the demonstrated net effects are compatible with the paper's theoretical predictions. Third, the net consequences are decomposed to establish thresholds for further policy. Thresholds are points where there are no net effects and where further intensifying accountability dynamics would produce adverse net impacts. At the stated thresholds, further policy actions must be complemented with accountability dynamics in order to modulate tax revenues for strong sustainability. We conclude that policy makers in sub-Saharan African nations should coordinate measures that improve accountability in view of other complementary policies, because accountability serves as a 'force multiplier' enhancing the absorptive capacity of tax mobilization, which in turn promotes strong sustainability.

Key words: sub-Saharan Africa, accountability quality, tax mobilization, sustainable development

JEL classification: J18, H20, O11

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1 Introduction

Historically, humans have evolved through diverse productive forces, such as during the primaeval, slavery, colonial, and capitalist eras (Nogueira 2019). The recent stage of evolution, the industrial phase, has contributed to unfavourable climate shifts (Haller 2017). These activities have adversely changed the ecosystem and further threaten present and future generations' survival (Sachs 2010). Given these negative consequences, the desire to mitigate further environmental degradation has paved the way for the ideology of sustainability.

Although the significance of sustainability has been emerging since the 1800s (Schlör et al. 2012), the framework of sustainable development principles first received the attention of global communities that were motivated to integrate economic development and social value with ecological concerns at the 1972 United Nations Conference on the Human Environment, which led to the Stockholm Declaration and the United Nations Environment Programme (United Nations 1972). Subsequently, in 1983 the United Nations convened a body named the World Commission on Environment and Development and produced a popular report, 'Our Common Future' (commonly called the Brundtland Report). This report put sustainable development on the major global policy agenda by establishing a concise concept (Strezov et al. 2017).

Since the phrase 'sustainable development' gained precedence following the publication of the Brundtland Report, it has evolved as a mainstream concept through which diverse initiatives have been formulated. For instance, the grand sustainability agenda (i.e. the 2000 Millennium Development Goals, followed by the 2015 Sustainable Development Goals (SDGs)) is based on the sustainability concept. In addition, efforts to achieve sustainable development are evident in all spheres of the policy process (i.e. global, regional, national, and private sector) despite the complexity of the concept from its inception (Tennberg 2018). The underlying reason for these efforts is traceable to the notion that the natural environment's capacity will fail to support livelihoods as resources diminish if sustainable development is not pursued (Tsaples and Papathanasiou 2021).

In light of the above, the premise of this paper is built on relevant insights from policy-making and the scholarly literature. In sub-Saharan Africa, as opposed to other regions of the world, the overall population in extreme poverty is growing: for instance, the figure grew from 278 million people in 1990 to 413 million people in 2015. The region is also home to 27 of the world's 28 poorest nations (World Bank 2018). The higher poverty level in the region is attributable to a decline in regional growth rates, conflict-related challenges, fragmented institutions, and a failure to channel historical growth towards poverty reduction and equality (Asongu et al. 2020; Magombeyi and Odhiambo 2018; Wang et al. 2019).

The growth projection for sub-Saharan Africa was estimated at 3.2 per cent for the year 2019, with a forecast 3.6 per cent increase for 2020; however, due to the COVID-19 pandemic, the region failed to attain the forecast, and growth contracted to -1.6 per cent (International Monetary Fund (IMF) 2020). The IMF (2020) asserted that if mismanaged, the COVID-19 pandemic might exacerbate development progress in the region. Other tragedies bedevilling sub-Saharan African countries include exclusive development, low productivity, climate degradation, poor governance, inequalities, inflation increases, forcibly displaced people due to security and environmental threats, capital flight, and others (Asongu and Odhiambo 2020b; Gebru 2017; Odugbesan et al. 2020; Sanz- Córdoba 2020; Yang 2019). All of these pose threats to the attainment of sustainable development in the region. Thus, it is essential to explore how fiscal policy and vital institutions might engender sustainable development in sub-Saharan Africa.

An adequate financial channel is essential to attain the SDGs. This claim is evident in IMF (2015), which reveals that the total annual funding deficit for health, education, infrastructure, power, clean water, and sanitation investments in developing economies is around USD 2.6 trillion. This suggests an extra yearly budget for the least developed nations, which may be up to 15 per cent of their gross domestic product (GDP) (United Nations 2019). The immense and persistent need of the least-developed countries could increase by billions or trillions in financing for the SDGs (IMF 2015). Thus, tax revenue is an important way of funding sustainable development (Long and Miller 2017).

Tax revenue mobilization through fiscal responsibility seems appropriate, as it provides predictable and stable resources for development (Prichard et al. 2018). The global community has rekindled the link between taxation and sustainable development, as is evident in various championed initiatives, such as the Addis Tax Initiative to support the adoption of the Addis Ababa Action Agenda on Financing for Development. Likewise, the economic fallout of the COVID-19 outbreak severely affected global economies, causing public spending to skyrocket and public revenues to dwindle (Sharif et al. 2020). With these financial gaps, the pandemic has reiterated the importance of domestic revenue generation for sustainable development. However, institutional constraints can impede the domestic mobilization of resources (Coulibaly and Gandhi 2018).

There are difficulties in the implementation of adequate and effective tax systems in sub-Saharan African countries (Epaphra and Massawe 2017). These difficulties are traceable to weak institutional quality characterized by corruption and a lack of government responsiveness, transparency, and accountability (Bird et al. 2007). These deficiencies might erode tax compliance. For instance, if there is a trust issue between citizens and the state, citizens will have little incentive to support the administration. In developing countries, governments' inability to generate sufficient tax revenue has been linked to low tax transparency and accountability (Coulibaly and Gandhi 2018; Dom 2018). In essence, the absence of strong governance quality reflects a policy syndrome that discourages taxpayers from complying with the tax policy, thereby limiting tax revenue for sustainable development (Koessler et al. 2019; Rodriguez-Justicia and Theilen 2018).

The desire to spur tax performance for sustainable development in sub-Saharan Africa is an endless quest for both policy makers and academics. It is therefore essential to identify and implement factors that might propel an adequate tax system in the region. Government quality is widely recognized as linked to the consolidation of a solid foundation for societal change (Asongu and Odhiambo 2019c; Iyoha and Oyerinde 2010; Kotschy and Sunde 2017; Ojeka et al. 2019). It is argued that the tax structure tends to reflect the political institutions. Bird and Martinez-Vazquez (2008: 68) argues that 'a legitimate state is an essential precondition for an adequate tax system in developing countries'. This presumes that if taxpayers perceive the government's responsiveness to be efficient and the state as expressing their interests, this perception will increase their tax efforts. Thus, the tax performance will improve if the state is responsive and accountable through adequate channels. In this way, accountability may be seen to measure the extent to which people believe they have a significant 'voice' to control the state. This paper argues that a higher level of accountability will compel taxpayers to be tax responsible, thereby leading to higher tax revenue for sustainable development.

Our research primarily focuses on sub-Saharan Africa because it is necessary to prioritize the region's economic, social, and environmental development, given its place in the post-2015 development agenda. This paper examines 41 of the 48 sub-Saharan African nations and spans 30 years from 1990 to 2019. The paper is based on recent research on interactive regressions. In accordance with the motivation for our research, we calculate net effects to assess the significance of accountability dynamics in modifying the impact of tax revenue on sustainable development. These net effects include not only conditional effects relating to the interaction between tax

revenue and accountability dynamics but also the unconditional effects of tax revenue on the sustainable development index (SDI).

The following conclusions can be drawn. First, accountability dynamics alter overall tax revenue in ways that have favourable net effects on the SDI. Second, accountability dynamics modify non-resource tax revenue to have favourable net effects on the SDI. Third, the conditional impacts between accountability dynamics and tax revenues are constantly negative, even though the demonstrated net effects are compatible with our theoretical predictions. This shows that increasing accountability dynamics beyond a certain point will cancel out the favourable net effects of tax income on sustainable development. Furthermore, our research extends beyond the creation of net connections to create accountability thresholds that modify the associated tax revenues in a way that promotes sustainable development. Notably, when expanding policy variables above critical masses or thresholds results in undesirable macroeconomic effects, it is a sign that other policy efforts should be added to the mix to permit desired or favourable outcomes. In this paper, the net effects are decomposed in light of the aforementioned information to establish thresholds for further policy. Thresholds are points where there are no net effects and where further escalating accountability dynamics would produce adverse net impacts. Therefore, at the stated thresholds, further policy actions must be added to accountability dynamics in order to modulate tax revenues for benefits to sustainable development. This further suggests that for the modulation to have a beneficial impact on sustainable development at the defined thresholds, accountability is a necessary but insufficient requirement.

The remainder of the paper is organized as follows. Section 2 expands on the theoretical highlights, while Section 3 covers the data and methods. The ramifications of the results are examined in Section 4. The conclusions and recommendations for further research are in Section 5.

2 Theoretical highlights

2.1 Augmenting endogenous growth and social contract theories

Endogenous growth theory refers to long-term economic growth at a pace determined by factors within the economic system, such as capital (resources), the labour force, and technological knowledge. The neoclassical growth theory of Solow (1956) and Swan (1956) suggests a procedure that is discrete, is independent of economic forces, and determines resource abundance. The neoclassical theory therefore means that scholars can take the long-term growth rate exogenously, from outside the economic system. However, this neoclassical perspective is called into question by endogenous growth theory, which suggests ways in which resource mobilization and thus the long-term rate of economic growth are affected (Howitt 2010). In essence, taxation may determine what decisions are taken, and eventually the pace of growth, by influencing the return on investment or the projected viability of research and development (Myles 2000). A mechanism for studying how taxation influences growth has only existed since the development of endogenous growth theory (Onakoya et al. 2017).

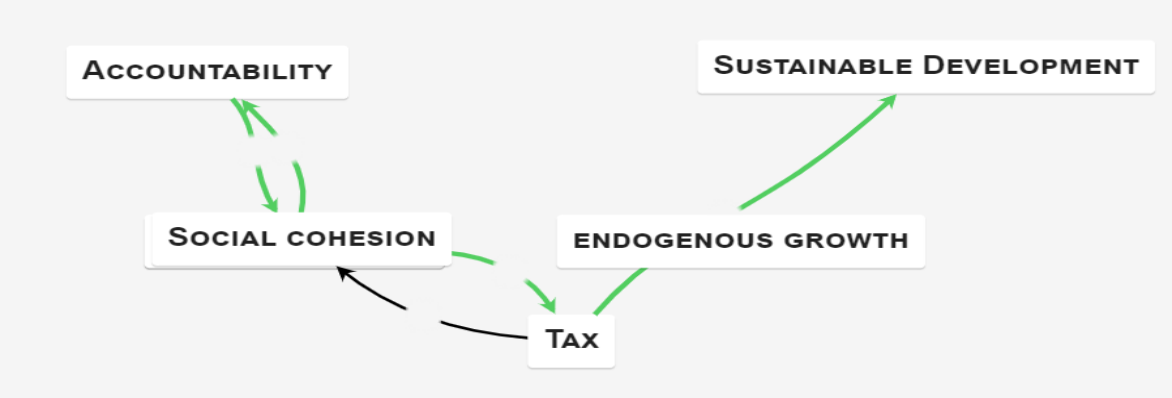
On the other hand, social contract theory explicitly describes a conceptual or concrete relationship between a society and its state. This relationship is said to be responsible for the foundations of human moral judgements. This means that people simply respect rules and laws in the expectation that others are doing the same, thereby contributing to a better and safer lifestyle. This argument builds upon many thinkers who have asked whether social consensus can justify the moral obligations of society. For example, Hobbes (2005) provides a vibrant description of the 'state of nature'—that is, what the world would be like without a social contract—indicating that the social

contract is an important factor in moral conduct. Locke (1988) is more positive and draws a more appealing image of the state of nature, indicating that even without imposed laws and regulations, morality would remain. Hume (2000) argues otherwise: no social contract is required to form moral commitments because common sense will inform people that respecting one another is necessary to guarantee a manageable society. Lastly, Rousseau (2004) considers social networks to be mutually self-interested agreements between individuals. He offers a new perception of the social contract and explains that securing the country does not have to mean losing one's rights, because one will greatly benefit from cooperating in a community.

Social contract theory constructs an account of political authority according to the concept of mutual consent and based on the notion that human beings are naturally free and equal (Stone 2012). The social contract has two main components (Neidleman 2012). The first is the pre-political condition or state of nature, which is the most important contemporary representative of social contract theory. In this primordial scenario, all citizens are equal, they are symmetrically placed, and they all have the opportunity to leave the state of nature for the perceived benefit of entering a democratic society. The second component is the regulatory definition of the contracting parties. The parties are defined as: (i) driven by self-interest to consent to the social contract only when they consider that contact to be advantageous; (ii) concerned about the interests of one another, if only because they know that the benefits they expect from the social contract are dependent on their ability to guarantee their peers the same benefits; (iii) able to fairly or ethically consider the needs of others, that is, holding the just or moral values that should guide the fulfilment of their interests.

In light of these theories, it is important to envisage the intertwined connections between taxation, accountability, and development in relation to social cohesion and endogenous growth theories (Figure 1). Taxation is not only a resource acquisition instrument for states; it also has a critically significant role in promoting equity and distributive justice (Mangoting et al. 2015). Although the concept of justice remains controversial in the literature, the social contract principle may be beneficial (Jos 2006). While people reject unequal or disproportionate taxes, fair taxation seems to be seen in terms of a share of the burden and an acceptance of duty. Similarly, Paz-Fuchs (2008) argues that when taxes are built upon consensus (i.e. as central but avoidable, according to the principles of the social contract), tax is treated as a public benefit, not as an intrinsic evil. Under this arrangement, consensus among citizens is essential.

Figure 1: Linkages between accountability, tax, and sustainable development



Source: authors' illustration.

However, the sociopolitical perspective of the social contract gives prominence to the taxpayer as a genuine decision maker within the social framework (Leroy 2008). Leroy (2008) claims that one of the criteria is the accountability of public financing and sufficient comparative knowledge within the context of a representative political judgement on tax levels, composition, and operations. More certainly, the sociopolitical agreement is related to the contribution tax paid by citizens, presumably altruists, who recognize the legality of the activities of interventionist tax state.

Taxpayers' aversion to paying taxes is also the motive behind fiscal sacrifices that seek to provide economic gains (Mangoting et al. 2015). When taxes are collected, the taxpayer does not receive a direct return; the incentives to pay are given as public utilities, the protection of lives and property, and government-built facilities. However, taxpayers may refuse further tax compliance if they perceive that the funds provided are not utilized maximally. For example, Russia has a poor history in this regard, with the lowest degree of taxpayer compliance, and this low compliance is traceable to taxpayers' mistrust of the government in relation to the handling of tax revenues and the lack of accountability. In the face of extensive and wide-scale corruption, taxpayers protest at the government's inefficiency and inability to deliver public services (Rothstein 2000).

In the social contract between taxpayers and the state, their respective tax responsibilities can be seen as parallel. Taxpayers are committed to paying taxes, and policy makers are committed to making tax revenues a source of funds for the rest of society. Under this arrangement, accountability is required. Modern academics contend that the social contract can only flourish if the government is accountable to the electorate and offers transparency about public and economic resources (Prichard 2010; Prichard et al. 2014). Social contract theory advocates claim that people pay taxes in exchange for a share in or benefit from the government (Besley and Persson 2013; Mangoting et al. 2015).

Government responsiveness and accountability include robust fiscal negotiation mechanisms by which people engage with state players (Quak 2019). Prichard et al. (2018) argue that residents should use taxation and tax resistance to force state authorities to comply with their share of the social contract. However, it is evident that governments' failure to generate adequate tax revenues is linked to low fiscal transparency and accountability in developing countries, particularly in African states, which refutes the presupposition of the social consensus principle (Addison and Levin 2011; Feger and Asafu-Adjaye 2014; Kogler et al. 2013; Morrissey et al. 2014).

This paper not only follows the notion that government accountability promotes tax compliance to generate reasonable resources from taxpayers but further presumes that this social consensus ought to promote sustainable development. The paper suggests that a positive effect stems from the relationship between accountability, domestic resources, and sustainable development. This means that better governance through greater accountability and responsiveness will increase public resources for development. Although the idea of relating taxes to better accountability is appealing in principle, its execution in practice is likely to be much more complicated. It is increasingly important to emphasize that a positive connection between accountability, taxation, and development is not inevitable or assured (Prichard 2010), but rather relies on the key characteristics of national and local tax structures as well as the broader social, political, and economic contexts in which they operate. Thus, it is necessary to establish thresholds that maintain the positive linkage between accountability, taxation, and development.

2.2 Literature review and gaps in literature

In the existing literature on taxation, accountability, and development, research gaps can be identified. The relevant development literature on Africa can be divided into two strands: (i) studies on linkages between taxation and accountability; (ii) scholarship that is specifically based on sustainable development in Africa. The possibility that taxation produces the kind of political mobilization that makes governments more open—and even more importantly, more responsible—to taxpayers has received the most attention in the literature linking taxation and governance (Moore et al. 2018). According to a growing body of evidence, taxation is a catalyst for improved responsiveness and transparency in Africa. These scholarly outputs include the work of Prichard et al. (2018), who conclude that states with more tax-dependent economies are more democratic.

In another study, Prichard (2015) attests that the enhancement of governance results from debates over taxes. Taxpayers are more likely to pay their taxes when they expect to receive incentives in exchange (Flores-Macías 2018). Likewise, Martin (2016) argues that individuals are more likely to expect transparency from policy makers if they have to pay for public services through taxation. Furthermore, previous studies have established a causal effect between accountability and tax efforts (Bird et al. 2007; Dom 2018; Javid and Iqbal 2008). The tax performance both influences the demand for accountability and is affected by the level of governance.

On the other hand, in the contemporary development literature, Cioacă et al. (2020) investigate how the knowledge economy influences economic growth and inequality reduction as sustainable development measures. Myovella et al. (2020) compare the role of technology in economic development between sub-Saharan Africa and the Organisation for Economic Co-operation and Development. Njoh (2018) examines the relationship between information and communications technology (ICT) and African development. Other strands of literature on financing development include the work of Gharleghi and Jahanshahi (2020), who define the point at which financial development and trade liberalization have a significant impact on income inequality as a metric of sustainable development. Odugbesan et al. (2020) explore the state of financial inclusion and sustainability alongside the modulating impact of foreign capital.

The next strand emphasizes the importance of good governance for long-term sustainability. Omri and ben Mabrouk (2020) investigate the relationship between governance and governance-related transformation networks, revealing new insights into how governance is linked to long-term sustainability dynamics. Aidt (2009) examines whether the connection between corruption and sustainable development is conditional on the assumptions that (i) political and legal institutions have direct impacts on sustainability and (ii) the impact of corruption is conditional on the efficiency of institutions.

Within these strands of literature, there are few empirical scholarly publications on how accountability quality modulates taxation for sustainable development, especially in African countries. Many contemporary bodies of literature have failed to establish the conditional effects between accountability and tax performance for development. Most importantly, studies on accountability, taxation, and inclusive development have failed to explore newly available data. To the best of our knowledge, there is no contemporary study on the underlying nexus between tax level, accountability, and sustainable development in sub-Saharan African countries. Therefore, this paper seeks to establish the accountability thresholds that ascertain the effect of tax performance on sustainable development.

In summary, the literature on dynamic relationships in sustainable development relative to public finance and governance has been limited in developing countries, especially sub-Saharan African

countries. The extant literature mostly provides bidirectional linkages between taxation and accountability, or taxation and sustainable development, or governance and sustainability. Previous studies have failed to provide the thresholds of governance that must be attained before public finance has a positive influence on sustainable development. Most scholarly studies on accountability, taxation, and sustainable development have also failed to explore newly available data.

3 Data, model specifications, and estimation strategies

3.1 Data

This paper explores a panel of 41 sub-Saharan African countries using data for the period 1990–2019 from the World Bank's World Development Indicators (WDI), the UNU-WIDER Government Revenue Dataset (GRD) (UNU-WIDER 2022), and the Varieties of Democracy (V-Dem) dataset version 12. The sampled countries and periodicity are limited by data availability.[1] Notably, the dataset entails non-overlapping intervals of five-year averages, resulting in six data points: 1990–94, 1995–99, 2000–04, 2005–09, 2010–14, and 2015–19.[2] This is in line with the extant literature in that it avoids instrument proliferation while increasing the possibilities to engage more variables in the conditioning information set for the generalized method of moments (GMM) (Asongu and Odhiambo 2020a; Saha and Sen 2021). However, alternative estimate techniques (i.e. instrumental variable (IV) Tobit regressions and quantile regressions (QRs)) for robustness of analysis and country heterogeneity are based on a yearly periodicity that covers 30 years.

This paper uses the SDI (n.d.) developed by Hickel (2020) as the dependent variable to measure how effective countries are in advancing holistic development. The SDI analyses the ecological efficiency of socio-economic development, acknowledging that development must be done within the constraints of the planet. It is designed to revise the Human Development Index (HDI) to reflect the ecological conditions of the Anthropocene.[3] Countries that attain a reasonably high level of human development while staying within or close to planetary boundaries rise to the top of the index. The SDI is comprised of five measures: education, life expectancy, income, carbon dioxide emissions, and material footprint. These parameters are the constituents of the HDI and the ecological impact index used to construct the SDI. The geometric mean of the life expectancy index, the education index, and a modified income index are used to produce the HDI. The ecological impact index, on the other hand, is determined by how much planetary limits are exceeded in terms of material footprint and carbon dioxide emissions per capita, depending on consumption. The index ranges between zero and one. In essence, the measure reflects the three principal components of sustainable development: economic, social, and environmental sustainability. In recent literature, the underlying sustainable development measurement has also been preferred (Destek et al. 2022; Din et al. 2022; Hametner 2022; Nchofoung and Asongu 2022).

[1] For instance, the SDI dataset contains 42 sub-Saharan African countries, among which Eritrea only has data for seven years. We therefore exclude Eritrea. Appendix A reports the sampled countries.

[2] However, we also computed three-year averages for the non-overlapping intervals. Although the results were consistent with those reported in this paper, we prefer the five-year averages, as they give room for more control variables.

[3] The objective of the HDI is to shift the emphasis of development economics away from national income accounting to people-centred policies by providing a metric that can be used to evaluate countries' progress not only in terms of economic growth, but also in terms of key social outcomes.

We use two principal explanatory indicators: (i) tax revenue extracted from the GRD; (ii) accountability proxied by five dynamics from the V-Dem dataset. In this paper, two specific measures are engaged to proxy for tax revenue: (i) total tax revenue (as a percentage of GDP), excluding social contribution and grants; (ii) non-resource tax revenue (as a percentage of GDP), determined as total tax revenue less resource tax revenue (i.e. taxes from natural products). Our reason for adopting non-resource tax revenue rather than overall government revenues is that total revenue is largely dependent on natural resources, which are rarely stable or predictable. Furthermore, non-resource tax revenue is far more homogenous compared with other revenue measures (Gnangnon and Brun 2018). In addition, non-resource tax revenue is often referred to as 'earned income' generated on a relatively large tax base rather than a single charge for services.

To capture the multidimensionality of accountability, this paper employs four indicators: (i) an accountability index, which measures constraints on the political power of the government; (ii) vertical accountability, which identifies the power of citizens to hold the government accountable through formal political participation and free elections; (iii) diagonal accountability, which captures the mechanisms engaged by citizens, civil society, and the media to hold the government accountable; (iv) horizontal accountability, which covers the capacity of state institutions to demand information and to query and punish officials for improper behaviour. The accountability data is extracted from the V-Dem database.[4] In order to account for the interactive regressions, we rescale the accountability proxies to zero to ten instead of using the unbounded interval scale (i.e. -5 to +5) of the V-Dem dataset. This process is consistent with relevant literature (Dom 2018; Tagem and Morrissey 2021).

Accountability is distinct from responsiveness, which refers to the state's capacity to satisfy people's needs, although the two are closely connected (Fumarola 2021; Speer 2012). This distinction is empirically significant because rulers may defuse tax protests by satisfying people's demands without enhancing accountability. However, the effect may be transient, since increasing responsiveness produces its own drive to institutionalize such conduct via accountability measures (Prichard 2015). In this light, it makes intuitive sense to examine the level of government responsiveness (i.e. social cohesion) through the V-Dem dataset's equal distribution index. The level of resource distribution in society, including both real and intangible resources, is measured by the equal distribution index, which promotes egalitarian democracy.

To correct for omitted variable bias in the regressions, four pieces of conditioning information are employed: trade openness, foreign direct investment, resource rent, and GDP per capita. Although the control variables are expected to enhance sustainable development, the outcomes might be altered depending on the economic dynamics. As an illustration, trade openness fosters economic growth, which is compatible with Managi (2013) and Ibrahim and Sare (2018). On the other hand, recent research by Nchofoung et al. (2022) shows that trade openness may be detrimental to sustainable development: nations with high foreign trade incomes are expected to consume more resources, leading to environmentally imprudent growth or a decline in sustainable development. Sustainable development may benefit from globalization through foreign direct investment. Existing research refutes the idea that a nation's economic health will suffer because of the richness of its natural resources (Destek et al. 2022), an idea known as the 'resource curse hypothesis' (Hartwell et al. 2019). In essence, the notion that shifting natural resource rents to the appropriate sectors can increase a country's economic production suggests that problems will occur if an economy is too dependent on natural resources. Dependence on natural resources and sustainable development may have an inverted U-shaped link, according to Destek et al. (2022). Economic expansion results in a rise in economic activity and carbon dioxide emissions (Hassan et al. 2015),

[4] See Coppedge et al. (2022) for more detail on the relevant construction and underlying assumptions.

which has repercussions for social development (Hartwell et al. 2019). Although growth is a metric of development, it is also an explanatory component of social development, and it explains environmental sustainability to a similar extent. Thus, GDP per capita may have both positive and negative effects on sustainable development.

Table A1 in Appendix B gives the complete definitions of the variables, while Table A2 contains the statistical summaries. The correlation matrices utilized to mitigate possible multicollinearity problems are described in Table A3. Panel A of Table A3 shows the non-instrumented independent and control variables, while Panel B shows the instrumented variables.

3.2 Model specifications

Our panel data study, which is based on the conventional sustainable development model of Nchofoung and Asongu (2022), depicts the SDI as dependent on a variety of macroeconomic variables, including trade, foreign investment, and technology. We extend the conventional method for estimating development regressions with an augmented model to evaluate the influence of taxes and accountability. Whereas Nchofoung and Asongu's (2022) model depends on technology and globalization, we extend it by including taxation, accountability, and the interaction term to explore the conditional effects of taxation and accountability on sustainable development while incorporating relevant conditioning information, in line with the literature (Din et al. 2022; Güney 2017; Jayaprakash and Radhakrishna Pillai 2021; Leung and Ng 2019; Nchofoung and Asongu 2022). Our principal focus in this paper is on the interaction effects measuring the effect of taxation on sustainable development within the context of accountability.[5] A theoretical model can thus be derived linking tax, accountability, and sustainable development, as in Equation 1:

$$SDI = f(Tax, Accountability) \tag{1}$$

With the SDI as the dependent variable, the empirical model can be described thus:

$$SDI_{it} = \alpha_0 + \alpha_1 Tax_{it} + \alpha_2 ACCt_{it} + \alpha_3 W_{it} + \varepsilon_{it} \tag{2}$$

where W is the battery of control variables, i is the cross-sectional dimension at period t, α is the coefficient associated with each variable, and ε is the stochastic error term.

If we utilize accountability dynamics to account for transmission mechanisms, Equation 2 is modified into Equation 3, in line with the literature (Nchofoung and Asongu 2022; Saha and Sen 2021):

$$SDI_{it} = \alpha_0 + \alpha_1 Tax_{it} + \alpha_2 ACCt_{it} + \alpha_3 W_{it} + \pi_1 (Tax_{it} \times ACCt_{it}) + \varepsilon_{it} \tag{3}$$

[5] Since our estimation technique includes interactive regressions, it is necessary to avoid certain pitfalls associated with this type of regression. Brambor et al. (2006) caution that interactive regressions should not be focused solely on interactive approximate coefficients, and that the parameters used to estimate the overall impact should be strict. Therefore, they suggest: (i) researchers should use interaction models, provided that their hypotheses are conditional in nature; (ii) all constitutive parameters should be used in the specifications of the interaction model; (iii) those constitutive parameters should not be interpreted as having marginal consequences unconditionally; (iv) marginal results and normal deviations should be built with substantive significance. This then motivates the computation of net effects and thresholds.

The sign and significance of π are of interest, since it captures the interaction effect of tax and accountability on the SDI. While Equation 3 is differentiated by tax proxies, Equation 4 is approximated in order to highlight the potential marginal impact of tax income on the SDI as accountability dynamics expand:

$$\frac{\partial SDI_{it}}{\partial Tax_{it}} = \alpha_1 + \pi_1 ACCt_{it} \tag{4}$$

Depending on the signs and coefficients of α_1 and π, there is a change of one unit in the SDI due to a change in accountability dynamics. Eventually, a net impact may be calculated if the signs and coefficients of the direct and indirect effects are opposite. If π is greater than zero, then Equation 5 suggests that a higher level of tax mobilization will improve strong sustainability as accountability dynamics expand. Contrariwise, if π is less than zero, then Equation 4 implies that a one unit increase in taxation will yield weak sustainability as the country tends to attain a greater level of accountability.[6]

From this viewpoint, Equation 5 can only be feasible if α_1 and π are opposite signs and significant:

$$SDI_{it} = \alpha_0 + \alpha_1 Tax_{it} + \alpha_2 ACCt_{it} + \alpha_3 W_{it} + \pi_1 (Tax_{it} \times ACCt_{it}) + (\alpha_1 + (\theta \times \pi)) + \varepsilon_{it} \tag{5}$$

θ is a mean of policy-influencing factors (i.e. the accountability and responsiveness proxies). Under these circumstances, there is a policy threshold for the enhanced modulating variables in Equation 6:

$$\frac{\partial SDI_{it}}{\partial Tax_{it}} = 0 \tag{6}$$

In this instance, the thresholds given by Equation 7 are appropriate:

$$ACCt_{threshold} = \frac{\alpha_1}{\pi_1} \tag{7}$$

The underlying notion for the calculation of thresholds is that when increasing policy variables beyond critical masses results in undesirable macroeconomic effects, it is expected that the policy variables should be complemented with other policy initiatives to facilitate desired or favourable outcomes on the dependent variable (Asongu and Odhiambo 2019b).

3.3 Estimation strategy

This paper investigates three simultaneity-robust estimation strategies: (i) the GMM, to account for persistence in sustainable development; (ii) the IV Tobit regression, to account for the constrained range of the dependent variable; (iii) the IV QR, to account for the initial point of the

[6] The issue of capital substitutability is often a concern in definitions of sustainable development in economic discourse (Giovannoni and Fabietti 2013). This substitutability encompasses social, natural, and human-made capital, and it may be used to distinguish weak sustainability from strong sustainability. To give a feasible dimension to sustainability, the concepts of strong and weak sustainability can be seen as two opposite ends of the quest for sustainable development. Weak sustainability features natural capital as an alternative to human-made or manufactured capital, whereas strong sustainability recognizes that natural resources are irreplaceable by human-made capital (Shi et al. 2019).

SDI. In line with the behaviour of the data, this motivates the adoption of a broad range of estimating methods. For instance: (i) the SDI and its first lag have a correlation that is greater than 0.8, meeting the threshold for establishing that sufficient stochasticity is present in the outcome variable to warrant the use of an estimation technique such as the GMM, which takes persistence in the outcome variable into account; (ii) in light of the fact that the nations of sub-Saharan Africa are the focus of this research, it is important to take into consideration the differences between countries; (iii) it is assumed that countries with lower levels of sustainable development may react differently to tax revenue and accountability dynamics compared with their more developed peers, due to the substantial heterogeneity in the outcome variable. This supports using an estimating method, such as QR, that takes into consideration comparisons for sustainable development.

System GMM

GMM is a good fit model for the following five reasons (Asongu et al. 2021).[7] First, the approach is ideal for the persistent dependent variable, which is determined when the first-order autocorrelation of the dependent variable is 0.8. Second, the number of countries should be greater than the number of time periods.[8] Third, any endogeneity concerns in the regression are addressed by the method. Fourth, the approach allows for differences across the countries. Fifth, it excludes any potential small sample variation from the difference estimator.

Based on the fifth reason, and by contrast with the difference GMM estimate posited by Arellano and Bond (1991), the system GMM (Arellano and Bover 1995) aligns with the estimate of Bond et al. (2001). Because the difference GMM is associated with (i) low reliability in simulation studies and (ii) bias in a large finite sample, the system GMM imposes some restrictions on the dynamic technique (Blundell and Bond 1998). Specifically, this paper adopts the Roodman (2009a, 2009b) method, which is an improvement on Arellano and Bover's (1995) forward orthogonal deviations against the first differences. The analysis is implemented to (i) adjust for cross-sectional differences and (ii) restrict overidentification or limit the proliferation of instruments (Baltagi 2008).

The one-step method is only consistent with homoscedasticity, but this paper controls for heteroscedasticity by using a two-step approach. The following equations in level (Equation 8) and first difference (Equation 9) model the standard system GMM estimation procedure.

$$SDI_{i,t} = \alpha_0 + \alpha_1 SDI_{i,t-\tau} + \alpha_2 Tax_{i,t} + \alpha_3 ACCt_{i,t} + \sigma_4 Tax \times ACCt_{i,t} + \sum_{h=1}^{n} \delta_h W_{h,i,t-\tau} + \eta_i + \xi_t + \varepsilon_{i,t} \quad (8)$$

$$SDI_{i,t} = \alpha_0 + \alpha_1 (SDI_{i,t-\tau} - SDI_{i,t-2\tau}) + \alpha_2 (Tax_{i,t} - Tax_{i,t-\tau}) + \alpha_3 (ACCt_{i,t} - ACCt_{i,t-\tau}) +$$
$$\sigma_4 (Tax \times ACCt_{i,t} - Tax \times ACCt_{i,t-\tau}) + \sum_{h=1}^{n} \delta_h (W_{h,i,t-\tau} - W_{h,i,t-2\tau}) + (\eta_i - \eta_{i-\tau}) + (\xi_t - \xi_{t-\tau}) + (\varepsilon_{i,t} - \varepsilon_{i,t-\tau}) \quad (9)$$

τ_t denotes the coefficient of autoregression, which is one within the framework of this paper because a year lag is capable of capturing past information. ξ_{it} is the time-specific constant, η_t is the country-specific effect, and $\varepsilon_{i,t}$ is the error term.

For a solid GMM specification, it is crucial to make use of identification attributes and exclusion constraints. This paper uses the GMM style since it is consistent with the variables used. Here,

[7] Although the first two reasons consist of the criteria for implementing the estimate approach, the latter three are benefits relevant to the estimate process.

[8] This assumption is maintained by the non-overlapping intervals of the five-year averages used in this paper.

only the dummy variable 'years' is treated as exogenous, and the appropriate approach is 'iv(years, eq(diff))'. Thus, it is very improbable that the first-difference estimate will identify the dummy 'years' to be endogenous (Roodman 2009a). All regressors are deemed presumptively endogenous or predetermined.

In addition, it is established that the exclusively exogenous variable (i.e. the dummy 'years' or identified instruments) only influences the output variable by means of the endogenous explanatory variable. The difference-in- Hansen test (DHT) for instrument exogeneity is evaluated for the statistical significance of this exclusion limit. Consequently, the null hypothesis of the test is not expected to be rejected to validate the exclusion restriction assumption. This signifies that if the null hypothesis of the Sargan overidentifying restrictions (OIR) is rejected, this is an indication in the standardized IV process that the instruments cannot describe the outcome variable without the explanatory variables. Although previous literature has used the IV procedure substantially (Asongu et al. 2021), the DHT is used in the GMM estimation strategy to establish if the dummy 'years' is strictly exogenous by allowing output variables to be explained within the endogenous explanatory variables.

IV Tobit regression

We use a Tobit model to underpin our empirical analysis, which allows us to account for the restricted range of the dependent variable. For this reason, ordinary least squares (OLS) estimation is not suitable for the SDI, which has a validity interval of zero to one only. Because of the restricted range of the dependent variable, a double-censored Tobit estimate method is used in this paper (Benito et al. 2014; Mohapatra et al. 2018). When there are no observations of zero or one, the likelihood functions of the double-censored Tobit model and the linear model are identical, making the former a suitable choice for estimation. This is consistent with the approach followed by Adegboye et al. (2021). This method of estimation is also consistent with the behaviour of the SDI data for the selected sub-Saharan African countries, as the index ranges between 0.207 and 0.748.

Equation 10 represents the canonical Tobit model (Carson and Sun 2007; Tobin 1958).

$$y^{*}_{i,t} = \alpha_0 + \alpha_1 Tax_{i,t} + \alpha_2 ACCt_{i,t} + \alpha_3 Tax \times ACCt_{i,t} + +\alpha_4 W_{i,t} + \varepsilon_{i,t} \tag{10}$$

where $y^{*}_{i,t}$ is a latent response variable and $\varepsilon_{i,t} \approx$ i.i.d. $N(0,\delta^2)$. Instead of observing $y^{*}_{i,t}$, we observe $y_{i,t}$ in Equation 11:

$$y_{it} = \begin{cases} y^{*}_{i,t}, & if \quad y^{*}_{i,t} > \gamma \\ 0, & if \quad y^{*}_{i,t} \leq \gamma \end{cases} \tag{11}$$

We address the problem of endogeneity here by accounting for both observable and unobserved forms of heterogeneity. In the baseline regressions, an IV Tobit technique is used to address the problem of simultaneity.[9]

[9] An IV is a surrogate for the independent variable of interest that is provided to solve the problem of simultaneity or reverse causation resulting from endogeneity. The four basic causes of endogeneity—omitted variables, concurrent causality, autoregression of the autocorrelated mistakes, and measurement error—must be taken into consideration (Greene 2008). It is rare to find an estimator that can wholly address all possible endogeneity causes. In the context

By instrumenting the variables with their initial lags, we address the issue of endogeneity in the relevant variables, that is, tax proxies and accountability dynamics. For instance, we instrument tax in Equation 12:

$$Tax_{i,t} = \alpha + \delta_j (Tax_{i,t-1}) + \varepsilon_{it} \tag{12}$$

The instrumentation procedure in Equation 12 requires the regression of the variables of interest on their initial lags and the preservation of the associated fitted values, which are then used as the primary independent variables in the Tobit estimates.[10] Heteroscedasticity and autocorrelation consistent standard errors are the requirements for instrumentation.[11] This process is consistent with previous literature (Asongu and Odhiambo 2020b; Asongu and Roux 2017).

IV QRs

Both the GMM and the Tobit estimator are based on the assumption that the dependent variable has a mean value. Blanket policies derived from models based on the mean of the dependent variables are less likely to be effective than those that take into consideration the initial value of the outcome variable. To remedy this problem, the QR method is used, since it takes into account pre-existing levels of sustainable development. Based on these estimates, we may classify nations into three groups: leaders, middle countries, and laggards in sustainable development. As a result of the QRs, we are able to explore the connection across all conditional distributions of the outcome variable (Firpo et al. 2022; Garza-Rodriguez et al. 2021; Maiti 2021).

Given the above, it is plausible to infer that studies that concentrate on mean effects may have errors that are embedded in the normal distribution. As the method allows the estimation process to model estimated parameters at different points of the conditional distribution of sustainable development, the empirical approach is also resilient to the presence of outliers (Koenker 2008, 2017).

The θ^{th} quantile estimator of sustainable development is achieved by resolving the following optimization issue, which is provided without subscripts to make it more understandable in Equation 13:

$$\min_{\beta \in R^k} \left[\sum_{i \in \{i: y_i \geq x_i'\}} \theta \, | y_i - x_i' \beta | + \sum_{i \in \{i: y_i \geq x_i'\}} (1-\theta) \, | y_i - x_i' \beta | \right] \tag{13}$$

where $\theta \in (0,1)$. With QR, the weighted sum of absolute deviations is reduced rather than the sum of squared residuals, which is the main goal of OLS. For example, the tenth or 90^{th} quantiles (with θ=0.1 or 0.9 respectively) are explored by roughly weighing the residuals. y_i is the conditional quantile of sustainable development given x_i:

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of this investigation, we have used internal instruments to adopt an IV method to address the issue of concurrent causality.

[10] The approach is subsequently employed for QRs.

[11] The specifications are made to address problems with autocorrelation and heteroscedasticity, which might lead to a bias in the estimated coefficients when the variables of interest are regressed on their initial lags. Following the regressions, the fitted values or instrumented variables are kept and utilized as the independent variables of interest in the Tobit and QRs. The instrumented variable in the tax equation, for instance, is wholly exogenous to tax revenue.

$$Q_y(\theta / X_i) = X_i^{'}\beta\theta \tag{14}$$

where distinct slope parameters are specified for every θ^{th} specific quantile. This approach is comparable to $E(y/x) = x_i'\beta$ in the OLS: slope parameters are only evaluated at the mean of the conditional distribution of sustainable development. In Equation 14, the dependent variable y_i is sustainable development, while x_i contains a constant term, tax proxies, accountability dynamics, their interactions, and conditioning information.

4 Empirical results and discussion of empirical findings

4.1 Results based on scatter plots

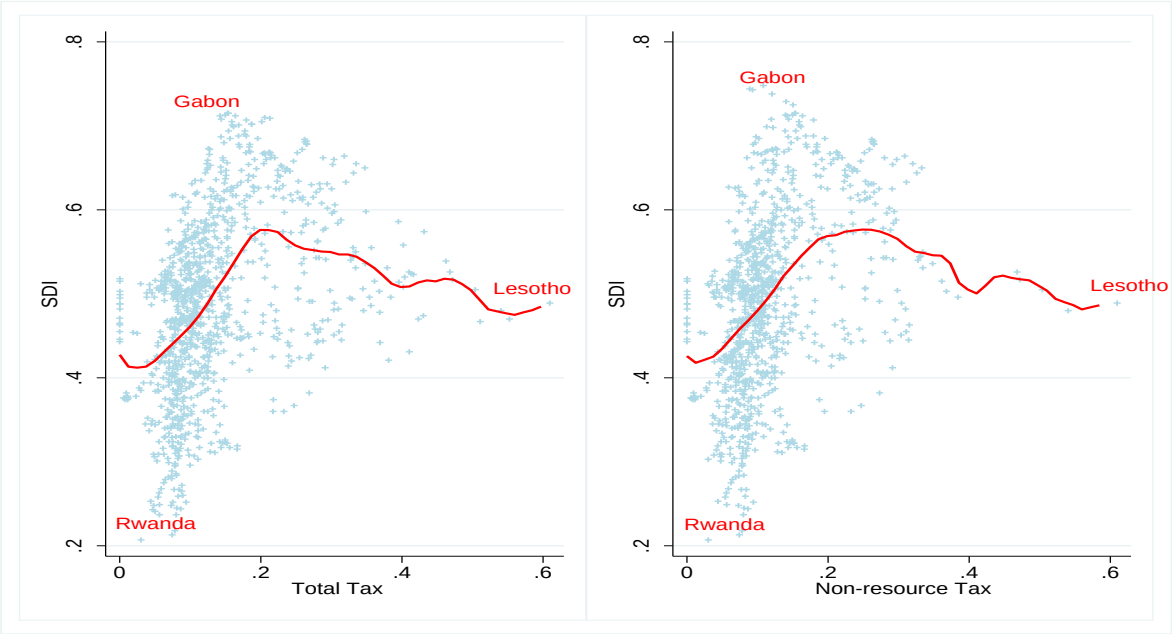
We begin by fitting the scatter plots of the link between the SDI and the dynamics of tax and accountability using kernel functions. Figure 2 depicts an inverted U-shaped connection between taxes and sustainable development, which suggests that there is an optimum level at which higher tax deepens further sustainable development. For instance, the average level of the SDI for the period 1990–2019 in Gabon is around 0.7, while its total tax revenue is 16.5 per cent of GDP, and the non-resource tax revenue is 11.34 per cent of GDP; in Lesotho the SDI is around 0.5, while total tax revenue (as a percentage of GDP) is about 40, and non-resource tax (as a percentage of GDP) is around 41.[12] Given the underpinning notion of the SDI, the results assert that amidst policy inefficiencies, resources through tax can be mobilized to improve socio-economic development while violating environmental sustainability, leading to weak sustainability.

However, Figure 3 shows a positive relationship between sustainable development and accountability dynamics. In other words, there is a high level of strong sustainability amidst enhanced accountability dynamics. A country such as Mauritius, with stronger accountability, demonstrates higher strong sustainability. This result supports the widespread argument in the governance and development literature that the capacity to plan and establish the institutions required for sustainable development is included in governance (Abhayawansa et al. 2021; Güney 2017; Odugbesan and Rjoub 2019; Stojanović et al. 2016).

Figures 4 and 5 report the association between the accountability dynamics and total revenue and non-resource tax respectively. The figures show a positive relationship between accountability dynamics and tax revenue. In other words, there is a high level of tax revenue mobilization when there is an enhanced level of accountability dynamics. This result supports the widespread argument in the governance and tax mobilization literature that the level of public accountability tends to dictate the level of tax compliance, which in turn influences tax mobilization (Igbo Igbeng et al. 2015; Uchenna et al. 2018). In order to promote fair, effective, and transparent tax systems, and ultimately domestic resource mobilization, strong accountability mechanisms have the potential to be a successful element (Bird et al. 2007; Quak 2019; Sobhkhiz et al. 2020).

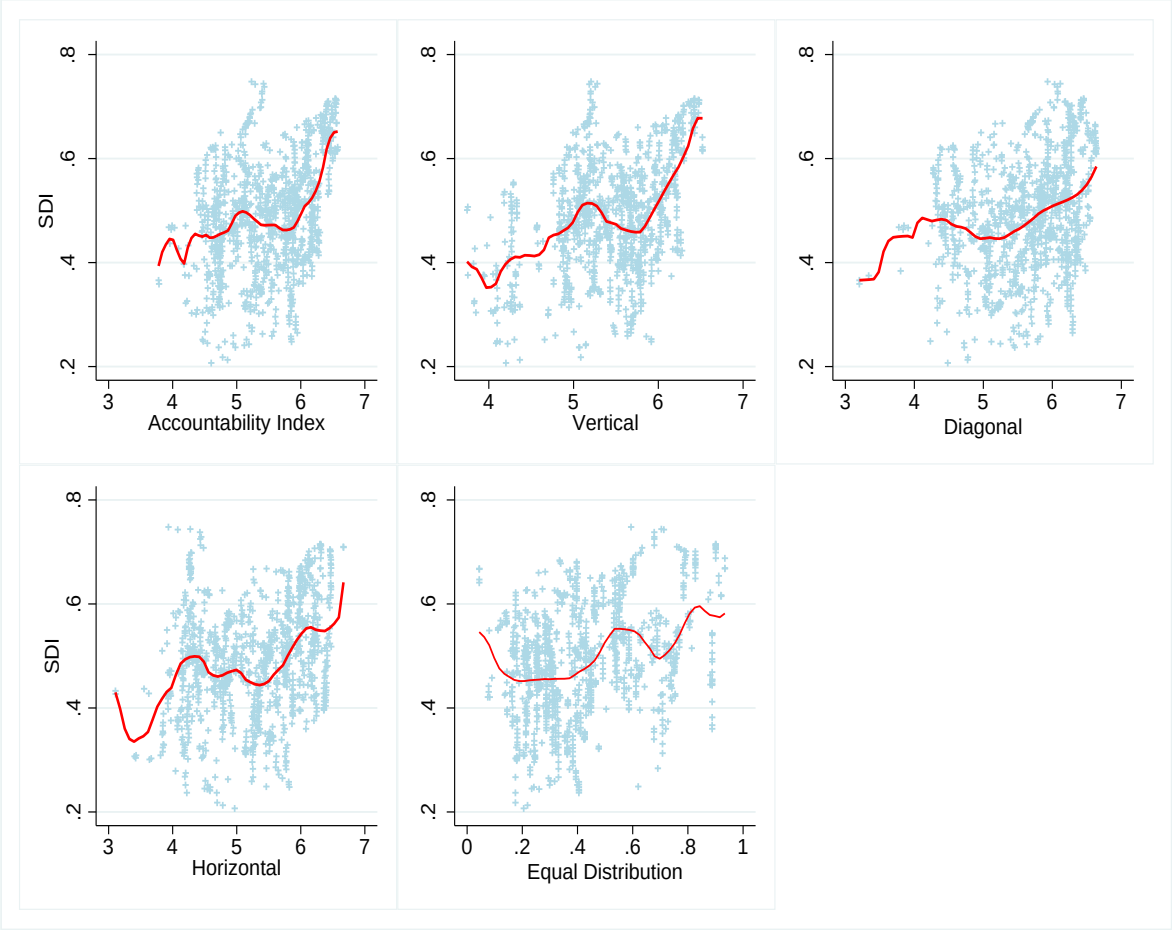
[12] In 2019 Gabon is ranked highest in sub-Saharan Africa via the SDI, whereas Lesotho has the highest total tax revenue in 2009.

Figure 2: Kernel fit plots for the relationship between sustainable development and tax revenue



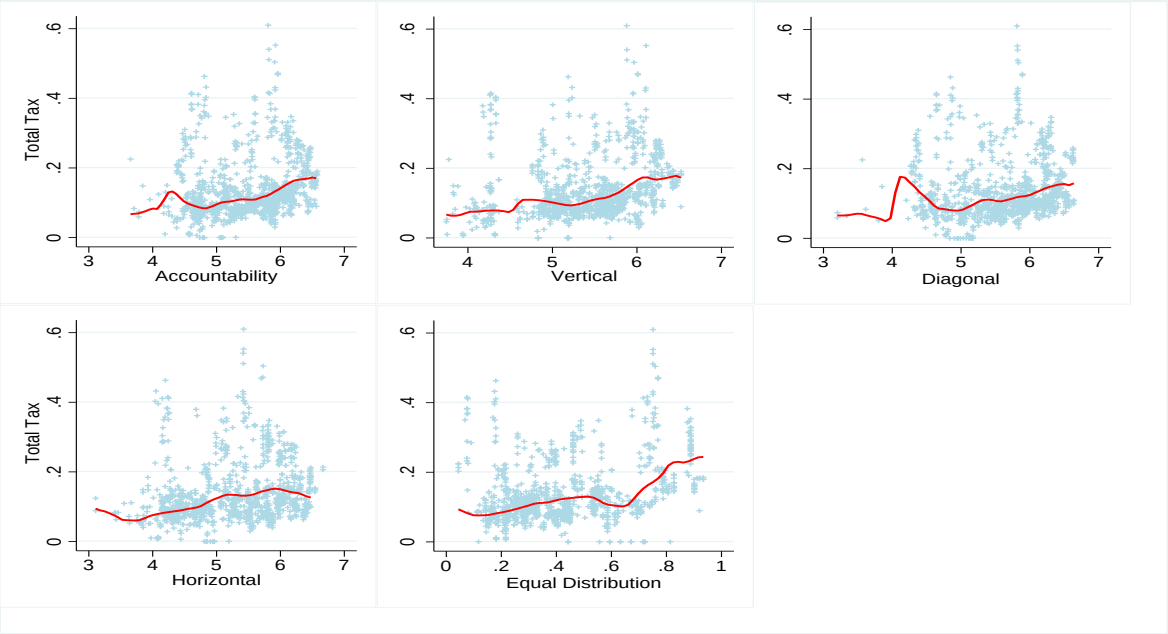
Source: authors' illustration based on data from SDI dataset and GRD.

Figure 3: Kernel fit plots for the relationship between sustainable development and accountability



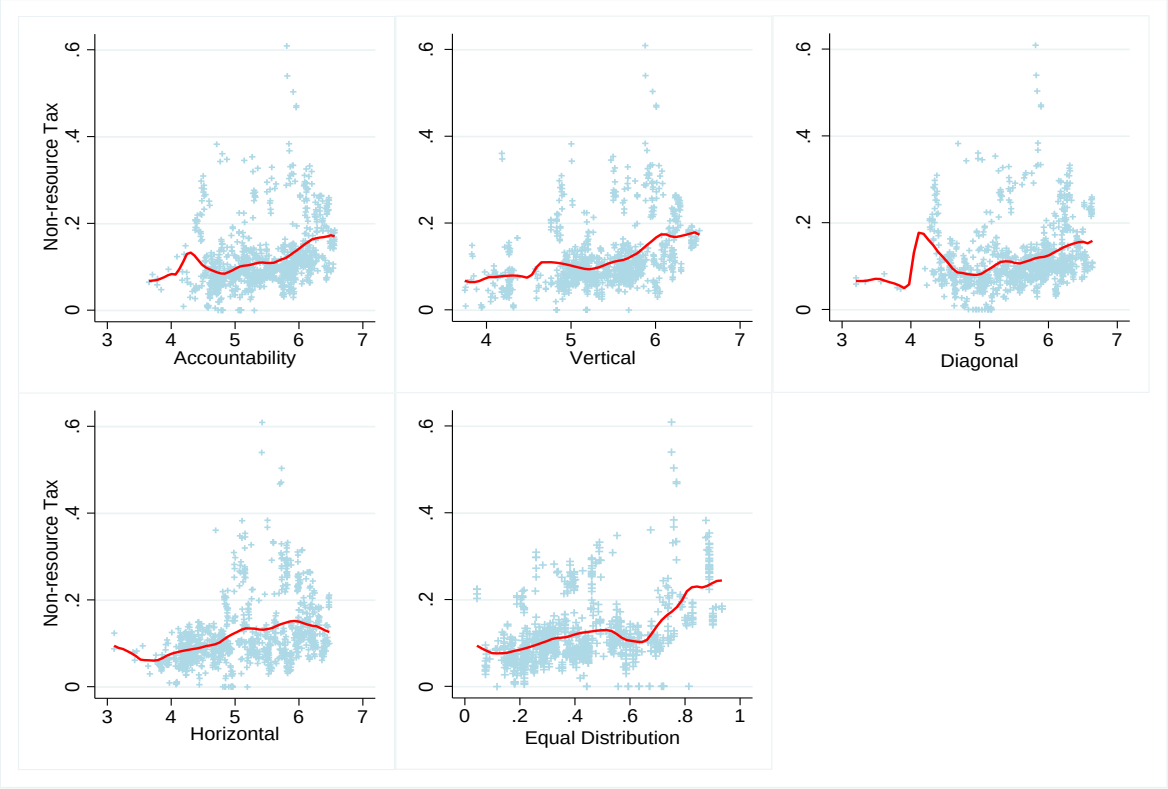
Source: authors' illustration based on data from SDI dataset and V-Dem.

Figure 4: Kernel fit plots for the relationship between total tax and accountability



Source: authors' illustration based on data from GRD and V-Dem.

Figure 5: Kernel fit plots for the relationship between non-resource tax and accountability



Source: authors' illustration based on data from GRD and V-Dem.

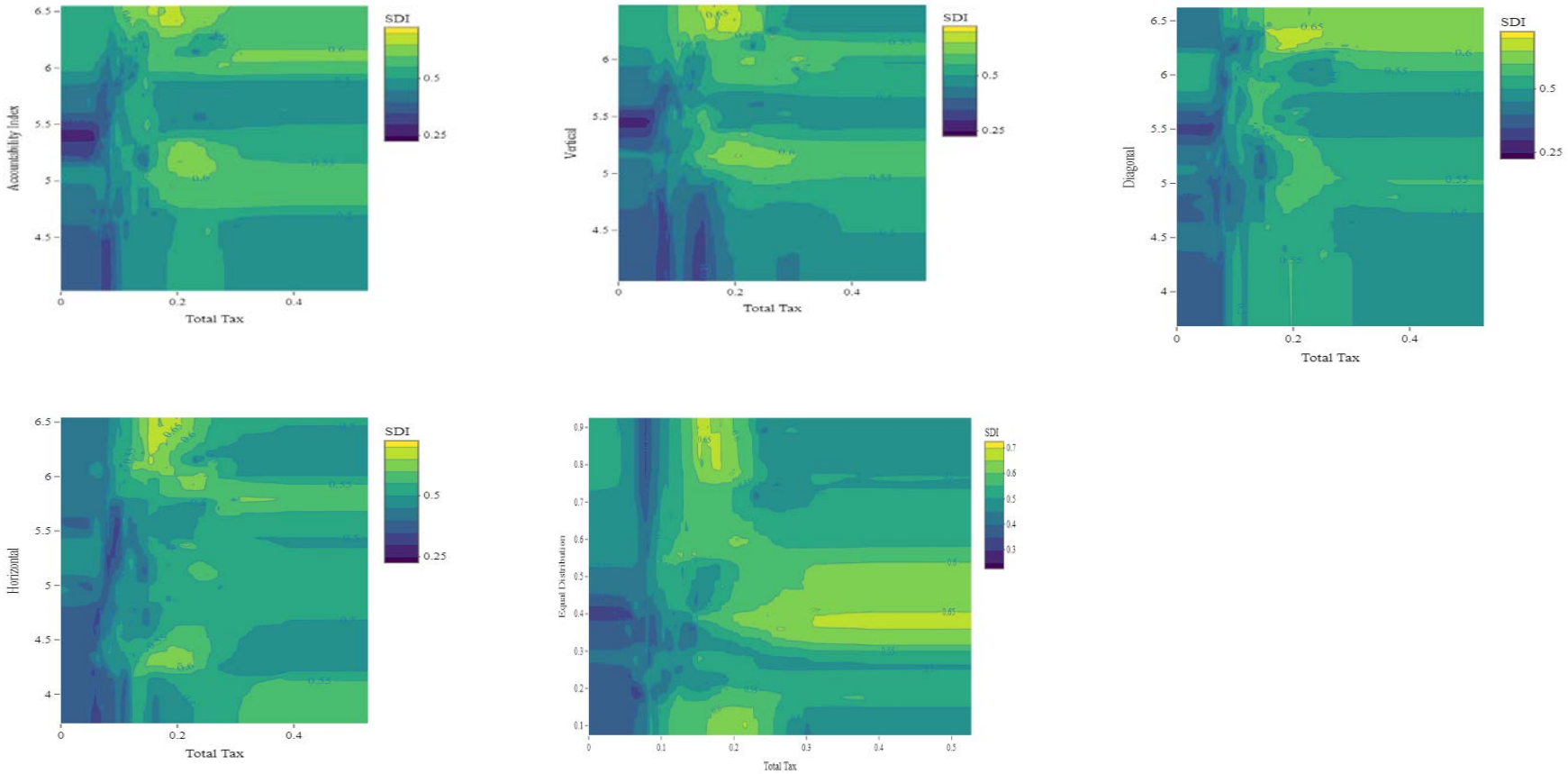
4.2 Results based on contour plots

In several fields, contour plots are used to display three-dimensional data in two directions. In addition to the standard axes, contour plots depict a dimension with colour- or line-represented contours. Consequently, the contour plot illustrates the link between two independent factors (i.e. accountability dynamics and tax revenue) and a dependent variable (i.e. SDI). Figure 6 depicts the SDI values for the combinations of total tax revenue and accountability dynamics, whereas Figure 7 depicts the SDI values for the combinations of non-resource tax revenue and accountability dynamics. The dynamics of tax revenue and accountability are shown along the x and y axes, while contour lines and bands indicate the SDI. The contour lines link the sequences of accountability dynamics and tax revenue that produce equal values of the SDI.

Figure 6 shows the relationship between accountability dynamics, total tax revenue, and the SDI for sub-Saharan Africa. The orange areas indicate higher sustainable development. These higher response values seem to form a ridge running from the upper middle to the lower right of the plot. The valleys in the lower left and upper right of the plot represent accountability dynamics and total tax revenue combinations that result in lower and higher sustainable development respectively.

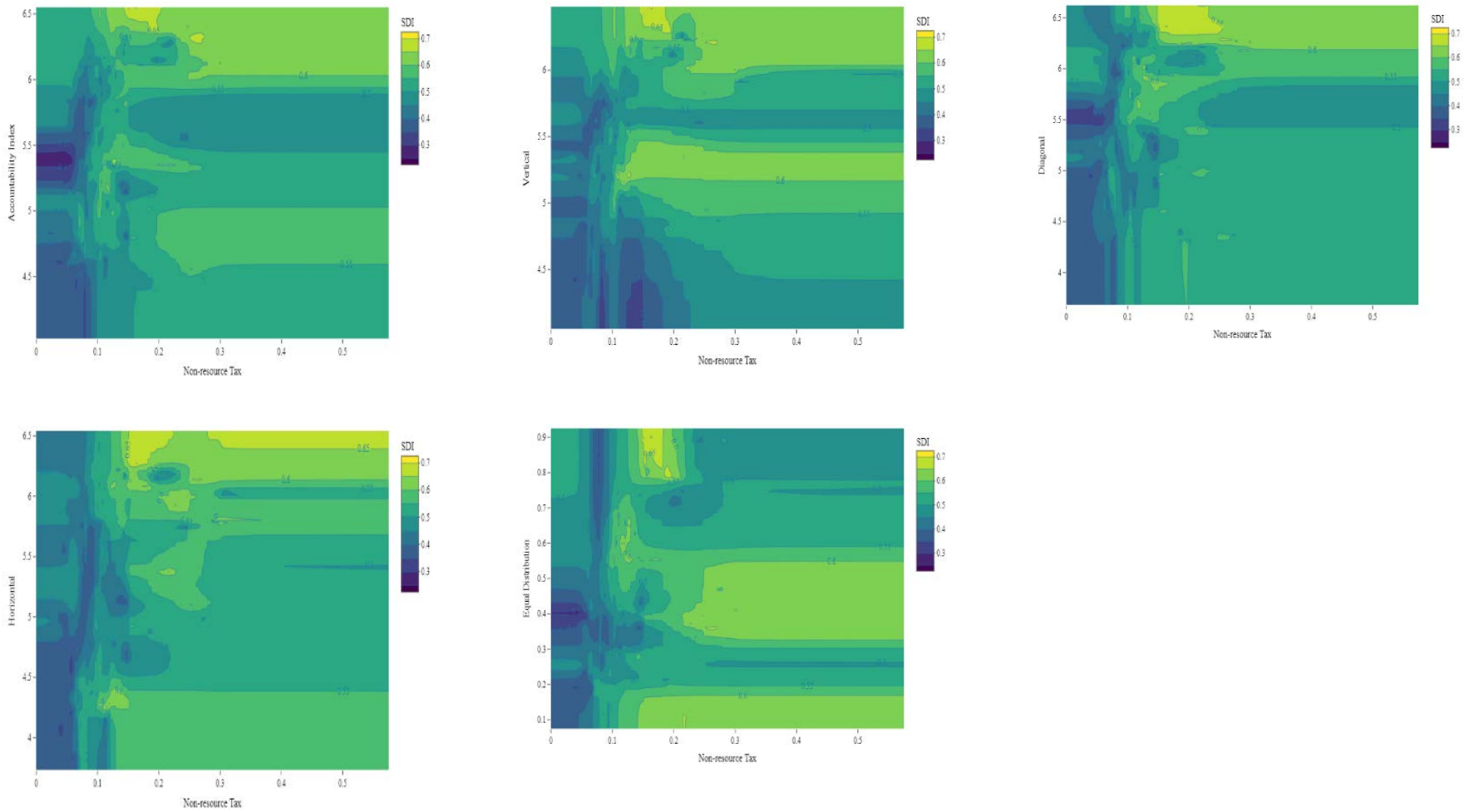
Figure 7 shows the relationship between accountability dynamics, non-resource tax revenue, and the SDI for sub-Saharan Africa. Importantly, the orange zones show greater sustainable development. These greater response values seem to create a ridge from the top centre to the bottom right of the plot. The valleys in the bottom left and upper right corners of the graph illustrate accountability dynamics and combinations of non-resource tax income that result in lower and higher sustainable development respectively. To acquire a stronger foundation for the findings, one should thoroughly examine whether the change in coefficients is significant or not.

Figure 6: Contour plots for the relationship between accountability, total tax, and SDI



Source: authors' illustration based on data from SDI dataset, GRD, and V-Dem.

Figure 7: Contour plots for the relationship between accountability, non-resource tax, and SDI



Source: authors' illustration based on data from SDI dataset, GRD and V-Dem.

4.3 Baseline findings based on regression outputs

Table 1 presents the interactive GMM and Tobit regressions linking accountability dynamics, total tax revenue, and sustainable development. Table 2 presents the interactive GMM and Tobit regressions linking accountability dynamics, non-resource tax revenue, and sustainable development. Each table is subdivided into five major sections: the overall accountability index, the vertical accountability index, the diagonal accountability index, the horizontal accountability index, and the equal distribution index. In contrast to the non-interactive regressions, which allow the assessment of the direct impacts of taxes on sustainable development, correlative interactive regressions allow the estimation of indirect effects through accountability dynamics. In other words, the research is able to investigate the part that accountability plays in supporting the impact of tax income on sustainable development.

Based on Brambor et al.'s (2006) cautions regarding the interpretation of interactive effects, we estimate the net effect (see Equation 4). This approach is consistent with the literature on interactive regressions to compute net effects, building on the unconditional effect of tax revenue dynamics as well as the conditional or marginal effects of the corresponding tax revenue and accountability dynamics on the SDI (Ajide et al. 2022; Amari et al. 2022; Asongu et al. 2022; Nchofoung et al. 2021; Omri and Belaïd 2021).

In light of the above, the net effects are calculated to determine the significance of accountability dynamics in modifying the impact of tax revenue on the SDI. These net impacts include both conditional effects related to the interplay between tax revenue and accountability dynamics and the unconditional effects of tax revenue on the SDI. For instance, column 1 of Table 1 is taken into consideration in order to put this calculation in a more comprehensive context. As shown in column 1 of Table 1, the net impact on the SDI from the relevance of the accountability index in modulating the influence of tax revenue on the SDI is 0.047 ([5.456 x -0.153] + [0.882]). According to this calculation, the average accountability index value is 5.456, total tax revenue has an unconditional influence on the SDI of 0.882, and the conditional impact of the interaction between the accountability index and total tax revenue is -0.153.

Table 1: Accountability, total tax, and sustainable development

	Dependent variable: SDI									
	GMM (5-year average)					IV Tobit regression				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
SDI (-1)	0.897***	0.870***	0.895***	0.913***	0.866***					
	(0.0354)	(0.0425)	(0.0352)	(0.0245)	(0.0321)					
TTax	0.882***	0.744***	0.615**	0.700***	0.310***	0.524*	0.480	-0.0668	0.614**	0.509***
	(0.217)	(0.232)	(0.259)	(0.137)	(0.0495)	(0.271)	(0.312)	(0.243)	(0.265)	(0.104)
ACC	0.0290***					0.0379***				
	(0.00575)					(0.00829)				
TTax X ACC	-0.153***					-0.0876*				
	(0.0403)					(0.0500)				
VER		0.0430***					0.0533***			
		(0.00470)					(0.00926)			
TTax X VER		-0.122***					-0.0796			
		(0.0408)					(0.0572)			
DIAG			0.0158**					0.0148*		
			(0.00659)					(0.00772)		
TTax X DIAG			-0.0991**					0.0226		
			(0.0462)					(0.0444)		
HOR				0.0327***					0.0294***	
				(0.00633)					(0.00694)	
TTax X HOR				-0.130***					-0.109**	
				(0.0286)					(0.0514)	
EQDI					0.178***					0.205***
					(0.0270)					(0.0319)
TTax X EQDI					-0.615***					-0.940***
					(0.107)					(0.201)
Trade	-0.0007***	-0.0008***	-0.0007***	-0.0006***	-0.0005***	-0.0005***	-0.0006***	-0.0009***	-0.0005***	-0.0004***
	(0.000121)	(0.000110)	(0.000122)	(0.000122)	(0.000121)	(0.000122)	(0.000116)	(0.000124)	(0.000125)	(0.000118)

FDI	0.000663	0.000679	0.000792*	0.000659	0.000440	0.00109*	0.000945*	0.00114**	0.00126**	0.00132**
	(0.000428)	(0.000413)	(0.000420)	(0.000425)	(0.000291)	(0.000561)	(0.000533)	(0.000571)	(0.000575)	(0.000548)
GDP per capita	0.00141	-0.00224	0.00132	0.00336	-0.00439	0.0827***	0.0797***	0.0840***	0.0846***	0.0792***
	(0.00348)	(0.00362)	(0.00329)	(0.00477)	(0.00403)	(0.00370)	(0.00368)	(0.00366)	(0.00362)	(0.00406)
Rent	0.00045***	0.0009***	0.0005**	0.001***	0.0009***	0.001***	0.001***	0.0009***	0.0009***	0.0008***
	(0.000172)	(0.000136)	(0.000182)	(0.000156)	(0.000154)	(0.000243)	(0.000239)	(0.000240)	(0.000256)	(0.000254)
Constant	-0.0438	-0.0947**	0.0284	-0.0868***	0.0745***	-0.285***	-0.345***	-0.172***	-0.243***	-0.149***
	(0.0339)	(0.0397)	(0.0409)	(0.0310)	(0.0171)	(0.0476)	(0.0478)	(0.0472)	(0.0425)	(0.0267)
Year effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Net effect	0.047	0.084	0.062	0.022	0.051	0.044	N/A	N/A	0.043	0.112
Thresholds	5.765	6.098	6.206	5.385	0.504	5.982	N/A	N/A	5.633	0.541
Diagnostic tests										
AR(1)_P-value	**[0.331]**	**[0.265]**	**[0.334]**	**[0.298]**	**[0.398]**	-	-	-	-	-
AR(2)_P-value	**[0.186]**	**[0.570]**	**[0.118]**	**[0.128]**	**[0.122]**	-	-	-	-	-
Sargan prob	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	-	-	-	-	-
Hansen prob	**[0.254]**	**[0.150]**	**[0.234]**	**[0.299]**	**[0.358]**	-	-	-	-	-
DHT for instruments										
(a) Instruments in levels										
H excluding group	**[0.342]**	**[0.287]**	**[0.380]**	**[0.131]**	**[0.233]**	-	-	-	-	-
Dif (null, H=exogenous)	**[0.260]**	**[0.162]**	**[0.217]**	**[0.542]**	**[0.487]**	-	-	-	-	-
(b) IV (years, eq(diff))										
H excluding group	**[0.139]**	**[0.083]**	**[0.196]**	**[0.170]**	**[0.236]**	-	-	-	-	-
Dif (null, H=exogenous)	**[0.835]**	**[0.729]**	**[0.470]**	**[0.841]**	**[0.756]**	-	-	-	-	-

Fisher	**63657*** **	**72235*** **	**43069*** **	**1436000*** **	**40614*** **	**106.3*** **	**118.3*** **	**101.5*** **	**104.7*** **	**106.9*** **
Countries	38	38	38	38	38	-	-	-	-	-
Instruments	35	35	35	35	35	-	-	-	-	-
Log likelihood						1085	1097	1077	1080	1098
Observations	163	163	163	163	163	929	929	929	929	929

Note: *, **, ***: significance levels of 10%, 5%, and 1% respectively. TTax: total tax revenue. ACC: accountability index. VER: vertical accountability index. DIAG: diagonal accountability index. HOR: horizontal vertical accountability. EQDI: equal distribution index. Trade: trade openness. FDI: foreign direct investment. Rent: natural rent. Dif: difference. Two factors contribute to the significance of the bold values: (i) the Hausman test and the Fisher statistics are significant; (ii) there is a failure to reject the null hypothesis of (a) no autocorrelation in AR (1) and AR (2) tests and (b) the validity of the instruments in the Sargan OIR test. In this case, N/A stands for 'not applicable', since at least one estimate coefficient required to calculate net impacts is not significant. Mean value of (five-year non-overlapping for GMM) accountability index is 5.455, vertical accountability is 5.406, diagonal accountability is 5.585, horizontal accountability is 5.218, equal distribution is 0.456. Instrumented mean value of (30 years for Tobit regression) accountability index is 5.479, vertical accountability is 5.426, diagonal accountability is 5.608, horizontal accountability is 5.236, equal distribution is 0.422.

Source: authors' calculations.

Table 2: Accountability, non-resource tax, and sustainable development

	Dependent variable: SDI									
	GMM (five-year average)					IV Tobit regression				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
SDI (-1)	0.872***	0.890***	0.903***	0.799***	0.783***	-	-	-	-	-
	(0.0231)	(0.0239)	(0.0289)	(0.0377)	(0.0363)	-	-	-	-	-
NRTax	2.754***	2.690***	2.577***	2.287***	0.408***	1.378***	1.770***	0.638**	2.602***	1.060***
	(0.478)	(0.517)	(0.437)	(0.454)	(0.111)	(0.312)	(0.400)	(0.274)	(0.422)	(0.114)
ACC	0.0597***					0.0490***				
	(0.00985)					(0.00823)				
NRTax X ACC	-0.484***					-0.220***				
	(0.0831)					(0.0547)				
VER		0.0641***					0.0705***			
		(0.00988)					(0.00953)			

NRTax X VER		-0.469***					-0.292***			
		(0.0877)					(0.0703)			
DIAG			0.0565***					0.0295***		
			(0.0110)					(0.00752)		
NRTax X DIAG			-0.446***					-0.0855*		
			(0.0767)					(0.0472)		
HOR				0.0520***					0.0529***	
				(0.00974)					(0.00808)	
NRTax X HOR				-0.427***					-0.448***	
				(0.0828)					(0.0767)	
EQDI					0.116***					0.266***
					(0.0276)					(0.0309)
NRTax X EQDI					-0.513***					-1.678***
					(0.164)					(0.215)
Trade	-0.00039***	-0.0003***	-0.0006***	-0.0006***	-0.0006***	-0.0007***	-0.0007***	-0.0007***	-0.0007***	-0.0005***
	(0.0000726)	(0.0000873)	(0.0001)	(0.0001)	(0.00008)	(0.000119)	(0.000113)	(0.000121)	(0.000118)	(0.000107)
FDI	0.000111	0.000017	0.000496*	0.000583*	0.000186	0.00100	0.000834	0.000988	0.00124**	0.00134**
	(0.000304)	(0.000299)	(0.000250)	(0.000345)	(0.000249)	(0.000624)	(0.000590)	(0.000640)	(0.000604)	(0.000536)
GDP per capita	0.00504*	-0.00378	0.00338	0.0220***	-0.000477	0.0829***	0.0808***	0.0824***	0.0878***	0.0743***
	(0.00284)	(0.00319)	(0.00258)	(0.00633)	(0.00493)	(0.00339)	(0.00338)	(0.00338)	(0.00322)	(0.00374)
Rent	0.000926***	0.00117***	0.00113***	0.00113***	0.00135***	0.00141***	0.00161***	0.00123***	0.00130***	0.00156***
	(0.000269)	(0.000192)	(0.000307)	(0.000207)	(0.000175)	(0.000241)	(0.000239)	(0.000235)	(0.000255)	(0.000255)
Constant	-0.250***	-0.226***	-0.232***	-0.260***	0.102***	-0.347***	-0.447***	-0.242***	-0.396***	-0.170***
	(0.0658)	(0.0618)	(0.0691)	(0.0698)	(0.0292)	(0.0473)	(0.0511)	(0.0452)	(0.0475)	(0.0234)
Year effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Net effect	0.113	0.155	0.086	0.059	0.192	0.173	0.186	0.159	0.256	0.352
Thresholds	5.690	5.736	5.778	5.356	0.795	6.264	6.062	7.462	5.808	0.634

Diagnostic tests										
AR(1)_P-value	**[0.304]**	**[0.253]**	**[0.312]**	**[0.293]**	**[0.384]**	-	-	-	-	-
AR(2)_P-value	**[0.231]**	**[0.592]**	**[0.179]**	**[0.034]**	**[0.118]**	-	-	-	-	-
Sargan prob	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	-	-	-	-	-
Hansen prob	**[0.169]**	**[0.131]**	**[0.229]**	**[0.407]**	**[0.413]**	-	-	-	-	-
DHT for instruments										
(a) Instruments in levels										
H excluding group	**[0.157]**	**[0.370]**	**[0.178]**	**[0.215]**	**[0.036]**	-	-	-	-	-
Dif (null, H=exogenous)	**[0.284]**	**[0.110]**	**[0.359]**	**[0.575]**	**[0.933]**	-	-	-	-	-
(b) IV (years, eq(diff))										
H excluding group	**[0.148]**	**[0.167]**	**[0.154]**	**[0.575]**	**[0.210]**	-	-	-	-	-
Dif (null, H=exogenous)	**[0.407]**	**[0.210]**	**[0.642]**	**[0.543]**	**[0.991]**	-	-	-	-	-
Fisher	**144273*** **	**163605*** **	**253131*** **	**92402*** **	**84232*** **	**138.7*** **	**151.4*** **	**136.6*** **	**159.7*** **	**178.7*** **
Countries	38	38	38	38	38	-	-	-	-	-
Instruments	35	35	35	35	35	-	-	-	-	-
Log likelihood						1041	1053	1036	1046	1074
Observations	156	156	156	156	156	873	873	873	873	873

Note: *, **, ***: significance levels of 10%, 5%, and 1% respectively. TTax: total tax revenue. ACC: accountability index. VER: vertical accountability index. DIAG: diagonal accountability index. HOR: horizontal vertical accountability. EQDI: equal distribution index. Trade: trade openness. FDI: foreign direct investment. Dif: difference. Two factors contribute to the significance of the bold values: (i) the Hausman test and the Fisher statistics are significant; (ii) there is a failure to reject the null hypothesis of (a) no autocorrelation in AR (1) and AR (2) tests and (b) the validity of the instruments in the Sargan OIR test. In this case, N/A stands for 'not applicable', since at least one estimate coefficient required to calculate net impacts is not significant. Mean value of (five-year non-overlapping for GMM) accountability index is 5.455, vertical accountability is 5.406, diagonal accountability is 5.585, horizontal accountability is 5.218, equal distribution is 0.456. Instrumented mean value of (30 years for Tobit regression) accountability index is 5.479, vertical accountability is 5.426, diagonal accountability is 5.608, horizontal accountability is 5.236, equal distribution is 0.422.

Source: authors' calculations.

The following GMM findings can be made from Tables 1 and 2.[13] First, the coefficients for total tax and for all the accountability and responsiveness proxies are positive and significant on sustainable development, suggesting that greater tax revenue and greater accountability enhance sustainable development. Second, the coefficients for the interaction term between total tax (non-resource tax revenue) and all the accountability and responsiveness proxies are negative and significant, demonstrating that tax and accountability together have a significant damaging effect on sustainable development in a country. However, our emphasis is based on the net effect. Third, the overwhelming majority of accountability dynamics modify total taxable income to have positive net impacts on the SDI. Fourth, the accountability dynamics adjust non-resource tax income to have positive net impacts on the SDI. Fifth, the significant control variables have the expected signs. Conversely, the results of the IV Tobit estimations are very similar to the GMM outputs.

The conditional impacts between accountability dynamics and tax revenue are continuously negative, despite the fact that the documented net effects are compatible with the theoretical predictions of the research. This suggests that enhancing accountability dynamics over a certain point would have no net impact on sustainable development. According to recent threshold literature, when increasing policy variables further beyond critical masses or thresholds results in undesirable macroeconomic effects, it is a sign that the policy variables should be combined with other policy initiatives to facilitate the desired or favourable results on the dependent variable (Asongu and Odhiambo 2019a; Asongu et al. 2022). Notably, the defined thresholds must be within the statistical range revealed in the summary statistics in order to be economically sound and relevant for policy (Amari et al. 2022; Nchofoung and Asongu 2022).

In light of the above, we dissect the net impacts in order to determine policy thresholds. These critical masses for complementing policies take into account the notion of diminishing contingent or interaction impacts. Thresholds are the level at which the net impacts are zero, and from which additional increases in accountability dynamics result in negative net consequences. Consequently, at the predetermined thresholds, accountability dynamics must be complemented with other policy efforts in order to regulate tax income for the benefit of sustainable development. This further suggests that, at the predetermined levels, accountability is a necessary but insufficient requirement for influencing tax income to generate positive outcomes on sustainable development.

The argument is supported by the examples used above to elucidate the estimations (see Equations 6 and 7). In column 1 of Table 1, the overall accountability threshold corresponds to 5.765 (0.882/|-0.153|). This suggests that the overall accountability index of 5.765 necessitates additional policies for total tax revenue to maintain a favourable link with sustainable development. To put this articulation into more perspective, when the accountability index is 5.765, the net relationship becomes zero ([5.765 x -0.153] + [0.882]). Consequently, when the accountability index exceeds the predetermined level, a negative link between total taxable income and the SDI

[13] Four information criteria are employed in this paper to validate the predicted GMM models. First, when one is establishing whether or not autocorrelation exists in the residuals, it is not essential to reject the null hypothesis of the second-order Arellano and Bond autocorrelation test (AR (2)). Second, the OIR tests conducted via Sargan and Hansen should not be significant, since their null hypotheses declare that the instruments are reliable or unrelated to the error terms. Fundamentally, the Sargan OIR is not robust but is not weakened by the instruments, while the Hansen OIR is not robust but is weakened by the instruments. Our research ensures that the instruments are smaller than the number of cross-sections in most specifications in order to prevent the proliferation of instruments. Third, the DHT for instrument exogeneity is also employed to confirm the validity of the Hansen OIR test findings. The combined validity of the generated coefficients is next tested using a Fisher test. All of the models pass their respective post-estimation diagnostic tests based on these criteria, proving that they are all overwhelmingly valid.

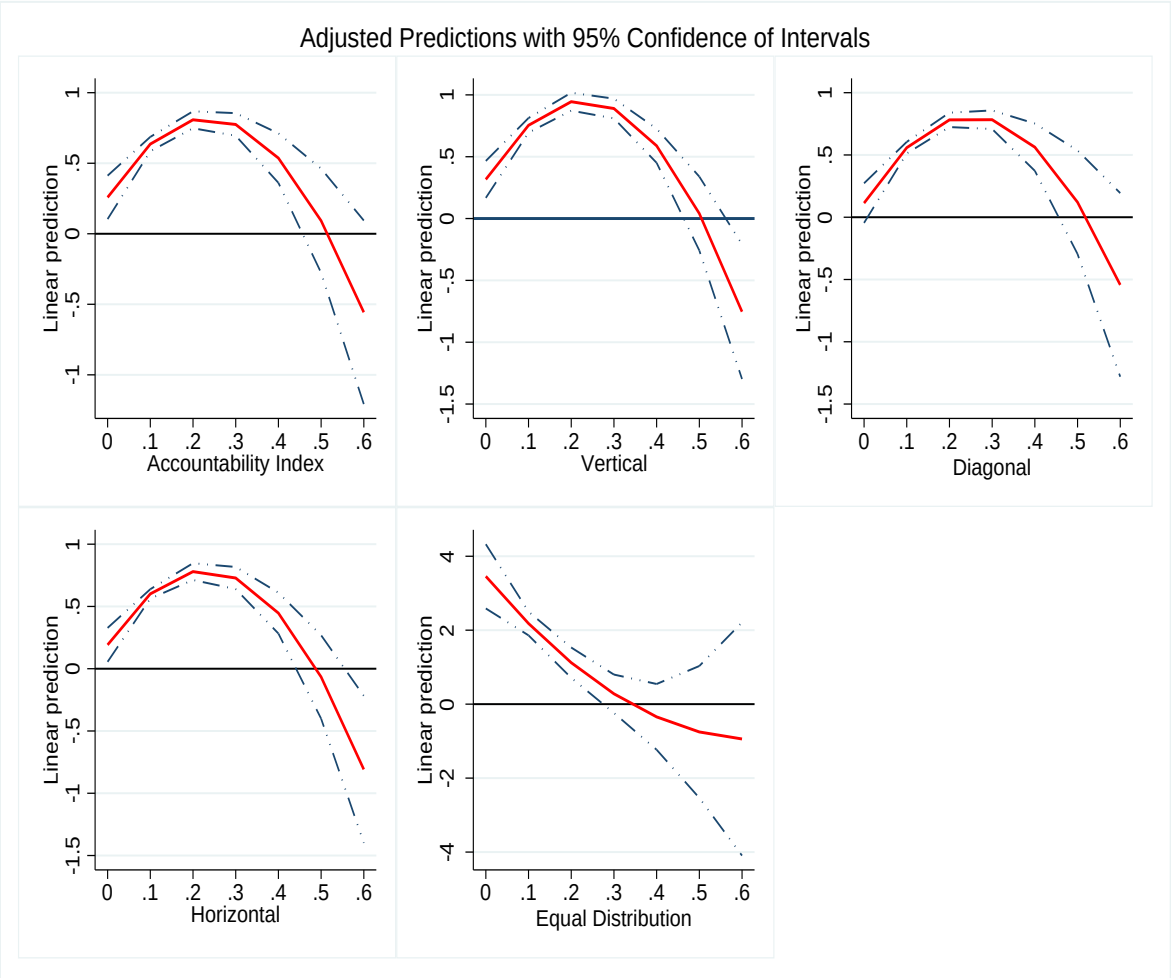
is evident. For instance, the net consequence of an accountability index of six is -0.036 ([6.00 x -0.153] + [0.882]).

At the established thresholds, therefore, accountability must be complemented with additional policy actions in order to modulate tax revenue for the purpose of promoting sustainable development. First, the established thresholds for modulating total tax income on sustainable development are an overall accountability index of 5.765 to 5.982, a vertical accountability index of 6.098, a diagonal accountability index of 6.206, a horizontal accountability index of 0.691, and equitable distribution of 0.504 to 0.541. Second, the set thresholds for the modulation of non-resource tax income on sustainable development are 5.690 to 6.264 for the overall accountability index, 5.736 to 6.062 for the vertical accountability index, 5.778 to 7.462 for the diagonal accountability index, 5.356 to 5.808 for the horizontal accountability index, and 0.634 to 0.795 for equal distribution. Because they fall within the statistical ranges of the accountability dynamics reported in the summary data, the set thresholds make economic sense and may be used by policy makers. This further shows that, at the thresholds, accountability is a necessary but insufficient requirement for the modulation of tax income to result in beneficial impacts on sustainable development.

Similarly, the marginal effects are also estimated using the IV Tobit regression graphically. The threshold level for the marginal effects of total tax and non-resource tax revenue are shown in Figures 8 and 9 respectively. The threshold level of the marginal effect of the total tax revenue is between 5.633 and 5.982 of accountability proxies (0.541 for equitable distribution), suggesting that after the threshold level of accountability and responsiveness, weak sustainability prevails as total tax revenue increases. The threshold level of the marginal effect of the non-resource tax revenue is between 5.808 and 7.462 of accountability proxies (0.634 for equitable distribution), indicating that as tax revenue rises, weak sustainability persists beyond the threshold level of accountability and responsiveness.

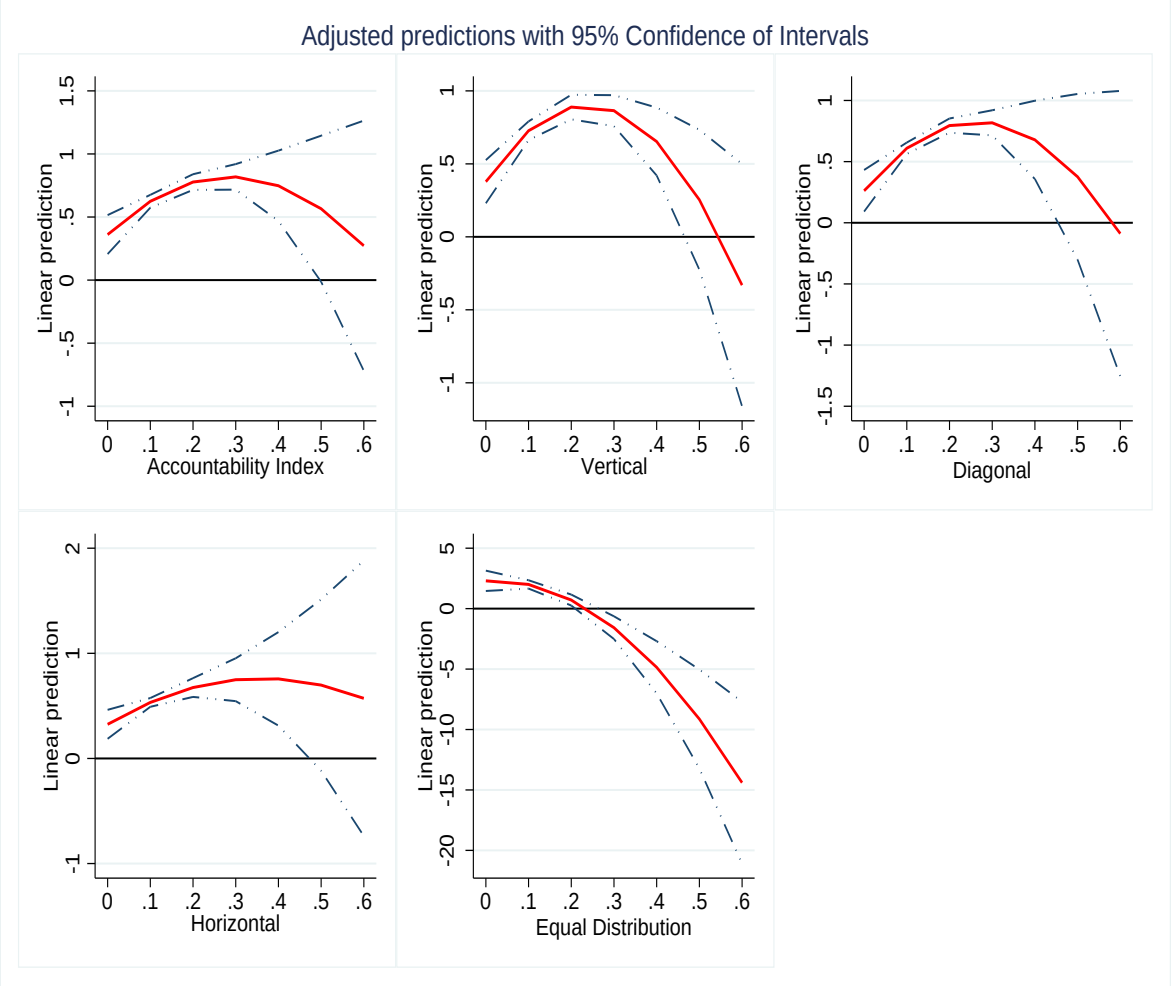
It is important to note that the fundamental idea of a threshold is congruent with the critical mass literature: ICT readiness, use, and intensity thresholds promote environmental sustainability (Amari et al. 2022); at critical masses of educational quality, the dissemination of knowledge via mobile phones promotes inclusive human development (Asongu and Nwachukwu 2018); at good governance thresholds, the unconditional impact of oil rents on wealth disparity becomes negative (Njangang et al. 2022); innovation thresholds drive the economy through institutional quality (Forson et al. 2021); there are basic circumstances for beneficial results (Cummins 2000); there is a critical mass for positive results (Batuo 2015).

Figure 8: Marginal effect of total tax revenue on SDI



Source: authors' illustration.

Figure 9: Marginal effect of non-resource tax revenue on SDI



Source: authors' illustration.

4.4 Additional findings: IV QRs

Table 3 reports the linkages between accountability dynamics, total tax revenue, and sustainable development. Table 4 shows the interactive linkages between accountability dynamics and non-resource tax revenue on sustainable development based on instrumental QRs. Panels A to E in each table report the results of the modulation of the accountability index, vertical accountability, diagonal accountability, horizontal accountability, and equal distribution index respectively. For a deeper perspective, Table 5 gives the names of the countries to which these percentiles correspond.

Table 3: Accountability, total tax, and sustainable development: instrumental QRs

	Dependent variable: SDI				
	Q10	Q25	Q50	Q75	Q90
Panel A: Accountability index	(1)	(2)	(3)	(4)	(5)
TTax	2.252***	-0.197	0.177	0.869**	1.722**
	(0.548)	(0.630)	(0.317)	(0.436)	(0.738)
ACC	0.0724***	0.0164	0.0274**	0.0500***	0.0736***
	(0.0177)	(0.0165)	(0.0120)	(0.0102)	(0.0159)
TTax X ACC	-0.477***	0.0354	-0.0255	-0.157**	-0.306**
	(0.110)	(0.127)	(0.0583)	(0.0729)	(0.127)
Constant	-0.651***	-0.358***	-0.316***	-0.287***	-0.325***
	(0.0929)	(0.116)	(0.0665)	(0.0538)	(0.0879)
Thresholds	4.721	N/A	N/A	5.535	5.627
Control variables	Yes	Yes	Yes	Yes	Yes
Pseudo R^2	0.272	0.278	0.304	0.354	0.39
Observations	929	929	929	929	929
Panel B: Vertical accountability					
TTax	1.777**	-0.524	-0.265	0.794***	0.955
	(0.743)	(0.395)	(0.391)	(0.268)	(0.803)
VER	0.0676***	0.0250*	0.0422***	0.0692***	0.0742***
	(0.0191)	(0.0128)	(0.0134)	(0.00820)	(0.0229)
TTax X VER	-0.384**	0.116	0.0508	-0.151***	-0.177
	(0.160)	(0.0799)	(0.0706)	(0.0462)	(0.144)
Constant	-0.615***	-0.331***	-0.359***	-0.352***	-0.291**
	(0.0878)	(0.0695)	(0.0664)	(0.0374)	(0.113)
Thresholds	4.628	N/A	N/A	5.258	N/A
Control variables	Yes	Yes	Yes	Yes	Yes
Pseudo R^2	0.266	0.289	0.318	0.372	0.398
Observations	929	929	929	929	929
Panel C: Diagonal accountability					
TTax	1.601*	-0.922***	-0.0349	0.409	2.123*
	(0.870)	(0.336)	(0.315)	(0.513)	(1.139)
DIAG	0.0468**	-0.00510	0.00817	0.0287***	0.0690***
	(0.0201)	(0.0103)	(0.0113)	(0.00957)	(0.0238)
TTax X DIAG	-0.330*	0.174	0.0180	-0.0762	-0.372*
	(0.177)	(0.0624)	(0.0592)	(0.0879)	(0.196)
Constant	-0.531***	-0.203***	-0.214***	-0.200***	-0.354**
	(0.0963)	(0.0726)	(0.0730)	(0.0683)	(0.143)
Thresholds	4.852	Outliner	N/A	N/A	5.707
Control variables	Yes	Yes	Yes	Yes	Yes
Pseudo R^2	0.254	0.278	0.299	0.343	0.381
Observations	929	929	929	929	929
Panel D: Horizontal accountability					
TTax	1.635***	0.224	0.122	0.288	-0.367
	(0.367)	(0.453)	(0.238)	(0.464)	(0.592)
HOR	0.0490***	0.0231**	0.0225***	0.0286***	0.00921
	(0.00993)	(0.00933)	(0.00856)	(0.0104)	(0.0167)
TTax X HOR	-0.383***	-0.0476	-0.0128	-0.0592	0.0544

	(0.0738)	(0.0909)	(0.0472)	(0.0834)	(0.112)
Constant	-0.516***	-0.411***	-0.288***	-0.186***	-0.00230
	(0.0571)	(0.0723)	(0.0567)	(0.0631)	(0.0800)
Thresholds	4.269	N/A	N/A	N/A	N/A
Control variables	Yes	Yes	Yes	Yes	Yes
Pseudo R^2	0.283	0.278	0.304	0.35	0.381
Observations	929	929	929	929	929
Panel E: Equal distribution					
TTax	0.418***	0.579***	0.288*	0.361***	-0.213*
	(0.135)	(0.188)	(0.163)	(0.140)	(0.112)
EQDR	0.183***	0.241***	0.221***	0.217***	0.0105
	(0.0343)	(0.0757)	(0.0402)	(0.0382)	(0.0507)
TTax X EQDR	-1.372***	-1.472**	-0.457*	-0.648***	0.319
	(0.252)	(0.592)	(0.255)	(0.209)	(0.302)
Constant	-0.324***	-0.370***	-0.227***	-0.136***	0.00147
	(0.0402)	(0.0460)	(0.0348)	(0.0225)	(0.0296)
Thresholds	0.305	0.393	0.630	0.557	N/A
Control variables	Yes	Yes	Yes	Yes	Yes
Pseudo R^2	0.308	0.299	0.327	0.377	0.387
Observations	929	929	929	929	929

Note: *, **, ***: significance levels of 10%, 5%, and 1% respectively. TTax: total tax revenue. ACC: accountability index. VER: vertical accountability index. DIAG: diagonal accountability index. HOR: horizontal vertical accountability. EQDI: equal distribution index. Trade: trade openness. FDI: foreign direct investment. N/A stands for 'not applicable', since at least one estimate coefficient required to calculate net impacts is not significant.

Source: authors' calculations.

Table 4: Accountability, non-resource tax, and sustainable development: instrumental QR

	Dependent variable: SDI				
	Q10	Q25	Q50	Q75	Q90
Panel A: Accountability index	(1)	(2)	(3)	(4)	(5)
NRTax	3.305***	0.740	1.163***	2.940***	3.357***
	(0.449)	(0.583)	(0.333)	(0.529)	(0.739)
ACC	0.0784***	0.0336**	0.0383***	0.0837***	0.103***
	(0.0150)	(0.0155)	(0.0113)	(0.00937)	(0.0157)
NRTax X ACC	-0.656***	-0.117	-0.178***	-0.496***	-0.579***
	(0.0924)	(0.111)	(0.0586)	(0.0902)	(0.129)
Constant	-0.645***	-0.460***	-0.366***	-0.481***	-0.521***
	(0.0766)	(0.104)	(0.0554)	(0.0624)	(0.0885)
Thresholds	5.038	N/A	6.534	5.927	5.798
Control variables	Yes	Yes	Yes	Yes	Yes
Pseudo R^2	0.291	0.327	0.401	0.449	0.291
Observations	873	873	873	873	873
Panel B: Vertical accountability					
NRTax	3.957***	0.941	1.316***	1.987***	2.615***
	(1.096)	(0.727)	(0.478)	(0.600)	(0.511)
VER	0.0935***	0.0503***	0.0671***	0.0889***	0.0912***
	(0.0229)	(0.0146)	(0.0159)	(0.0142)	(0.0130)
NRTax X VER	-0.795***	-0.152	-0.211**	-0.340***	-0.453***
	(0.220)	(0.138)	(0.0854)	(0.104)	(0.0934)

Constant	-0.743***	-0.507***	-0.480***	-0.465***	-0.434***
	(0.114)	(0.0907)	(0.0813)	(0.0818)	(0.0622)
Thresholds	4.977	N/A	6.237	5.844	5.773
Control variables	Yes	Yes	Yes	Yes	Yes
Pseudo R^2	0.297	0.304	0.338	0.409	0.45
Observations	873	873	873	873	873
Panel C: Diagonal accountability					
NRTax	2.353*	-0.0844	0.734**	2.000**	3.248***
	(1.363)	(0.448)	(0.365)	(0.789)	(0.729)
DIAG	0.0607**	0.00954	0.0214*	0.0580***	0.0880***
	(0.0273)	(0.0128)	(0.0109)	(0.0126)	(0.0133)
NRTax X DIAG	-0.453*	0.0429	-0.0964	-0.325**	-0.540***
	(0.259)	(0.0829)	(0.0635)	(0.133)	(0.127)
Constant	-0.552***	-0.284***	-0.280***	-0.337***	-0.475***
	(0.132)	(0.0954)	(0.0614)	(0.0887)	(0.0778)
Thresholds	5.194	N/A	N/A	6.154	6.015
Control variables	Yes	Yes	Yes	Yes	Yes
Pseudo R^2	0.275	0.291	0.322	0.389	0.444
Observations	873	873	873	873	873
Panel D: Horizontal accountability					
NRTax	3.830***	2.013*	1.880***	2.983***	3.034***
	(0.608)	(1.188)	(0.465)	(0.338)	(0.991)
HOR	0.0706***	0.0427**	0.0362***	0.0689***	0.0711***
	(0.0126)	(0.0205)	(0.00916)	(0.00795)	(0.0226)
NRTax X HOR	-0.752***	-0.348	-0.301***	-0.522***	-0.500***
	(0.119)	(0.237)	(0.0816)	(0.0614)	(0.174)
Constant	-0.603***	-0.496***	-0.357***	-0.431***	-0.364***
	(0.0600)	(0.104)	(0.0495)	(0.0383)	(0.126)
Thresholds	5.093	N/A	6.246	5.715	6.068
Control variables	Yes	Yes	Yes	Yes	Yes
Pseudo R^2	0.321	0.294	0.329	0.396	0.428
Observations	873	873	873	873	873
Panel E: Equal distribution					
NRTax	0.919***	1.196***	0.815***	0.711***	0.0503
	(0.142)	(0.151)	(0.141)	(0.135)	(0.243)
EQDR	0.231***	0.303***	0.243***	0.274***	0.0867
	(0.0252)	(0.0396)	(0.0427)	(0.0362)	(0.0719)
NRTax X EQDR	-2.106***	-2.198***	-1.070***	-1.121***	-0.167
	(0.262)	(0.296)	(0.324)	(0.206)	(0.457)
Constant	-0.354***	-0.365***	-0.159***	-0.108***	0.0197
	(0.0323)	(0.0320)	(0.0307)	(0.0194)	(0.0339)
Thresholds	0.436	0.544	0.762	0.634	N/A
Control variables	Yes	Yes	Yes	Yes	Yes
Pseudo R^2	0.360	0.347	0.355	0.41	0.426
Observations	873	873	873	873	873

Note: *, **, ***: significance levels of 10%, 5%, and 1% respectively. TTax: total tax revenue. ACC: accountability index. VER: vertical accountability index. DIAG: diagonal accountability index. HOR: horizontal vertical accountability. EQDI: equal distribution index. Trade: trade openness. FDI: foreign direct investment. N/A stands for 'not applicable', since at least one estimate coefficient required to calculate net impacts is not significant.

Source: authors' calculations.

Table 5: List of corresponding countries under different percentiles based on SDI

Percentile	Corresponding countries
tenth	Mali, Sierra Leone
25th	Democratic Republic of the Congo, Rwanda
50th	Côte D'Ivoire, Togo
75th	Madagascar, Nigeria
90th	Ghana, Namibia

Source: authors' calculations.

The following findings are established in Table 3. First, the interactions between the accountability index and total tax revenue are negative at the tenth, 50th, 75th, and 90th quantiles. Thus, the thresholds for the modulation of total tax revenue income on sustainable development at which complementary policies are needed alongside the accountability index are 4.721 (tenth quantile), 5.535 (75th quantile), and 5.627 (90th quantile). Second, it is evident that there are negative interactions between vertical accountability and total tax at the tenth and 75th quantiles. Therefore, it is necessary to identify the thresholds for complementary policies for favourable sustainable development, which are 4.628 (tenth quantile) and 5.258 (75th quantile). Third, it is evident that there are negative interactions between diagonal accountability and total tax at the bottom and top quantiles. Therefore, it is necessary to identify the thresholds for complementary policies for favourable sustainable development, which are 4.628 for the bottom quantile and 5.258 for the top quantile. Fourth, it is evident that there are negative interactions between horizontal accountability and total tax at the bottom quantile alone. Therefore, it is necessary to identify the threshold for complementary policies for favourable sustainable development, which is 4.269 for the bottom quantile. Fifth, it is evident that there are negative interactions between an equal distribution and total tax at all quantiles except the top quantile. Therefore, it is necessary to identify the thresholds for complementary policies for favourable sustainable development, which are 0.305 (tenth quantile), 0.393 (25th quantile), 0.630 (50th quantile), and 0.557 (75th quantile).

The following findings are established in Table 4. First, the interactions between the accountability index and non-resource tax revenue are negative at the tenth, 50th, 75th, and 90th quantiles. Thus, the thresholds for the modulation of non-resource tax revenue income on sustainable development at which complementary policies are needed alongside the accountability index are 5.038 (tenth quantile), 6.534 (50th quantile), 5.927 (75th quantile), and 5.798 (90th quantile). Second, it is evident that there are negative interactions between vertical accountability and non-resource tax at the tenth, 50th, 75th, and 90th quantiles. Therefore, it is necessary to identify the thresholds for complementary policies for favourable sustainable development, which are 4.977 (tenth quantile), 6.237 (50th quantile), 5.844 (75th quantile), and 5.773 (90th quantile). Third, it is evident that there are negative interactions between diagonal accountability and non-resource tax at the bottom, middle and top quantiles. Therefore, it is necessary to identify the thresholds for complementary policies for favourable sustainable development, which are 5.194 (tenth quantile), 6.154 (75th quantile), and 6.015 (90th quantile). Fourth, it is evident that there are negative interactions between horizontal accountability and non-resource tax at the bottom, middle and top quantiles. Therefore, it is necessary to identify the thresholds for complementary policies for favourable sustainable development, which are 5.093 for the bottom quantile, 6.246 for the middle quantile, 5.715 for the 75th quantile, and 6.068 for the top quantile. Fifth, it is evident that there are negative interactions between equal distribution accountability and non-resource tax in all quantiles except the top quantile. Therefore, it is necessary to identify the thresholds for complementary policies for favourable sustainable development, which are 0.436 (tenth quantile), 0.544 (25th quantile), 0.762 (50th quantile), and 0.634 (75th quantile).

4.5 Discussion of findings and policy implications

Our fundamental assumption concerns the linked relationship between taxes, accountability, and development with respect to ideas about social cohesion and endogenous growth theory. Notably, this paper assumes not only that government accountability encourages tax compliance in order to collect sufficient resources from taxpayers, but also that this societal consensus should foster sustainable development. A beneficial impact is expected to result from the conditional relationship between accountability, tax income, and sustainable development. This argument states that stronger governance via increased accountability and government responsiveness would boost public resources for sustainable development.

Theoretically, accountability dynamics may play a significant role in enhancing tax morale for tax mobilization, which might have an impact on development. This paper has demonstrated that taxes, accountability, and development are interconnected in terms of social cohesion and endogenous growth theory. It is evident that taxes require a level of accountability and government responsiveness to acquire resources that will foster sustainable development. According to Paz-Fuchs (2008), when taxes are based on consensus (i.e. as an essential but avoidable element of the social contract) through accountability, tax is seen as a public benefit rather than an inherent evil. This model requires social responsiveness via accountability for tax revenue to foster sustainable development. Although statements linking taxes to greater accountability are attractive in theory, their implementation in reality is likely to be much more difficult. Increasingly, it is essential to emphasize that the positive relationship between accountability, taxation, and development is neither inevitable nor assured (Prichard 2010). However, this paper has established the positive net effects.

The conditional impacts between accountability dynamics and tax revenues are constantly negative, although the demonstrated net effects are compatible with our theoretical predictions. This shows that increasing accountability dynamics beyond a certain point will nullify the beneficial net effects of tax income on sustainable development. Our research extends beyond the construction of net connections to build accountability levels that modify the associated tax revenues to positively affect sustainable development. According to recent threshold research (Asongu and Odhiambo 2019a; Asongu and Vo 2020; Nchofoung and Asongu 2022; Njangang et al. 2022), when increasing policy variables beyond critical masses or thresholds results in undesirable macroeconomic outcomes, this is a sign that the policy variables should be combined with other policy initiatives to facilitate desired or favourable results on the dependent variables. The underlying conceptions and definitions of thresholds are consistent with the attendant critical mass literature, including the thresholds at which growing environment degradation has a negative influence on inclusive development (Asongu 2018), the initial conditions for rewarding effects (Cummins 2000), and the critical masses for favourable effects (Batuo 2015; Röller and Waverman 2001).

We decomposed the net effects in light of the aforementioned information to establish the thresholds for further policy. The notion of declining conditional or interacting impacts is taken into consideration by these critical masses for complementary actions. Thresholds are points where there are no net effects and where further escalating accountability dynamics would produce adverse net impacts. Therefore, at the stated thresholds, further policy actions must be added to accountability dynamics in order to modulate tax revenues for benefits to sustainable development. This further suggests that for the modulations to have beneficial impacts on sustainable development at the defined thresholds, accountability is a necessary but insufficient requirement. These thresholds are crucial for policy-making because, beyond the tipping points, more efforts that will lessen the detrimental impacts of tax revenue on sustainable development should be made in conjunction with the continued improvement of accountability dynamics.

The major policy that merits highlighting is the idea that accountability is important for enhancing the absorptive capacity of tax mobilization, which in turn promotes sustainable development. In essence, accountability systems will aid governments in achieving sustainable development by serving as a 'force multiplier' for such national activities (such as revenue collection). Therefore, policy makers in sub-Saharan African nations should coordinate measures that improve accountability dynamics. Such measures should include, among other things: limitations on the use of political power by the government through potential sanctions and demands that it justify its actions; free and fair elections; checks and balances between institutions; unhindered oversight by civil society organizations and media activity. In order to ensure that governments allocate adequate, fair, and accountable funding for sustainable development, participatory budgeting initiatives might be expanded, as might mechanisms to monitor budget allocations and other facets of fiscal policy. However, due to diminishing modulating effects, such policies should be complemented with other programmes that will increase the absorption of tax revenue, such as programmes to increase government responsiveness and transparency, institutional quality, ICT adoption, human development, gender inclusion, and income equality.

5 Conclusion

Modern scholars argue that the social contract can only thrive if the government is accountable to the voters and its use of public and economic resources is transparent. While statements linking taxes to greater accountability are attractive in theory, their implementation in reality is challenging. Increasingly, it is necessary to emphasize that favourable relationships between accountability, taxes, and development are not inevitable. Consequently, it is necessary to create criteria that will preserve the strong relationship between accountability, taxes, and development.

This paper has examined the impact of accountability quality on the relationship between taxes and sustainability in 41 sub-Saharan African nations from 1990 to 2019. GMM, IV Tobit, and QR methods support the empirical evidence. The following conclusions are established. First, accountability dynamics have net positive impacts on sustainable development by modifying tax revenue. Second, the conditional effects between accountability dynamics and tax revenues are consistently negative, despite the fact that the observed net effects are consistent with our theoretical expectations. Third, we decomposed the net implications to determine the policy thresholds where there are no net benefits and the further intensification of accountability dynamics would result in negative net outcomes. At the specified thresholds, further policy measures must be complemented with accountability dynamics in order to adjust tax revenues for strong sustainability.

These findings come with two caveats. First, governance is a multifaceted phenomenon that includes factors such as accountability, pluralism, political stability, the absence of violence, and government efficiency. This paper has focused on the accountability part of governance, which it further subdivided into vertical, diagonal, and horizontal accountability. Second, the estimate method used in this paper is designed to reduce endogeneity by removing fixed effects, which might correlate with error terms and result in endogeneity. This is an inherent flaw in the GMM strategy. Because of this, we have not taken country fixed effects into account.

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Appendix A

List of sample countries

Angola; Benin; Botswana; Burkina Faso; Burundi; Cabo Verde; Cameroon; Central African Republic; Chad; Congo; Côte D'Ivoire; Democratic Republic of the Congo; Eswatini; Ethiopia; Gabon; Gambia (Republic of the); Ghana; Guinea; Kenya; Lesotho; Liberia; Madagascar; Malawi; Mali; Mauritania; Mauritius; Mozambique; Namibia; Niger; Nigeria; Rwanda; Sao Tome and Principe; Senegal; Seychelles; Sierra Leone; South Africa; Togo; Uganda; United Republic of Tanzania; Zambia; Zimbabwe.

Appendix B

Table A1: Definitions of variables

Variable	Acronym	Measurement	Source
Sustainable development index	SDI	Ecological efficiency of socio-economic development, acknowledging that development is achieved within the constraints of the planet	Hickel (2020)
Total tax revenue	TTax	Total tax revenue (% of GDP) excluding social contribution and grants	GRD
Non-resource tax	NRTax	Non-resource tax revenue (% of GDP), determined as total tax revenue less resource tax revenue (i.e. taxes from natural products)	GRD
Accountability index	ACC	Constraint on the political power of the government	V-Dem
Vertical index	VER	Power of citizens to hold the government accountable through citizen's formal political participation and free elections	V-Dem
Horizontal index	HOR	Capacity of state institutions to demand information and to query and punish officials for improper behaviour	V-Dem
Diagonal index	DIAG	Mechanisms engaged by citizens, civil society, and media to hold the government accountable	V-Dem
Equal distribution index	EQDR	Level of resource distribution in society, including both real and intangible resources	V-Dem
Trade openness	Trade	Imports plus exports (% of GDP)	WDI
Foreign direct investment	FDI	Foreign direct investment (% of GDP)	WDI
GDP per capita	GDP	Natural logarithm of GDP per capita (constant 2015 US$)	WDI
Natural rent	Rent	Total natural resources rents (% of GDP)	WDI

Source: authors' compilation.

Table A2: Descriptive statistics

Variable	Obs	Mean	Std dev	Min	Max
Panel A: Descriptive statistics, GMM 5-year average					
SDI	230	.49	.104	.228	.74
TTax	236	.135	.084	0	.527
NRTax	222	.119	.076	0	.575
ACC	246	5.456	.597	4.027	6.55
VER	246	5.406	.536	4.054	6.477
HOR	246	5.585	.621	3.682	6.623
DIAG	246	5.218	.743	3.733	6.542
EQDR	246	.421	.207	.075	.925
Trade	219	68.297	32.999	24.75	204.298
FDI	242	3.654	6.101	-2.76	70.308
GDP	242	7.005	.956	5.383	9.69
Rent	242	11.288	10.109	.003	51.171
Panel B: Descriptive statistics, 30 years					
SDI	1139	.491	.105	.207	.748
TTax	1150	.135	.086	0	.609
TTax (IV)	1115	.136	.082	.007	.59
NRTax	1059	.117	.073	0	.609
NRTax (IV)	1032	.118	.069	.007	.586
ACC	1230	5.456	.615	3.653	6.576
ACC (IV)	1189	5.479	.587	3.768	6.546
VER	1230	5.406	.585	3.744	6.522
VER (IV)	1189	5.426	.507	4.001	6.389
HOR	1230	5.585	.638	3.203	6.639
HOR (IV)	1189	5.236	.734	3.209	6.634
DIAG	1230	5.218	.762	3.107	6.667
DIAG (IV)	1189	5.608	.61	3.338	6.615
EQDR (IV)	1189	.422	.205	.049	.929
Trade	1083	68.262	33.716	19.684	225.023
FDI	1208	3.656	7.322	-11.199	103.337
GDP	1209	7.003	.957	5.318	9.74
Rent	1205	11.221	10.576	.001	59.433

Source: authors' calculations.

Table A3: Correlation matrices

Panel A: Correlation matrix for 30-year period without IVs

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
1. SDI	1										
2. TTax	0.409***	1									
3. NRTax	0.415***	0.861***	1								
4. ACC	0.334***	0.255***	0.352***	1							
5. VER	0.425***	0.316***	0.411***	0.882***	1						
6. DIAG	0.257***	0.147***	0.231***	0.949***	0.775***	1					
7. HOR	0.274***	0.234***	0.368***	0.822***	0.699***	0.685***	1				
8. GDP	0.662***	0.627***	0.579***	0.313***	0.406***	0.205***	0.297***	1			
9. FDI	0.0739*	0.0985**	0.124***	0.0160	0.0714*	-0.00348	-0.0314	0.116***	1		
10. Trade	0.325***	0.534***	0.493***	0.0668	0.202***	-0.0372	0.0387	0.633***	0.369***	1	
11. Rent	-0.107**	-0.134***	-0.360***	-0.319***	-0.351***	-0.268***	-0.379***	-0.171***	0.0918**	0.0870*	1

Panel B: Correlation matrix for 30-year period with IVs

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
1. SDI	1										
2. TTax	0.404***	1									
3. NRTax	0.409***	0.851***	1								
4. ACC	0.345***	0.249***	0.353***	1							
5. VER	0.430***	0.308***	0.412***	0.882***	1						
6. DIAG	0.270***	0.142***	0.234***	0.950***	0.776***	1					
7. HOR	0.283***	0.225***	0.365***	0.825***	0.701***	0.691***	1				
8. GDP	0.264***	0.245***	0.380***	0.421***	0.453***	0.265***	0.523***	1			
9. FDI	0.322***	0.523***	0.485***	0.0718*	0.205***	-0.0306	0.0434	0.304***	1		
10. Trade	0.0665	0.101**	0.116***	0.0156	0.0738*	-0.00630	-0.0281	0.0393	0.370***	1	
11. Rent	0.658***	0.624***	0.576***	0.323***	0.416***	0.216***	0.303***	0.363***	0.639***	0.112**	1

Note: * $p<0.05$, ** $p<0.01$, *** $p<0.001$.

Source: authors' calculations.