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Essays on Taxation in Africa and Tax Reforms in Angola

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To Graça, Ngindumuntu, Nlembami, and Luzololuanzambi

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Resumo

A tese responde às seguintes questões de investigação: Qual foi o impacto da reforma-tributária nas receitas fiscais não-petrolíferas em Angola? Como é que a tributação afeta os índices de democracia em África? Há evidência de existência da curva-de-Laffer nos impostos em África?

Primeiro, avaliamos o impacto da reforma-tributária nas receitas fiscais não-petrolíferas entre 2008-2021, utilizando modelos de regressão econométricas. Os resultados mostraram que as reformas tiveram impacto positivo. O modelo ARDL mostrou que, em comparação com os anos anteriores à reforma, a de 2011 contribuiu para um aumento de 46% das receitas fiscais, a de 2015 para um aumento de 140,5%, e a de 2019 para um aumento de 115,6%.

Depois, aplicamos métodos econométricos para dados-em-painel para estudar o impacto da tributação, medida pelo rácio receitas-fiscais/PIB, nos índices de democracia em 50 países Africanos entre 1980-2021. Os resultados revelaram que a relação é côncava, demonstrando que o impacto da tributação é positivo até um determinado limiar, após o qual os índices de democracia começam a diminuir. O limiar está entre 26%-27%, claramente superior ao rácio médio das receitas fiscais/PIB observado no Continente, que foi de 14%.

Finalmente estimamos a curva de Laffer para três categorias de impostos (empresas, trabalho, e impostos indiretos), utilizando 25 países Africanos entre 2011-2021, recorrendo a métodos de regressão paramétricos e não-paramétricos. Descobrimos evidências de curva de Laffer nos três impostos. As taxas-de-impostos maximizadoras das receitas fiscais dos impostos sobre as empresas estão entre 26%-27%; dos impostos indiretos, entre 13%-15,2%; e sobre o trabalho, entre 40.8%-45%.

Classificação JEL: C20, H20.

Palavras-chave: África, Angola, Índices de Democracia, Curva de Laffer, Tributação, Reforma Tributária.

Abstract

The thesis addresses the following research questions: What was the impact of the tax-reforms on the non-oil tax revenues in Angola? How is taxation affecting democracy indices in Africa? Is there evidence of a Laffer curve for taxes in Africa?

First, we estimated the impact of tax-reforms on non-oil tax revenues in Angola 2008-2021. We found that reforms had a positive impact on the non-oil fiscal revenues. The ARDL model showed, in comparison to the years before the reforms, that the 2011 reform contributed to 46% more non-oil tax revenues, the 2015 reform to 140.5%, and the 2019 reform to a 115.6%.

Then we applied econometric methods for-panel-data to study the impact of taxes, measured by tax revenues/GDP ratio on democracy indices in 50 African countries in the period 1980-2021. The findings reveal that the relationship is concave, demonstrating that the impact of taxation is positive up to a certain threshold, after which democracy-indices start to decrease. The threshold was found to be around 26%-27%, greater than the observed average tax-revenue/ GDP ratio in the continent, which was of 14%.

Finally, we estimated the Laffer curve for three tax revenues categories (corporate, labour, and indirect) using a panel of 25 African countries in the period of 2011-2021 using parametric and non-parametric regressions. We found evidence of Laffer curve for the three tax categories. The Revenues-Maximizing-tax-rates for the corporate tax revenues were found to be between 26%-27%; for the indirect taxes, between 13%-15.2%; and for the labour taxes, between 40.8%-45%.

JEL Classification: C20, H20.
Keywords: Africa, Angola, Democracy Indices, Laffer curve, Taxation, Tax Reform.

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List of Acronyms and Abbreviations

ADF - Augmented Dickey-Fuller unity root test
AGT - *Administração Geral Tributária*
AIC - Akaike Information Criterion
ARDL - Auto Regressive Distributed Lag
BNA – Banco Nacional de Angola (Angolan Central Bank)
Ccorruption - Control of Corruption Index
CT – Corporate Tax
DNI - *Direcção Nacional dos Impostos*
ECM - Error Correction Model
ECT - Error Correction Term
Fexchanger - formal exchange rate
FE – Fixed Effects
FE-LDV - Fixed Effects Lagged Dependent Variable
Frmpd – Fractional Regression Model for Panel Data
FOB – Free On Board
GLM – Generalized Linear Model
GMM - Generalized Method of Moment
GDP - Gross Domestic Product
Govefect - Government effectiveness index
Iexchanger - Informal exchange rate
IV-2SLS - Instrumental Variable Two Stage Least Squares
IQ – First Quarter
IMF - International Monetary Fund
INE - *Instituto Nacional de Estatística of Angola*
IRT – *Imposto sobre Rendimento do Trabalho* (Personal Income Tax)
KPSS - Kwiatkowski-Phillips-Schmidt-Shin unity root test
LT – Labour Tax
N- Number of Observations
Notaxes - Nominal non-oil tax revenues
Nnogdp - Nominal non-Oil GDP
OLS - Ordinary Least Squares
OECD- Organization for Economic Cooperation and Development
p.p. - Percentage points
PERT - *Projecto Executivo para a Reforma Tributária*
PP - Phillips–Perron Unity Root Test
RA - Revenue Authority

RMTR – Revenue Maximizing Tax Rates
RU-MIDAS - Reverse Unrestricted Mixed Data Sampling
2SLS - Two Stage Least Squares
SBA - Stand-By Arrangement
SBC - Schwarz Bayesian Information Criterion
SUR - Seemingly Unrelated Regression
TSLS Two-stage Least Squares
UNU-WIDER - United Nations University World Institute for Development Economics Research
USD - United States Dollar
V-Dem - Varieties of Democracy
VAT - Value-Added Tax
WGI - Worldwide Governance Indicators
WLS - Weighted Least Squares

Introduction

In these **three essays** we conduct empirical studies related to taxation in Africa, and the impact of fiscal reforms on the non-oil tax revenues in Angola. Africa is the Continent with the lowest tax revenue to GDP ratio in the World. In their paper on the Determinants of Tax Revenue in Sub-Saharan Africa, using IMF data from 1990 to 2005, Addison and Levin (2007) documented that the fiscal revenues to GDP ratio in Africa were the lowest compared to other Continents such as Europe, Asia, and America. This is still true today. In fact, data from Global Revenue Statistic Database from the OECD (2023) show that revenue collection in Africa is still lower in comparison to other regions, standing at 16% in 2021, while in Asia was 20%, in the Pacific, Latin America, and Caribbean was 22%, and 34% in the OECD countries. In developing countries that are rich in natural resources such as Angola most of the fiscal revenues derive from those natural resources, which makes them vulnerable to the fluctuation of commodity prices in international markets, affecting their public finances and the overall macroeconomic indicators (World Bank, 2022). In order to mitigate the potential negative impact of this type of uncertainty, these countries are urged to reform their tax systems in order to bring into the system more taxpayers, especially those in the non-resources sectors of the economy. The essays herein therefore address the following three research questions: (1) what was the impact of the recent tax reforms on the non-oil tax revenues in Angola? (2) How is taxation affecting democracy indices in Africa? And (3) are there possible Revenues Maximizing (RM) tax rates, according to the Laffer curve theory, in a panel of African countries?

The first essay (Chapter 1) answers the first research question. It analyses the case of Angola, an African oil producing country, in which the oil sector as of 2021 accounted for almost a third of the total GDP and is the main driver of the entire economy, accounting for 96% of exports. The revenues from international trade generated in the sector are used to import capital goods, raw materials, and final goods and services needed in the non-oil sector of the economy.

When the civil war ended in 2002, nearly 80% of total fiscal revenues used to finance public expenditure and investment came from the oil sector. Jensen and Paulo (2011) argued that the 2008/09 international crisis had a huge impact on public finance management. Thereafter the government decided to pursue a tax reform (administrative, legislative, changes in tax rates, and introduction of a new indirect tax) of the non-oil sector in order to increase fiscal revenue collection and reduce the dependency on oil tax revenues. More than 10 years have passed since the onset of the non-oil tax reform and data show a steady increase of the nominal non-oil tax revenues. Thus, it is important to study the main determinants of this growth and to assess the impact of the tax reform that was implemented.

Angola is an interesting case study because it is the second largest oil-producer in the Continent (after Nigeria) and is among the ten biggest economies in terms of GDP (and among the five in Sub-Saharan Africa). Angola's economic and development performance without doubt affect the region and the continent as a whole. The empirical economic literature on taxation, on the determinants of non-oil tax revenues for oil-producing countries, and on the effectiveness of the non-resources tax reform in increasing revenue collection is scarce, especially for developing countries. The first chapter of this thesis will fill this gap by studying the case of Angola and the conclusions of this study are of interest for other oil-producing developing countries wishing to reduce their dependence on oil fiscal revenues by reforming the non-oil tax system.

Nigeria is an example of a resource-rich African country receiving scholarly interest regarding its tax reforms. The aim of the tax reform in Nigeria was similar to that of Angola's reforms, namely to increase tax revenues and diversify the tax base. The main difference is that reform in Nigeria began earlier (in the 1990s) and included all the sectors of the economy, whereas in Angola the reforms were implemented later (in 2011) and the focus was on the non-mineral sectors of the economy. Ebi and Ayodele (2017) examined the impact of tax reform on tax revenues collection in Nigeria between 1981 and 2014 employing cointegrated error correction models (ECM) and concluded that the reform had a positive and significant effect. They analysed both total tax revenues and oil tax revenues but not the non-oil tax revenues specifically.

In Chapter 1 we use monthly and quarterly data of non-oil tax revenues from 2008 to 2021 to study the impact of fiscal reforms on the non-oil tax revenues in Angola. For the quarterly data the ARDL bound cointegration and error correction model (ECM) was applied; and for the monthly, quarterly, and annual data, the Reverse Unrestricted Mixed Data Sampling (RU-MIDAS) regression was used, both to measure the impact of tax reform on non-oil tax revenues mobilization and to identify its main determinants. We are not aware of any similar work in the empirical taxation literature that uses the MIDAS regression. Both estimated regression models showed that the reforms had a positive and significant impact on the non-oil fiscal revenues collection. The ARDL model revealed that in comparison to the years before the reform, the 2011 reform contributed to an additional of 46% of the non-oil tax revenues, the 2015 reform to 140.5% more non-oil tax revenues, and the 2019 reform to a 115.6% increase in the non-oil tax revenues. The RU-MIDAS regression (with monthly tax revenues and yearly regressors) presented much lower impacts: 3.5% for the 2011 reform, 8.8% for the 2015 reform, and 0.04% for the 2019 reform. Furthermore, we also find that oil prices and production have negative impacts and are causing an eviction effect on the non-oil tax revenues in Angola.

In Chapter 2 we answer the second research question by studying how taxation (measured as tax revenues to GDP ratio) may be affecting democracy indices in Africa. Most developing countries around the world, especially in Africa, receive aid from Western developed countries and are urged to improve their political regimes in order to become more democratic, with the conviction that democracy will lead to more economic development, which in turn can positively affect the standard of living of people. Acemoglu *et al.* (2019) found that a country shifting from non-democracy to democracy attains about 20% higher GDP *per capita* in the long run. Western countries, in general, adjust the development aid and other technical assistance given to developing countries in Africa to a set of prerequisites including good governance, respect for human rights, and promotion of democracy. From an outsider's point of view, it seems that democracy in Africa, instead of being demanded by citizens, is imposed by the West.

What can spark a desire or demand amongst citizens for more democracy from their leaders? There is some empirical evidence that taxation leads to more democratization in developing countries in general (Barro, 1999; and Dom *et al*. 2023). Baskaran (2013) argues that evidence from pre-modern Europe and North America suggests that once rulers start to impose fiscal burden on their citizens, they are forced to become more democratic by yielding to their citizens' voices. Taxation can therefore help a country's population to participate in the public debate and hold their leaders to account.

Due to abundant fiscal revenues and royalties from the natural resources, some developing countries neglect to tax other non-resources economic sectors and their citizens in general for the sake of power concentration and to avoid accountability (Kolstad and Wiig, 2018). Because of this, in Chapter 2 we study if and how taxation is affecting democracy indices in Africa. We are not aware of empirical studies that focus on the relationship between taxation and democracy indices in Africa. Investigating this relationship for possible causation is relevant for the continent, taking into account that the democratic process is not yet stable, and many countries in Africa have been receiving aid from the West in an attempt to improve democracy (Cilliers, 2023). If the taxation level does affect democracy indices in the continent, the aid could be channelled toward the improvement of the tax system within the countries, since an endogenous variable such as taxation can better contribute to improve democracy in comparison to an exogenous variable such as foreign aid. We study a panel of 50 African countries using yearly data from 1980 to 2021 to see how the level of taxation is affecting the democratization process in the continent. We used the democracy indices from the V-Dem Project as it produces the most extensive dataset on democracy (for 202 countries, from 1789 to 2022), involves thousands of scholars and other country experts, and measures hundreds of different features of democracy (Papada *et al*., 2023).

We used two econometric model approaches: the standard OLS, FE, and IV Regressions which are the most used in the literature, and the Fractional Regression approach to more accurately gauge the relationship between taxation and democracy. The standard regressions have some obvious limitations because the dependent variable of democracy index is fractional, thus bounded in the unit interval, i.e., ranging between zero and 1. The fractional regression is thus the most suitable econometric regression approach to deal with this type of dependent variable. We are not aware of any paper on taxation and democracy literature that has used the fractional regression approach to investigate the relationship between the two. We wish to contribute to the literature by using this most appropriate econometric method.

The findings reveal that the taxation level impacts positively all democracy indices in the continent up to a certain taxation threshold, after which a further increase causes a decrease in the democracy indices. Thus, the regressions showed that the nonlinear relationship between tax revenue to GDP ratio and democracy indices in Africa is of a concave type. The results are robust in both standard and fractional regression models, showing an approximate level of taxation that maximizes democracy indices around 26%-27% of GDP. Furthermore, amongst all the control variables used, non-tax revenues showed to have a negative impact on democracy indices, the impact of the *per capita* GDP proved to be positive, and as for the aid it also had a mildly positive impact on all democracy indices.

In Chapter 3, to answer the third research question we use parametric, semi-parametric, and non-parametric regressions to explore if there is evidence of the Laffer curve for corporate, labour, and indirect taxes in a selected panel of African countries. African countries collect lower tax revenues as percent of GDP in comparison to developed countries, and to other continents such as Latin America and Asia. African countries are therefore urged to increase tax revenues on the one hand and to decrease tax rates in order to attract more foreign investment on the other hand. The international competition for foreign direct investment leads countries to lower corporate tax rates to attract investment that might boost the economic activities and generate employment. But countries also need to raise taxes to increase tax revenues to satisfy the growing demand for public services and infrastructures. To compensate for the lower corporate tax rates, some countries increase the tax rates for the labour and indirect (consumption) taxes.

How can African countries meet these seemingly contradicting goals of collecting more tax revenues and lowering tax rates? The notion of a Laffer curve can help us to understand and answer this question. The Laffer curve, presented as a theoretical result, establishes a concave (inverted U-shaped) relationship between tax rates and the volume of tax revenues collected by the government. The curve illustrates the idea that changes in tax rates have two effects on tax revenues: the arithmetic effect and the economic effect. According to Arthur Laffer (2004), the economist after which the curve was named, the arithmetic effect is simply that if tax rates are lowered tax revenues (per dollar of tax base) will be lowered by the amount of the decrease in the rate. As for the economic effect, the reduced tax rates can have a positive impact on the tax base by increasing the incentive of the economic agents to work, consume, and produce more, which can boost taxable income.

Several studies have demonstrated empirical evidence of the Laffer curve in different countries and regions of the world, as the literature review section shows. However, we are not aware of studies that focus on the relationship between tax rates and tax revenues in Africa. It is important to study this relationship for the case of African countries because in this era of competition for investments between countries, in which countries are urged to lower some taxes and increase others, it is essential for them to know in which range of the Laffer curve their tax rates are, and consequently to see if it is feasible to reduce them or not. We use parametric, semi-parametric, and nonparametric regression models to gauge the relationship between tax rates and tax revenues (corporate, labour, and indirect) in a panel of African countries. The use of nonparametric regression models for the Laffer curve, which does not pre-assume any specific functional form, as the parametric regression does, is also one of the contributions to the literature. In the regressions we also controlled for the effects of the informal economy by using the size of the shadow economy as percent of GDP for each country.

The results from the parametric, semi-parametric, and nonparametric approaches show clear evidence of the existence of the Laffer curve in the three tax categories. For the corporate taxes we found the RM tax rates around 26%-27% for the panel of African countries, which is lower than that of the OECD countries, in the range of 26% to 34%, estimated by Clausing (2007); and that of China's 40%, estimated by Lin and Jia (2019). For the labour and indirect taxes, the RM tax rates were in the ranges of 40%-45% and 13%-15.2%, respectively. Finally, the impact of the shadow economy on each tax revenue category is negative and statistically significant in all three tax revenues categories (corporate, labour, indirect), showing that reducing informality can boost tax revenues in Africa.

The remainder of the dissertation is organized as follows: Chapter 1 presents the study on The Impact of Tax Reforms and the Determinants of the Non-oil Fiscal Revenues in Angola; in Chapter 2 we present the research on The impact of Taxes on Democracy indices– An empirical study for a panel of African Countries; in Chapter 3 the Estimation of the Laffer curve for a panel of African countries is presented, and in Chapter 4 the main conclusions are presented.

1. The Impact of Tax Reforms and the Determinants of the Non-oil Fiscal Revenues in Angola

Executive Summary: In this chapter we used Auto Regressive Distributed Lag (ARDL) and Reverse Unrestricted Mixed Data Sampling (RU-MIDAS) regression models to assess the fiscal impact of the tax reforms implemented and the determinants of non-oil tax revenues in Angola, an oil-rich country in Africa, using data from 2008 to 2021 at different frequencies. Both models estimated showed that the reforms had a positive and significant impact on the non-oil fiscal revenues collection. The ARDL model with quarterly data showed that in comparison to the years before the reforms the 2011 reform contributed to 46% more non-oil tax revenues, the 2015 reform to 140.5%, and the 2019 reform to a 115.6% increase. The RU-MIDAS regression with monthly tax revenues and yearly regressors presented much lower impacts: 3.5%, 8.8%, and 0.04% for the 2011, 2015, and 2019 reforms, respectively. In the ARDL model, we also found that oil prices and oil production have a negative impact and are causing an eviction effect on the non-oil tax revenues in Angola: a 1% increase in oil prices (production) leads to a 0.3% (4.7%) decrease in the non-oil tax revenues. In the RU-MIDAS regression both oil prices and oil production also have negative impacts of 0.3% and 1.8% respectively.

Keywords: Angola, ARDL, RU-MIDAS, Non-Oil Tax Revenue, Tax Reform.

JEL Classification Codes: C22, H20, H24, Q33, Q35.

1.1 Motivation and Main Findings

In developing countries that are rich in natural resources, such as Angola, most of the fiscal revenues come from the exploration of natural resources, which makes them vulnerable to the fluctuation of commodity prices in international markets, affecting their public finances and the overall macroeconomic indicators (World Bank, 2022). In order to mitigate the potential negative impact of this type of uncertainty, these countries are urged to reform their tax systems in order to bring into the system more taxpayers, particularly those in the non-resources sectors of the economy.

In the case of Angola the oil sector accounted for almost a third of the total GDP in 2021 and was the main driver of the entire economy, accounting for 96% of the country's exports. The revenues from international trade generated in the sector are used to import capital goods, raw materials, and final goods and services needed in the non-oil sector of the economy. When the civil war ended in 2002, nearly 80% of total fiscal revenues, used to finance public expenditure and investment, came from the oil sector. Therefore, oil production and prices play an important role in the economic activity of the non-oil sector, affecting also its tax revenue collection.

Jensen and Paulo (2011) argued that the 2008/09 international crisis had a huge impact on public finance management. The crisis led to a sharp drop in the oil prices which negatively affected the oil fiscal revenues, leading to the accumulation of internal arrears because the government was not able to pay its suppliers of goods and services. To mitigate the situation the IMF had to step in with a loan of 1.4 billion US dollars (USD) to help the treasury and the balance of payment. Thereafter the government undertook a tax reform of the non-oil sector in order to increase fiscal revenue collection and reduce the dependency on oil tax revenues. More than 10 years have passed since the implementation of the non-oil tax reform and data show a steady nominal increase of the non-oil tax revenues, as discussed in Section 3. It is important to study the main determinants of this growth and also to assess the impact of the tax reform.

Angola is an interesting case study because it is the second largest oil-producer in the Continent (after Nigeria) and is among the ten biggest economies in terms of GDP (and among the five in Sub-Saharan Africa). Angola's economic and development performance without doubt affect the region and the continent as a whole. The empirical economic literature on taxation, on the determinants of non-oil tax revenues for oil-producing countries[1] and on the effectiveness of the non-resources tax reform in increasing revenue collection is scarce, especially for developing countries. This paper will fill this gap by studying the case of Angola and the conclusions of this study are of interest for other oil-producing developing countries wishing to reduce their dependence on oil fiscal revenues, by reforming the non-oil oil tax system.

Nigeria is an example of a resource-rich African country receiving scholarly interest regarding its tax reforms. The aim of the tax reform in Nigeria was similar to that of Angola's reforms, namely to increase tax revenues and diversify the tax base. The main difference is that reform in Nigeria began earlier (in the 1990s) and included all the sectors of the economy, whereas in Angola the reforms were implemented later (in 2011) and the focus was on the non-mineral sectors of the economy. Ebi and Ayodele (2017) examined the impact of tax reform on tax revenues collection in Nigeria between 1981 and 2014 employing cointegrated error correction models (ECM) and concluded that the reform had a positive and significant effect. They analysed both total tax revenues and oil tax revenues but not the non-oil tax revenues specifically. A possible reason for not including the non-oil tax revenues was perhaps the fact that when Ebi and Aladajare (2016) studied the long- and short-run relationships between non-oil tax revenues and their determinants using the ARDL model and the period from 1980 to 2013 (GDP, Exchange rate, Inflation) found no statistical significance[2].

We fill the gap in the literature by studying the impact of tax reform and the determinants of non-oil tax revenues in a distinct oil producing country using data observed at different frequencies. Hence, this paper studies the case of Angola, an oil-rich country in Africa, to find out what the main determinants of non-oil tax revenues are and the extent to which the ongoing non-oil tax reform has been contributing to the increase of non-oil fiscal revenues. As Angola is an oil-producer with highly concentrated exports, we also study the impact of oil production and oil prices on the non-oil fiscal revenue mobilization, adding to the estimations other variables taken from previous research, which may explain non-oil tax collection for oil-producing countries.

In this paper we use monthly and quarterly data of non-oil tax revenues from 2008 to 2021. For the quarterly data, the ARDL bound cointegration and error correction model (ECM) was applied; and for the monthly, quarterly, and annual data, the Reverse Unrestricted Mixed Data Sampling (RU-MIDAS) regression was used, both to measure the impact of tax reform on non-oil tax revenues mobilization and its main determinants. MIDAS regressions have the advantage of allowing us to model a high frequency variable (in this case monthly data, with a large number of observations) in

[1] The paper by Cotton (2012) studied the measure of the responsiveness (or the elasticity) of the non-oil tax revenues in relation to the non-oil GDP in Trinidad and Tobago over the period 1990-2009, using OLS, and concluded that the non-oil tax revenues responded positively to the growth of the non-oil GDP. In this study the author included only one explanatory variable - the non-oil GDP - and did not study the impact of tax reform on the non-oil tax revenues collections in the country.

[2] They obtained statistically significant results for only total and oil tax revenues. They did not analyse the impact of the tax reform.

the same regression as lower frequency covariate variables (quarterly and yearly data). We are not aware of any paper in the taxation literature that uses the MIDAS regression.

Both estimated regression models showed that the reforms had a positive and significant impact on the non-oil fiscal revenues collection. The ARDL model revealed that in comparison to the years before the reform, the 2011 reform contributed to an additional 46% of the non-oil tax revenues, the 2015 reform to 140.5% more non-oil tax revenues, and the 2019 reform to a 115.6% increase in the non-oil tax revenues. The RU-MIDAS regression (with monthly tax revenues and yearly regressors) presented much lower impacts, 3.5% for the 2011 reform, and 8.8% for the 2015 reform, and 0.04% for the 2019 reform, although still positive. Furthermore, we also find that oil prices and production have negative impacts and are causing eviction effect on the non-oil tax revenues in Angola. The ARDL model showed that for the case of the short-run relationship a 1% increase in oil prices leads to a 0.3% decrease in the non-oil tax revenues and in the oil production results in a 4.7% decrease, whereas the long-run relationship indicated that in the oil production it leads to a 6.5% reduction in the non-oil tax revenues. In the MIDAS regression with quarterly variables both oil prices and oil production also have negative impacts of 0.3% and 1.8% respectively.

The chapter proceeds as follows. In Section 1.2 we present a brief literature review. In Section 1.3 we provide a background on the non-oil fiscal reforms and an overview of the Angolan economy. In Section 1.4 we present and analyse the data and the methodologies. In section 1.5 we present the regression results. In section 1.6 we discuss the results and policy implications. Section 1.7 presents the conclusions.

1.2 Literature Review on the Determinants of Tax Revenues for Developing Countries

In the macroeconomic literature related to the Keynesian model, part of the aggregate taxes are usually a function of the level of economic activity, measured by GDP, or output, and the other part is considered to be autonomous, that is, not depending on income but on other factors or variables not specified in the model. Over the years many researchers have investigated those other factors that may determine tax revenues.

Early quantitative studies on the determinants of tax levels such as that reported by Musgrave (1969) and other authors used as explanatory variables the level of *per capita* income, the degree of urbanization, the literacy rate, the degree of monetization of the economy, the ratio of exports and imports to GDP, the share of mining or agriculture in GDP, and the size of the country.

The IMF Working Paper by Vito Tanzi (1988) is one of the first papers on the taxation literature that theoretically and empirically presented the impact of some macroeconomic policies and variables on the level of taxation in developing countries. Tanzi discussed the connection between tax levels and the official exchange rate, inflation, interest rate, public debt, import substitution, and trade liberalization. Tanzi looked at the fluctuation of the tax-GDP ratio of some developing countries (Argentina, Bolivia, Dominican Republic, Ghana, Madagascar, Mozambique, and Sierra Leone) between 1970 and 1986 and concluded that traditional determinants of taxes could not alone explain the fluctuation, but changing macroeconomic policies had impacted the level of taxes and the performance of tax reforms and tax administrations in collecting taxes.

Using a panel of 22 countries in Sub-Saharan Africa, from 1980–1996, and applying the Generalized Method of Moment (GMM) regressions, Agbeyegbe *et al.* (2004) found that exchange rate appreciation and higher inflation showed some linkage to lower tax revenues or its components (personal and corporate income tax), whereas agricultural share in GDP had a positive effect on total tax revenues.

Analysing an unbalanced panel of 43 developing countries from America, Africa, Asia, and Europe over the period 1973–2002, Madhavi (2008) applied a GMM estimation and found that the tax to GDP ratio is positively affected by the size of the international trade sector, percent of the urban population, adult literacy rate, *per capita* income, level of political democratization, and reduced level of corruption and negatively affected by an increase in aid inflow, percent of elderly population, population density, the degree of monetization, and the rate of inflation.

Taking into account that in general, developing resource-rich countries depend much on the fiscal revenues and royalties coming from the extraction of natural resources and usually tax the non-resources sectors to a lesser degree, in recent years researchers have been studying the effect of resource exploration on non-resource tax revenue internal mobilization.

Using panel data of 45 Sub-Saharan African countries and covering a period from 1990 to 2007, Botlhole *et al.* (2012) studied the relationship between natural resources tax revenues and non-natural resources tax revenues employing ordinary least squares (OLS), instrumental variable two stage least squares (IV-2SLS), and GMM estimation models. They found that the relationship between the two variables has mostly mixed results in the literature and for them, additional natural resource revenues reduce non-natural resource tax revenues when institutions are poor in the countries, whereas in countries with good functioning institutions, more natural resources revenues contribute to more internal tax mobilization – and concluded that good institutions are keys for tax revenue mobilization.

In another study, using an unbalanced panel dataset of 35 resource-rich countries[3] covering a period from 1992 to 2009 and applying OLS and GMM regressions, with fixed country and time effects, Crivelli and Gupta (2014) found a negative relationship between resource revenues and total domestic (non-resource) revenues, including for the major tax components (corporate, personal income, VAT, and trade taxes). They found that for each additional percentage point of GDP in resource revenues there is a drop in domestic (non-resource) revenues of about 0.3 percentage points (p.p.) of GDP. This causality is called the eviction effect.

However, using also a panel dataset of 31 countries[4] covering a period from 1998 to 2012 employing Pooled OLS regressions with a country-fixed effect, Knebelmann (2017) found no such evidence of an eviction effect, that is no effect of oil revenue on non-oil tax revenues through taxation channels, but actually the linkages between oil sectors with the non-oil economy seem to yield additional non-

[3] The countries in the sample were the following: Algeria, Angola, Argentina, Bahrain, Botswana, Brunei, Cameroon, Colombia, Congo Republic, Equatorial Guinea, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Guyana, Indonesia, Iran, Ivory Coast, Kazakhstan, Mali, Mexico, Nigeria, Norway, Oman, Peru, Russia, Saudi Arabia, Senegal, Sierra Leone, Syria, Trinidad and Tobago, United Arab Emirates, Vietnam, and Yemen.

[4] The countries included in the study are the following: Angola, Algeria, Azerbaijan, Belize, Bolivia, Brunei Darussalam, Cameroon, Chad, Congo Republic, East Timor, Egypt, Equatorial Guinea, Ecuador, Gabon, Indonesia, Iran, Iraq, Ivory Coast, Kazakhstan, Kuwait, Libya, Malaysia, Mexico, Nigeria, Saudi Arabia, Syria, Sudan, Trinidad and Tobago, United Arab Emirates, Vietnam and Yemen.

oil tax revenues. The author further concluded that non-oil tax revenues respond in a slightly positive way to variations in oil revenue. This happens perhaps due to the linkage between the oil sector and the non-oil sector of the economy, since in most countries the non-oil sector supplies goods and services to the oil sector following the so-called policy of local content, which requires oil companies to purchase (whenever available) locally produced goods and services when carrying out their main oil production activities.

As one can see from the research cited above, most of the studies presented in the literature on the determinants of tax revenues employ panel data combining different countries, but there are few studies in which a single country is studied with time series variables to determine the variables that affect the level of taxation within that country. It is true that through panel data studies one can gain a broader perspective of the main drivers of tax levels among the countries, but they also have some limitations, since in general in a panel data the numbers of countries are greater than the number of years studied and it does not capture well the temporal dependency of the data, whereas time series overcome this limitation by using more temporal observations that help to understand what is happening within the country in the course of the years.

Some researchers are following this approach of studying a specific country to find out the main determinants of tax revenue within that country throughout the years and the impact of tax reforms. Cotton (2012) carried out a study to measure of the responsiveness (or the elasticity) of the non-oil tax revenues in relation to the non-oil GDP in Trinidad and Tobago over the period 1990-2009 using OLS, and concluded that the non-oil tax revenues responded positively with the growth of the non-oil GDP, but the author used only one explanatory variable – the non-oil GDP – and did not analyse the impact of tax reform on the non-oil tax revenues collection in the country.

Kanyi and Kalui (2014) analysed the effect of tax reform in Kenya between 2003 and 2013, when the government shifted policies toward indirect taxes as opposed to direct taxes, and found that the new policies had a positive effect on the increase of fiscal revenues. However, they used a limited number of observations and applied only correlations analysis and OLS model.

Ebi and Aladajare (2016), using the ARDL model and the period from 1980 to 2013, studied the long- and short-run relationships between non-oil tax revenues and their determinants (GDP, Exchange rate, Inflation) in Nigeria but found no statistical significance. A year later Ebi and Ayodele (2017) examined the impact of tax reform on tax revenues collection in Nigeria between 1981 and 2014 employing the cointegrated error correction model (ECM) and concluded that it had a positive and significant effect. The authors analysed both total tax revenues and oil tax revenues, but not the non-oil tax revenues.

Ndiaye (2019) studied the case of Senegal using data from 1970 to 2014 and applying the OLS regression model and showed that in the case of this country tax reform, trade openness, and *per capita* GDP contributed positively and significantly to the increase of tax revenue collection, but the variation of the share of agriculture in the GDP and foreign aid contributed negatively and the share of industry in the GDP had no statistical significance.

Kamasa *et al.* (2022) studied the case of Ghana using an annual time series data set over the period 1980 to 2018 and applying an autoregressive distributed lag model together with dynamic ordinary least squares and fully modified least squares techniques. They found that variables such as real GDP growth rate, the ratio of central government debt to GDP, human capital (measured by the numbers of years of schooling), and the tax reform had a positive significant impact on the total tax revenue generation in the country, whereas unbridled corruption hampered revenue mobilization efforts. As for the short run, the error correction model (ECM) revealed that the debt-to-GDP ratio, real effective exchange rates, and human capital did not significantly affect tax revenues, whereas changes in the corruption index, agricultural share of GDP, and inflation in the previous period affected tax revenue collections negatively.

Quite a number of studies have been using the ARDL approach in many areas of the social sciences especially in the field of finance, macroeconomics, energy economics, and trade. In the taxation literature we found only one study that applied this methodology (Kamasa *et al.,*2022, which studied the impact of tax reform on revenue mobilization in Ghana).

In summary, the main explanatory variables that are usually used in the literature to explain tax revenue collection are those presented in Table 1.

Table 1- Literature on the Main Determinants of Total Tax Revenues in Developing Countries

Variables	Main Studies that used them	Expected sign
Total GDP (constant or nominal)	Das-Gupta *et al.*, 1995; Ebi and Aladajare, 2016; Ebi and Ayodele, 2017; Kamasa *et al.*, 2022	+
Non-oil GDP	Cotton (2012), studied the elasticity of non-oil tax revenues in relation to the non-oil GDP	+
% of agriculture in GDP	Tanzi, 1992; Addison and Levin, 2008; Botlhole *et al.,* 2012; Crivelli and Gupta, 2014; Knebelmann, 2017; Ndiaye, 2019; Kamasa *et al.*, 2022	+ / -
% of Industrial sector in GDP	Tanzi, 1992; Gupta, 2007; Botlhole *et al.,* 2012; Ndiaye, 2019	+
Trade openness (Imports+Exports/GDP)	Gupta *et al.*, 2003; Knebelmann, 2017; Addison and Levin, 2008; Botlhole *et al.,* 2012; Crivelli and Gupta, 2014; Ndiaye, 2019	+
Inflation rate	Tanzi, 1992; Das-Gupta *et al.*, 1995; Mahdavi, 2008; Crivelli and Gupta, 2014; Ehrhart, 2012; Ebi and Aladajare, 2016; Knebelmann, 2017; Kamasa *et al.*, 2022	- /+
Real effective exchange rate	Tanzi, 1992; Ebi and Aladajare, 2016; Kamasa *et al.*, 2022	+ / -
Per capita GDP	Tanzi, 1992; Addison and Levin, 2008; Mahdavi, 2008; Crivelli and Gupta, 2014; Knebelmann, 2017; Kamasa *et al.*, 2022	+
Population	Addison and Levin, 2008; Mahdavi, 2008	+(urban) -(rural)
Literacy rate or Human capital (years of schooling)	Tanzi, 1992; Mahdavi, 2008; Kamasa *et al.*, 2022	+
Development Aid (share of GDP)	Gupta, 2007; Addison and Levin, 2008; Mahdavi, 2008; Botlhole *et al.,* 2012; Ndiaye, 2019	+/-
Govt. stability	Gupta, 2007; Knebelmann, 2017s	+
Corruption	Gupta, 2007; Crivelli and Gupta, 2014; Kamasa *et al.*, 2022	-
Political stability	Gupta, 2007	+
Economic stability	Gupta, 2007	+
Public Debt	Ndiaye, 2019; Kamasa *et al.*, 2022	+
Foreign aid	Addison and Levin, 2008; Crivelli and Gupta, 2014; Ndiaye, 2019	+/-
Oil revenues (% of GDP)	Botlhole *et al.,* 2012; Knebelmann, 2017	+/-
Quality of Institutions	Botlhole *et al.,* 2012	+
Tax reform index	Ndiaye, 2019; Kamasa *et al.*, 2022	+

This chapter contributes to the empirical economics literature on taxation by using ARDL and RU-MIDAS regression models to investigate the impact of tax reform and the main determinants of the non-oil tax revenues mobilization in Angola, an African oil-rich country in which at the end of its 27 years of civil war in 2002 more than 80% of its total fiscal revenues came from the oil sector, and in 2011 started a program of reforming the non-oil tax system with the aim of expanding its tax base and increasing non-oil tax revenues. We are not aware of any studies focusing on non-oil fiscal revenue mobilization in an oil-rich developing country and using both regression models. Thus the case of Angola can be viewed as benchmark for developing oil-producing countries that are endeavouring to tax the non-oil sector.

1.3 Main Aspects of the Non-oil Fiscal Reform and Background on the Angolan Economy

Angola is a country located at the southern part of the African continent, sharing borders to the north with the Republic of Congo (Brazzaville) and the Democratic Republic of Congo (Kinshasa), to the east with the Republic of Zambia, and to the south with Namibia. The area is 1,246,700 km^2 and its coast (Atlantic Ocean) has a length of 1,650 km. The country gained independence from Portugal on 11 November 1975, following a colonial domination of almost 500 years.

Upon gaining independence the ruling party imposed a communist regime, nationalized all private businesses, and the country plunged into a civil war that brought most of the economic activity to a halt. The only sectors that did not stop producing were diamond mining and petroleum extraction because they were the ones that sustained the financing of the war between the two belligerent factions. In the early 1990s the country adopted a multi-party regime, and following the first elections (in 1992) officially abandoned the socialist regime and adopted a market-oriented regime.

Taking into account that upon gaining independence in 1975 the government nationalized all private enterprises, and the onset of the civil war made it almost impossible to carry out any meaningful and consistent private economic activity, up to 1992 there was no way, so to speak, to tax "non-existent" private businesses. Since only oil production and diamond mining were being undertaken by international companies, the government depended on tax revenues coming from these sectors, especially from the oil sector. In 1992, with the transition from socialism to a more market-oriented economy, private businesses started to emerge, hence also a taxable base.

Above, we mentioned studies on the impact of tax reforms on fiscal revenues mobilization in Senegal, Ghana, and Nigeria. Before going into the details of the tax reform in Angola it is important to highlight that, in general, the reforms in those countries were quite similar to those of Angola in the sense that they were focused on the same pillars: registration of tax payers, review and drafting of new tax laws, changes in tax rates, strengthening of the role of tax administration offices, introduction of indirect taxes such as VAT, and the establishment of an electronic payment system. The main differences were the scope of the reforms and the timing of the start of the reforms. In Angola the aim was only at the non-oil taxes, whereas in other countries the objective was all sectors. In Senegal the introduction was in the early 1970s (Ndiaye, 2019), in Ghana it occurred in the 1980s (Kamasa *et al*, 2022), and in Nigeria in the 1990s (Ebi and Ayodele, 2017). In Angola the reform came considerably later, only in 2011.

1.3.1 The Non-oil Fiscal Reforms

The end of the civil war in 2002 made possible an environment more conducive to private investments in various sectors of the economy but the government at that time did not seriously consider taxing the non-oil sector, perhaps due to the abundant fiscal revenues coming from the oil sector between 2003 and 2008, a period in which international oil prices were high and the country boosted the oil production. The 2007/2008 international financial crisis affected the oil prices negatively and consequently also the oil fiscal revenues in Angola, prompting the IMF to advise the government to reform the non-oil tax system. Table 2 summarizes the main events and reforms undergone with the aim of diversifying the tax base and increasing the collection of the non-oil tax revenues.

Table 2 - Key Events of the Non-oil Tax Reform in Angola

2009	2010	2011	2014	2015	2019
The international financial crisis causes a drop in oil prices and oil tax revenues. The government requests an intervention and a loan of USD 1.4 billion from the IMF in order to mitigate the negative effect of the global financial crisis. In the Stand-By Arrangement (SBA) between the IMF and Angola it was agreed that the government would increase non-oil tax revenues by reforming the tax system.	The Executive Program for Tax Reform (in Portuguese PERT—*Projecto Executivo para a Reforma Tributária*) is created by means of the presidential decree 155/10 of July 28th with the specific goal of reforming and modernizing the non-oil fiscal system, the tax administration, and the tax justice system.	PERT starts to operate fully and renovates tax collection offices and massively register new taxpayers, activates the online taxpayers' portal that enabled the electronic payment of taxes.	Transversal tax codes (General Tax Code, the Code of Tax Procedures, and the Tax Collection Enforcement Code) are approved by the Parliament and new income tax rates (personal and corporate) are implemented.	Created a single entity responsible for the collection of all taxes, the General Tax Administration (*Administração Geral Tributária* - AGT), resulted from the merger of the National Directorate of Tax (*Direcção Nacional dos Impostos* –DNI) responsible for collecting domestic taxes, the Customs (*Serviço Nacional das Alfândegas*) that used to collect the tax and other duties on imports and exports and the Project for Tax Reform (PERT).	Introduced for the first time the Value Added Tax (VAT), progressively replacing the consumption tax.

1.3.1.1 The Onset of the Reforms

In 2009 the oil price in the international market dropped dramatically and so did the oil fiscal revenues, and the government requested an intervention and a loan of USD 1.4 billion from the IMF in order to mitigate the negative effect of the global financial crisis. In the Stand-By Arrangement (SBA) between the IMF and Angola the government agreed to "commit to taking further steps to improve fiscal management over the medium-term, increase non-oil revenues by reforming the tax system, and de-link the fiscal stance from short-term movements in oil revenues"[5].

[5] Press Release: IMF Executive Board Approves US</head>1.4 Billion Stand-By Arrangement with Angola

In response, in 2010 the then President José Eduardo dos Santos created by means of a presidential decree 155/10 of July 28th the Executive Program for Tax Reform (in Portuguese PERT—*Projecto Executivo para a Reforma Tributária*) with the specific goal of reforming and modernizing the non-oil fiscal system, the tax administration, and the tax justice system. The main objective was to increase the non-oil tax revenues by bringing into the system more taxpayers (expanding the tax base) and simplifying the system of tax payment. The Tax Reform Program was coordinated by the Secretary of State of Finance, which reported directly to the President of the Republic. In practical terms, an executive technical unit for tax reform was established within PERT to run the reform in all its dimensions, with the help of the international consulting firm McKinsey[6].

According to the PERT's annual progress report[7] of 2012, almost two years after the onset of the tax reform program the Executive Project for Tax Reform (PERT) had already recruited 287 trained personnel to work in the reform process; provided training to the then-workers of the National Directorate for Tax (which was responsible for collecting domestic taxes); activated the online taxpayers' portal, which enabled the electronic payment of taxes; updated and simplified the three main tax codes inherited from colonial administration: The General Tax Code (*Código Geral Tributário*), the Code of Tax Procedure (*Código de Processo Tributário*), and the Tax Collection Enforcement Code (*Código das Execuções Fiscais*) generally referred to as the transversal tax codes that were approved by the Parliament in 2014 and 2015 (Fjeldstad *et al.,* 2020).

The reform also placed strong emphasis on a massive communication strategy of informing the population of the importance of paying taxes, getting the taxpayer number, and paying tax debt (especially in the case of enterprises and small businesses).

One of the milestones of the reform was the creation in 2015 of a single entity responsible for the collection of all taxes, the General Tax Administration (*Administração Geral Tributária* - AGT), which resulted from the merger of the National Directorate of Tax (*Direcção Nacional dos Impostos* –DNI) responsible for collecting domestic taxes, the Customs (*Serviço Nacional das Alfândegas*) that used to collect the tax and other duties on imports and exports, and the Project for Tax Reform (PERT). Fjeldstad *et al.* (2020) argue that the aim was to create an effective tax administration, to improve collection mechanisms, and modernize audit procedures.

During this period the number of registered taxpayers increased tremendously, in the case of individuals from almost 250,000 in 2010 to 5.9 million in 2021, and for corporate entities from 20,000 in 2010 to over 231,000 in 2021. The massive communication campaign pursued first by PERT and then by the General Tax Administration (AGT) may help to explain the overall increase in the number of registered taxpayers. For a country with an active population as of 2022 of over 16 million (9 million people work in the informal market[8], and nearly 5 million are unemployed) there is a huge potential for further increase in the number of individual taxpayers (i.e., the tax base) in terms of labour tax if the appropriate economic and social policies are set in place.

[6] According to Fjeldstad *et al.* (2020) "PERT was richly aided by foreign consultants led by the international consulting company McKinsey & Co. At a news conference in September 2010, the then Minister of State Carlos Feijó, said: 'We will work with McKinsey to revamp all our fiscal sector. Our goal is to increase our tax revenues'. (Reuters, 2010)".

[7] PERT- *Balanço Anual das Actividades* 2012, *Ministério das Finanças*.

[8] See Figure A2 in the appendix.

Summarizing, the non-oil tax reform had three main moments worth highlighting: the setting up of the Executive Project for Tax Reform (PERT) and its technical unit that started to operationalize the reform in 2011; the establishment in 2015 of a single entity responsible for the collection of all taxes, the General Tax Administration (AGT); and the introduction for the first time in the system of a new indirect tax, the value added tax (VAT) in October of 2019. We assess the impact of these key tax reform events on the non-oil tax revenues collection below.

1.3.1.2 Changes in the Main Tax Rates

In terms of tax rates, the reform was able to increase some tax rates and reduce others, as Tables 3 and 4 show. The authorities decided to cut corporate tax rates from 35% in 2009 to 30% in 2014 and to 25% in 2020[9]. As for the businesses in the agriculture, livestock, and fisheries sectors, the tax on their profits was reduced from 20% in 2009 to 15% in 2014, and to 10% in 2020. The tax on rented properties also fell from 30% to 25%, but the tax on capital gains rose from 15% to 27%.

Table 3 - Main Tax Rates (%)

Main tax and rates (%)	2009	2014	2019	2020
Profits	35	30		25
Agriculture and Fisheries	20	15		10
Capital gain	15	27		27
Property (rented)	30	25		25
VAT			14	

Source: compilation of the author from official documents (Law 14/1992 of July 3rd, Law 5/1999 of August 6th, Law 18/1977 of September 15th, Law 19/2014 of October 22nd, Legislative Presidential Decree 2/2014 of October 20th, Law 7/2019 of April 24th, Law 20/2020 of July 9th, and Law 26/2020 of July 20th), and the Book *Direito Fiscal Angolano* Vol. I by António Vicente Marques.

Looking at the labour tax rates (Table 4) or personal income tax rates, there is no major difference between the changes made in 2014 from those that existed in 2009, but in 2020 there was a major change, increasing, in general, the tax burden of the fewer workers that are in the formal sector of the economy. In 2009 all workers earning less than Kwanzas 25,000 (USD 314) were exempted from paying personal income tax. In 2014 the exemption was increased to Kwanzas 30,000 (USD 304), and in 2020 to Kwanzas 70,000 (USD 121) [10]. All workers earning above the exemption pay a fixed tax plus a variable amount that is computed by applying the rate on the excess of their base salary over the limit of the bracket, after discounting the social security contribution.

[9] The 2020 Law of Industrial- Tax on Profits (Law 26/20 of 20 of July) in article 64, number 3, states that the profits of financial sector (banking and insurance) and telecommunications operators are subject to a tax rate of 35%.

[10] The values of the tax exemptions in USD have been falling due to the depreciation of the exchange rate of the local currency Kwanza in relation to the USD. In 2009 the average USD/Kwanza exchange rate was 79.6 Kwanzas per US Dollar, in 2014 it was 98.6, and in 2020 it was 578.4.

Table 4 - Personal Income Tax Rates

Personal Income Tax							
	2009		2014		2020		
Base salary	Fixed part	Rate (%) over the excess of the previous bracket	Fixed part	Rate (%) over the excess previous bracket	Base salary	Fixed part	Rate (%) over the excess previous bracket
25,000	0	0	0	0			
30,000	0	5	0	0	70,000	0	0
35,000	250	6	0	6	100,000	3,000	10
40,000	550	7	550	7	150,000	6,000	13
45,000	900	8	900	8	200,000	12,500	16
50,000	1,300	9	1,300	9	300,000	31,250	18
70,000	1,750	10	1,750	10	500,000	49,250	19
90,000	3,750	11	3,750	11	1,000,000	87,250	20
110,000	5,950	12	5,950	12	1,500,000	187,250	21
140,000	8,350	13	8,350	13	2,000,000	292,000	22
170,000	12,250	14	12,250	14	2,500,000	402,250	23
200,000	16,450	15	16,450	15	5,000,000	517,250	24
230,000	20,950	16	20,950	16	10,000,000	1,117,250	24.5
230,000+	25,750	17	25,750	17	Over 10 m	2,342,250	25

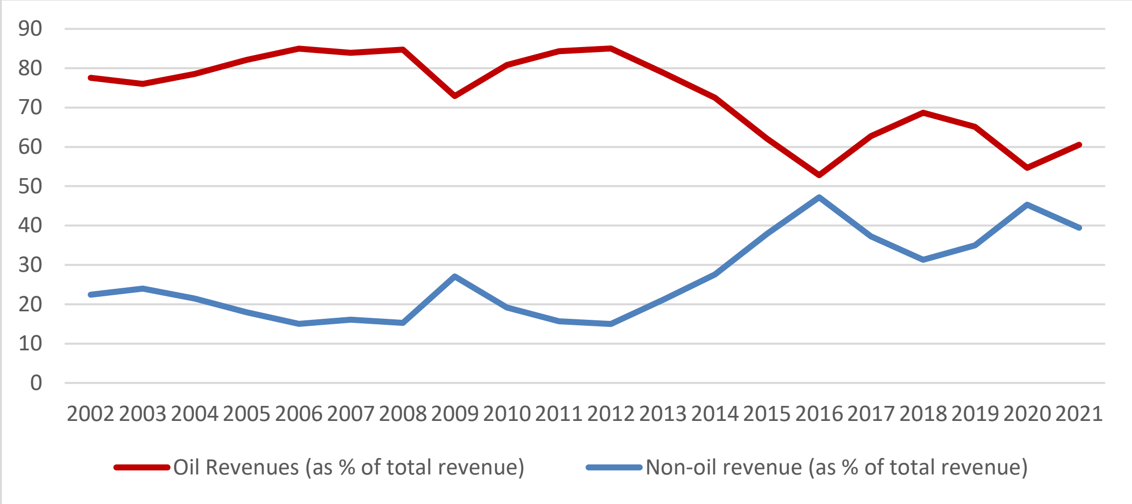
Source: compilation of the author from official documents (Executive Decree 80/2009 of August 7th, Law 18/2014 of October 22nd, and Law 28/2020 of July 22nd).

The tax on consumption also had its rates changed (depending on the type of goods and services) and in 2019 for the first time the value added tax (VAT) was introduced, replacing, in general, the tax on consumption, although some goods and services are still being charged under the so-called special consumption tax.

1.3.1.3 Evolution of the Non-oil Tax Revenues Before and After the Reforms

In 2002 oil fiscal revenues accounted for about 80% of the total tax, whereas the non-oil tax revenues were 20%. This situation continued until 2012, when the share of the oil taxes started to decrease, due mainly to the fall first in oil production and thereafter in oil prices. At the onset of the reform (in 2011) the non-oil fiscal revenues accounted for 16% of the total tax revenues, four years later, when the single general tax administration office (AGT) was created in 2015, the weight of the non-oil tax revenues had more than doubled, increasing to 38%; and in 2020, with the introduction of VAT in 2019, the non-oil tax revenues represented 35% of the total fiscal revenues, as we can see in Figure 1.

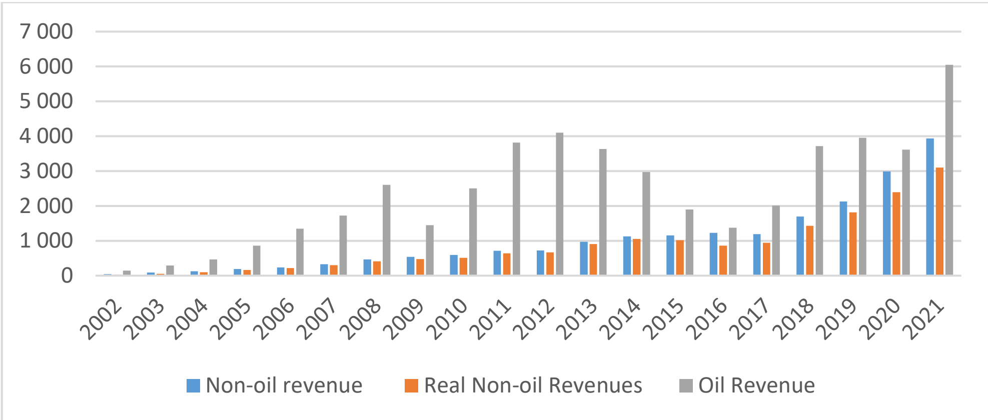
Figure 1 - Oil and Non-oil Tax Revenues (% of Total Fiscal Revenues)



Source: Computed by the author according to the data from the Angolan Ministry of Finance.

As Figure 1 shows, the share of non-oil tax revenues in total taxes started to grow in 2013 and reached the value of 40% in 2021, and the oil tax share fell to 60% in 2021. Looking at Figure 2, it is clear that the non-oil oil taxes grew in nominal terms from 42 billion Kwanzas (USD 1 billion) in 2002 to 3.9 trillion Kwanzas (USD 6.3 billion) in 2021, which is 92 times greater; whereas in the same period, oil taxes grew by a factor of 41, from 146 billion Kwanzas (USD 3.4 billion) to 6 trillion Kwanzas (USD 9.7 billion).

Figure 2 - Tax Revenues (Oil and Non-Oil) in Billions of Kwanza



Source: the Angolan Ministry of Finance. Real non-oil tax revenues computed by the author.

One can rightly argue that nominal values are strongly influenced by the inflation rate, so it is better to look at the real values of the non-oil taxes. After discounting for the inflation (using the consumer price index variation) to obtain the real non-oil fiscal revenues, Figure 2 also reveals that the non-oil tax revenues increased in real terms as well.

We next break down the main non-oil tax revenues as presented in Table 5. In 2008, three years before the onset of the reform, the consumption tax was the leading non-oil tax revenue with a share of 26.4% of the total non-oil tax revenues, followed by the tax on imports (21%). The profit tax was the third largest with a share of 16.8%, followed by the stamp tax (12.3%), and by personal income or labour tax (9.2%). With the start of the reform in 2011 and thereafter the tax on profits became the largest, the consumption tax the second largest, the labour tax the third, followed by the tax on imports, and then the stamp tax.

Table 5 - Main Non-oil Tax Revenues (% of Non-oil Total Taxes)

Year	Profits	Labour	Consumption	VAT	Imports	Capital Gain	Stamp	Diamond	Property	S Consumption	Others
2008	16.8	9.2	26.4		21.1	0.7	12.3	2.0	0.2		11.2
2009	20.2	10.1	25.3		19.4	1.0	11.7	1.2	0.2		11.0
2010	20.7	10.5	23.9		16.1	1.0	11.8	1.4	0.2		14.4
2011	**25.1**	**10.4**	**20.6**		**13.7**	**0.9**	**12.0**	**1.6**	**0.6**		**15.1**
2012	23.1	13.6	20.7		15.3	1.4	12.7	1.0	1.9		10.3
2013	25.1	15.0	20.6		13.6	2.4	11.4	0.8	2.0		9.1
2014	25.4	14.3	18.4		15.3	4.0	10.6	0.7	2.1		9.4
2015	**34.5**	**16.3**	**14.2**		**11.0**	**2.7**	**10.0**	**0.7**	**2.3**		**8.2**
2016	33.5	18.5	16.0		7.3	3.4	10.4	1.0	2.4		7.5
2017	26.6	19.0	19.1		9.4	4.7	9.9	1.0	2.4		7.9
2018	26.3	17.7	16.7		10.6	4.8	9.9	1.1	1.9		11.1
2019	**27.6**	**22.0**	**10.5**	**5.8**	**9.5**	**5.8**	**8.1**	**1.4**	**1.9**	**0.3**	**7.2**
2020	27.0	21.0	0.6	23.9	9.7	5.3	1.5	1.6	1.5	1.6	6.4
2021	23.1	22.6	0.2	27.2	7.7	5.5	1.4	1.9	1.3	1.3	7.9

Source: computed by the author based on data from the General Tax Administration (AGT). S Consumption = Special Consumption (see below).

Following the introduction of the Value-Added-Tax (VAT) in October 2019, the consumption tax was almost replaced by it[11], and in 2021 VAT ended up being the largest non-oil tax, with a share of 27%, followed by the tax on profits (23%), and labour (22.6%). The shares of stamp tax and tax on imports fell, most likely due for the case of the former to the fact that some goods and services were now being taxed under VAT, and the latter due to the reduction of both imports and imports tariffs.

Taxes on capital gains and properties increase modestly, and in the case of the latter there is a huge potential for a further increase, if the government is able to put forth efforts to register and give title deeds to all property owners in the country and track all transaction and renting of properties.

Although diamonds are the second-largest export product (on average 3% of total exports) and the most important non-oil export (more than 80% of the non-oil exports), when it comes to tax revenues its share in non-oil total tax revenues is on average only 1.2%. The tax reform did not cover the diamond sector, as it has a special tax regime. In Table 5 the other tax revenues include fines, late-payment interest, customs fees, tolls and taxes on vehicles, and other charges. The Special consumption tax (S Consumption in the Table) encompasses the so-called sin taxes (alcohol, tobacco) and taxes on luxury goods.

1.3.2 The Evolution of the Economy

When the civil war ended (in 2002) Angola increased the extraction of oil and the economy experienced remarkable growth, with the government collecting enormous fiscal revenues from the oil sector. Driven by the oil exploration boom with an average growth of nearly 17% from 2004 to 2008, the economy grew well above 10% in real terms and the non-oil sector grew below that average, as can be seen in Figure 3.

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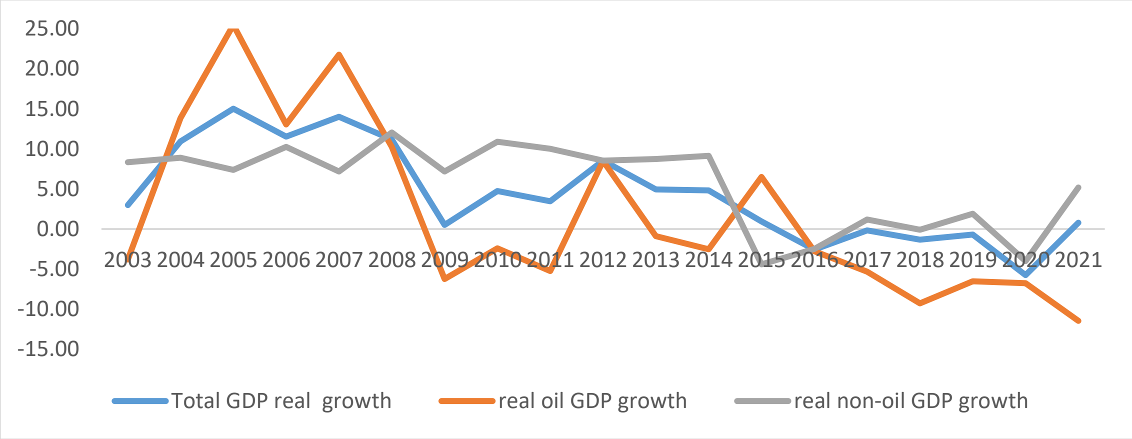
[11] With the introduction of VAT, consumption tax will cease to exist in the near future, but since the VAT is being implemented in phases, some goods and services are still being taxed under consumption tax.

Figure 3 - Real GDP Growth (%)



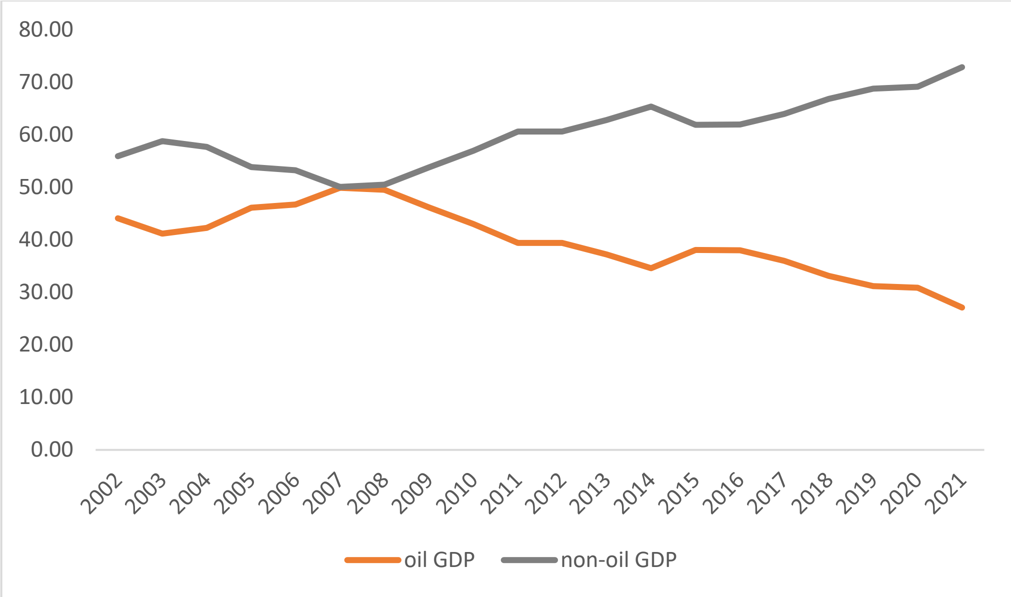
Source: National Institute of Statistics of Angola (INE), National Accounts.

The tax reforms were implemented amid lower economic growth and economic recession contexts. At the onset of the reform in 2011 the oil-sector GDP was in recession (-5.2%). In 2015, when the General Tax Administration was created, the non-oil sector GDP was also in recession (-4.4%); and in 2019, with the implementation of VAT, both oil GDP and total GDP had negative growth of 6.5% and 0.7% respectively.

When the international financial crisis hit in 2009 the oil sector experienced a recession (2009-2011) that led to a dramatic drop in the overall GDP growth, but the non-oil sector continued growing steadily above the average, up to 2014. In the midst of the oil recession (in 2011) the government set up a program to reform the non-oil tax, to broaden the tax base and to some extent to make up for the loss of oil fiscal revenues. Jensen and Paulo (2011) argued that the crisis was a wake-up call for the government to the budget process and public financial management. In 10 years, from 2011 to 2021, the oil sector experienced positive growth only two times (2012 and 2015) and deep recession for the majority of the time, reaching the trough in 2021 with a massive decrease of -11.5%. In the same period, the non-oil sector experienced recession four times (2015, 2016, 2018, and 2020), and for the remaining six years a mildly positive growth.

The negative performance of the oil sector during these years dramatically affected its weight or share in the total GDP, as can be seen in Figure 4.

Figure 4 - Oil GDP and Non-oil GDP (% Total GDP)



Source: Own calculations based on data from INE-Angola, National Accounts.

The share of oil GDP in total GDP grew from 44% in 2002 to 49.9% in 2007, its highest share during all periods. From that point on it dropped dramatically to 27% in 2021, and as a result the non-oil GDP share bounced back to its highest point of almost 73%. In fact, the overall increase in the share of the non-oil sector from 2009 on is due not only to an actual real growth greater than that of the oil sector, but also due to the fact that the oil sector experienced negative growth rates for almost a decade.

If one looks at the composition of the total exports in Table 6, it is clear that oil continues to dominate the economy in terms of international trade, since its average share (2012-2022IQ) is well above 96% and shows no sign of a structural change. The increase in the non-oil sector's share of GDP is therefore not reflected in the total export structure. Besides oil, diamonds are the second-largest export product, with an average share of 3%, which means that the overall mineral exports (oil and diamonds) are 99% of total exports. The non-mineral exports' weight is less the 1%, showing that almost all non-oil GDP, except for diamonds, is for domestic consumption.

Table 6 - Share in Total Exports (%)

	2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022IQ**
Oil Sector	98.1	98.0	97.4	96.1	95.6	96.2	96.7	96.1	93.5	94.8	95.8
Diamonds	1.6	1.7	2.3	3.2	3.6	3.3	2.8	3.5	5.1	4.6	3.8
Other Sectors	0.3	0.3	0.3	0.7	0.9	0.5	0.5	0.4	1.4	0.6	0.4

Source: BNA (Angolan Central Bank).

The main subsectors comprising the non-oil GDP are wholesale and retail, with an average share of 19.5%, public administration, defence, and social security with an average share of 14.3%, construction with the average weight of 13.8%, and real estate with the average share of 8.4%. Agriculture's average share in non-oil GDP is 7%, whereas manufacturing is 6%, and diamonds and fisheries are 3.6% and 3.5%, respectively. Although the diamond sector represents only 3.6% of the non-oil GDP, within the non-oil export structure it accounts for more than 85%. The transport subsector weighs on average 3.3%, the banking and insurance 2.8%, telecommunication 2.2%, and electricity and water 1%.

In summary, after peering into the non-oil tax and GDP data, it is clear that non-resources fiscal revenues have been increasing in both nominal and real terms and that the GDP of the non-oil sectors experienced, over the last ten years, a real growth greater than that of the oil sector GDP. From the previous discussion it is important to find out what the main drivers or determinants of the non-oil tax revenues in Angola are, and to assess the impact of the tax reform by applying econometric methods such as ARDL and MIDAS regression in order to draw some policy implications.

1.4 Data and Methodology

In this section we present the variables used in our estimations, both the dependent and the independent variables, data sources, methodological issues, and also assess stationarity.

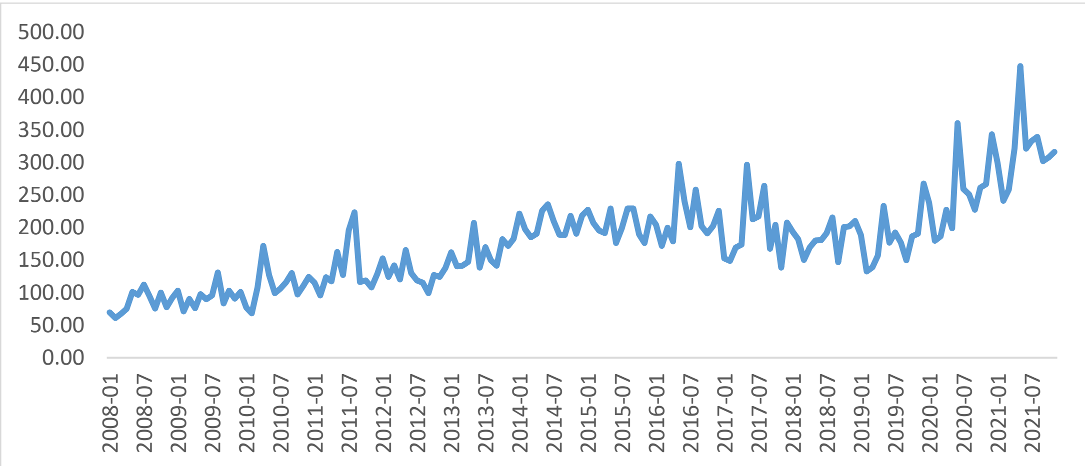
1.4.1 Data and Variables

The issue of establishing the presence or not of a unit root (non-stationarity) is paramount in time series econometrics, to decide if the variables in the regression enter in levels or in first-differences[12]. To that end, specific tests such as the Augmented Dickey-Fuller (ADF) by Dickey and Fuller (1979), and the Phillips–Perron (PP) by Philips and Perron (1988) are used to test for unit roots, and the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) by Kwiatkowski *et al.* (1992) to test for stationarity. The results are presented for each variable in the Appendix, from Tables A1 to A21.

1.4.1.1 Dependent Variables

The dependent variables are the monthly and quarterly[13] nominal non-oil tax revenues (notaxes) with a sample size of 168 months and 56 quarters for the period of 2008 to 2021. The monthly data is used in the RU-MIDAS regression model, whereas the quarterly is in the ARDL model.

Figure 5 - Monthly Non-oil Tax Revenues in Billions of Kwanzas



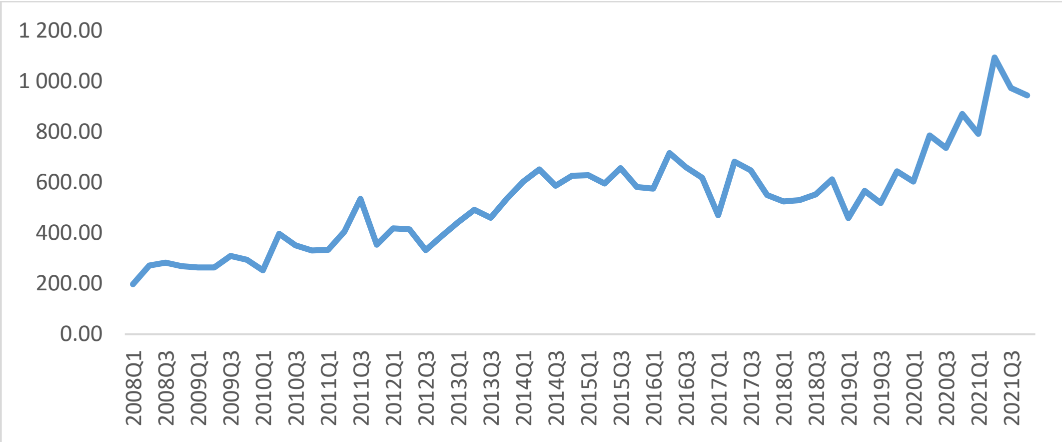
Source: AGT (Angolan General Tax Administration).

[12] It is important to highlight that in the ARDL methodology it is not necessary to establish the same order of integration among the variables and there is no need for pretesting for unit roots. See 1.4.2.1 for more details.

[13] Quarterly data results from the sum of corresponding months. See the methodology Subsection 1.4.2 for more details.

Figures 5 and 6 show an increase in the level of non-oil tax revenues collected from the monthly value of 85 billion Kwanzas in 2008 to 317 billion kwanzas in 2021, and from quarterly value of 255 billion in 2008 to 951 billion in 2021.

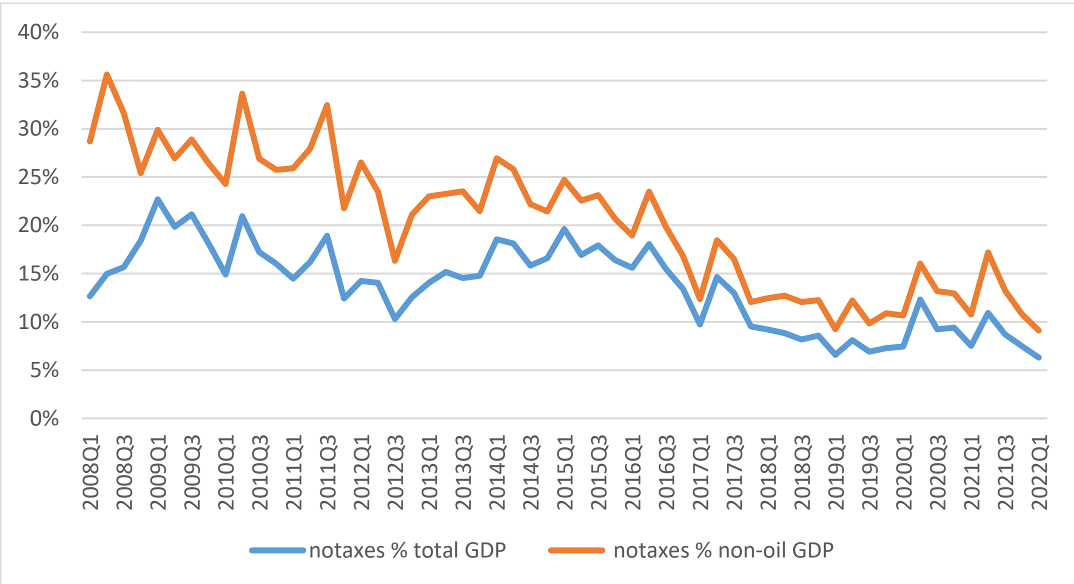
Figure 6 - Quarterly Non-oil Tax Revenues in Billions of Kwanzas



Source: AGT (Angolan General Tax Administration).

Looking at the unit root tests in Tables A1 and A2 in the Appendix, one can see that the non-oil tax revenues are non-stationary in levels. The results are the same for both monthly and quarterly data.

Figure 7 - Quarterly Non-oil Tax Revenues as % of GDP (Total and Non-oil)



Source: Computed by the author using data from AGT (Angolan General Tax Administration) and INE.

Looking at the quarterly non-oil tax revenues in Figure 7, now as percentage of both total GDP and non-oil GDP, one sees a clear reduction over the years of the non-oil tax revenues ratio to GDP. At the onset of the reform, in 2011Q1, the non-oil tax revenues ratio to total GDP was 14% and to non-oil GDP 28%. In 2015Q4 with the establishment of the General Tax Administration the ratio to GDP increased marginally to 16% and the non-oil GDP ratio fell to 21%; and as of 2021Q4, following the introduction of VAT, the non-oil tax revenues ratio to total GDP dropped dramatically to 7% and to 11% as non-oil GDP ratio. This overall decline of the non-oil tax revenues ratio to GDP implies that during these years the nominal GDP (total and non-oil) grew more than the nominal non-oil tax revenues, i.e., the tax system is unable to collect fiscal revenues in proportion to the growth of the GDP.

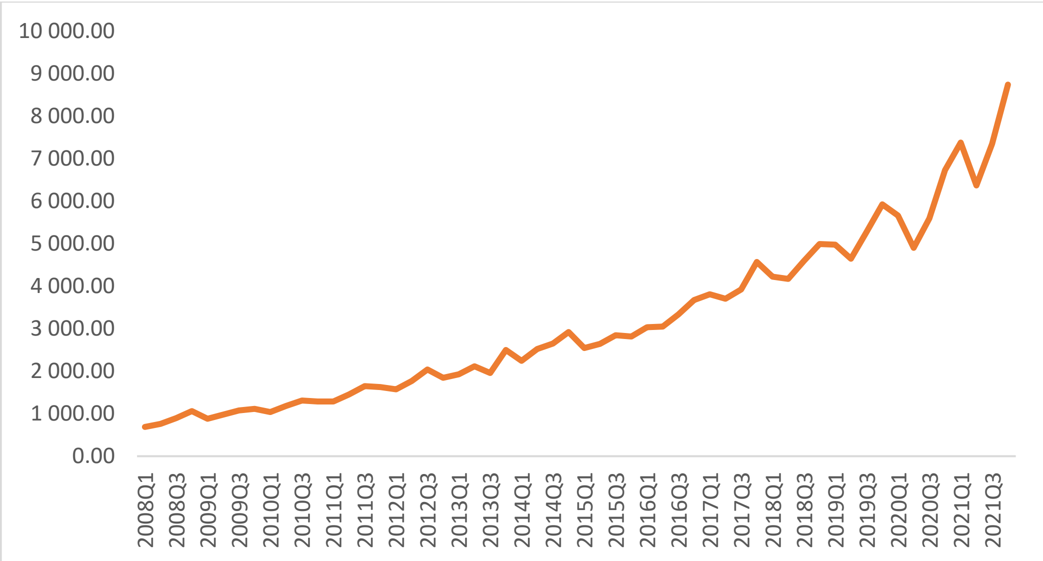
1.4.1.2 Independent Variables

Following the literature, besides the dummy variables that define the timing of the fiscal reforms, and will be described below, eight variables at different frequencies were used as regressors in the models: nominal non-Oil GDP (nnogdp), inflation rate (inflation), oil production (oilproduction), oil price (oilprice), formal exchange rate (fexchanger), total number of taxpayers (taxpayers), control of corruption index (ccorruption), and the government effectiveness index (govefect). Since Angola is an oil-producing country and the sector accounts for more than 95% of the country's total exports, we included in the regression both the oil price and production to see how these variables affect the non-oil tax revenues.

1.4.1.2.1 Non-oil GDP

During the 56 quarters the nominal non-oil GDP increased from 689 billion kwanzas in 2008Q1 to 8.7 trillion kwanzas in 2021Q4, as Figure 8 shows. The expansion of the non-oil GDP is important for a country like Angola, which needs to diversify its economy, generate more employment to reduce the high rate of unemployment, and to expand the non-oil tax base.

Figure 8 - Quarterly Nominal Non-oil GDP in Billions of Kwanzas



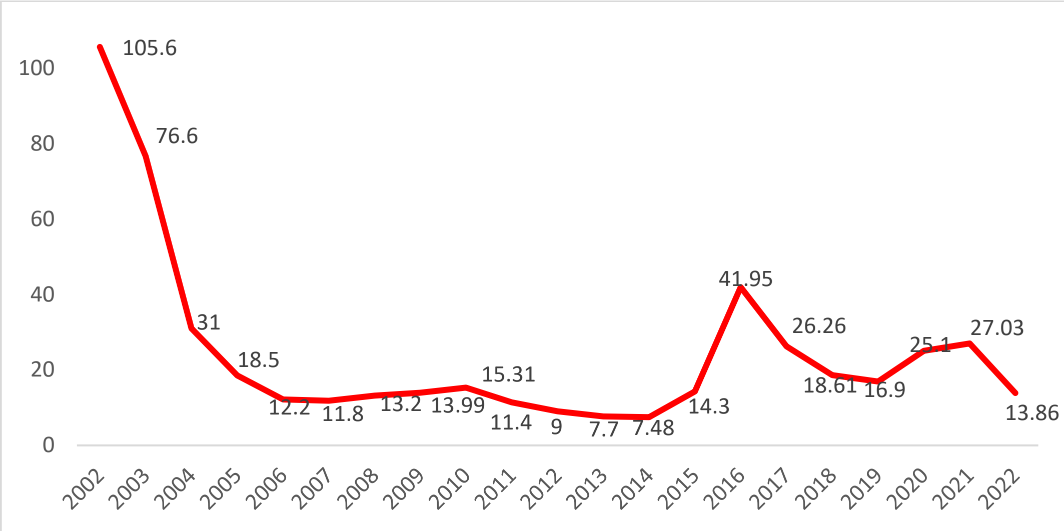
Source: INE-Angola (Angola National Institute of Statistics).

The tests in Table A3 in the Appendix point to non-stationarity of non-oil GDP in levels and stationary in its first difference, confirming the data plotted in Figure 8.

1.4.1.2.2 Inflation Rate

At the end of the civil war, in 2002, the country had a triple-digit end-year inflation rate of 105.6%, which had a tremendous effect on the purchasing power of all economic agents, especially the consumers. The authorities were able to curb the inflation, bringing it down to a two-digit and eventually to a one-digit rate, reaching the lowest value of 7.48% in 2014, as shown in Figure 9. But, in 2015, the inflation rate started to rise again, going back into the realm of two-digits.

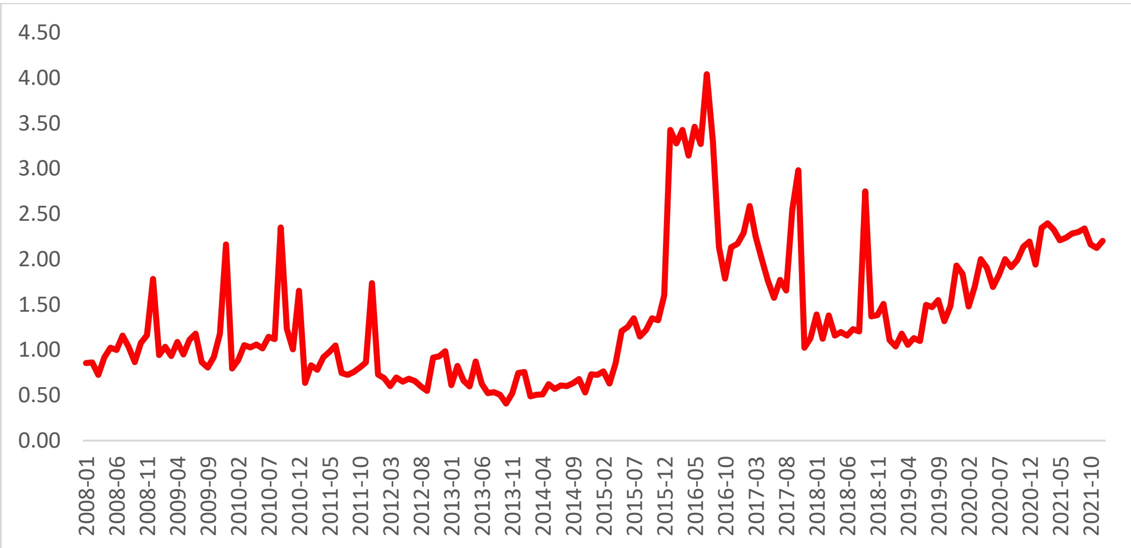
Figure 9 - Annual Inflation Rate (%)



Source: INE-Angola (Angola National Institute of Statistics).

Higher oil prices allowed the authorities to bring inflation down. Angola is an import-dependent country, with more than 2/3 of goods in the consumer price index basket being imported. So, the exchange rate, which depends on the inflow of foreign reserves (US dollars), greatly affects the prices of imported goods and the overall level of prices in the country. This means that higher oil prices in the international market increase foreign reserves, which in turn appreciate the local currency making imports cheaper, which also reduces the price level. As for the monthly inflation rate (variation of price levels between consecutive months), Figure 10 shows its evolution between January 2008 and December 2021.

Figure 10 - Monthly Inflation Rate (%)



Source: INE-Angola (Angola National Institute of Statistics).

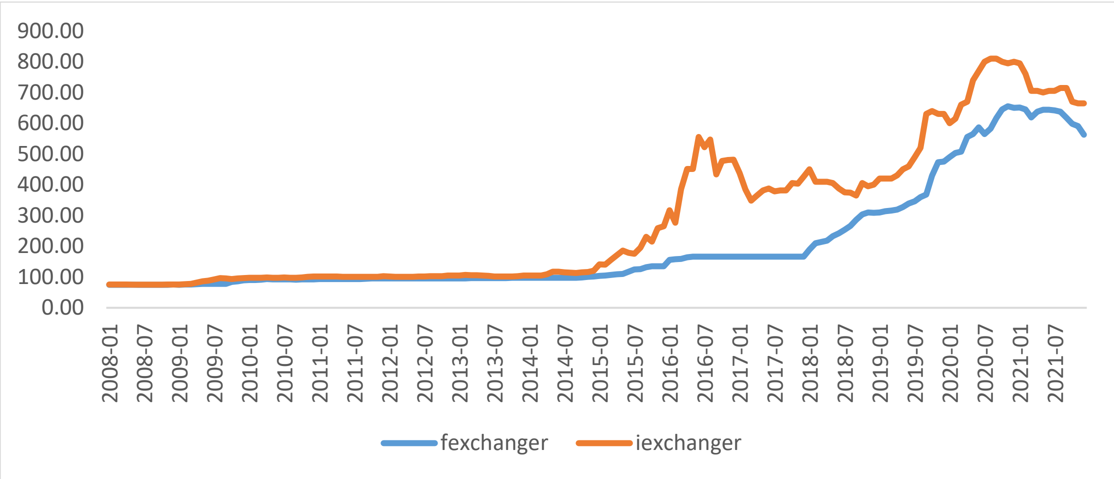
According to the ADF and PP test results in Table A6 in the appendix, the inflation rate is non-stationary and its first difference is stationary, but looking at the KPSS test it seems that inflation is stationary.

1.4.1.2.3 Exchange Rate

In Angola there are two types of exchange rates: the formal exchange rate (fexchanger) used by the Central Bank, commercial banks, and other economic agents, which have access to the banking system, and the informal exchange rate (iexchanger) used in the informal market by those who do not have easy access to the formal exchange rate market.

Looking closely at the USD/Kwanza exchange rates as presented in Figure 11, one can see that the Angolan Central Bank (BNA) used a fixed exchange rate regime up to 2017, as the variation during this period is very small. Higher oil prices allowed the central bank to keep this kind of regime, since with much more foreign reserves, the BNA was able to intervene in the foreign exchange market by buying and selling USD from and to the commercial banks, in order to keep the exchange rate under control with the aim of bringing down the inflation rate. The exchange rate was therefore used as an anchor to stabilize the level of prices.

Figure 11 - Monthly Formal and informal Exchange Rates (USD/Kwanza)



Source: Angola Central Bank (BNA) for the formal exchange rate and Arquivo de #kinguilas - ANGOLA FOREX for the informal exchange rate.

Between 2008 and 2014 the formal and informal exchange rates were almost the same because of the higher foreign reserves that allowed the Central Bank to intervene in the market.

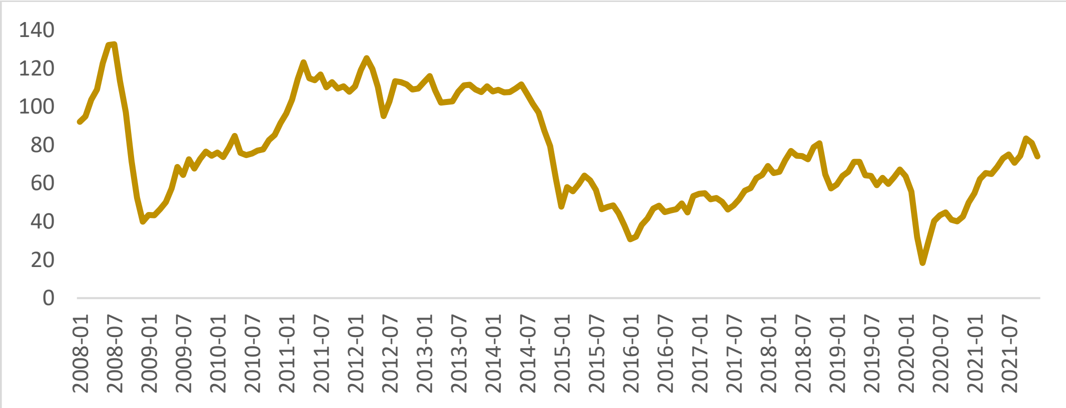
From 2015 to 2017 the Central Bank (BNA) was running out of foreign reserves due to lower oil prices and production, and was forced to start devaluating the currency, which led to a sharp increase in the gap between formal and informal exchange rates. In 2018 the BNA adopted a more flexible exchange rate regime. This was necessary in order to reduce the gap between the formal and informal exchange rates, which over the period from 2015 to 2017 reached a difference of more than double, but following the regime change in 2018 the gap started to narrow, and as of 2021 the difference was of 13 p.p.

Both the ADF and PP tests, in Table A9 in the appendix, point to the presence of a unit root in the formal exchange rate. Taking first differences, the tests point to stationarity.

1.4.1.2.4 Oil Price

Figure 12 shows the volatility of the oil price in the international market. In January of 2008 the price of Brent crude was 92.18 USD per barrel and dropped to 43.32 USD in January of 2009. It recovered to a maximum of 123.26 in April 2011, and in 2014 started a dramatic drop to 30.7 USD in January 2016. The lowest price during this period was in April 2020, with the value of 18.38 USD during the COVID-19 pandemic, and as the economies started to reopen, the oil price started to rebound.

Figure 12 - Monthly Oil Price (USD/Barrel)



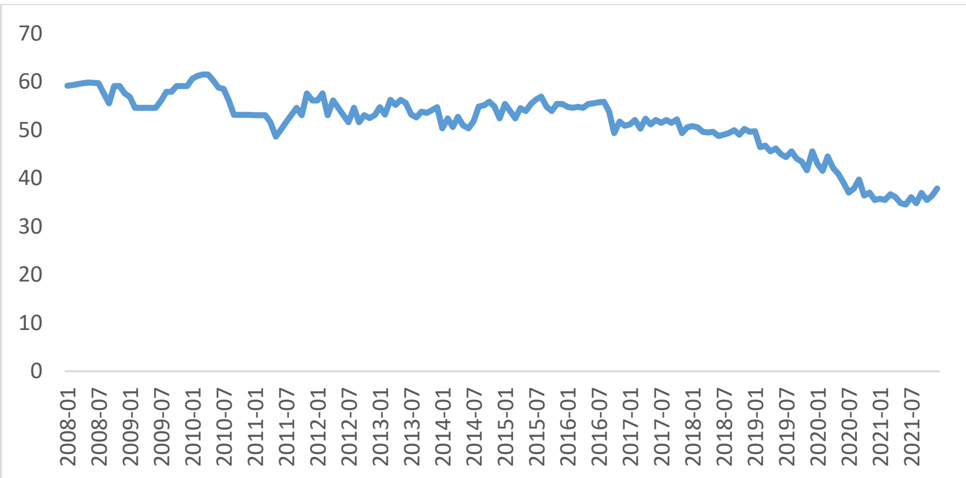
Source: Europe Brent Spot Price FOB (Dollars per Barrel) (eia.gov).

The test results for unit root of both ADF and PP presented in Table A11 show that oil price is non-stationary and its first difference is stationary. KPSS on the other hand point to stationarity at 5% of level of confidence.

4.1.2.5 Oil Production

The production of oil in Angola has been trending downward since 2010, as Figure 13 shows. In April 2010 oil production was 61 million barrels and from then on started to drop to 38 million barrels in December 2021. Lack of investment in the discovery of new fields of extraction and some technical issues explain this negative trend.

Figure 13 - Monthly Oil Production in Millions of Barrels



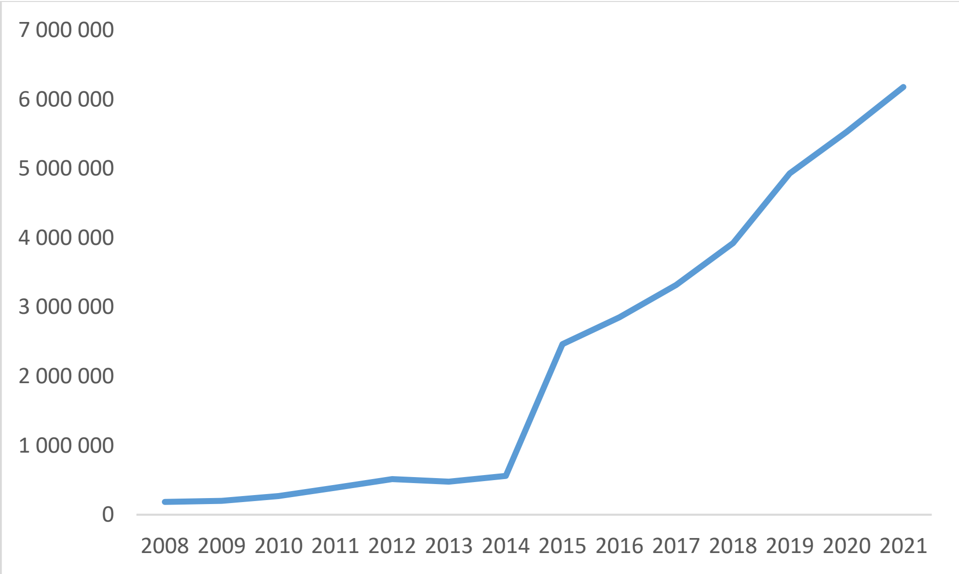
Source: US Energy Information Administration.

Looking at Table A14 in the Appendix, oil production is non-stationary according to the ADF and PP tests results, and its first difference is stationary. The KPSS test results also point to non-stationarity with drift and trend at 10% of significance level.

1.4.1.2.6 Number of Taxpayers

The total number of registered taxpayers in 2008 was only 185,393 (164,881 private persons and 20,512 corporate) but in 2012, one year after the onset of the reform, the total number jumped to 515,242 (447,631 persons and 37,611 corporate). Notably, as of 2021 the total number was 6,180,201 (5,949,050 persons and 231,151 corporate), as Figure 14 shows.

Figure 14 - Yearly Number of Total Taxpayers



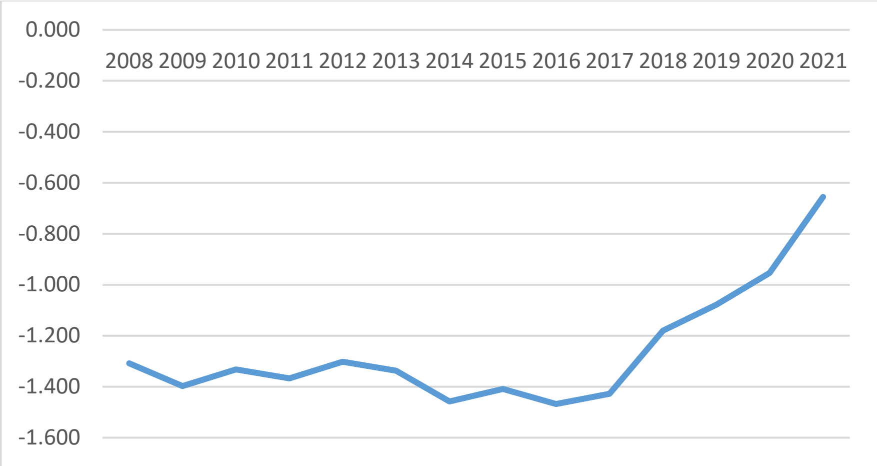
Source: AGT (Angolan General Tax Administration).

The ADF and PP test results in Table A16 in the appendix show that the number of taxpayers is non-stationary, but taking the first difference it becomes stationary.

1.4.1.2.7 Control of Corruption Index

The control of corruption index captures the perception of the extent to which public authorities are able to mitigate corruption in a given country. The index ranges between -2.5 to + 2.5, for which higher values indicate less perceived corruption. In the case of Angola, as seen in Figure 15, in general the control of corruption index has been improving, especially between 2017 and 2021.

Figure 15 - Control of Corruption Index



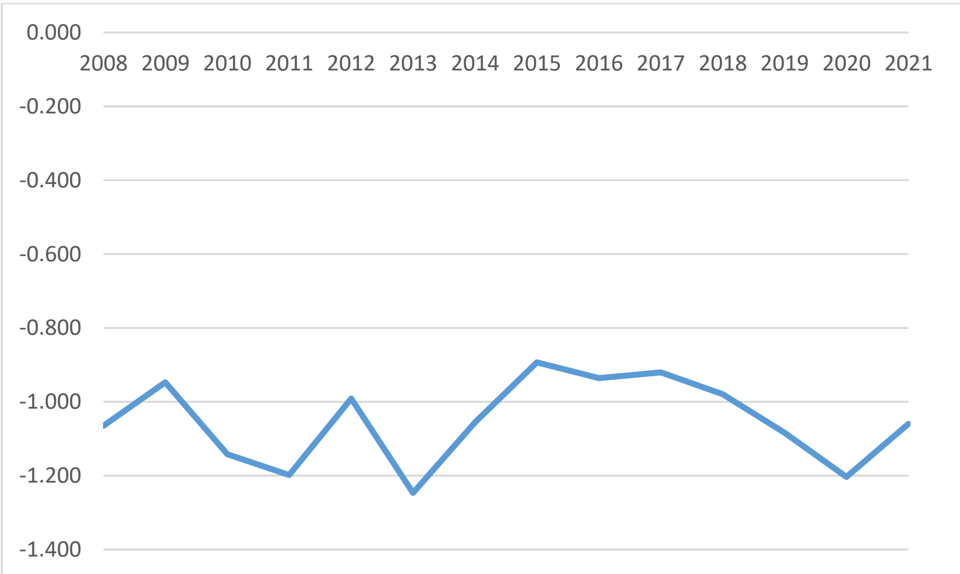
Source: World Bank Worldwide Governance Indicators (WGI).

Looking at the test results of both the ADF and PP presented in Table A18, it is clear that the control of corruption index is non-stationary, but taking the first difference it becomes stationary.

1.4.1.2.8 Government effectiveness index

This variable captures the perception of the quality of public services, policies' implementation, and the credibility of the government's assurance to improve them. Like the control of corruption index, this index ranges between -2.5 and +2.5, whereby the greater the value, the more effective is the government. Looking at Figure 16, although there is a slight progress in the value of the index between 2015 and 2019, there is no clear overall trend of improvement in this index in the country if one takes into account the entire period 2008/2021.

Figure 16 - Government Effectiveness Index



Source: World Bank Worldwide Governance Indicators (WGI).

The ADF, PP, and KPSS tests presented in Table A20 in the Appendix all point to stationarity of the government effectiveness index, and the plot in Figure 16 confirms that.

1.4.1.2.9 Fiscal Reforms

We use three dummy variables to measure the impact of the main events of the tax reform on the non-oil tax revenue collections. Each defines zero for the years before the beginning of the main event of the reform and 1 for the years after the reform. Reform2011 equals zero for the years before the reform and is 1 from 2011 to 2021 and measures the effect of the onset of the non-oil tax reform; Reform2015 equals 1 from 2015 on and measures the impact of the establishment of General Tax Administration (AGT) as the single entity responsible for tax collection in the country; Reform2019 is zero for the years before 2019 and 1 in 2019 and thereafter and measures the impact of the introduction of VAT on mobilization of non-oil tax revenues in Angola.

For the sake of completeness, Table 7 summarizes the variables and the data sources used in this study.

Table 7 – Variables' Descriptions (of the first research on the impact of tax reform)

Variables	Period	Source
Total non-oil tax revenues(monthly)	January 2008 to December 2021	Angolan General Administration Tax (AGT)
Number of Taxpayers (yearly)	2008 to 2021	Angolan General Administration Tax (AGT)
GDP (Oil and Non-oil) (quarterly and yearly)	2008Q1 to 2021Q4	National Institute of Statistics (INE)
Inflation rate (monthly and yearly)	January 2008 to December 2021	National Institute of Statistics (INE)
Oil price (monthly and yearly)	January 2008 to December 2021	Thomson Reuters
Oil production (monthly and yearly)	January 2008 to December 2021	US energy information administration
Exchange Rate (USD/Kwanza) monthly and yearly	January 2008 to December 2021	Angolan Central Bank (BNA)
Control of Corruption Index (yearly)	2008 to 2021	Worldwide Governance Indicators (WGI)
Government Effectiveness Index (yearly)	2008 to 2021	Worldwide Governance Indicators (WGI)

1.4.2 Methodology

In this chapter we use two econometric regression methods: the Auto Regressive Distributed Lag (ARDL) model, with its bounds test for cointegration developed by Pesaran et al. (2001) and the MIDAS (Mixed Data Sampling) regression model developed and proposed by Ghysels et al. (2004), in order to handle the different data frequencies (monthly, quarterly, and yearly) present in the data in order to preserve the information in the higher sampling frequency (Liu, 2019). Since in our study the dependent variable is of high frequency (monthly), we used the Reverse Unrestricted MIDAS (RU-MIDAS) model extended by Foroni et al. (2018), in which the high frequency dependent variable is regressed on the low frequency explanatory variables (quarterly and annual).

In the ARDL model all monthly variables were transformed into quarterly data: for the cases of non-oil tax revenues, inflation, and oil production by aggregation (sum of the corresponding three months); oil price and the exchange rate by taking averages. For the governance indicators (control of corruption and government effectiveness indices) and taxpayers, the values are the same for each quarter throughout the year, assuming that these variables do not change within the year, since their calculation is annual.

In order to avoid the loss of the highest frequency information of the dependent variable, instead of aggregating it, in the RU-MIDAS regression model the monthly non-oil tax revenues are regressed first on the quarterly independent variables, and then on the annual independent variables using two separate regressions[14].

1.4.2.1 The ARDL Model Specification

Cho et al. (2021) presented a very concise summary of the recent developments of the ARDL modelling framework and its extensions or variants. They explain that the model has its onset in the analysis of autocorrelated trend stationary processes, in which the general practice was to model the de-trended series as a stationary distributed lag. According to them, when Koyck (1954) studied investment, and Almon (1965) studied capital appropriations and expenditures, the ARDL approach was already in use.

As its name implies, the ARDL regression model combines an autoregressive component of lags of a scalar dependent variable, with a distributed lag component of lags of a vector of independent or explanatory variables. The estimation is done by OLS, as long as the lag structure of the ARDL model accounts for the autocorrelation structure in the data.

Pesaran and Shin (1998) applied (for the first time) ARDL models to non-stationary series and the analysis of the cointegration relationship between first-order integrated or difference-stationary processes. Later Pesaran *et al.* (2001) presented an important generalization of a bounds test approach, which allows for mixed orders of integration among the variables being studied in the ARDL model when it is not known with certainty whether the underlying regressors are trend- or first-difference stationary.

The ARDL bounds test for cointegration is a procedure that is usually used when there is no certainty if the variables in the regression are I(0) or I(1), and the F-test is computed to find out if there is a cointegration between the dependent variable and the regressors in the model. According to Baek (2014) some of the advantages of this ARDL methodology include the absence of need to pre-test for unit roots, and it is an appropriate tool to study dynamic interactions.

The ARDL regression model is estimated by OLS because it can manage serial correlation through the selection of an appropriate lag order and it can provide consistent estimates of the long-run parameters, even in a case in which the regressors are weekly endogenous (Cho *et al.,* 2021).

Regarding the selection of the appropriate lag order of the ARDL process, Pesaran and Shin (1998) suggested using the Schwarz (1978) Bayesian information criterion (SIC or SBC). Other criteria such as the Akaike (1973) information criterion (AIC) are also used. In fact, Pesaran *et al.* (2001) used both AIC and SBC when selecting the lag order of the earnings equation in their empirical study[15].

To check the validity of the results of the estimated ARDL model there are some diagnostic tests that are performed such as the test for homoskedasticity (Heteroskedasticity test of Breusch–Pagan–Godfrey), non-serial correlation of the errors (Breusch–Godfrey serial correlation Lagrange

[14] Two separate regressions were used, first the monthly non-oil tax revenues with the quarterly independent variables and then with the yearly independent variables, because the R software package (midasr) only allow regressors of the same frequency in the regression. We were not able to find a package that allowed regressors of different frequencies in the same regression.

[15] In the econometric R software, which we used in the estimations in this chapter, there is an ARDL package developed by Natsiopoulos and Tzeremes (2023) with an automatic ARDL model selection that searches for the best order specification using both AIC and SBC criteria.

multiplier), normality, no functional form mis-specification (Ramsey's RESET), and stability of the regression coefficients (CUSUM test).

In this first part of the chapter we use the following ARDL -ECM model in equation (1)

$$\begin{aligned}\boldsymbol{\Delta \ln \mathrm{notaxes}_t} = \boldsymbol{\beta_0} + \boldsymbol{Ct} + \sum_{k=1}^{p1} \boldsymbol{\alpha_1}\ \boldsymbol{\Delta \ln \mathrm{notaxes}_{t-k}} + \sum_{k=0}^{p2} \boldsymbol{\alpha_2}\ \boldsymbol{\Delta \ln \mathrm{oilprice}_{t-k}} + \sum_{k=0}^{p3} \boldsymbol{\alpha_3}\ \boldsymbol{\Delta \ln \mathrm{oilproduction}_{t-k}} \\ + \sum_{k=0}^{p4} \boldsymbol{\alpha_4}\ \boldsymbol{\Delta \ln \mathrm{fexchanger}_{t-k}} + \sum_{k=0}^{p5} \boldsymbol{\alpha_5}\ \boldsymbol{\Delta\ \mathrm{inflation}_{t-k}} + \sum_{k=0}^{p6} \boldsymbol{\alpha_6}\ \boldsymbol{\Delta \ln \mathrm{nogdp}_{t-k}} + \boldsymbol{ECT} \\ + \boldsymbol{\beta_1 \ln \mathrm{notaxes}_{t-1}} + \boldsymbol{\beta_2 \ln \mathrm{oilprice}_{t-1}} + \boldsymbol{\beta_3 \ln \mathrm{oilproduction}_{t-1}} + \boldsymbol{\beta_4 \ln \mathrm{fexchanger}_{t-1}} \\ + \boldsymbol{\beta_5\ \mathrm{inflation}_{t-1}} + \boldsymbol{\beta_6 \ln \mathrm{nogdp}_{t-1}} + \boldsymbol{\Phi \ln \mathrm{taxpayers}_{t-1}} + \boldsymbol{u\ \mathrm{ccorruption}_{t-1}} + \boldsymbol{\mu\ \mathrm{govefect}_{t-1}} \\ + \boldsymbol{\Upsilon_1 \mathrm{reform}_{2011}} + \boldsymbol{\Upsilon_2 \mathrm{reform}_{2015}} + \boldsymbol{\Upsilon_3 \mathrm{reform}_{2019}} + \boldsymbol{\varepsilon_t},\end{aligned}$$

$$\boldsymbol{t = 1, \dots, T} \qquad (1)$$

The dependent variable is the non-oil total tax[16] revenues (*notaxes*) and as for the explanatory variables: *oilprice* is the oil price, *oilproduction* is the oil production, *inflation* is the inflation rate, *fexchanger* stands for the formal exchange rate, *GDP* is the gross domestic production (the non-oil), and *taxpayer* is the total number of registered taxpayers (both individuals and companies).

All variables are in natural logarithms except for the inflation (because it is in percentage change), the control of corruption (*ccorruption*) and government effectiveness (*govefect*) indices, due to the fact that these variables include negative values. Taking into account that the variables are in different units, applying logarithms helps to harmonize them by having a common measure equivalent to a percentage change.

The three annual variables transformed into quarterly, the number of taxpayers, the control of corruption, and government effectiveness indices, are not in differences in the equation, due to the fact of assuming that their values are the same throughout the quarters in each year.

The coefficients α measures the short-run effect of each explanatory variable, whereas β measures the long-run effects if cointegration is established, Φ measures the effect of the number of tax payers, u measures the impact of control of corruption index, μ measures the effect of government effectiveness index, the Y's measure the impact of the tax reforms, β_0 is the intercept, Ct is the trend to be estimated, and ε is the error term. The plots of non-taxes in Figures 5 and 6 suggest that the variable has a positive trend, so it makes sense to include it in the equation.

The optimal lags orders of the $ARDL\ (P1, P2, P3, P4, P5, P6)$ model, which were selected by using both the AIC and BIC criterion, are ($5,6,6,6,6,5$).

1.4.2.1.1 Bounds Tests for Cointegration

Pesaran *et al.* (2001) propose a joint F-statistic for testing for the existence of cointegration or a long-run relationship between the variables in the ARDL model, checking the significance of the

[16] We also used non-oil tax revenues as a percentage of total GDP (*notaxesgdp*), and as percentage of non-oil GDP (*notaxesnogdp*), as dependent variables using the same explanatory variables to check if the results change significantly. The results in Tables A24 to A27 in the appendix show that the coefficients are quite similar for the three dependent variables (non-oil taxes, non-oil taxes as percent of total GDP and non-oil taxes as percent of non-oil GDP), with the main difference being on the coefficient of the reform 2011, which is positive and significant for the non-oil taxes revenues and as percent of non-oil GDP, but negative and non-significant for the non-oil taxes as percent of total GDP.

lagged levels of the variables in a univariate equilibrium correction mechanism. The procedure tests if the coefficients of the independent variables in levels are jointly zero, against the alternative of non-zero, with the null hypothesis of no cointegration.

If the p-value associated with the computed F-statistic is smaller than the significance level (or if the F-statistic is above the upper bound critical value provided by Pesaran *et al*, 2001, tables of asymptotic critical value bounds for the F-statistic), the level/long-run relationship or cointegration is established. In the case of the opposite, i.e., when the null of no cointegration is not rejected and there is no evidence of the long-run relationship, the focus will be only on the short-run relationship.

We applied the bounds test for cointegration to the non-oil tax revenues and its determinants. The value of F-test (Wald) equals 28.325 and the associated p-value is 0.000001. Thus, it is clear that the null of no cointegration is rejected, meaning that there is a long-run relationship between the variables and this is also confirmed by the negative and significant error correction term-ECT (see Table 10).

The error correction term (ECT) is a parameter that captures the short-run dynamics of the ARDL model and measures the deviation from the long-run equilibrium and the speed of its correction, helping to ensure that the long-run relationship is maintained, confirming in this way the cointegration. The cointegration is only established through the ECT if its value is negative and statistically significant, and this was true in the case of this study (see Table 10).

1.4.2.1.2 ARDL Diagnostic Tests

Before presenting the estimated coefficients and their interpretation we discuss the results of the diagnostic tests of the model (in Table 8).

The Heteroskedasticity test of the Breusch–Pagan test (BP test) indicate that the null hypothesis of homoskedasticity is not rejected, meaning that the variance of the errors of the model is constant . The Breusch–Godfrey serial correlation Lagrange multiplier test (BG LM test) confirms that there is non-serial correlation of the errors.

Table 8 - Diagnostic Tests Results of the ARDL Model (5,6,6,6,6,5)

Diagnostic tests			
BP test	49.185	RESET test	2.579
p-value	0.3469	p-value	0.250
BG (LM)test	1.4056	Normality test	7.2
p-value	0.3576	p-value	0.408
		CUSUM test	0.956
		p-value	0.321

The model has a suitable functional form according to the Ramsey's RESET test. The Pearson test of normality shows that the errors of the model are normally distributed, and the Huber-CUSUM test of stability of the regression coefficients confirm that they are stable.

1.4.2.2 RU-MIDAS Regression Model

Regressions are generally estimated with the dependent variable on the left-hand side having the same frequency as the variables on the right-hand side, either annually, quarterly, monthly, weekly, or daily. With the MIDAS regression model it is possible, in the same equation, to use variables with different time frequencies. For instance, the dependent variable can be observed annually and the independent variables quarterly.

The Mixed Data Sampling approach was first introduced by Ghysels *et al*. (2004) in a case where the low-frequency dependent variable's response to the high-frequency explanatory variable is done using highly parsimonious distributed lag polynomials (Ghsysels and Massimiliano, 2018).

The basic (Autoregressive Distributed Lags) ADL-MIDAS regression considers a low-frequency dependent variable (Y) regressed on a higher-frequency variable (X).

$$\mathrm{Y_t} = \mu + \alpha \mathrm{Y_{t-1}} + \beta \sum_{j=1}^{T} \omega_{\mathrm{j}}(\theta) X_{\mathrm{j,tm-1}} + u_{\mathrm{t}} \tag{2}$$

where Y is the low-frequency variable, t is the time subscript of the lower frequency variable, X_j are the high-frequency variables, m is the number of higher frequency periods within the low frequency variable, $\omega_{\mathrm{j}}(\theta)$ is the parameterization of the lagged coefficients of high-frequency variables, T is the total number of high-frequency periods within each low frequency period, β is the regression coefficient that relates the low-frequency dependent variable to the weighted sum of the high-frequency independent variable observations (Schumacher, 2016), α and u are parameters, and the error term is assumed to be white noise and uncorrelated with the explanatory variables.

Various polynomial specifications are used to align the high-frequency coefficients with the low-frequency variable such as beta polynomial, Almon lag polynomial, step functions, and others. The most used is the "exponential Almon lag, since it is closely related to the smooth polynomial Almon lag functions that are used to reduce multicollinearity in the distributed lag literature", according to Ghsysels and Massimiliano, 2018 (p.460). In this paper we used the exponential Almon polynomial due to the fact of being the most used. Its expression is the following:

$$\omega(k;\theta) = \frac{\exp\,(\theta_1 k + \theta_2 k^2 + \cdots + \theta_q k^q)}{\sum_{k=0}^{K} \exp\,(\theta_1 k + \theta_2 k^2 + \cdots + \theta_q k^q)} \tag{3}$$

where K is the lags of high frequency variable, and the parameter θ determines the pattern of the weights and avoids the proliferation of the lag parameters of high frequency variable. Here, θ is commonly set to be two parameters $[\theta_1, \theta_2]$, which allows the weights to be decreasing, increasing, hump-shaped, and flat – when the two parameters are each equal to 1, Ghysels *et al.* (2006). The weights sum up to 1 by construction and they are not fixed by time aggregation, but are based on functional lag polynomials (Schumacher, 2016).

Taking into account the nonlinear function of the functional lag polynomial used for the high frequency observations aligning, the estimation method of the restricted MIDAS is the nonlinear least squares (NLS). This estimation method implies the use of iterative algorithm for the estimation of the coefficients employed for aligning the high-frequency variable with the low-frequency one. The main coefficient of interest is β, which measures the change in the low-frequency dependent variable, caused by one unit change in the weighted sum of the high-frequency independent variable.

Published empirical papers on MIDAS regression focus primarily on forecasting, so the values of the coefficients of the regressions in these papers are generally not shown or interpreted. In our work herein, however, since we seek to find the determinants of the non-oil monthly tax revenues, the coefficients of the explanatory variables of the MIDAS regression will be our main focus, looking at their statistical significance, sign, and estimated values.

The MIDAS literature also considers models in which a high-frequency dependent variable is regressed on low-frequency regressors, and these models are usually called Reversed MIDAS. Faroni *et al.* (2018) introduced the reverse unrestricted MIDAS (RU-MIDAS) with the goal of including low-frequency information in models that explain high-frequency variables. In this case, the equation (2) becomes:

$$\mathrm{Y}_{\mathrm{tm}} = \mu + \beta \sum_{j=1}^{T} \omega_{\mathrm{j}}(\theta) X_{\mathrm{j,t-1}} + u_{\mathrm{tm}} \tag{4}$$

where Y is the dependent high-frequency variable, m is the number of higher frequency periods within the low frequency variable, X the explanatory low-frequency variables, t is the time subscript of the lower frequency variable, T is the total number of low-frequency observations, $\omega_{\mathrm{j}}(\theta)$ is the parameterization of the lagged coefficients of low-frequency variable that produces the high-frequency estimate of the low-frequency variable, β is the regression coefficient that relates the high-frequency dependent variable to the weighted sum of the low-frequency independent variable observations, α and u are parameters, and the error term (u_{tm}) is assumed to be white noise and uncorrelated with the explanatory variables.

Hecq et al. (2023) argue that the reverse unrestricted MIDAS (RU-MIDAS) is very flexible and parsimonious, as it does not require a model specification for the low frequency variable, or for forecasting, and it can automatically incorporate high frequency data released within an ongoing low frequency period.

We use the reverse unrestricted MIDAS (RU-MIDAS) regression to model the monthly non-oil tax revenues: first using yearly explanatory variables received as such without any aggregation (inflation, exchange rate, oil price, oil production, non-oil GDP, number of taxpayers, control of corruption index, or government effectiveness index); and then using the same regressors but in quarterly frequencies (for the case of non-oil GDP using the original quarterly data, and for the other variables by aggregating in quarterly data as explained in point 1.4.2). Both the dependent variable and the regressors (with the exception of the control of corruption and government effectiveness indices) in the two regressions are in natural logarithm variation. We have two distinct regressions with the same dependent variable (monthly non-oil tax revenues), one with only yearly explanatory variables and the other with only quarterly regressors, because the R software package (midasr) we used allows regressors of only the same frequency in the regression.

1.4.2.2.1 MIDAS Diagnostic Test

There is a test to verify the adequacy of the functional constraint of MIDAS regression specification to see if the exponential Almon lag restriction is suitable or one needs to use another polynomial specification. The test was developed by Kvedaras and Zemlys (2012) and is called hAh_test (with a robust version hAhr-test). In the null hypothesis the restriction on the MIDAS regression coefficients holds, meaning that the restriction is adequate. In our model the null hypothesis was not rejected.

1.5 Estimation Results

In this section we present the estimation results of both the ARDL and RU-MIDAS regressions models on the impacts of the tax reforms and the determinants of the non-oil tax revenues in Angola.

1.5.1 ARDL Results of the Long-run and Short-run Relationships

The multipliers coefficients of the long-run relationships of the ARDL regression model, presented in Table 9, show a negative and significant impact of: oil production on the non-oil tax revenues, that is, *ceteris paribus* a 1% increase in the oil production leads to a -6.5% decrease in non-oil tax revenues; formal exchange rate (meaning that a 1% increase in the exchange rate causes a -2.5% decrease in the non-oil tax revenues); nominal non-oil GDP (which means that a 1% increase in non-oil GDP leads to -3.1% decrease in the non-oil taxes, but at 10% of significance). For the long-run the coefficients of oil prices and inflation are not statistically significant.

Table 9 - Long-run Multipliers Coefficients

Regressors	Coefficients	Standard error	t-Statistic	p-value
Intercept	133.441	19.372	6.888	0.006
Trend	1.409	0.279	5.051	0.015
Ln oilprice	-0.280	0.154	-1.819	0.166
Ln oilproduction	-6.454	0.881	-7.324	0.005
Ln fexchanger	-2.532	0.408	-6.206	0.008
Ln inflation	-0.055	0.097	-0.573	0.607
Ln nnogdp	-3.120	1.104	-2.827	0.066
Ln taxpayers	-1.053	0.261	-4.037	0.027
ccorruption	-1.084	0.292	-3.719	0.034
govefect	-0.088	0.221	-0.397	0.718
reform2011	0.406	0.142	2.860	0.065
reform2015	1.405	0.334	4.212	0.024
reform2019	1.156	0.127	9.12	0.003

In the Literature, the coefficient of non-oil GDP is called *tax buoyancy,* and it measures the responsiveness or elasticity of the non-oil tax revenues to changes in the non-oil GDP. Its sign was expected to be positive, but we found a negative non-oil tax buoyancy, implying that the non-oil tax revenues in Angola are not a close function of the non-oil economy. In fact this result is not so surprising taking into account that in Figure 7 it was shown that the non-oil tax revenue ratio to both total and non-oil GDP has been decreasing systematically, and this overall decline of the non-oil tax revenues ratio to GDP indicates that during these years the nominal GDP (total and non-oil) grew more than the nominal non-oil tax revenues, i.e., the tax system was unable to collect fiscal revenues in proportion to the evolution of the GDP.

Since Angola depends to a large degree on imports, the negative coefficient of the formal exchange rate reveals that higher exchange rate negatively affects the economy activity, since it leads to higher importing costs, which reduces the profits (base) on which the taxes are computed, reducing the overall tax revenues.

Control of corruption index has a negative and significant impact, meaning that an increase of one unit in this index results in a 108% decrease in the non-oil tax revenues. It was expected that higher corruption control would lead to higher tax collections, but the case of Angola shows that the control has not been effective enough to avoid loss of non-oil tax revenues. It is therefore of paramount importance to really fight against corruption with strong institutions, since corruption erodes confidence and undermines tax revenues collection.

The dummy variables of tax reforms have positive and significant impacts. For the case of the onset of the reform in 2011, with 10% of significance, it had a 40.6% impact on the increase of the non-oil tax revenues, the foundation of the Single Tax Administration Office in 2015 had an effect of 140.5% increase in comparison to the years before the onset of the reform, and the introduction of the VAT had an impact of 115% increase, also in comparison to the years before the first reform in 2011.

Comparing the effect of 2019 reform (the introduction of VAT) with that of 2015 (establishment of AGT), it can be seen that the former resulted in 25 percentage points less revenue than the latter, meaning that the introduction of a new indirect tax penalized the collection of the non-oil fiscal revenues in comparison to the creation of a single entity responsible for the collection of all taxes. This can also mean that the type of the reforms matter, that is, creating new taxes does not necessarily mean higher tax collections, but reforms aiming at a better organization of tax administration offices can yield higher tax revenues. The full result of the level relationship is presented in Table A22 in the appendix.

Table 10 - Short-run Multipliers Coefficients

Regressors	Coefficient	Standard error	t-Statistic	p-value
Intercept	133.441	19.372	6.888	0.006
Trend	1.409	0.279	5.051	0.015
d(Ln oilprice)	-0.330	0.125	-2.645	0.077
d(Ln oilproduction)	-4.677	0.731	-6.399	0.008
d(Ln fexchanger)	-2.592	0.334	-7.757	0.004
d(Ln inflation)	0.099	0.077	1.277	0.292
d(Ln nnogdp)	-2.041	0.299	-6.815	0.006
Ln taxpayers	-1.053	0.146	-7.196	0.000
ccorruption	-1.084	0.074	-14.566	0.000
Govefect	-0.088	0.093	-0.947	0.371
reform2011	0.406	0.059	6.911	0.000
reform2015	1.405	0.185	7.581	0.000
reform2019	1.156	0.059	19.481	0.000
Ect	-1.713	0.080	-21.289	0.000

Now according to the short-run multipliers coefficients shown in Table 10[17], in the short run, at 10% of significance, a 1% increase in the oil price is associated with 0.33% decrease in the non-oil tax revenues and a 1% increase in the oil production is associated with 4.6% decrease in the non-oil tax revenues. For the exchange rate a 1% increase results in a 2.6% decrease in the non-oil tax revenues. The variation of the non-oil nominal GDP has a negative effect on non-oil tax revenues, meaning that a 1% increase in the former leads to 2.1% decrease in the latter.

The negative impact of oil price and oil production on tax revenue mobilization in developing countries is also documented in the literature. Using an unbalanced panel dataset of 35 resource-rich countries, Crivelli and Gupta (2014) found that for each additional percentage point of GDP in resource revenues, there is a drop in domestic (non-resource) revenues of about 0.3 percentage points of GDP. Botlhole *et al*. (2012) argued that additional resource revenues reduce tax revenues when institutions are poor in the countries, whereas in countries with well-functioning institutions contribute to more internal tax revenues mobilization.

The coefficient of the number of taxpayers shows that a 1% increase in total number of taxpayers is associated with a 1.1% decrease in the non-oil tax revenues, which is contrary to what is expected. This negative relationship might indicate fiscal evasion since more taxpayers should imply more tax revenues and not less tax revenues.

The coefficient of control of corruption index is negative and statistically significant, meaning that a one unit increase in this index reduces the non-oil tax revenues by 108%. This result may imply that the level of control of corruption as a whole has not been good enough to induce greater tax collection and it is actually causing fiscal revenue loss. In the literature, corruption generally has a negative impact on tax revenues collection. For instance Gupta (2007), Crivelli and Gupta (2014), and Kamasa *et al*. (2022) all showed that corruption contributed negatively to fiscal revenues mobilization in the countries that they studied. But in our study we are using, not the perception of corruption index, but the control of corruption index, which we expected would show a positive impact on tax revenues. The negative effect found in this case might imply that the control of corruption in Angola is still insufficient to positively impact fiscal revenues collection.

As for the coefficient of the dummy variables measuring the impact of the tax reforms, its values are positive and statistically significant, meaning that, *ceteribus paribus*, the onset of the reform in 2011 has contributed to the collection of 41% more non-oil taxes, impacting positively the growth of fiscal revenues. The 2015 reform (creation of a single tax administration entity) had an impact of 140% increase in the non-oil tax revenues, and the introduction of the VAT in the 2019 reform had an impact of 115% in comparison to the years before the start of the first reform. Now comparing the effects of the reforms[18] between 2011 and 2015, the 2015 reform contributed to almost a 100% rise in non-oil tax revenues; between 2015 and 2019, the 2019 reform contributed to 25% less non-oil tax revenue.

The positive impact of the tax reforms on fiscal revenues collection found in this paper is in line with the other studies in the literature that analyse the effect of tax reforms in developing countries. For

[17] The full results of the short-run relationship are presented in Table A23 in the appendix.

[18] Taking the difference between the dummy coefficients of each consecutive reform yields the impact: between 2011 and 2015 (140%-40% = 100%); between 2015 and 2019 (115%-140% = -25%).

instance, Kanyi and Kalui (2014) when studying Kenya, Ndiaye (2019) when studying Senegal, Kamasa *et al*. (2022) when studying Ghana, and Ebi and Ayodele (2017) when studying Nigeria. They all found that the tax reforms had a positive and significant impact on the mobilization of tax revenues in the respective countries.

The coefficient of the Error Correction Term (ECT) is negative and statistically significant, which also confirms that there is a cointegration or long-run relationship between the non-oil tax revenue and its determinants. This coefficient captures the speed at which the dependent variable adjusts toward the long-run equilibrium after a shock in the regressors. Its value, being of -1.71, is sizeable taking into account that it usually ranges between zero and -1[19].

1.5.2 RU-MIDAS Regression Results

1.5.2.1. Monthly Non-oil Tax Revenues and Yearly Regressors

The RU-MIDAS regression results are in general quite similar to the ARDL regressions, with exception of the coefficient of the oil price. From Table 11 it can be seen that the oil price in RU-MIDAS regression has a positive and statistically significant impact on the non-oil taxes with a 1% increase in the annual oil price leading to almost a 1% increase in the non-oil tax revenues, *ceteris paribus*. This result is different from the ARDL regression, where in the short run the oil price is negatively affecting the non-oil tax revenues. Oil production has a negative and significant effect on the non-oil tax revenues, with a 1% increase leading to a 0.6% reduction in the non-oil taxes; the formal exchange rate also has a negative impact, meaning that 1% increase in this variable results in a 0.7% decrease in the non-oil tax revenues. Nominal non-oil GDP has a negative and significant impact, implying that a 1% increase in the non-oil GDP causes a 5.7% drop in the non-oil tax revenues, showing a negative non-oil tax buoyancy, which also reveals that the non-oil tax revenues in Angola are not a close function of the non-oil local economy. All these results are similar to those of the ARDL model presented above, although the value of the coefficients (impact) are much smaller.

The negative impact of the formal exchange rate on the non-tax revenues collection shows that the stability of the foreign exchange market, especially for countries highly dependents on imports, is important to avoid tax revenues loss. Using a panel of 22 countries in Sub-Saharan Africa, from 1980–1996, Agbeyegbe *et al*. (2004) found also that the exchange rate showed some linkage to lower tax revenues mobilization.

[19] There are studies using the ARDL approach that also come up with an error correction term coefficient outside the range of -1, particularly in some developing countries. For instance, Loyaza and Ranciere (2005), when studying the relationships between financial development, financial fragility, and growth, using annual data from 1960 to 2000, found an error correction term coefficient of -2.36. Narayan and Smyth (2006) studied the determinants of migration flows from Fiji to the US using annual data from 1972 to 2001, and found a coefficient of error correction term of -1.21, which they considered to imply that instead of monotonically converging to the equilibrium path directly, the error correction process fluctuates around the long-run value in a diminishing manner and once the process is complete the convergence toward the equilibrium is fast.

Table 11 - RU-MIDAS Regression Coefficients of Yearly Regressors

Regressors	Coefficients	Standard error	t-Statistic	p-value
Intercept	0.917	2.30E-14	3.99E+13	0.000
d(ln Oilprice)	0.995	1.35E-14	7.40E+13	0.000
d(ln Oilproduction)	-0.699	6.39E-14	-1.09E+13	0.000
d(ln Fexchanger)	-0.722	7.10E-15	-1.02E+14	0.000
d(ln Inflation)	0.359	1.56E-15	2.30E+14	0.000
d(ln nnogdp)	-5.770	9.24E-14	-6.25E+13	0.000
d(ln taxpayers)	-0.243	9.05E-15	-2.68E+13	0.000
ccorruption	-1.034	7.08E-15	-1.46E+14	0.000
govefect	0.474	1.87E-14	2.53E+13	0.000
reform2011	0.035	4.01E-15	8.85E+12	0.000
reform2015	0.088	2.95E-15	2.99E+13	0.000
reform2019	0.004	4.12E-15	9.85E+11	0.000

The coefficient of the number of annual taxpayers is negative and statistically significant, which implies that an increase of 1% in the number of taxpayers leads to 0.24% reduction in the non-oil tax revenues, contrary to what is expected. The coefficient of control of corruption index is also negative and statistically significant, implying that a 1 unit increase in this index results in 103% reduction in the non-oil tax revenues, whereas the government effectiveness index has a positive and significant coefficient, which means that a 1 unit increase in this index causes a 47% increase in the non-oil tax revenues.

All of the reform dummy variables in the RU-MIDAS regression have positive and significant effects. For the onset of the reform in 2011 it resulted in 3.5% more non-oil tax collection in comparison to the years before the reform, the establishment of the General Tax Administration in 2015 caused an 8.8% additional increase in the non-oil tax revenues compared with the years before the reform, whereas the introduction of the VAT in 2019 resulted in a very moderate additional increase in the non-oil tax revenues of 0.4%. Comparing the effect of the reforms, the 2015 reform caused a 5.3% rise in non-oil tax revenues than before the 2011 reform, and the 2019 reform resulted in 8.4% less non-oil tax revenue compared with the 2015 reform. These results are quite similar to those obtained from the ARDL model, which also showed a positive impact of the reforms, with the RU-MIDAS regression presenting lower effects than that of the ARDL.

1.5.2.2. Monthly Non-oil Tax Revenues and Quarterly Regressors

The quarterly regressors coefficients of RU-MIDAS regression reported in Table 12 show that oil production has a negative impact on non-oil tax revenues, an 1% increase in oil production results in a 1.8% reduction in the non-oil tax revenues.

Table 12 - RU-MIDAS Regression Coefficients of Quarterly Regressors

Regressors	Coefficients	Standard error	t-Statistic	p-value
Intercept	-0.005	0.061	-0.076	0.940
d(ln Oilprice)	-0.317	0.225	-1.414	0.165
d(ln Oilproduction)	-1.825	0.706	-2.585	0.014
d(ln Fexchanger)	0.770	0.692	1.112	0.273
d(ln Inflation)	-0.083	0.106	-0.787	0.436
d(ln nnogdp)	-0.135	0.577	-0.234	0.816
d(ln taxpayers)	0.111	0.192	0.578	0.567
ccorruption	0.060	0.727	0.082	0.935
govefect	-0.416	0.444	-0.938	0.354
reform2011	-0.055	0.075	-0.740	0.464
reform2015	-0.083	0.071	-1.163	0.252
reform2019	0.115	0.052	2.213	0.033

The reform of 2019 that resulted in the introduction of the VAT has a positive and significant coefficient, implying that this reform caused an 11.5% increase in the non-oil tax revenues, compared to the years before that reform.

Comparing the results of both RU-MIDAS regressions in Tables 11 and 12, it can be seen that oil production has a negative and significant impact on the non-oil tax revenues, with the impact using quarterly data being higher (-1.8%) than that of the yearly case, which is -0.69%. The impact of the 2019 reform is also higher in the quarterly frequency (11.5%) than in the yearly one (0.04%). None of the remaining regressors are statistically significant to explain the variable of interest when using the quarterly data.

The negative relationship between the oil production and the non-oil tax revenues that both RU-MIDAS models showed are in harmony with that of the ARDL models presented above, and this relationship is called in the literature the eviction effect (Grivelli and Gupta, 2014). The exploration of natural resources leading to lower non-natural resources tax revenues is perhaps due to the fact that in most developing countries rich in natural resources the governments tend to tax less the non-resources sectors to avoid accountability.

1.6 Discussion of the Main Results and Policy Implications

Oil production coefficients are negative in both the ARDL and RU-MIDAS regression models, showing that in case of Angola the increase in this variable leads to lower non-oil tax revenues collection. In the taxation literature this negative relationship between resource revenues and total domestic (non-resource) fiscal revenues is called eviction effect by Crivelli and Gupta (2014), who found that for each additional percentage point of GDP in resource revenues, there is a drop in domestic (non-resource) revenues of about 0.3 percentage points of GDP in resources-rich countries (and Angola was included in the sample). When studying 45 Sub-Saharan African countries, Botlhole *et al.* (2012) concluded that more resource revenues reduce non-resources tax revenues when institutions are poor in the countries, but when the institutions are strong and functional more resources exploration leads to more non-resources tax revenues due to the linkage between the two sectors (Knebelmann, 2017).

The eviction effect of oil production on the non-oil tax revenues for the case of Angola might reveal that oil revenues are not affecting positively the dynamism of the non-oil sector in such a way that it contributes to more non-oil tax revenue collection, or if the oil revenues are indeed affecting positively, then the tax system is not capturing it. Facts in Angola show that higher oil price and oil production leads to higher foreign exchange reserves that allow the country to import more goods and services in detriment of local production, and as local goods and services are less demanded profits of the local producers drop, which also affect the taxes paid. So, it should be important for the government to ensure that oil revenues are channelled toward the real promotion and development of local production for the sake of local job generation and more collection of non-oil fiscal revenues, instead of being wasted on imports that do not in the long run benefit the economy as a whole.

The **formal exchange rate** coefficients in both the long-run and short-run ARDL model, and in the RU-MIDAS regression are negative and statistically significant, which make sense for the case of all importers of either intermediary or final goods and services, since a higher exchange rate increases the costs and reduces the profits (especially if they are not able to increase the prices accordingly) on which the taxes are based. These results highlight the importance of adopting macroeconomic policies that would keep the exchange rate relatively stable, in order to ensure a steady collection of the non-oil tax revenues in the country.

The **inflation rate** in the RU-MIDAS regression with the yearly regressors has a positive and significant coefficient, meaning that moderate inflation leads to higher non-oil fiscal revenues collection. This result is in harmony with that of Crivelli and Gupta (2014) and Tanzi (1988), who showed that in developing countries a relatively high inflation affects tax revenues collection positively, especially for countries that depend on indirect taxes such as the VAT and corporate (profit) income taxes. In this case, inflation works like a tax. In Angola, on average, indirect and corporate taxes represent more than 50% of total non-oil tax revenues (see Table 5), so it makes sense that a moderate inflation affects the non-oil tax revenues positively.

The **coefficient of the non-oil GDP** is negative and statistically significant in both the ARDL and the RU-MIDAS regressions (for yearly regressors), revealing a negative non-oil tax buoyancy. These results seem to be contrary to those reported in the literature that reveal a positive association between GDP and tax collection. In fact, the data on Angola's tax buoyancy (which measures the elasticity of total tax revenues to changes in total GDP) presented in the International Data and Economic Analysis (IDEA) computed in the USAID's Collecting Taxes Database (2024) also showed a negative tax buoyancy for Angola, with the average of -1.5 between 2011 and 2021, with the tax buoyancy of -3.96 in 2020 being the highest in absolute value in this period. These negative values reveal that tax revenues are not following the dynamic of the domestic economy, which corroborates with the data in Figure 7 that show that the non-oil tax revenue ratio to both total and non-oil GDP has been decreasing systematically.

Tax exemptions might explain the negative relationship between non-oil tax revenues and non-oil GDP for the case of Angola. The government granted tax exemptions to selected companies in the non-oil sector and other companies benefitted from tax reduction. Although those tax measures were aimed at increasing investment and the overall economic activity, it seems that they also had the negative side effect of loss of taxes. Fiscal exemptions and other tax benefits (reduction of tax rates) were granted on a discretionary basis and without control, especially before the reform in 2011 and even after the tax reforms, so much so that it was only in 2022 that the Tax Benefits Code was approved. Before that, the ministries and the President of the Republic determined the investments that should have tax exemptions or benefits, and the tax administration was not able to monitor and record all the exemptions and benefits granted. Although the Law states (Law 8/22 article 2 number 2) that tax benefits and exemptions are considered fiscal expenditures that must be presented in the General State Budget, the government never presented these figures publicly in either the budget or in any other official document. The widespread use of tax incentives and exemptions was recently also pointed out in a High-Level Summary Technical Assistance Report–Angola of the IMF stating that “regarding corporate income tax, the main issue encountered is the widespread use of tax incentives. These erode the tax base, because firms that qualify will pay much lower taxes, in some cases 90 percent less than what the standard tax system foresees. The presence of a contractual regime, under which taxes can be negotiated rather than being determined based on clear rules, creates further complications”[20].

The literature describes examples where sectoral GDP is negatively related with tax revenues. Addison and Levin (2007) and Crivelli and Gupta (2014) showed that in general but especially in developing countries, the agriculture GDP is negatively related to tax revenues. They explain several factors that contribute to this: a large part of the agricultural sector is small-scale with a limited number of taxpayers paying tax on income or profits; a substantial part of the agricultural output is consumed and not marketed; and marketed agricultural products, are to a large extent, exempted from taxation. For the case of Ghana, Kamasa et al. (2022) showed that the share of agricultural output in GDP, can reduce tax revenue in the short and long run, because it is difficult to tax most economic activities in the informal sector, especially those engaged in agricultural production. For Senegal, Ndiaye (2019) also found a negative and significant relationship between the agriculture share and tax revenue. In the case of Angola, taking into account that only a third of registered taxpayers effectively pay taxes and the level of tax exemptions and benefits granted in the non-oil sector and the level of the informal sector, these factors can explain the negative relationship between non-oil tax revenues and the non-oil GDP in Angola.

The **coefficient of the number of taxpayers** in both models[21] is also negative and significant. These results seem contrary to what is anticipated since it is expected that registering people and businesses in the tax system, i.e., increasing the tax base, would increase tax collection. Nevertheless, although registration is necessary, it is not sufficient; it is crucial that those being registered are also able to pay their respective taxes. So, it should be important for the tax administration to continue registering them and ensure that the ones with the activity pay taxes. It is true that the tax reform has been of help in this regard, For instance, in 2008 there were 185,393 registered taxpayers (164,811 persons and 20,512 companies) and as of 2021 the total number was 6,180,201 (5,949,050

[20] Klemm *et al*. (2024), Angola, Modernazation of the Income Taxation, High-Level Summary Technical Assistance Report–Angola, IMF, February 2024, page 3.

[21] We also added interaction variables in the regressions, for which the number of taxpayers was interacted with the dummy variables of tax reforms (ln taxpayers*reform11+ ln taxpayers*reform15+ ln taxpayers*reform19) but there were also no significant results in either the long run or short run.

persons and 231,151 companies). However, there is more to be done, especially for the registration of single taxpayers, taking into account that the total work force[22] is about 16 million people, and the total population is of 34 million[23].

Even for those who are registered, few effectively pay their respective taxes. For instance, considering the personal income tax (IRT), although the total number of registered individual taxpayers is 5.9 million, only workers in the formal sector (about 2.2 million) in principle actually pay this tax, i.e., only a third of registered taxpayers pay the personal income tax. For the case of the enterprises, although the total number of corporate taxpayers is over 230,000, the reality is that only 15,000 regularly pay taxes on profit and about 35,000 pay other taxes. So taking into account that the total number of taxpayers used in the regression is biased, that is, it does not represent the actual number of taxpayers who really pay taxes (registered taxpayers versus paying taxpayers), there is a measurement error in the regression that might also explain the unexpected negative coefficient sign of the taxpayers in relation to the non-oil tax revenues.

The **governance indicator index of control of corruption** has a negative and significant coefficient. The RU-MIDAS regression with yearly regressors shows that one unit increase in this indicator results in 103% reduction in the non-oil tax revenues collection, whereas in the ARDL the impact is of 108%. Corruption is a drag on tax collection in a country, particularly countries such as Angola. Since the index is of control of corruption, it was expected that greater corruption control would lead to higher tax collection, but the case of Angola shows that the control has not been effective enough to avoid loss of non-oil tax revenues. It is thus of paramount importance to genuinely fight against corruption with strong institutions.

The coefficient of the other governance indicator, the **government effectiveness index**, in the RU-MIDAS regression with yearly regressors obtained a positive and significant coefficient, showing that one unit increase in the government effectiveness index leads to 47% increase in the non-oil tax revenues. This result highlights the importance of government policies and public services effectiveness in general for a higher non-oil tax collection. For example, when it comes to property taxes, the tax administration is unable to collect more due to lack of registration of properties (buildings, houses, lands) and issuing of a title deed by the Ministry of Justice. If the property is not registered and the citizen does not have a title deed, the tax administration cannot enforce tax payment and the government loses revenues.

The **coefficients of the dummy variables that measure the impact of three main events related to the non-oil tax reform** (the onset of the reform in 2011, the creation of a single entity responsible for tax collection in 2015, and the introduction of VAT in 2019) are positive and statistically significant in both models.

The ARDL model showed a 46% impact of the onset of the reform in 2011, 140.5% impact of the 2015 reform that resulted in the establishment of general tax administration (AGT), and a 115.6% impact of the 2019 reform that introduced the VAT, on the increase of the non-oil taxes, compared

[22] See Figures A1 and A2 in the appendix for more information on employment and unemployment data in Angola.

[23] Of course the registration does not depend on only the tax administration but certainly much more on the Ministry of Justice, which has the responsibility of issuing the citizen identification number that the tax administration uses as the tax number for the individual taxpayers. So, coordination with the Ministry of Justice should be of paramount importance.

with the years before such reforms. These results also show that the introduction of VAT in 2019 yielded less tax revenues (25 percentage points less) collection in comparison to the 2015 reform that established the general tax administration. This shows that the type of reform also matters. The introduction of a new indirect tax resulted in less revenue in comparison to the creation of a single entity responsible for the collection of all taxes. This can signify that reforms aimed at improving the efficiency of the tax administration offices can generate greater tax revenues than the introduction of a new tax in the system or in the way that tax collections are enforced and monitored.

The RU-MIDAS regression (with monthly tax revenues and yearly regressors) showed much lower impacts, 3.5% for the onset of reform in 2011, 8.8% for the creation of AGT in 2015, and 0.4% for the introduction of VAT in 2019. These results demonstrate that the reforms were important for more non-oil tax collections and without them non-oil fiscal revenues would have been lower; but the type of reform also matters here too, since reforms aimed at the improvement of the efficiency of the tax administration (2015) generated greater revenue than that of introducing a new tax (2019).

1.7 Conclusion

Angola, an oil-rich country in Africa, saw the need to reform its non-oil tax system in order to expand the tax base and to reduce the dependence on oil fiscal revenues. In this chapter we used ARDL and RU-MIDAS regressions to assess the impact of the tax reform and the determinants of non-oil tax revenues in this country in the period from 2008 to 2021. Both regression models showed that the reforms had a positive and significant impact on the non-oil fiscal revenues collection. Both models revealed that the establishment of a single entity responsible for tax collection in 2015 yielded greater impact on the non-oil tax revenues collection than the introduction of a new indirect tax (VAT); this can indicate that for developing countries reforms that aim at better organization of tax administrations might result in greater revenues collection, rather than creating new taxes.

Variables such as the formal exchange rate, non-oil GDP, number of registered taxpayers, and the control of corruption index are negatively affecting the non-oil tax revenues mobilization in Angola, whereas inflation and government effectiveness index are influencing it positively. In the case of the non-oil GDP, since it is the tax base of the non-oil fiscal revenues, it was supposed to have a positive effect, but the negative impact found might be explained by the number of tax exemptions granted. The government granted tax exemptions to selected companies in the non-oil sector and other companies benefitted from tax reduction. Although those tax measures were aimed at increasing investment and the overall economic activity, it seems that they also had the negative side effect of loss of tax revenues. It is thus important for the government to perform cost benefit analyses before granting tax exemptions and also do an assessment of the benefits for the economy of all the tax exemptions and benefits granted to date. The negative impact of the exchange rate on the non-oil tax revenues highlights the importance of stabilizing the foreign exchange market and avoiding a highly volatile currency, in order to ensure higher non-oil fiscal revenues. The negative effect of the number of registered taxpayers showed that it is not enough to register more taxpayers. It must also be ensured that they also actually pay taxes. Hence, a better system of tax surveillance is needed.

In this study we also find that oil price and oil production are causing an eviction effect on the non-oil tax revenues in Angola, since the ARDL regression model presented negative coefficients of both oil price and oil production of 0.3% and 4.7%, respectively, for the case of short-run relationship and of 6.5% for the oil production in the long-run relationship. The RU-MIDAS regression also showed negative coefficients of the annual oil production of 0.6% and 1.8% for the quarterly oil production. These findings align with those of Crivelli and Gupta (2014), who found that for each additional percentage point of GDP in resource revenues, there is a drop in non-resource revenues of about 0.3 percentage points of GDP in resource-rich countries. Nevertheless, it does not need to be the case, since Botlhole *et al*. (2012) argued that additional resource revenues reduce tax revenues when institutions are poor in the countries, whereas in countries with well-functioning institutions more resources revenues contribute to more internal tax revenues mobilization. It is therefore important for the government of Angola to have strong institutions that would guarantee that oil revenues are channelled toward the real promotion and development of local production for the sake of local job generation and more collection of non-oil fiscal revenues.

In this chapter we were able to assess the impact of the tax reforms on the non-oil tax revenues collection in the country only as a whole. Taking into account that the reforms were implemented throughout the entire country in all 18 provinces, future research could study how the reforms affected the mobilization of fiscal revenues province by province. In view of the negative relationship between oil production and non-oil tax revenues, it is also crucial to understand the mechanisms through which this eviction effect occurs, and future research can shed more light on these mechanisms.

2. The impact of Taxes on Democracy indices– An empirical study for a panel of African Countries

Executive Summary: here in Chapter 2 we use different econometric methods for panel data (fixed effects, IV regressions, and fractional regressions) to study the impact of taxes measured as tax revenues to GDP ratio, on democracy indices (electoral, liberal, participatory, deliberative, and egalitarian) in 50 African countries in the period from 1980 to 2021. Using data on democracy from the Varieties of Democracy (V-Dem) project, the findings reveal that the relationship between the tax revenues to GDP ratio and democracy indices in Africa is concave (an inverted U shape), demonstrating that the impact of taxation is positive up to a certain threshold after which it starts to decrease. That taxation threshold was found to be, depending on the method and type of democracy index, close to 26%-27%, clearly higher compared with the average tax revenue to GDP ratio in the continent of 14%. Furthermore, among the control variables used, non-tax revenues showed to have a negative impact on democracy indices, the impact of the *per capita* GDP proved to be positive, and aid as percentage of GDP had a mildly positive impact on all democracy indices.

Keywords: Africa, Democracy Indices, Taxation, Fractional Regression, FE Estimator, IV Regression.
JEL codes: C33, H20, O23.

2.1 Motivation and Main Findings

Most developing countries around the world, especially in Africa, receive aid from Western developed countries, and are urged to improve their political regimes in order to become more democratic, with the conviction that democracy will lead to more economic development which in turn can raise the people's standard of living. There is empirical evidence showing that democracy affects economic growth positively (Heshmati and Kim, 2017). Acemoglu *et al.* (2019) found that a country shifting from non-democracy to democracy boosts GDP *per capita* by about 20% in the long-run. Western countries, in general, make development aid and other technical assistance given to developing countries in Africa conditional upon a set of prerequisites such as good governance, respect for human rights, and promotion of democracy. From an outsider's point of view, it seems that democracy in Africa, instead of being demanded by citizens, is imposed by the West; and according to Cilliers (2023), the demand for democracy and good governance by the Western countries has resulted in the early democratization of Africa, since many countries in Africa have higher levels of democracy *vis-à-vis* other countries in the world with similar low levels of education and income.

What can spark the desire amongst citizens to demand more democracy from their leaders? There is some empirical evidence that taxation leads to more democratization in developing countries in general (Barro, 1999; and Dom *et al*. 2023). Baskaran (2013) argues that evidence from pre-modern Europe and North America suggests that once leaders start to impose a fiscal burden on their citizens, they are forced to become more democratic by yielding to their citizens' voices. So, taxation can help a country's population to participate in the public discourse and hold their leaders to account.

Due to abundant fiscal revenues and royalties from their natural resources some developing countries neglect to tax other non-resources economic sectors and their citizens in general for the sake of power concentration and to avoid accountability (Kolstad and Wiig, 2018). In a theoretical paper Moore (2007) argued that the overall level of taxes does help to mobilize citizens politically by demanding better governance, and the degree of dependence of states on unearned income (non-tax income from oil and other mineral resources) is likely to have negative effects on the quality of governance. Di John (2009), in another theoretical paper, focused on Sub-Saharan Africa and argued that in that region taxation is not just a source of revenue, but also a possible means of improving accountability, legitimacy, and representation of the state.

We investigate if and how taxation is affecting democracy indices in Africa. We are not aware of any empirical studies that focus on the relationship between taxation and democracy indices in Africa. Studying this possible causal relationship is relevant for Africa, taking into account that the democratic process is not yet stable, and many countries in Africa have been receiving aid from the West in an attempt to improve democracy (Cilliers, 2023). If taxation levels do affect democracy indices in the continent, the aid could be channelled toward the improvement of the tax system within the countries, since an endogenous variable such as taxation can better contribute to improve democracy in comparison to an exogenous variable such as foreign aid.

Our purpose is to assess if the level of taxation imposed on population increases the awareness of citizen participation in the public debate, or if it leads to more democracy as measured by democracy indices. We study a panel of 50 African countries using yearly data from 1980 to 2021 to see how the level of taxation is affecting democratization processes within the continent. Dom (2018) studies the relationship between taxation and accountability in sub-Saharan Africa and found that tax revenue is positively linked to accountability indicators, but the author did not specifically study the relationship between taxation and democracy indicators. So, in this paper we will use democracy indicators computed by the Varieties of Democracy (V-Dem) Project to study how taxation is affecting the democratization processes in Africa. Most studies on taxation and democracy have used either electoral rights and civil liberties or the Polity IV democracy index as measures of democracy (Barro, 1999; Baskaran, 2013). In our paper we use the democracy indices from V-Dem Project because the project produces the most extensive dataset on democracy for 202 countries from 1789 to 2022, involving thousands of scholars and other country experts, measuring hundreds of different features of democracy (Papada *et al*., 2023).

We used two econometric model approaches: the standard OLS, FE, and IV Regressions, which are the most used in the literature, and the Fractional Regression approach – to gauge the relationship between taxation and democracy. The standard regressions have some limitations, because the dependent variable democracy indices are fractional, bounded in the unit interval ranging between zero (0) and one (1). Therefore, the fractional regression is the most suitable econometric regression to deal with this type of dependent variable. We are not aware of any paper on taxation and democracy literature using the fractional regression approach to study the relationship between the level of taxation and democracy indices. We therefore contribute to the literature by using the most appropriate econometric method taking into account the type of dependent variable.

The findings reveal that taxation impacts positively all democracy indices in Africa up to a certain taxation threshold, after which a further increase causes a decrease in the democracy indices. The regressions show that the nonlinear relationship between tax revenue to GDP ratio and democracy indices in Africa is of a concave type. The results are robust in both standard and fractional regression models, showing an approximate level of taxation that maximizes democracy indices between 26%-27% of GDP. Furthermore, among the control variables used, non-tax revenues revealed a negative impact on democracy indices, the impact of the *per capita* GDP proved to be positive, and the aid also had a mildly positive impact on all democracy indices.

The rest of Chapter 2 is organized as follows: in Section 2.2 we present a brief review of the literature. Section 2.3 analyses the evolution of democracy and political regimes in Africa. Section 2.4 presents the data and describes the methodologies. Section 2.5 presents the estimation results. Section 2.6 discusses the main results and some policy implications, and in Section2.7 the main conclusions are presented.

2.2 Literature Review of Political Regimes and the Determinants of Democracy Indices

In his book, *Politics*, the ancient Greek philosopher Aristotle (350 B.C.) wrote extensively about the main forms of political systems that existed in his time: monarchy, aristocracy, oligarchy, and democracy, and explicitly distinguished each form of government, the number of rulers/leaders in each political system and the way they are selected, and compared each form of government side by side. Actually, the social contract theory plainly developed by Thomas Hobbes (1651) and systematized by Jean-Jacques Rousseau (1762) is the theoretical basis of most of modern political systems, whether monarchy, authoritarianism, totalitarianism, or democracy; since in the social contract theory the individuals agree tacitly or explicitly to forgo some of their rights and freedoms and submit themselves to the authority for the sake of maintaining the social and political order and avoiding anarchy and chaos (Friend, 2004; Castiglione, 2015).

In democracy the adult population elects the government and the members of parliament that rule the country for a specific period of time, in which elections are held periodically. The literature, both theoretical and empirical, presents the main factors that influence democracy around the world.

In a seminal paper on democracy, using historical and comparative methods and correlation analysis covering 47 countries with data from mid-1950s, Lipset (1959) revealed that an increased level of education and an enlarged middle class stimulate democracy, taking into account that more educated people and those with higher income are in general more demanding and better informed when it comes to the voting process, forcing the authorities to govern in such way it that benefits society as a whole. According to Barro (1999), Lipset actually traced the idea that prosperity and education promote democracy back to Aristotle, arguing that only in an affluent society in which relatively few citizens lived in real poverty could the circumstances exist in which the population could judiciously participate in politics and develop the self-restraint needed to avoid yielding to the will of demagogues. Lipset (1959) also pointed out that urbanization and industrialization are associated with higher levels of political participation and democratic values in a society, but stressed that political legitimacy (which depends on social cohesion, institutional effectiveness, and ideological consensus) is the fundamental thing for the stability of democracy.

Using comparative historical research approach in studying the impact of economic development on democracy in Europe, South, and Central Americas, Huber *et al.* (1993) argued that for the case of the developing countries the class and social structure changes caused by industrialization and urbanization are most important for democracy. Their analysis of the agrarian class relations led them to conclude that democratization is most likely to occur in developing countries without a substantial group of large landholders and with a noteworthy agrarian middle class.

Empirical research by Barro (1999) on the determinants of democracy, in a panel of 113 countries from different continents, covering a period between 1960 and 1995, using Weighted Least Squares (WLS) methods and Seemingly Unrelated Regression (SUR), revealed that that improvements in per capita GDP, in education (as measured by years of primary schooling), and a smaller gap between male and female primary schooling increase the propensity for democracy (measured by the electoral rights indicator). The author also found that for a given level of GDP per capita, democracy tends to fall with urbanization and with greater reliance on natural resources revenues. Barro (1999) still argued that democracies that start without prior economic development (perhaps due to imposition by former colonial powers or other international organizations) tend not to last.

Using a comparative historical approach and some empirical data analysis of some countries in Africa[24], Asia[25] and Latin America[26], Braütigam *et al.* (2008) found evidence of a positive relationship between taxation and State-building in Developing Countries, arguing that it does matter that governments tax their citizens rather than living from natural resources tax revenues or other sources, since taxing people can stimulate demand for representation. They found historical evidence that taxation has the potential to shape relations between state and society in significant and distinctive ways.

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[24] Ethiopia, Ghana, Kenya, Nigeria, Madagascar, Mauritius, Rwanda, South Africa, Tanzania, and Uganda.
[25] China and India.
[26] Argentina, Brazil, and Colombia.

In an empirical study, using Ordinary Least Square (OLS) and Two Stage Least Squares (2SLS), with a panel of 122 countries around the world, covering the period between 1981 and 2008, Baskaran (2013) found that general government tax revenues (as percentage of GDP) had a mild positive impact on democracy indicator (measured by POLITY IV democracy index). The author also argued that since the magnitude of fiscal burden affects democracy positively, development agencies and donors should perceive taxation as a channel that they can use to foster democratization in developing countries.

The literature also documents research that investigates not only the impact of taxation on democracy, but how democracy can influence taxation among countries as well. Anderson (2017) took this approach, studying 31 countries in Western Europe, the Americas, Australia, New Zealand, and Japan, with data covering the period 1810-2011, using a dynamic error correction model (ECM). The author found that democracy increases income taxes and decreases excise and consumption taxes in more urbanized states, whereas in rural countries it reduces property taxes.

Kolstad and Wiig (2018) used a cross-sectional dataset of 143 countries, applying OLS and Two Stages Instrumental Variables (2SIV) techniques to study the relationship between economic diversification and democracy particularly in developing countries. They argued that economic diversification (as measured by the export concentration index) can lead to more democratization (measured by the Polity Democracy Index), by reducing the power of elites who benefit from resource concentration, and that less-concentrated economic power in a society leads to a more widely distributed political power, hence fostering democracy. Consequently, they concluded that economic diversification has a positive effect on the levels of democracy, and since the ruling elites in some natural resource rich developing countries are aware that diversification can undermine their power, measures aimed at increasing economic diversification in these countries are likely to be resisted or captured by them.

Dom *et al.* (2023) studied the impact of taxation on accountability in a panel of 47 Sub-Saharan African countries, using data from 1980 to 2019, applying 2SLS IV estimators, and found a robust positive correlation between taxation and accountability, providing support for a causal interpretation that the level of taxation increased accountability in the region. The effect of taxation was only observed for vertical accountability, which captures the quality of elections and party competition, and not for other measures of accountability that capture the role of civil society or the judiciary, consistent with the emergence of a tax bargain. However, they did not specifically analyse how taxation is affecting democracy indicators in African countries, as we do in this paper.

After briefly reviewing the literature, in Table 13 we summarize the main empirical studies that focused on determinants of democracy indices around the world, and particularly in developing countries, using econometric methods.

Table 13 - Main Variables used to Explain Democracy Indicators in the Empirical Studies

Dependent variable	Main Explanatory Variables	Impact	Period studied	Number of Countries	Regression Method	Authors
Electoral rights Civil liberties	GDP *per capita* Years of Primary Schooling Gap between male and female education Urbanization rate Population Dummy for oil rich countries	+ + - - + -	1960-1995	113 (38 Africa, 22 Asia, 23 Europe, 20 Latin America, 7 Middle East and North Africa and 3 Oceania)	Seemingly unrelated regression (SUR) Weighted least squares (WLS) Ordinary least squares (OLS)	Barro (1999)
POLITY IV democracy index	General government revenues to GDP GDP *per capita* Agriculture share of GDP Manufacturing share of GDP Development aid, % of GDP	+ + - + -	1981-2008	122(48 Africa, 21 Asia, 17 Europe, 19 Latin America, 8 Middle East, 2 North America, and 9 Oceania)	Ordinary least squares (OLS) Two stage least squares (2SLS) Limited information maximum likelihood (LIML)	Baskaran (2013)
POLITY IV democracy index	Export products diversification GDP *per capita* Population Land area cultivated	+ + +/- +/-	2011	143 (Africa 42, Latin America 17, Asia 30, Europe 34, North America 5, Oceania 14)	OLS Two Stages Instrumental Variables (2SIV)	Kolstad and Wiig (2018)
Accountability Index	Total tax revenue % GDP GDP *per capita* GDP Growth Development aid, % of GDP Years of education among citizens older than 15 Trade Urban population, %	+ +/- + + - + +	1980-2015	47 Sub-Saharan Africa	FE lagged dependent variable (FE-LDV) model Instrumental Variable (IV estimator) two-stage least squares (2SLS)	Dom *et al.* (2023)

There is a gap in the empirical literature that focuses on the relationship between the levels of taxation and the levels of democracy, or the effect of the fiscal burden borne by citizens on democracy in African countries. The existing studies include panels of countries from different continents, but herein we focus only on Africa countries. Cilliers (2023) argues that the demand for democracy and good governance by Western countries has resulted in the early democratization of Africa and the bipolar Cold War between the West and the Soviet Bloc constrained the continent's freedom of action, in the sense that during the post-colonial era, African countries were held hostage to a bipolar World order that rewarded loyalty rather than democracy, despite the West's concerns for elections, human rights, and accountability in the continent. Consequently, it is important to investigate what effect internal factors such as taxing local population and businesses, taking into account the social contract theory, is having on the democratization process in Africa measured by democracy indices.

This chapter also uses a new dataset on democracy indicators, computed by the Varieties of Democracy (V-Dem) Project from the V-Dem Institute of Department of Political Science at the University of Gothenburg. According to Papada *et al.* (2023) the project produces the most extensive dataset on democracy for 202 countries starting from 1789 and going until 2022, involving thousands of scholars and other country experts, measuring hundreds of different features of democracy. We are not aware of any studies that have used this new dataset to assess the impact of taxation on democracy. As for the estimation method, besides the standard econometric approach, we also use the fractional regression method, which is suitable to our fractional dependent variable, the democracy index. Our work is the very first to use this regression method.

We used the democracy indices from the Varieties of Democracy (V-Dem) Project, which represent the five principles of democracy, to analyse the democratization process in Africa, how it has been evolving, the main drivers of this process, to and check the impact of the efforts of domestic fiscal revenues mobilization (taxation) on the levels of democracy indices in Africa. In the literature two main democracy indicators are used, namely the electoral rights (civil liberties) and the polity IV democracy index. The electoral rights and polity IV are related in a sense that polity IV is a democracy measure that assigns scores to countries based on their level of political rights and civil liberties, ranging from -10 strongly autocratic to +10 strongly democratic[27]. The Varieties of Democracy (V-Dem) indices produce the most extensive dataset on democracy for 202 countries, measuring different features of democracy[28] (Papada *et al.*, 2023), ranging from zero to 1; closer to zero being very low democracy and closer to 1 very high index of democracy.

2.3 Analysis of the Evolution of Political Regimes in Africa

Countries around the world adopt political regimes that best suit the interest of the ruling elites and the ideology of the political parties. It is not easy to categorize political regimes, but in principle there are two main opposing political regimes today: autocracy and democracy; and between them subcategories exist. Lührmann *et al.* (2018) classify four main types of political regimes – closed and electoral autocracies, and electoral and liberal democracies, based on the political science literature on political regime typologies, and on Dahl's (1998) theory of what distinguishes a democracy from autocracy, based on six institutional guarantees[29] - as presented in Table 14.

Table 14 - Political Regimes Classification

Closed Autocracy	Electoral Autocracy	Electoral Democracy	Liberal Democracy
No *de-facto* multiparty, or free and fair elections, or Dahl's institutional prerequisites not minimally fulfilled		*De-facto multiparty, free and fair elections, and* Dahl's institutional prerequisites minimally fulfilled	
No multiparty elections for the chief executive or the legislature	*De-jure* multiparty elections for the chief executive and the legislature	The rule of law, or liberal principles not satisfied	The rule of law, and liberal principles satisfied

Source: Lührmann *et al.* 2018.

[27] PolityProject (systemicpeace.org)

[28] See Table 16 for more information on the main type of democracy indices computed by the V-Dem project.

[29] Namely: (1) elected officials, (2) free and fair elections, (3) freedom of expression, (4) alternative sources of information, (5) associational autonomy, and (6) inclusive citizenship. (Dahl, 1998).

Taking into account the values of the electoral democracy index and those of the liberal democracy indices[30], V-Dem project classifies[31]:

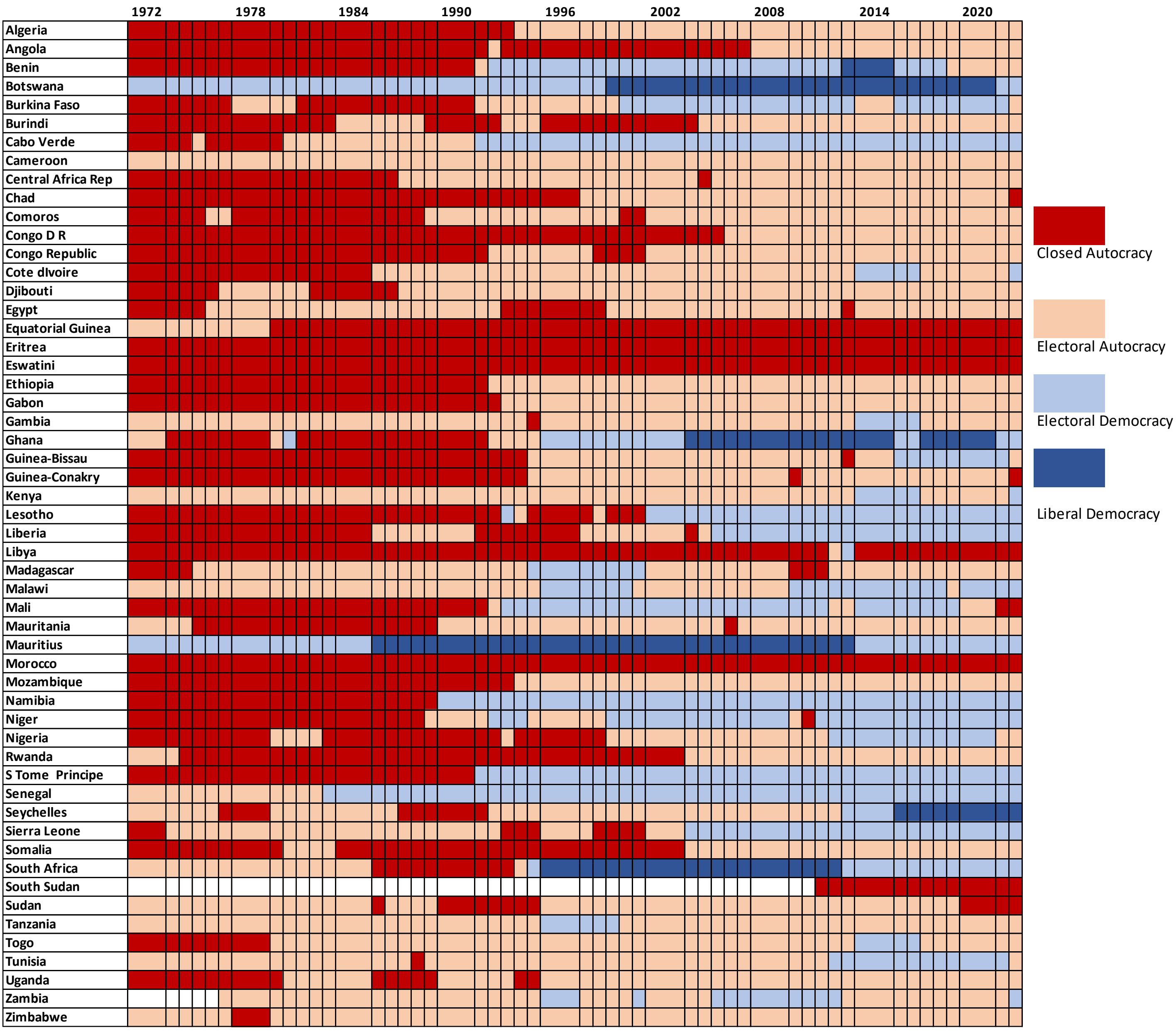
1. Closed autocracy, countries with indices between [0 and 0.25[;
2. Electoral autocracy, countries with indices between [0.25 and 0.5[;
3. Electoral democracy, countries with average indices values between [0.5 and 0.75[, and;
4. Liberal democracy, countries with indices ranging between [0.75 to 1].

Our analysis of the political regimes in Africa is based on the above classification and using the data V-Dem project on world political regimes. Accordingly, as it can be seen in Table 15, the majority of the African countries were classified between 1972 and 1990 as having a closed autocracy political regime, characterized by the non-existence of multiparty system, free and fair elections, or freedom of expression and association. Although during this period most of the countries had already gained independence, the Cold War between the West and the Soviet Union hindered somehow the democratization process. In the same period some countries were classified as electoral autocracies (Cameron, Gambia, Kenya, Malawi, Senegal, Tanzania, Tunisia, Zambia, and Zimbabwe), with multiparty elections, but without any electoral accountability or free and fair elections, due to strong limitations on political party competition and no respect for the rule of law. Only three countries (Botswana, Mauritius, and Senegal) were considered to be electoral democracies, with a functioning multiparty system, with free and fair elections, but with no satisfactory checks and balances, and due respect to the rule of law.

A closer look at Table 15 shows that after the year 1990, in general the process of democratization started to take place, since most closed autocratic countries started holding elections, becoming electoral autocracies; and some electoral autocracies became electoral democracies, and at least six countries (Benin, Botswana, Ghana, Mauritius, Seychelles, and South Africa) were classified at some point in time as liberal democracies with satisfactory rule of law and liberal principles. In the entire period between 1972 and 2022, only three countries (Eritrea, Eswatini, and Morocco, with the last two being absolute monarchies) did not experience any political regime change.

[30] See point 2.4.1.1 for more details and information on the indices.
[31] Interactive Maps – V-Dem

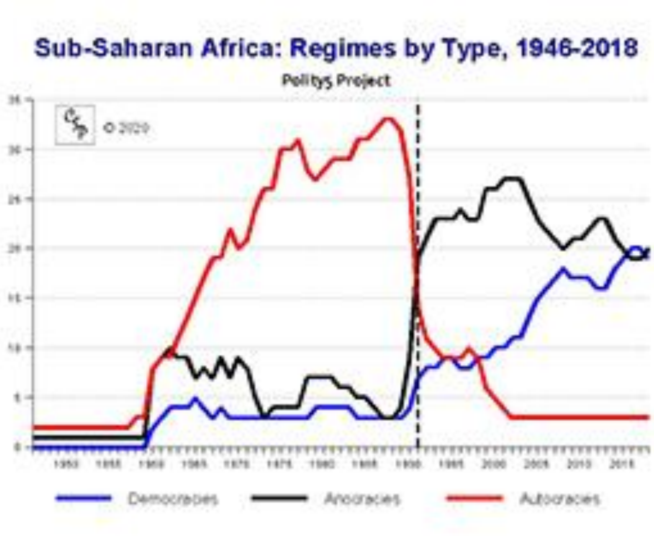
Table 15 - Evolution of Political Regimes in Africa by Country, 1972-2022



Source: Democracy Report 2023.

Other institutions that track the development of democracy also confirm the trend of democratization that the data from V-Dem on world political regimes shows regarding the African continent. For instance, the Center for Systemic Peace uses a threefold regime classification: autocracy, democracy, and anocracy (an hybrid regime, with some features of democracy, such as regular elections that coexist with autocratic behaviour and institituions like the limited oversight of the legislative power). The data presented in Figure 17 also indicate that the number of countries with autocratic regimes (red line) has been falling, and the number of countries with hybrid regimes or anocracies (black line), along with the number of countries classified as democracies in the continent (blue line), have been growing since the fall of the Berlin Wall, which marked the symbolic end of the major influence of the Soviet Bloc around the World.

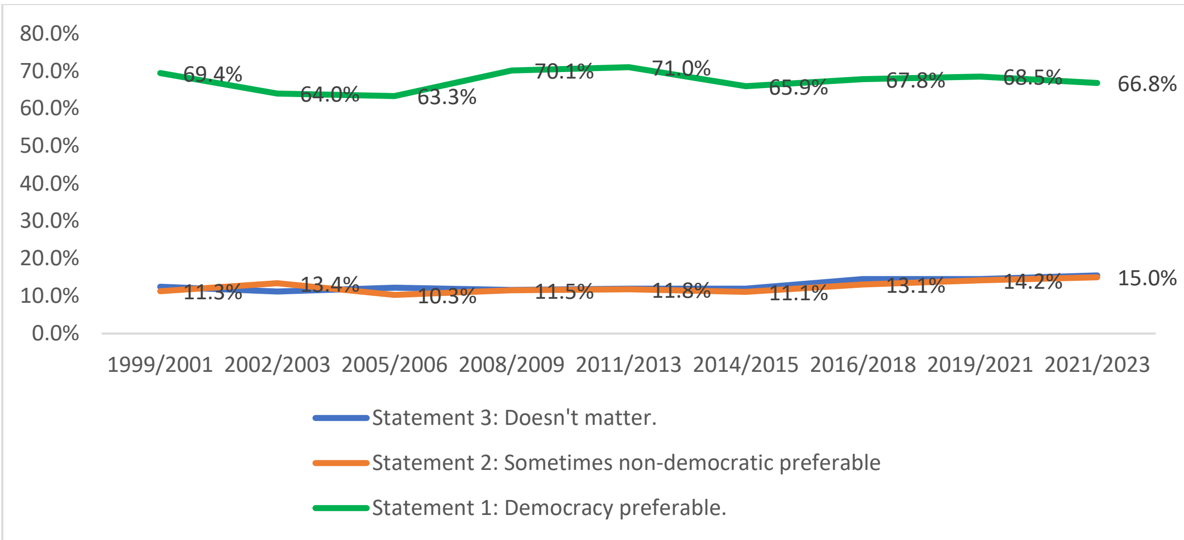
Figure 17 - Political Regimes by Type in Sub-Saharan Africa



Source: https://www.systemicpeace.org/p5creports.html

Regarding the general opinion of the population in Africa on the type of government they prefer, data based on a survey from the Afrobarometer[32], reveal that over the years more than 65% of people prefer democracy as a better form of government , as can be seen in Figure 18.

Figure 18 - People's Opinion on Preferred Type of Government in Africa



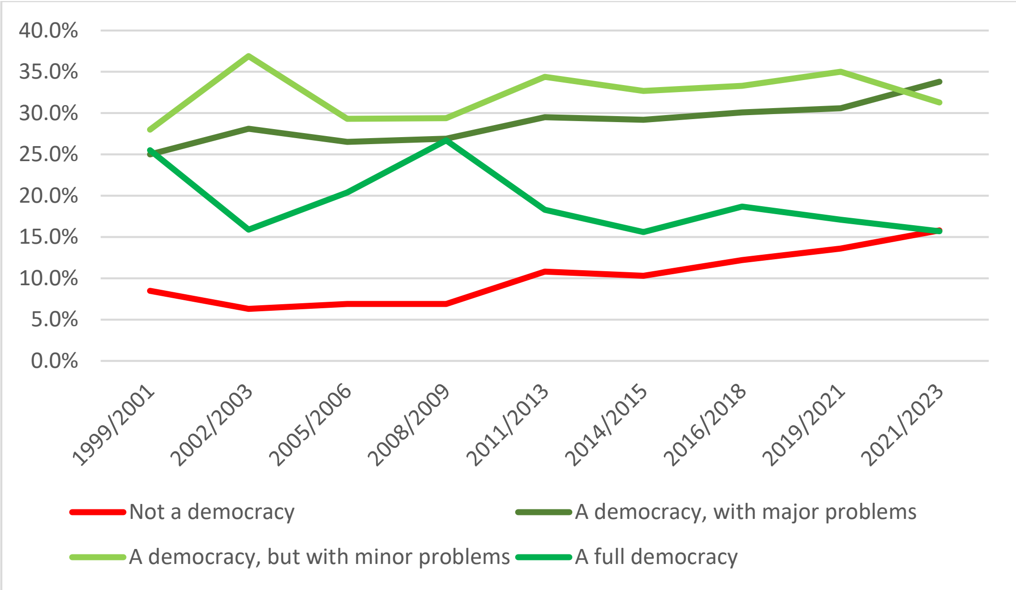
Source: Afrobarometer.

In more than 20 years of this survey, the percentage of people who select democracy as a preferable type of political regime in their respective countries in Africa has been steadily above 63%, showing that the majority of the population want a more democratic government. Looking at Figure 18 it can also be seen that the percentage of people who are indifferent to the type of political regime

[32] https://www.afrobarometer.org/

and those who sometimes prefer non-democratic regimes is almost the same, being on average 12.4% between 1999 and 2023.

Figure 19 - People's Opinion on the Type of Democracy in Africa

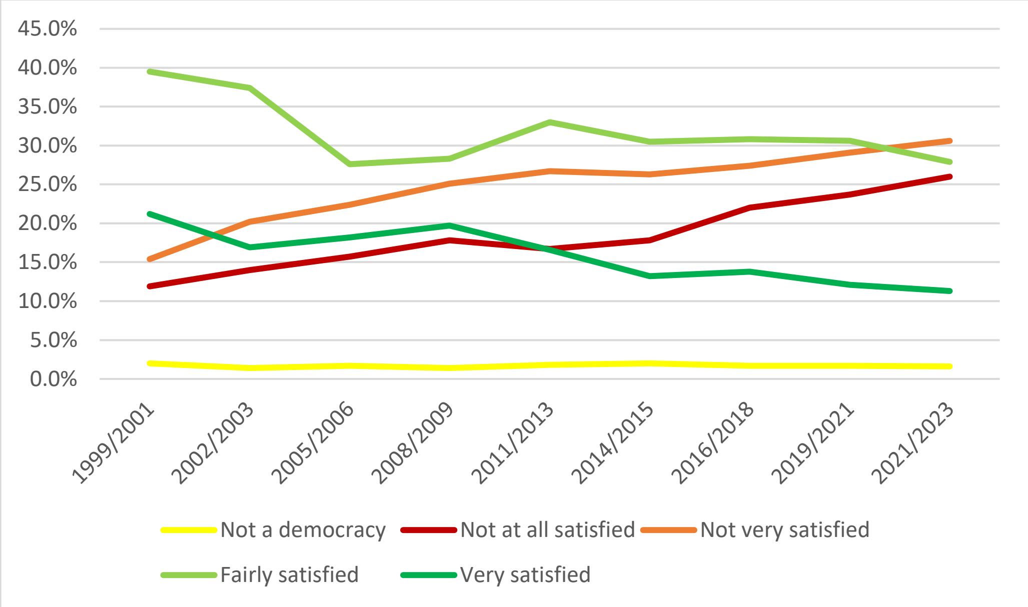


Source: Afrobarometer.

Regarding the kind of democracy people have in their countries, the Afrobarometer's survey data in Figure 19 reveal that most people acknowledge that they have a democratic regime with either minor or major problems. The percentage of those who view their countries as a full democracy has fallen from 25% in 1999 to 15% in 2023, whereas the percentage of those who recognize their countries as not a democracy has been increasing from less than 10% in the early 2000s to 15% in 2023, but it is still much lower in comparison to those who view their countries as democratic.

The people's opinion on the level of satisfaction with the democracy that they have in their countries is presented in Figure 20. Both the percentage of people who are fairly satisfied and those who are very satisfied (green lines) have been falling, from 40% and 20% in 1999 to 28% and 11% in 2023, respectively. In the same period, the percentage of those who are not very satisfied and that of those who are not at all satisfied with the type of democracy have been increasing from 15% and 12% to 30% and 28%, respectively. This trend might signal the growing demand for democracy in Africa, i.e., people longing for more democratic governments, which are able to take into account their needs and preferences.

Figure 20 - People's Opinion on Their Satisfaction with the Democracy in Africa



Source: Afrobarometer.

In summary, the data on the evolution of political regimes in Africa, from both the Varieties of Democracy Project and the Center for Systemic Peace, clearly show that the process of democratization has been taking place, since the number of countries classified as autocracies is dropping, and the number of the countries categorized as democracies are in general increasing over time. Moreover, the Afrobarometer survey data on democracy reveal that most Africans prefer democracy as a political regime and want more democratic governments.

2.4 Data and Methodology

In this section we present the variables and data sources used to assess the impact of the level of taxation on democracy indicators in Africa, and the econometric methodology that we apply.

2.4.1 Data and Variables

Three main data sources are used: the Varieties of Democracy (V-Dem) Project dataset, for the democracy indicators used as dependent variables; The United Nations University World Institute for Development Economics Research (UNU-WIDER) Government Revenue dataset[33], for the main independent variable of interest level of taxation (tax revenues as percentage of GDP); and the World Development Indicators dataset[34] from the World Bank for the control variable nominal GDP *per capita* and the instrument variable trade as a % of GDP. Table 16 summarizes the variables and the data sources.

[33] UNU WIDER : GRD – Government Revenue Dataset
[34] World Development Indicators | DataBank (worldbank.org)

Table 16 - Variables Description and Data Sources (of Study on the Impact of Taxation on Democracy in Africa)

Variables	Brief definition	Period	Sources
Electoral Democracy index	It measures the core value of making leaders responsive to citizens, through electoral competition for the electorate's approval under circumstances when suffrage is extensive. It ranges from Zero (0) to One (1), closer to zero being low and closer to one high index. Dependent variable (Y)	1980-2021	V-Dem Dataset
Liberal Democracy index	It measures the protection of individual and minority rights against the tyranny of the state and the tyranny of the majority, achieved by strong rule of law and independent judiciary. It ranges from Zero (0) to One (1), closer to zero being low and closer to one high index. Dependent variable (Y)	1980-2021	V-Dem Dataset
Participatory Democracy index	It measures the active participation by citizens in all political processes, electoral and non-electoral. It also ranges from Zero (0) to One (1), closer to zero being low and closer to one high index. Dependent variable (Y)	1980-2021	V-Dem Dataset
Deliberative Democracy index	It measures the process in which public policies are focused on the common good as contrasted with emotional appeals, solidary attachments, parochial interest, or coercion. It ranges from Zero (0) to One (1), closer to zero being low and closer to one high index. Dependent variable (Y)	1980-2021	V-Dem Dataset
Egalitarian Democracy index	It measures the extent to which the rights and freedoms of individuals are protected equally across all social groups, the resources are equally distributed, and all have equal access to power. It ranges from Zero (0) to One (1), closer to zero being low and closer to one high index. Dependent variable (Y)	1980-2021	V-Dem Dataset
Tax revenues % GDP	Total tax revenues as % of GDP. Called taxation throughout our work. Independent variable (X)	1980-2021	UNU-WIDER Government Revenue Dataset
Non-tax revenues % GDP	Mainly royalties from natural resources as % of GDP, known as political resource curse. Independent variable (X)	1980-2021	UNU-WIDER Government Revenue Dataset
Aid % GDP	Grants or development aid received as % of GDP. Independent variable (X)	1980-2021	UNU-WIDER Government Revenue Dataset
GDP *per capita* (nominal)	GDP per capita is gross domestic product divided by midyear population. In US $. Control variable (X)	1980-2021	World Development Indicators - World Bank
Trade (Exp+Imprts) % GDP	Sum of exports and imports of goods and services, as a share of gross domestic product. Instrument variable (Z)	1980-2021	World Development Indicators - World Bank
Revenue Authority (RA)	Dummy = 1 in a country[35]-year pair if Revenue authority has been established and afterwards, and 0 (zero) otherwise. Instrument variable (Z	1980-2021	Fjeldstad and Moore (2009); Dom (2017)

2.4.1.1 Dependent Variables

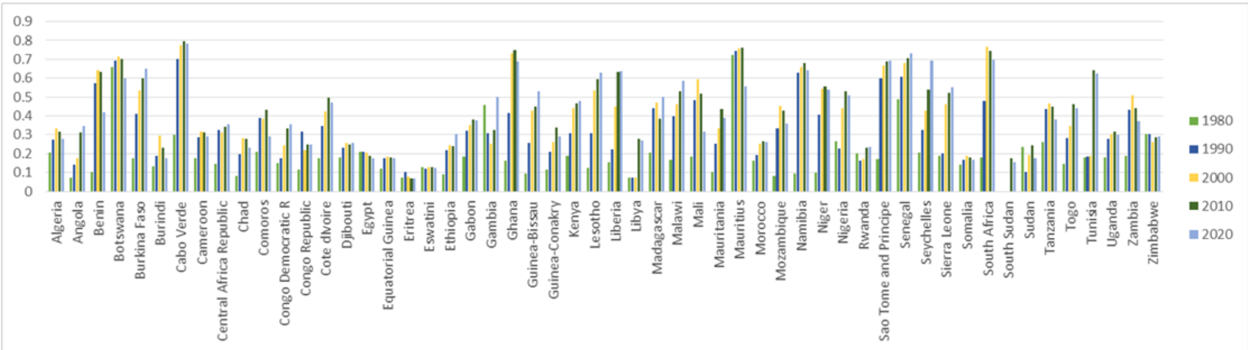
We use as dependent variables five democracy indices that characterize democracy as computed by the V-Dem Project. On the project's website[36] it is explained that the multidimensional and disaggregated dataset that they produce gauges the complexity of the concept of democracy as a ruling system goes beyond the mere holding of elections, but distinguishes between five high-level principles of democracy namely: electoral, liberal, participatory, deliberative, and egalitarian, and collects data to compute democracy indices that quantify these principles. Therefore, the five democracy indices that characterize democracy at the highest level, following the above-mentioned principles,

[35] See Table B1 in the Appendix for the 25 Countries with a Revenue Authority in Africa, and the respective years of establishment.
[36] V-Dem Project – V-Dem

are: Electoral Democracy Index, Liberal Democracy Index, Participatory Democracy Index, Deliberative Democracy Index, and Egalitarian Democracy Index. As for the regressions, more emphasis is given to the Electoral Democracy Index, due to the fact that it is the most noticeable manifestation of democracy, as explained below. Each democracy index is explained in the Codebook of the project by Coppedge et al. (2023) as:

Electoral Democracy Index quantifies the electoral principle of democracy that tries to embody the fundamental value of making the leaders responsive to citizens, which is achieved through the elections when the suffrage is extensive; political and civil society organizations can operate freely; elections are clean, and not marred by fraud or systematic irregularities; and elections affect the composition of the chief executive of the country. In between elections there is freedom of expression and an independent media, capable of presenting alternative views on matters of political relevance. The index ranges from zero (0) to one (1), where closer to zero means lower electoral democracy, and closer to one high.

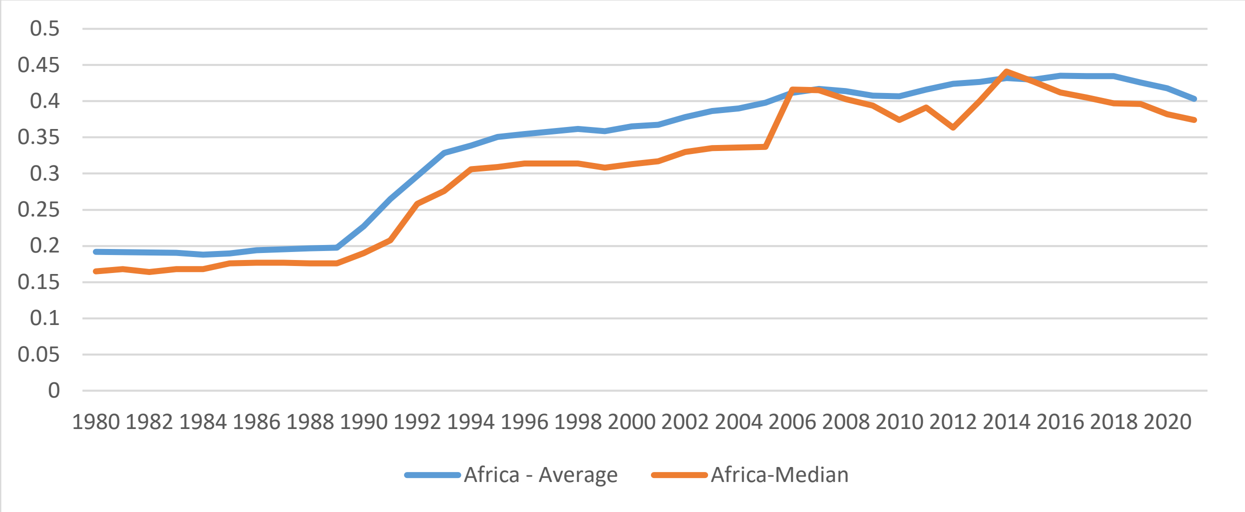
Figure 21 - Electoral Democracy Index in African Countries, 1980-2020



Source: V-Dem Project Dataset

The data in Figure 21 show for each country the evolution of the average electoral index in a decade; and it can be seen that countries such as Cape Verde, Mauritius, Ghana, Botswana, South Africa, Senegal, Namibia, and Malawi have the highest electoral democracy in Africa, with values between 0.7 and 0.8, being classified as liberal democracies; whereas Eritrea, Eswatini, Libya, Somalia, Sudan, Egypt, Morocco, Chad, and Angola have the lowest electoral democracy index scores, with values below 0.3, classified as electoral autocracies.

Figure 22 - Average and Median Electoral Democracy Index in Africa

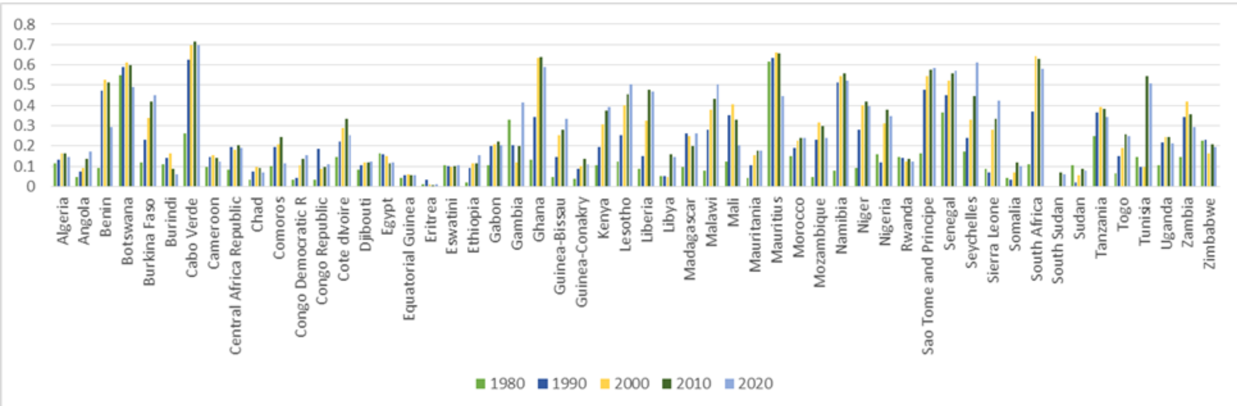


Source: Computed by the author[37] based on the V-Dem Project Dataset.

Looking at the yearly average and median electoral democracy index of the continent as a whole in Figure 22, it is clear that, especially since 1990, right after the fall of the Berlin Wall, there has been a steady increase of this index, from an average of 0.23 in the 1990s, to an average of 0.42 in 2021.

Liberal Democracy Index measures the liberal principle of democracy that emphasizes the importance of protecting individual and minority rights against the tyranny of the state and the tyranny of the majority, judging the quality of democracy by the limits placed on governments. This is achieved by constitutionally protected civil liberties, strong rule of law, an independent judiciary system, and effective checks and balances that, together, limit the exercise of executive power. The index interval is also from low to high (0-1).

Figure 23 - Liberal Democracy Index in African Countries, 1980-2020



Source: V-Dem Project Dataset.

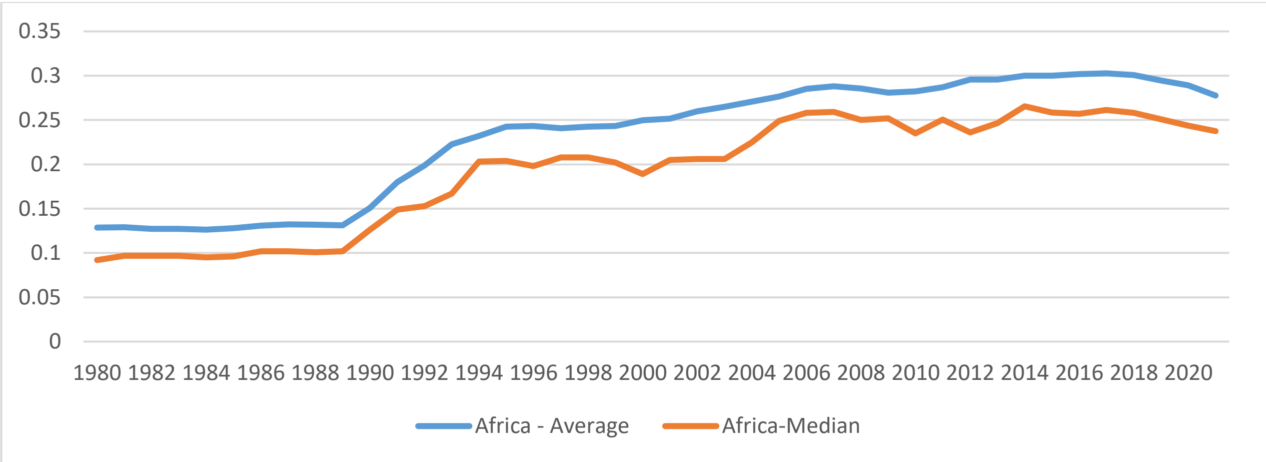
The data presented in Figure 23 show that Cape Verde, Ghana, Mauritius, Botswana, South Africa, Senegal, Seychelles, Namibia, Lesotho, and São Tomé had the highest average score of liberal democracy index in Africa in the decades of 2000, 2010, and 2020, with values between 0.5 and 0.7,

[37] The average indices for the continent were computed by summing the countries' indices and dividing by the total number of countries.

being classified as electoral democracies. The countries with the lowest scores are Eritrea, Chad, Congo, Djibouti, Sudan, Libya, Equatorial Guinea, Guinea Conakry, and Angola, with values between 0.03 and 0.4, classified as electoral autocracies.

The evolution of the yearly average and the median liberal democracy index in the continent as a whole are in Figure 24, which shows that the average increased from 0.13 in 1980 to 0.28 in 2021, values below 0.3.

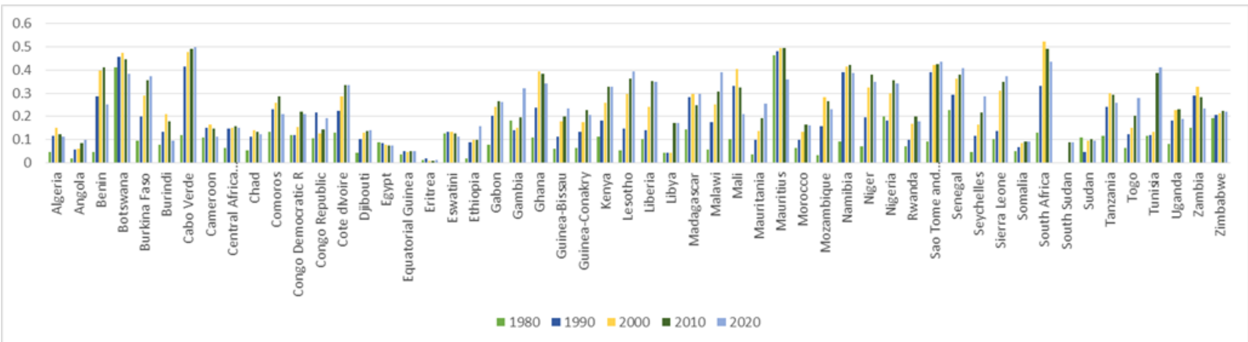
Figure 24 - Yearly Average and median Liberal Democracy Index in Africa



Source: Computed by the author based on the V-Dem Project Dataset.

Participatory Democracy Index computes the participatory principle of democracy that highlights active participation by citizens in all political processes, electoral and non-electoral. It is motivated by unease about a core practice of electoral democracy: delegating authority to representatives. Thus, a direct rule by citizens is preferred wherever practicable. This model of democracy thus takes suffrage for granted, emphasizing engagement in civil society organizations, direct democracy, and subnational elected bodies. This index interval is from low to high (0-1) as well.

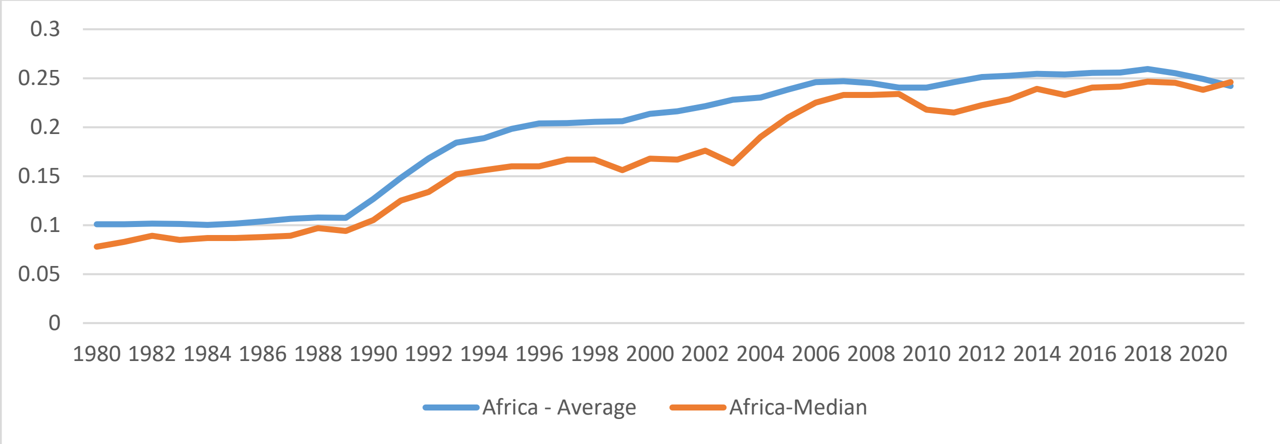
Figure 25 - Participatory Democracy Index in African Countries, 1980-2020



Source: V-Dem Project Dataset

As showed in Figure 25, the countries with the highest average (per decade) participatory democracy indicators in the continent are Cape Verde, Mauritius, South Africa, São Tomé, Ghana, Benin, Burkina Faso, Lesotho, Liberia, and Namibia, with values between 0.3 and 0.5; the countries with the lowest indicators are Eritrea, Equatorial Guinea, Angola, Sudan, and Djibouti. Figure 26 presents the time series pattern of the continent's average and median participatory democracy index, growing from 0.10 in 1980 to 0.24 in 2021, but also below 0.3.

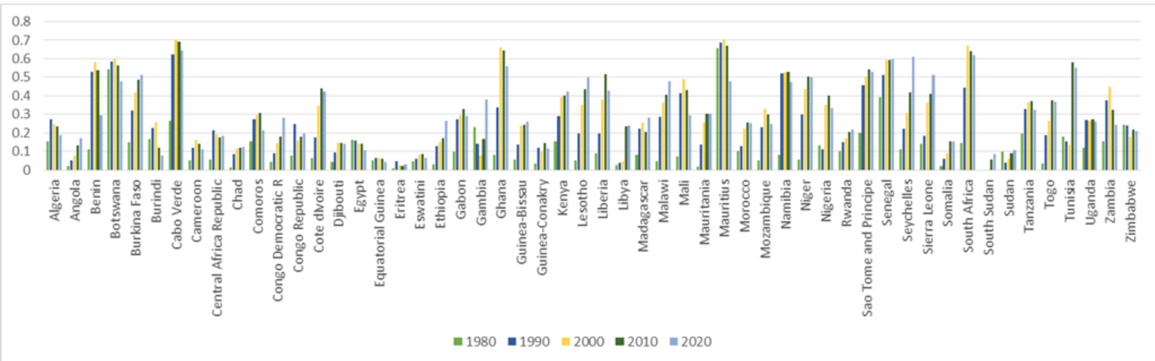
Figure 26 - Yearly Average and Median Participatory Democracy Index in Africa



Source: Computed by the author based on the V-Dem Project Dataset.

Deliberative Democracy Index gauges the deliberative principle of democracy focusing on the process by which decisions are reached in a community. A deliberative process is one in which public reasoning focuses on the common good that motivates political decisions—as contrasted with emotional appeals, solidarity attachments, parochial interests, or coercion. According to this principle, democracy requires more than an aggregation of existing preferences. There should also be respectful dialogue at all levels—from preference formation to final decision—among informed and competent participants, who are open to persuasion. The index interval is also from zero (0) to one (1), that is, from low to high.

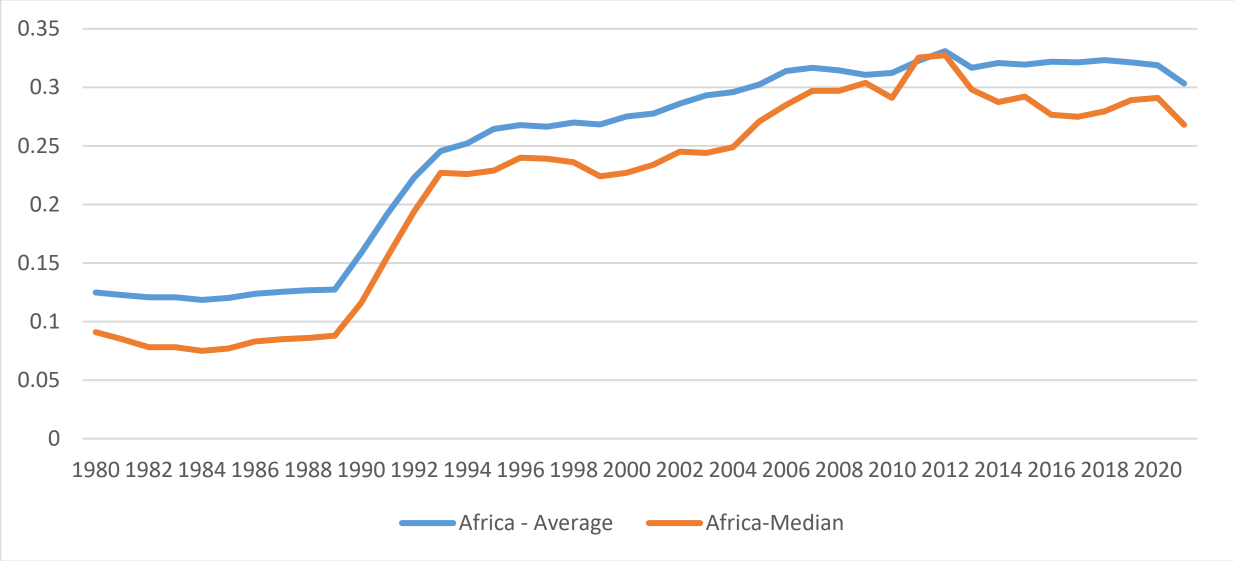
Figure 27 - Deliberative Democracy Index in African Countries, 1980-2020



Source: V-Dem Project Dataset

In Figure 27 it can be seen that with average (per decade) values between 0.5 and 0.7, Cape Verde, Ghana, Mauritius, South Africa, Senegal, Botswana, and Burkina Faso have the highest deliberative democracy index – above of the continent's average presented in Figure 28; whereas Eritrea, Eswatini, Equatorial Guinea, Chad, and Angola have the lowest indicator. The whole continent's average deliberative democracy index increased from 0.12 in 1980 to 0.30 in 2021, values below 0.4.

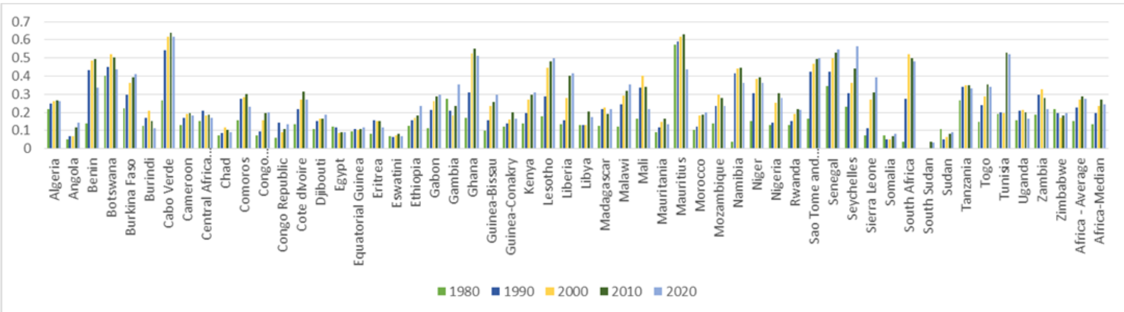
Figure 28 - Yearly Average and Median Deliberative Democracy index in Africa



Source: Computed by the author based on the V-Dem Project Dataset.

Egalitarian Democracy Index seeks to quantify the egalitarian principle of democracy, and holds that material and immaterial inequalities constrain the exercise of formal rights and liberties and diminish the ability of citizens from all social groups to participate. Egalitarian democracy is achieved when at least three requisites are met: (1) rights and freedoms of individuals are protected equally across all social groups; (2) resources are distributed equally across all social groups; and (3) groups and individuals enjoy equal access to power. The index interval is also from low to high (0-1).

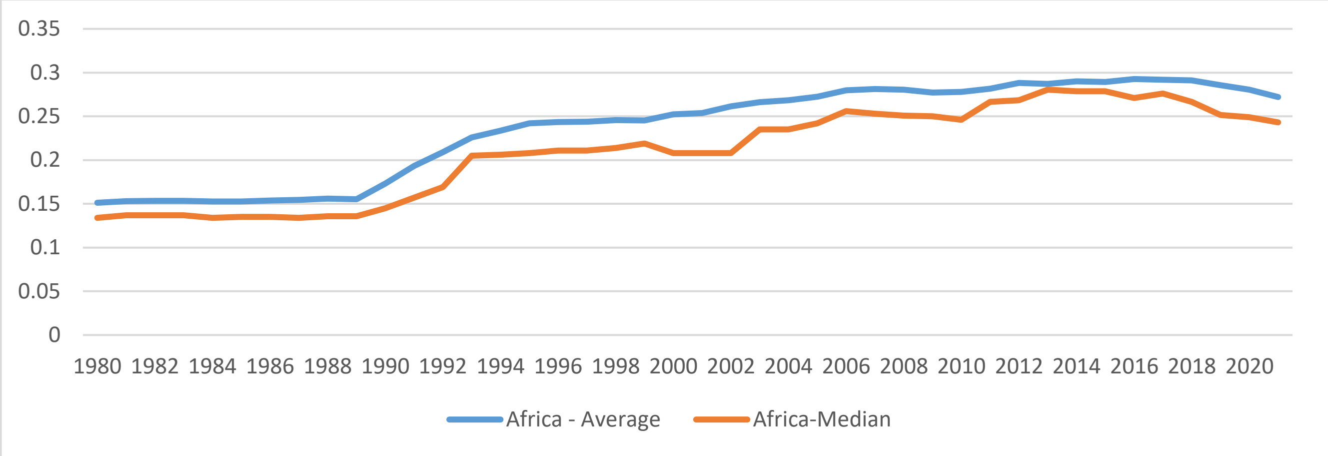
Figure 29 - Egalitarian Democracy Index in African Countries, 1980-2020



Source: V-Dem Project Dataset

The data on the Egalitarian democracy index presented in Figure 29 show that Cape Verde, Mauritius, Ghana, Senegal, Seychelles, São Tomé, South Africa, Botswana, and Benin are the countries with the highest index, with values between 0.5 and 0.6; whereas Somalia, Sudan, Eswatini, Chad, and Angola are the countries with the lowest indicators. Looking at the continent's yearly average and median as presented in Figure 30, it has been evolving from 0.15 in 1980 to 0.27 in 2021, but is still below 0.3.

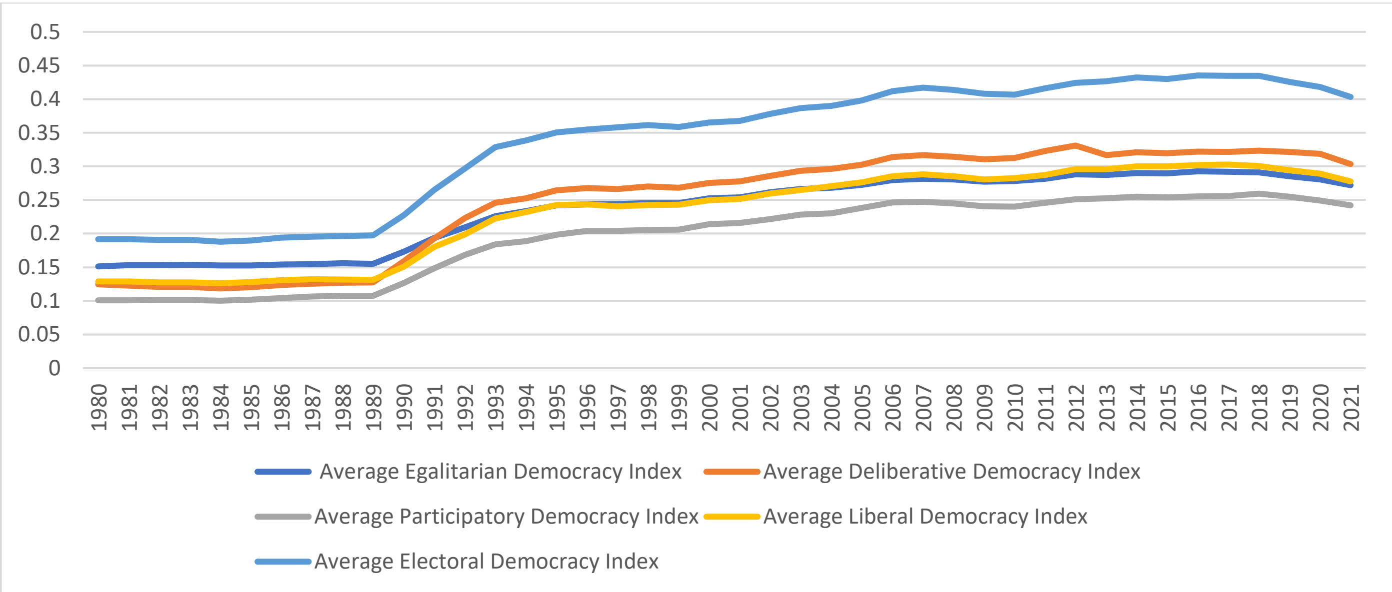
Figure 30 - Average and Median Egalitarian Democracy Index in Africa



Source: Computed by the author based on the V-Dem Project Dataset.

Looking at the yearly average evolution of the five democracy indices together in one graph as presented in Figure 31, it can be seen that the Electoral Democracy index is the highest, followed by the Deliberative Democracy index, and by the Liberal and Egalitarian indices; the Participatory Democracy index is the indicator with the lowest score among them all. The evolution of the indices over time looks similar, which may imply that the results of the regressions will be similar, i.e., the impact of taxation on each index will most likely be similar across democracy indexes. In our study the main dependent variable is the electoral democracy index and the other indices will be used to check for the robustness of the results.

Figure 31 - Evolution of Democracy Indices in Africa

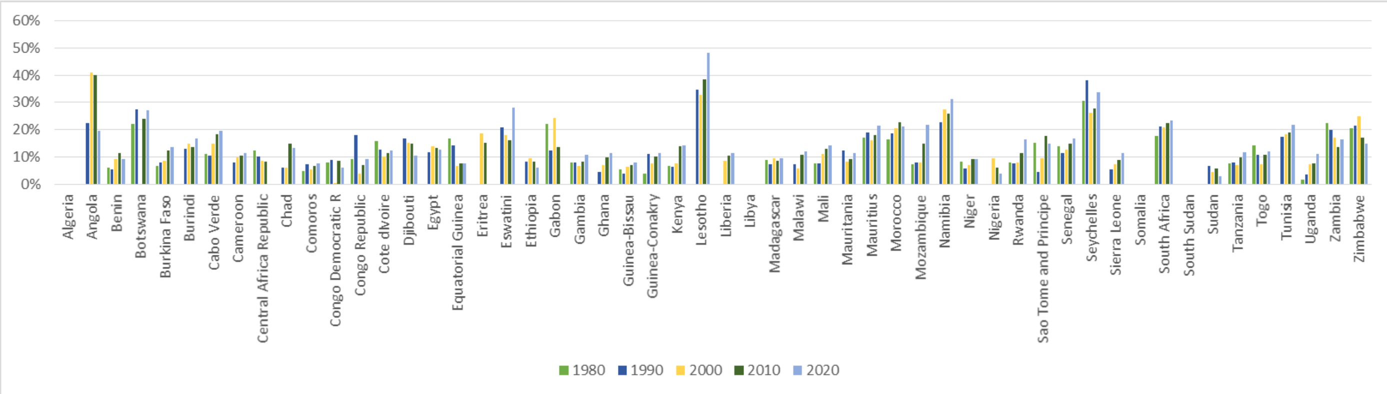


Source: Computed by the author based on the V-Dem Project Dataset.

2.4.1.2 Independent, Control, and Instrumental Variables

The main determinant of interest herein is taxation in each country, which is measured as tax revenues to GDP ratio, which represents the fiscal burden borne by citizens and companies as a whole in a country. There are three measures of taxation: the total tax revenues, the resources tax revenues, and the non-resources tax revenues, all as percent of GDP. Nevertheless, in our regressions only the total tax revenues are used, since the results with the non-resources tax revenues would have been similar, as the latter almost explains the former, as Figure 20 below shows; and for the resources tax revenues there is a considerable lack of data for most of the countries[38].

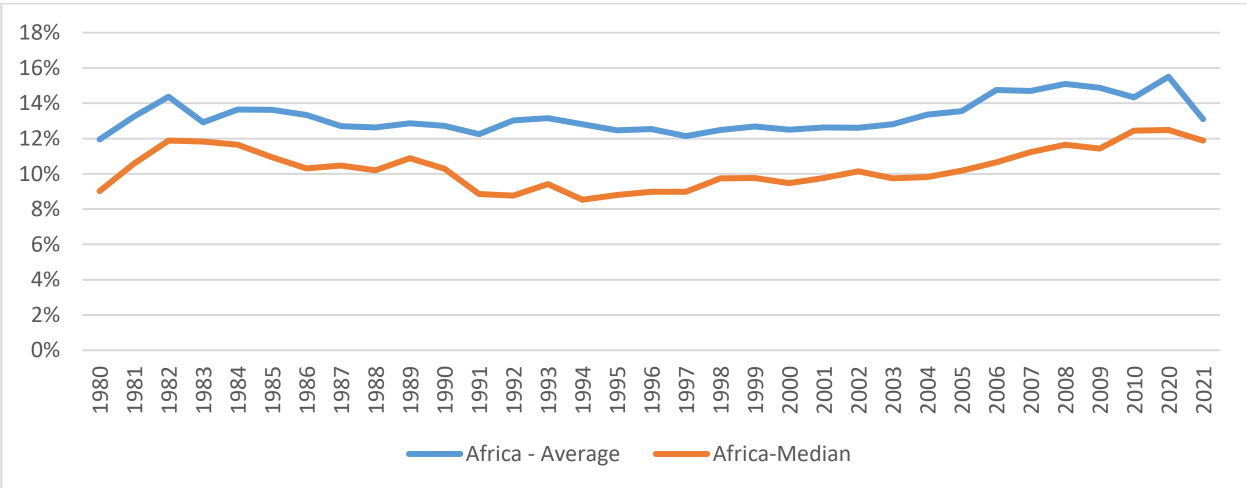
Figure 32 - Total Tax Revenues as percentage of GDP



Source: UNU-WIDER Government Revenue Dataset

The data on **total tax revenues to GDP ratio** showed in Figure 32 represents the values for each country in ten years average, and allows us to see the evolution in decades. The data reveal that Lesotho, Seychelles, Angola, Botswana, Namibia, Morocco, Mauritius, South Africa, and Eswatini have the highest taxation level in the continent. The countries with the lowest taxation levels are Sudan, Guinea Bissau, Uganda, Benin, Comoros, Niger, and Nigeria. There are no data for Algeria, Libya, Somalia, or South Sudan.

Figure 33 - Average and Median Total Tax Revenues as % of GDP in Africa



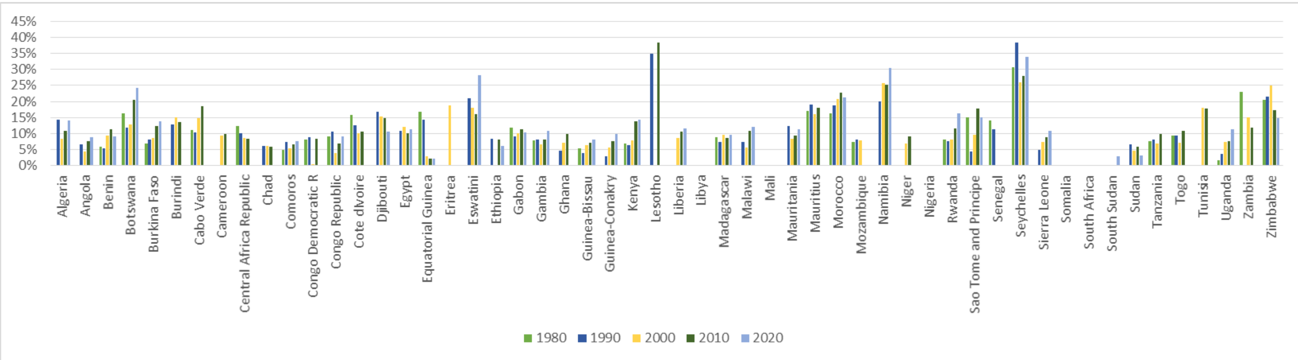
Source: Computed by the author based on the UNU-WIDER Government Revenue Dataset.

[38] As for the resources tax revenues, the tax collected from the exploration of natural resources, there are data for only 15 countries, as seen in Figure B1 in the appendix. Among those countries, Angola, Botswana, Equatorial Guinea, Chad, Republic of Congo, and Guinea Conakry have the highest tax levels as percent of GDP. As Figure B2 in the appendix also shows, the average resources tax revenues in the continent is around 1% of GDP.

In Figure 33 it can be seen that taking the continent as a whole the yearly median and average taxation level almost stagnated around 9%-12%, between 1981 and 1999, and started to marginally increase in the early 2000s up to 2020, where it reached the revenues to GDP ratio of 12%-16%.

Looking at the **non-resources tax revenues** (Figure 34), which is the tax collected in the non-natural resources sectors of each country, which actually affect the majority of people and enterprises, one can see that Seychelles, Lesotho, Namibia, Eswatini, Botswana, Zambia, and Zimbabwe are the countries with the highest non-resources taxation levels as percent of GDP. The countries with the lowest levels are Angola, Benin, Chad, and Sudan. There are no data for Libya, Mali, Nigeria, Somalia, or South Africa.

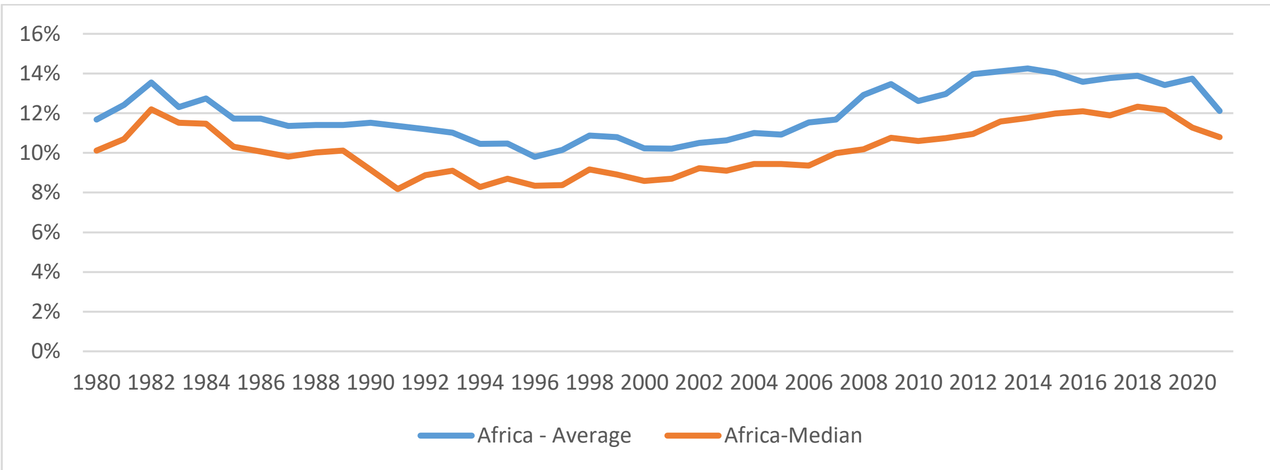
Figure 34 - Non-Resources Tax Revenues as % of GDP



Source: UNU-WIDER Government Revenue Dataset.

The yearly average non-resources taxation levels in the continent are showed in Figure 35 and it reveals a trend similar to that of total taxation level presented in Figure 33.

Figure 35 - Average and median Non-Resources Tax Revenues as % of GDP in Africa

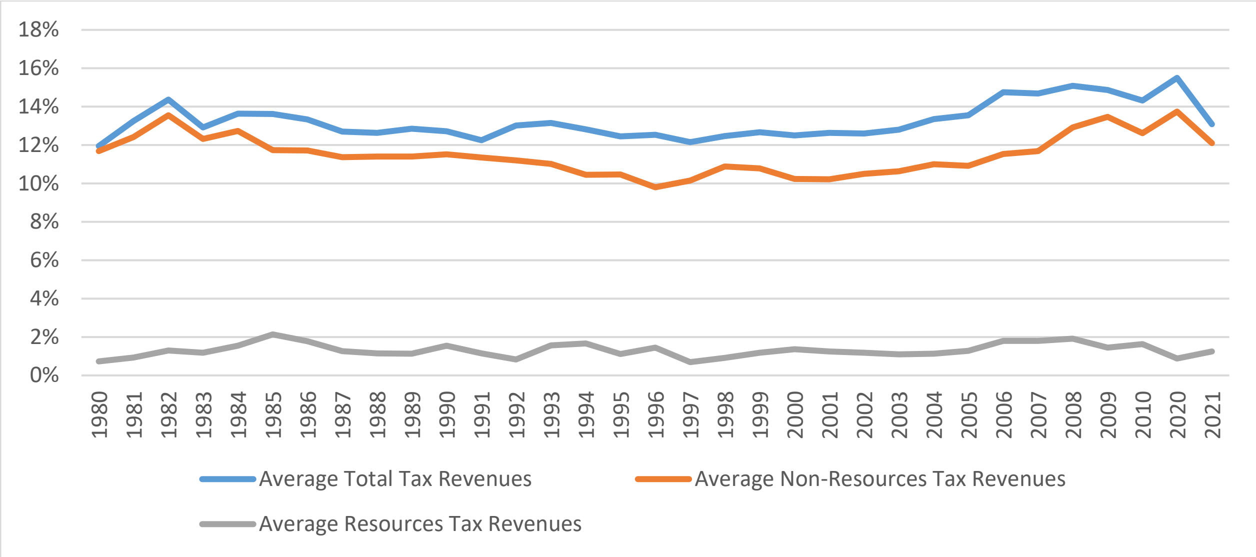


Source: Computed by the author based on the UNU-WIDER Government Revenue Dataset.

Combining in the same graph the three taxation ratios (total, non-resource, and resource) as shown in Figure 36, it is clear that the non-resources tax revenues have a similar trend with the total revenues and it seems to drive it[39]. It is far higher than the resources tax revenues as percent of GDP.

[39] That is why only total tax revenues was used as a regressor. It was not necessary to have specific regressions with the non-resources taxes as a regressor, since the results would be similar.

Figure 36 - Average Tax Revenues in Africa as % of GDP



Source: Computed by the author based on the UNU-WIDER Government Revenue Dataset.

As for the rest of the explanatory variables, there are three variables used, as in the literature:

1. Non-Tax Revenues – to control for the so called "political resource curse" (Ross, 1999; Prichard 2018), which claims that in the developing countries abundant in natural resources revenues and royalties, these are detrimental to the democracy;
2. Nominal GDP *per capita* – since it is an indicator of economic well-being/development, which is one of the main factors that explain democracy (Lipsit, 1959; Barro, 1999, Acemoglu *et al.,* 2008, and Baskaran, 2013); and
3. Development aid received as percentage of GDP – Cilliers (2023) argues that the demand for democracy and good governance by the Western countries has resulted in the early democratization of Africa, and development aid is conditional on those demands.

Taking into account the possible reversed causality between taxation and democracy and to address the issue of endogeneity, two[40] variables that explain taxation but not democracy were used as instruments for taxation in the IV regressions: the level of trade (exports + imports) as percentage of GDP and a dummy variable that represents the establishment and existence of a semi-autonomous revenue authority (RA) in each country[41], the value being 1 from the year of creation of the revenue authority and thereafter and zero before that year, and for the countries without a revenue authority.

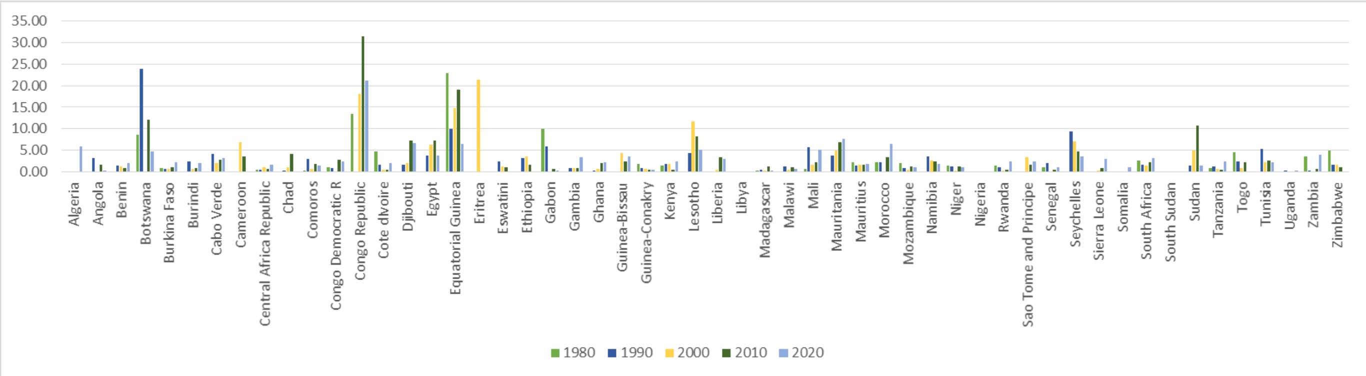
Non-tax Revenues as a percent of GDP

Most African countries are rich in natural resources and these resources are usually explored by international firms that pay (in addition to taxes) licenses and royalties to local governments for the exploration of the resources. Figure 37 shows the values for each country, in ten years average,

[40] See the methodology Section 2.4.2.1 for the main reasons for using the two variables as instruments.
[41] Consult Table B1 in the appendix to see the countries with revenues authorities in Africa, and the year of establishment.

which shows the evolution by decade. The data reveal that the Republic of Congo, Equatorial Guinea, and Botswana have the highest share of non-tax revenues ratio to GDP.

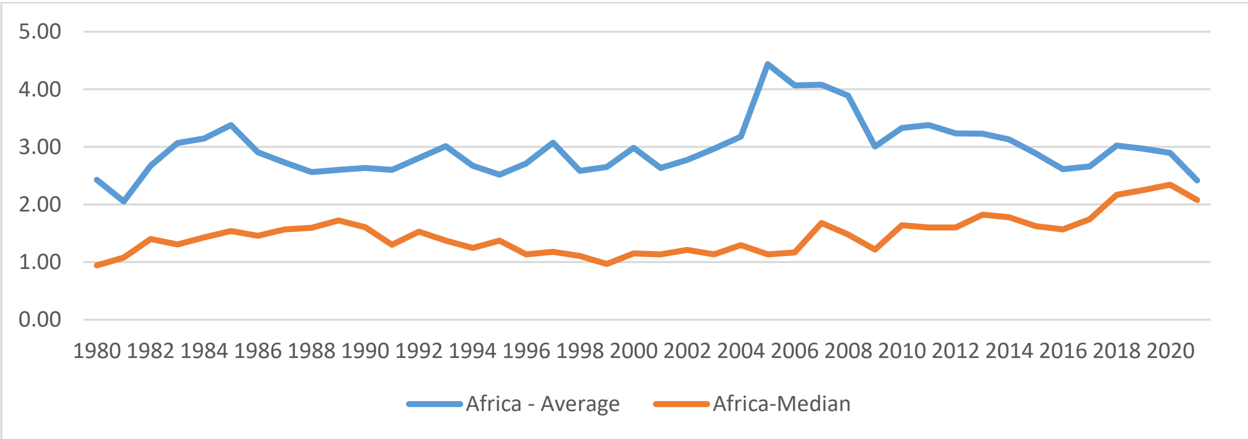
Figure 37 - Non-tax Revenues as % of GDP in African Countries, 1980-2020



Source: UNU-WIDER Government Revenue Dataset.

Looking at Africa as a whole, Figure 38 shows that the average share of non-tax revenues between 1980 and 2002 was 2.7%, and from 2003 to 2005 went up to slightly above 4%, but after 2006 started to fall, reaching the value of 2.4% in 2021.

Figure 38 - Yearly Average and Median Share of Non-Tax Revenues as % of GDP in Africa

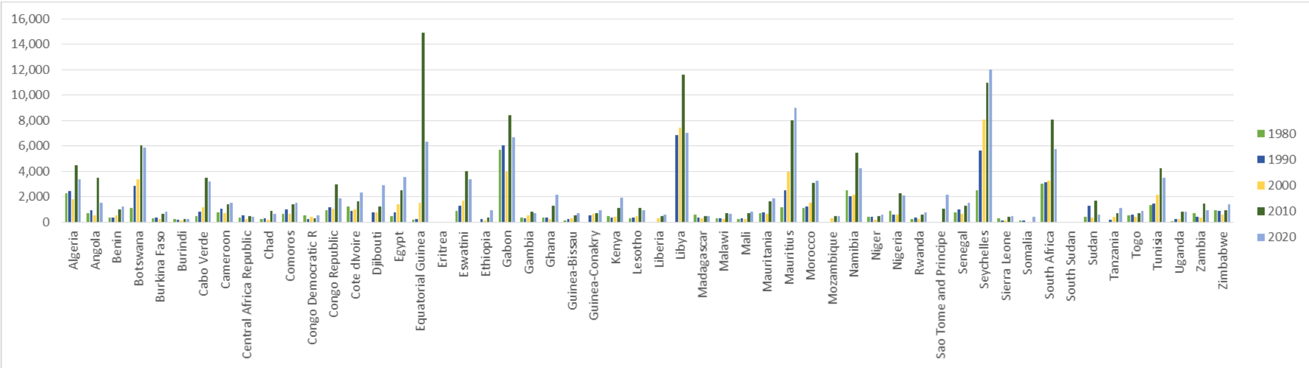


Source: Computed by the author based on UNU-WIDER Government Revenue Dataset.

Nominal GDP *Per Capita*

A common measure of living standards among the countries is the total Gross Domestic Production (GDP) divided by total population. In general, greater GDP *per capita* implies better standards of living of the citizens of a country, in comparison to countries with lower GDP *per capita*.

Figure 39 - GDP *Per Capita* in Africa Countries (USD), 1980-2020

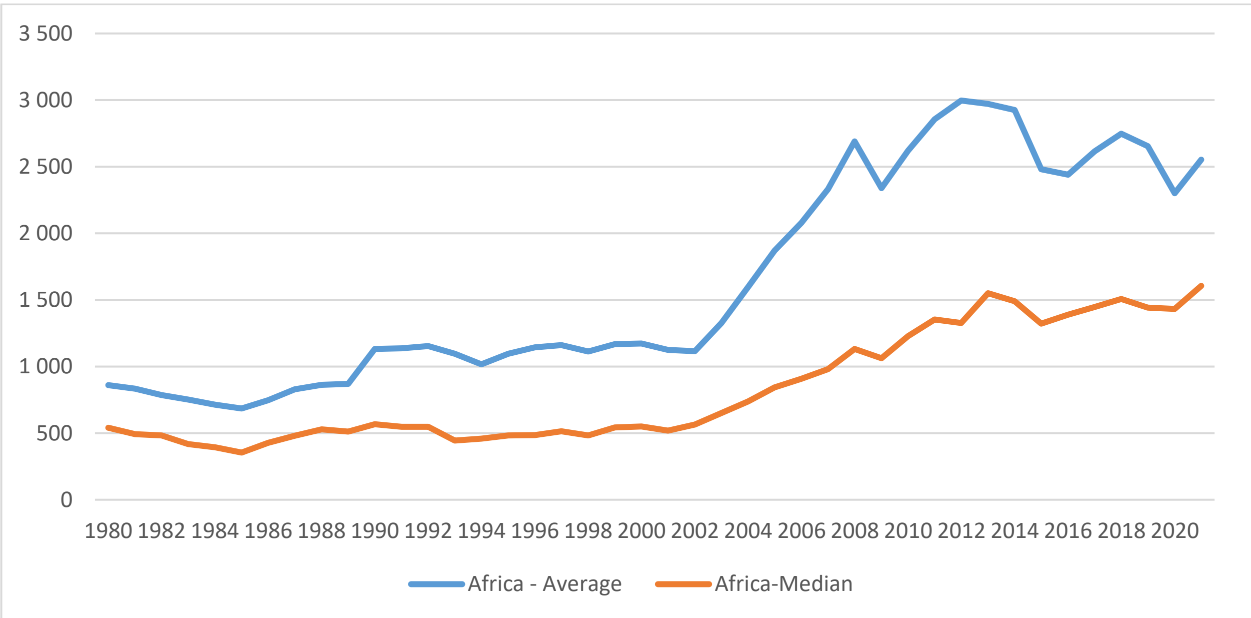


Source: World Development Indicators - World Bank.

According to the data in Figure 39 the African countries with highest nominal GDP *per capita* in the years of our analysis (by decade) are Seychelles, Mauritius, Libya, Gabon, and South Africa. The countries with lowest GDP *per capita* and the poorest are Somalia, Chad, Mali, Malawi, Burundi, and Sierra Leon. There are no data for Eritrea and South Sudan. It is important to highlight that although Nigeria is the biggest economy in Africa in terms of total GDP, due to having also the largest population, it has a lower GDP *per capita* than many other countries in Africa.

As for the yearly average and median nominal GDP *per capita* in the continent, Figure 40 shows a steady growth, especially since 2002.

Figure 40 - Yearly Average and Median Nominal GDP *Per Capita* in Africa (USD)



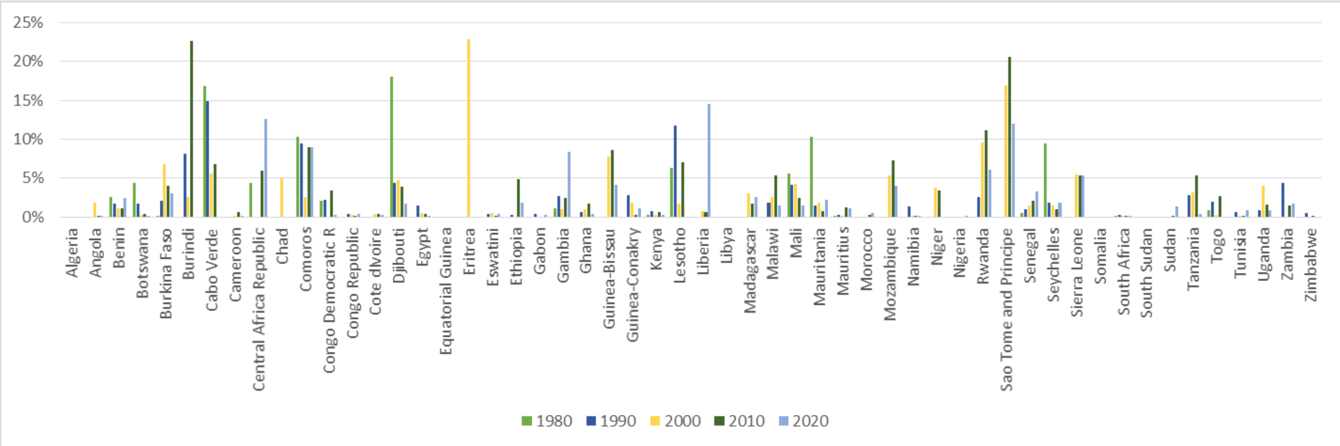
Source: Computed by the author based on the World Development Indicators - World Bank.

As for the possible endogeneity of GDP, one of the instruments being used to account for endogeneity between democracy and taxation, which is the level of trade, is also valid for the GDP *per capita*. The level of trade clearly affects GDP (Fatima *et al.,* 2020; World Bank Brief, 2023). So, by using trade as an instrument, we are accounting for the possible endogeneity of both taxation and GDP *per capita*.

Development Aid as a percent of GDP

The vast majority of African countries are aid recipients, and the continent has been receiving grants especially from Western countries. As can be seen in Figure 41, many countries in Africa receive aid equivalent to 5% of their GDP. Burundi, Cape Verde, Comoros, and São Tomé are among the most aid dependent in the continent.

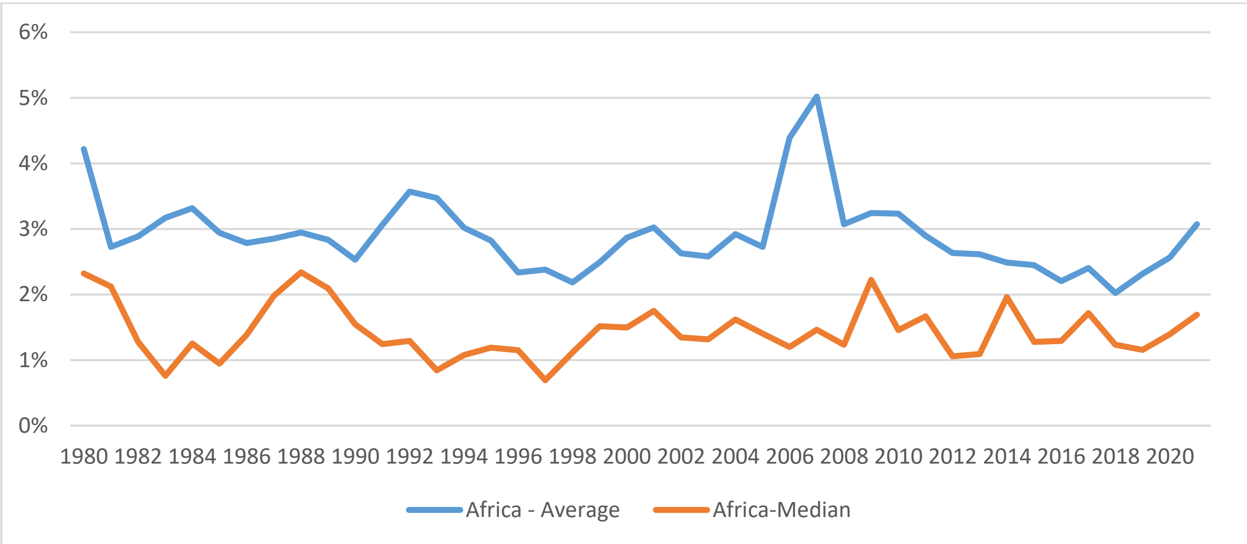
Figure 41 - Development Aid as % of GDP in African Countries, 1980-2020



Source: UNU-WIDER Government Revenue Dataset.

Looking at the continent as a whole, Figure 42 shows that the average aid received has been decreasing in general, especially since 2007, the year that reached the highest value of 5%.

Figure 42 - Yearly and Median Development Aid as % of GDP in Africa



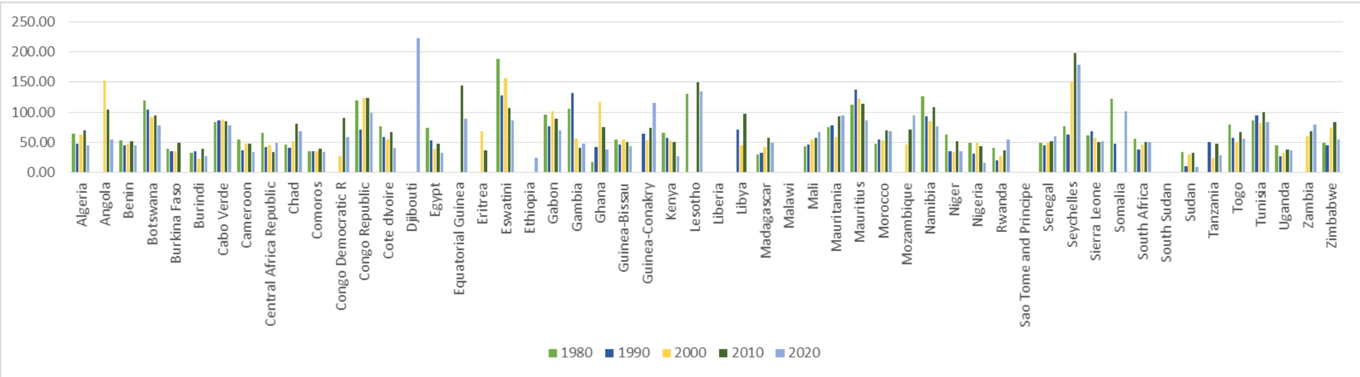
Source: Computed by the author based on UNU-WIDER Government Revenue Dataset.

Trade (Imports + Exports) as percent of GDP

The degree of openness of an economy is usually measured by the ratio of imports plus exports to GDP, which gives an indication of how much foreign trade a country is carrying out with the rest of the world. In the case of the African countries, most have a sizeable degree of openness of their economy, meaning that they have considerable imports from and exports to the rest of the world.

Looking at Figure 43 one can see the countries in Africa with the greatest degree of openness of their economies. Seychelles, Eswatini, Mauritius, Lesotho, and Botswana have the highest trade to GDP ratio.

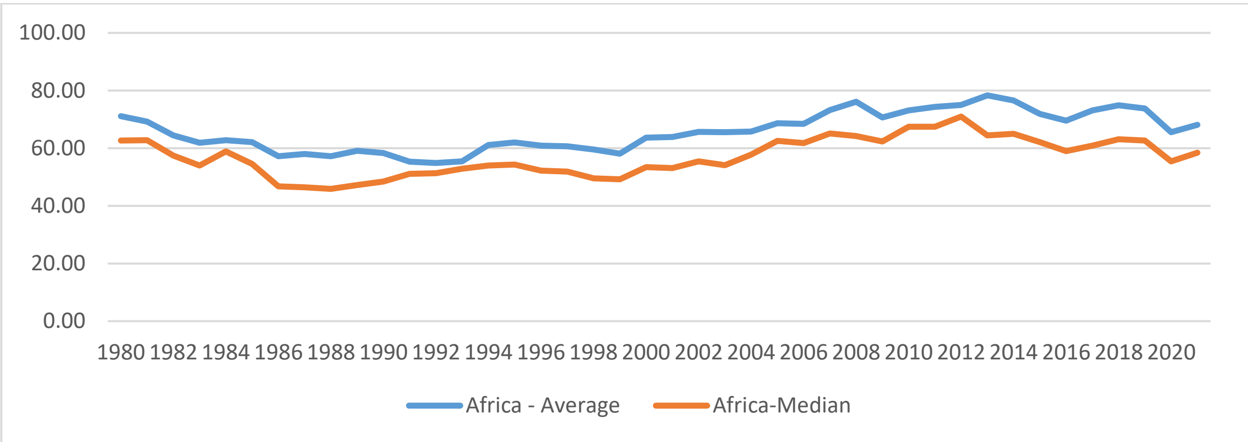
Figure 43 - Trade as % of GDP in African Countries, 1980-2020



Source: World Development Indicators - World Bank.

Looking at Africa as a whole, Figure 44 presents the average trade to GDP ratio of the continent over the years. One can see that between 1980 and 1990 there was a slight and gradual decrease, but from 1995 on there has been an increase, showing that the Continent is actively participating in global trade.

Figure 44 - Yearly and Median Trade as % of GDP in Africa



Source: Computed by the author based on the World Development Indicators - World Bank.

Table 17 presents the summary of descriptive statistics of all variables used to study the impact of taxation on democracy indices in Africa. The continent has 54 countries, but due to significant lack of data on the main variable of interest (taxation or tax revenue to GDP ratio) four countries were dropped from the sample, namely Algeria, Libya, Somalia, and South Sudan. Thus, the total number of countries studied is 50. We are dealing with an unbalanced panel, because regarding the independent and control variables there are some countries with no data, which reduced the total number of observations[42]. In Table 17 N represents the total number of observations, lowercase n is the number of countries, and T is the number of years being studied over the period 1980-2021.

Table 17 - Descriptive Statistics of the Main Variables

Variables	Dimensions	Mean	Standard deviation	Min	Max	Observations	
			Dependent (Y)				
Electoral Democracy	overall	0.348	0.2	0.032	0.806	N	2100
	between		0.145	0.08	0.737	n	50
	within		0.139	0.216	0.802	T	42
Liberal Democracy	overall	0.241	0.182	0.005	0.723	N	2100
	between		0.146	0.014	0.633	n	50
	within		0.11	0.071	0.653	T	42
Participatory Democracy	overall	0.203	0.13	0.008	0.534	N	2100
	between		0.099	0.012	0.476	n	50
	within		0.085	0.110	0.498	T	42
Deliberative Democracy	overall	0.257	0.188	0.033	0.723	N	2100
	between		0.146	0.028	0.671	n	50
	within		0.12	0.119	0.672	T	42
Egalitarian Democracy	overall	0.242	0.146	0.033	0.653	N	2100
	between		0.119	0.073	0.595	n	50
	within		0.086	0.176	0.585	T	42
			Independents (X)				
Taxation (TaxGDPratio)	overall	13.49	7.9	0.573	60.946	N	1961
	between		7.085	5.117	38.106	n	50
	within		3.57	9.732	39.914	T	39
Taxation^2	overall	244.4	324.247	0.329	3714.467	N	1961
	between		282.257	31.882	1511.777	n	50
	within		161.409	265.92	2447.067	T	39
Nontax revenues (% GDP)	overall	3.287	4.648	0.008	43.943	N	1835
	between		4.114	0.19	18.491	n	50
	within		2.599	5.681	42.658	T	37
Aid (% GDP)	overall	3.237	5.153	-0.193	123.251	N	1595
	between		3.361	0.063	16.911	n	50
	within		4.043	6.144	109.577	T	32
GDP per capita ($ nominal)	overall	1,556	2,313.82	93.69	19,849.72	N	1985
	between		1,789.48	196.89	8,921.21	n	49
	within		1,457.84	3,807.18	15,886.71	T	41
			Instruments (Z)				
Trade (% GDP)	overall	66.24	36.406	4.128	347.997	N	1759
	between		43.039	22.721	284.904	n	47
	within		18.131	50.113	169.621	T	37
Revenue Authority (RA)	overall	0.206	0.404	0	1	N	2100
	between		0.238	0	1	n	50
	within		0.328	0	1	T	42

[42] For the case of nominal GDP *per capita* five countries were excluded: Libya, Somalia, South Sudan, Liberia, and São Tome e Principe. For the case of Trade, seven countries were excluded: Algeria, Libya, Somalia, South Sudan, Djibouti, Eritrea, and Ethiopia.

2.4.2 Methodology

The empirical models that are used to study the impact or effect of taxation (total tax revenues as percent of GDP) on the democratization process in Africa are based on panel econometric regressions, whose coefficients are estimated by methods such as the Pooled OLS, Fixed Effect estimator, and the Instrumental Variable approach to deal with possible endogeneity between taxation and GDP per capita and democracy, and by fractional regressions due to the fact that the dependent variable democracy ranges between zero and 1.

2.4.2.1 Standard Regression Approach (Fixed Effects Estimators and IV Regression)

The following equation describes the basic linear panel model that is used for Pooled OLS (without the individual and time effects) and Fixed Effect regressions:

$$\mathbf{Democracy_{i,t}} = \boldsymbol{a_i} + \boldsymbol{\delta_t} + \boldsymbol{\beta_1}\mathbf{Taxation_{i,t}} + \boldsymbol{\beta_2}\mathbf{X_{i,t}} + \boldsymbol{\mu_{i,t}} \tag{5}$$

where i is the country; t is the time period; $Democracy$ is the indicator for each electoral democracy index (electoral, liberal, distributive, participatory, and egalitarian); $\boldsymbol{a_i}$ accounts for country-specific time invariant unobservables, such as the geographical size of a country; δ_t takes into account global time developments that affect countries similarly; $Taxation$ is total tax revenues to GDP ratio, the independent variable of interest, where β_1 captures the effect of taxation on Democracy; X is a vector of control variables, such as nominal *per capita* gross domestic product, foreign aid received as percent of GDP, and non-tax revenues (such as royalties from natural resources and other revenues) as percent of GDP; and μ is an error term.

Equation 1 may be adjusted taking into account the assumptions made regarding the parameters, the errors, and the exogeneity of the regressors (Croissant and Millo, 2008). Assuming parameter homogeneity the parameters of interest are equal for all countries and time periods, and adding no serial correlation in the error term in this case the data in the standard linear model will be pooling and the estimator is the pooled OLS. Assuming heterogeneity in the time and individual effects, the error term of the equation has two separate components, one of which is explicit to the individual fixed effect and unchangeable over time. If the individual error component is correlated with the regressors, the pooled OLS estimator will be inconsistent and, in this case, the fixed effects will be the most appropriate estimator. If the individual-specific error component is not correlated with the regressors, the random effects model is used.

For the FE estimator we will follow two main steps: first, checking for the existence of time and individual effects; if these exist, the second step will be choosing between fixed and random effects models using the Hausman-type test. By comparing the two models, under the null hypothesis of no significant difference the random effects model will be chosen, if this is rejected the fixed effect is chosen.

Taking into account the significant temporal significance of democracy indices, a Fixed Effect Lagged Dependent Variable estimator (FE-LDV) model was also used. The FE-LDV regression equation is the following:

$$\mathbf{Democracy_{i,t}} = \boldsymbol{a_i} + \boldsymbol{\delta_t} + \boldsymbol{\beta_1}\mathbf{Taxation_{i,t}} + \boldsymbol{\beta_2}\mathbf{X_{i,t}} + \boldsymbol{\beta_3}\mathbf{Democracy_{i,t-1}} + \boldsymbol{\mu_{i,t}} \tag{6}$$

where $Democracy\ i_{,t-1}$ is the past value of democracy index and β_3 measures the impact of the lagged value of democracy index in the current index. But now with the inclusion of the past democracy index in the regression, the interpretation of β_1 that captures the effect of taxation on democracy slightly changes in the fact of measuring the short-run (contemporaneous) impact of taxation on democracy. The long-term effect of taxation on democracy is given by $\frac{\beta 1}{(1-\beta 3)}$. Regarding the asymptotic consistency of the FE LDV estimator, Judson and Owen (1999) report that the model with lagged dependent variable produces biased estimates, called Nickell bias (Nickell,1981), when the time dimension of the panel (T) is small (lower than 30). In our case, for the panel that we are using the time period is from 1980 to 2021, which is 42 years on average for each country, so the bias is expected to be insignificant.

To check for the possible nonlinear relationship between democracy and taxation, a quadratic term of taxation is included in the regressions,

$$\mathbf{Democracy_{i,t}} = \boldsymbol{a_i} + \boldsymbol{\delta_t} + \boldsymbol{\beta_1}\mathbf{Taxation_{i,t}} + \boldsymbol{\lambda}\mathbf{Taxation^2_{i,t}} + \boldsymbol{\beta_2}\mathbf{X_{i,t}} + \boldsymbol{\beta_3}\mathbf{Democracy_{i,t-1}} + \boldsymbol{\mu_{i,t}} \quad (7)$$

Here, λ is the coefficient that if statistically significant will confirm the nonlinear relation, where if the parameter is negative, the relationship is concave and if λ is positive the relationship is convex. In this case to obtain the partial effect of taxation on democracy we have:

$$\frac{\partial Democracy}{\partial Taxation} = \boldsymbol{\beta_1} + \mathbf{2\lambda Taxation} \quad (8)$$

where β_1 gives the impact on democracy when taxation is equal to zero and λ tells both the direction and steepness of the curvature. Taking equation (4) equal to zero and solving for Taxation we obtain, for $\lambda<0$, the tax revenues ratio to GDP that yields the highest democracy index.

The Instrumental Variable (IV) Approach

Taking into account that a reverse causality between taxation and democracy is very likely since democracy can also affect the level of tax revenues to GDP ratio, Instrumental Variable (IV) estimators are also used to address the issue of endogeneity. The IV estimator uses variables as instruments that are correlated with taxation, but do not help explain democracy. Two variables were used as instruments for taxation: the ratio of foreign trade (export+imports/GDP) and a dummy variable that represents the establishment and existence of a semi-autonomous revenue author (RA) in each country, the value being 1 from the year of creation of the revenue authority on and zero before that year and for the countries without a revenue authority.

We used these two variables as instruments because the literature clearly shows that trade affects the level of taxation in developing countries positively (Addison and Levin, 2008; Botlhole *et al.*, 2012; Crivelli and Gupta, 2014; Morrissey *et al.*, 2016; Knebelmann, 2017) but there is no empirical evidence of trade affecting the democracy index directly. As for the case of revenue authority (RA), studies also show that the establishment of these semi-autonomous institutions responsible for collecting all tax revenues[43] do have a positive impact on the increase of tax revenues in developing countries (Bird and Gendron 2007; Fjeldstad and Moore 2009; Baskaran 2013). Moreover, there is no evidence in the literature of the democracy index affecting the establishment or adoption of

[43] Fjeldstad and Moore (2009) define semi-autonomous revenue authority (RA) as an entity organizationally distinct from ministries of finance, with some real operational autonomy, and with staff paid at rates substantially higher than those in comparable public sector jobs.

revenues authorities. We therefore have good reasons to assume that both trade and the dummy for revenue authority (RA) adoption are suitable instruments for taxation to address endogeneity. To check the validity of the instrumental variables (IV) approach three main diagnostic tests are presented:

(1) The F test for weak instruments tests whether the instruments are correlated with the endogenous regressor. The null hypothesis is that the instruments are weak, and its rejection indicates a good informativeness of the variables, demonstrating a strong correlation between the instruments and the endogenous regressor.

(2) The Wu-Hausman (1978) test for endogeneity checks if the endogenous regressor is indeed correlated with the error term, establishing in this way the existence of endogeneity, which justifies the use of the IV approach. The null hypothesis is that the regressor is exogenous.

(3) The Sargan's (1958) test of over-identifying restrictions. This test checks the validity of over-identifying restrictions. The null hypothesis is that the over-identifying restrictions are valid.

Besides the two stage least squares (2SLS) estimator we also used the generalized method of moment (GMM) IV regression, based on Arellano and Bond (1991) using the pgmm R package developed by Croissant and Millo (2008), since it is more general and flexible, and able to deal with the over-identification restrictions when the number of instruments is greater than the number of endogenous regressors.

2.4.2.2 Fractional Regression Approach

Taking into account that the dependent variables in our study (democracy indices) have values that range between 0 and 1 we also use regression models with fractional responses to see if the results are similar or not with the previous regression models based on linear estimators. When the dependent variable is bounded in the unit interval the fractional regression model is an appropriate approach to be used by researchers.

Ramalho (2019) gives examples of fractional variables that may require the use of these regression models: firm market shares, proportion of debt in the financing mix of firms, fraction of land allocated to agriculture, and proportion of exports in total sales and data envelopment analysis efficiency scores.

Papke and Wooldridge (1996) presented the following structural equation to model a fractional response variable (y):

$$\boldsymbol{E}\ (\boldsymbol{y}|\boldsymbol{x}) = \boldsymbol{G}\ (\boldsymbol{x\theta})\ , \tag{9}$$

where G(.) is a nonlinear function that satisfies the condition $0 \leq G(z) \leq 1$ for all $z \in \mathbb{R}$ which may be consistently estimated by quasi maximum likelihood (QML); or by nonlinear least squares (maximum likelihood), but with less efficiency than QML estimation which requires the specification of the conditional distribution of y given x (Ramalho *et al*, 2011).

The estimation procedure proposed by Papke and Wooldridge (1996) is the following Bernoulli log-likelihood function:

$\mathbf{LL_i\ (\theta) = Y_i \log[G(X_i\theta)] + (1\text{-}Y_i) \log[1\text{-}G(X_i\,\theta)]}$. (10)

Considering that the Bernoulli distribution is from the linear exponential family, the QML estimator of θ is defined by the following expression

$\hat{\theta} \equiv \arg\max \sum_{i=1}^{N} LLi(\theta)$, (11)
which is consistent and asymptotically normal regardless of the true distribution of the y conditional on x, provided that equation (9) is correctly specified.

But in our case since we are dealing with panel data and following Ramalho (2019) the equation (9) can be transformed into the following structural panel model:

$\mathbf{E(Y_{it}|X_{it})= G(X_{it}\theta+\alpha_i+ \phi_{it})}$, (12)

where G(.) is the nonlinear function as in equation (9), i is the individual country, t is the time period, α is the individual effects, and ϕ the time-varying unobservables, which are assumed to be not correlated. In our paper Y is the democracy indices and X the explanatory variables.

Ramalho (2019) argues that in this case, with individual and time effects the QML estimator based on equation (9) is no longer consistent because in this setting conditioning on x does not remove the dependency of the model on the unobservables even if X and α, ϕ are not correlated. To overcome this situation, Ramalho *et al*. (2018) proposed a way that allows the observable and unobservable covariates to become additively separable, which allows us to estimate the equation (12) by the exponential fractional regression models, which includes as particular cases the Logit and Cloglog models.

The econometric method of estimation used in this framework by Ramalho (2019) is the panel data GMM estimators with both pooled random and fixed effects[44]. The pooled random effects estimator (GMMpre) assumes that X_{it} and α_i are independently distributed, so it treats α_i and ϕ_i as a single error term. The pooled fixed effects (GMMpfe) estimator allows X_{it} and α_i to be correlated and it interprets α_i as a vector of individual-specific intercepts to be estimated simultaneously with θ. The estimators can be used with both balanced and unbalanced panels, but with the condition that the frmpd R package does not allow unavailable (NA) values, so missing data for some variables in some years for some countries need to be excluded in order to include only the countries/years for which all variables are observed.

Taking into account that a correct specification of function G(.), the conditional mean of Y, is critical for consistent estimation of the parameters, there are specification tests available to check the statistical validity of the type of function assumed (Logit, Probit, Cauchy, and Binary probit). These tests

[44] See Ramalho (2019) for more details on other GMM based estimators such as Fixed effects estimators based on quasi- and mean-differences (GMMww estimators that assume weak exogeneity; the GMMc estimator based on Chamberlain's (1992) proposal for the exponential regression model; the GMMbgw estimator based on the mean differenced transformation used by Blundell et al. (2002) for exponential models); and the correlated random effects estimator (GMMcre) similar in spirit to the QML estimators proposed by Papke and Wooldridge (2008) and Wooldridge (2010).

are: the RESET test, the GOFF tests with three main variants, each one based on a different generalization of G (.) of interest, and the P test. These tests are available for only cross-sectional fractional regression models (frm) and not yet for the panel data regression models.

Linear Transformation of Models for Fractional Responses

Knowing that bounded dependent variables in nonlinear regression models for fractional responses analysis can be transformed so that linear regression models might be used for their analysis, we also transformed the dependent variable democracy by applying two alternative specifications: Logit and Cloglog.

For instance, the nonlinear function $Yi = G\ (Xi'\beta + \mu i)$ can be transformed into linear function $H(Yi) = Xi'\beta + \mu i$ using the following transformations of the dependent variable:
Logit: $H(Yi) = \ln(\frac{Yi}{1-Yi})$
Cloglog: $H(Yi) = \ln\,[-\ln(1 - Yi)]$

To show how the dependent variable changes with the linear transformation, Table 18 presents the dependent variable electoral democracy index statistics of both original data and those of linear transformed data.

With these linear transformations OLS estimation methods can be used and it is also possible to deal with panel data and endogenous variables. But one of the limitations is that prediction in the original scale requires complex methods (Ramalho 2020).[45]

Table 18- Electoral Democracy index Before and After Transformation

	Original data	Linear transformation (Logit)	Linear transformation (Cloglog)
N	2100	2100	2100
Mean	0.35	-0.75	-1.01
Sd	0.2	0.98	0.78
Median	0.29	-0.88	-1.06
Min	0.03	-3.41	-3.43
Max	0.81	1.42	0.49

We are not aware of studies on the relationship between taxation and democracy that have used fractional regression models. Existing studies in the literature on democracy usually use linear estimators such as FE, 2SLS, and GMM. We have the examples of Barro (1999), Acemoflu *et al.* (2005 and 2008), Baskaran (2013), and Dom *et al.* (2023)[46].

[45] According to the 2020 PhD Class material of Advanced Econometrics I of Professor Ramalho, Slide Theory 3, page 30
[46] Baskaran (2013) justifies the non-use of fractional models in studying democracy by the fact that country fixed effects needed to be included to account for omitted country specific effects, and citing Greene and Hensher (2010), for the case of fractional models, particularly the probit estimator, is not consistent if country fixed effect are included, especially when the number of groups is large relative to the number of observations within groups.

2.5 Estimation Results

In this section we present the main results of the regressions' estimation according to the approaches described in Section 2.4.2 of the methodology.

2.5.1 Standard Regression Approach for the Electoral Democracy index

2.5.1.1 Fixed Effects Estimators

We first tested for the existence of individual effects using the R package plm and the null hypothesis was rejected[47]. Then we used the Hausman test[48] to compare the random and fixed effects specifications, and the fixed effect was selected. The Lagrange Multiplier test[49] was also applied to check for the presence of both individual (country) and time effects and the presence of significant individual and time effects was confirmed, so the FE regressions include country and time (year) fixed effects.

Table 19 shows the baseline results of the regressions using fixed effects estimators, with the electoral democracy index as the dependent variable, tax revenue ratio to GDP (taxation) as the main regressor of interest, and other control variables (non-tax revenues, GDP *per capita*, Aid and taxation squared to test for the nonlinearity hypothesis between taxation and democracy). The first column of results (called OLS) reports the pooled estimations; the second column (FE1) presents the fixed effect regression with just two explanatory variables (taxation and non-tax revenues); the third column (FE2) presents the fixed effect regression with all control variables; the fourth column (FE-LDV1) is the fixed effect lagged dependent variable using just two regressors, and the fifth column (FE-LDV2) presents the fixed effect lagged dependent variable using all control variables.

[47] Results of the pooling test: F = 45.309, df1 = 88, df2 = 1381, p-value = 0.000.
[48] Hausman test results: chisq = 100.54, df = 5, p-value = 0.000.
[49] Lagrange Multiplier Test: normal = 70.25, p-value = 0.000.

Table 19 - Effect of Taxation on Electoral Democracy Index

	OLS	FE1	FE2	FE-LDV1	FE-LDV2
Tax Revenues (% GDP)	**0.0051**	**0.0049**	**0.0099**	**0.0012**	**0.0033**
Std. Error	(0.0006)	(0.0007)	(0.0021)	(0.0004)	(0.0012)
p-value	0.000	0.000	0.000	0.007	0.008
Non-Tax Revenues (% GDP)	**-0.005**	**-0.002**	**-0.003**	**-0.001**	**-0.001**
Std. Error	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
p-value	0.000	0.048	0.009	0.294	0.421
Log GDP *per capita*			**0.103**		**-0.009**
Std. Error			(0.007)		(0.007)
p-value			0.00		0.169
Aid (% GDP)			**0.0015**		**0.0002**
Std. Error			(0.001)		(0.000)
p-value			0.051		0.726
Tax Revenues^2 (% GDP)			**-0.00015**		**-0.00005**
Std. Error			(0.000)		(0.000)
p-value			0.000		0.058
Taxation Threshold (% GDP)			**33.3**		**36.1**
Lag of elect democracy				**0.751**	**0.735**
Std. Error				(0.015)	(0.018)
p-value				0.000	0.000
Countries	50	50	48	50	48
N	1825	1825	1475	1772	1448
R-Squared	0.043	0.033	0.216	0.597	0.572

Note: In the OLS, due to significant missing data, four countries were excluded: Algeria, Libya, Somalia, and South Sudan. In the FE2 estimations also due to significant missing data, six countries were excluded: Algeria, Eritrea, Libya, Nigeria, Somalia, and South Sudan. The threshold of tax revenue to GDP ratio after which the impact of taxation on democracy is decreasing was computed according to the formula in equation (8).

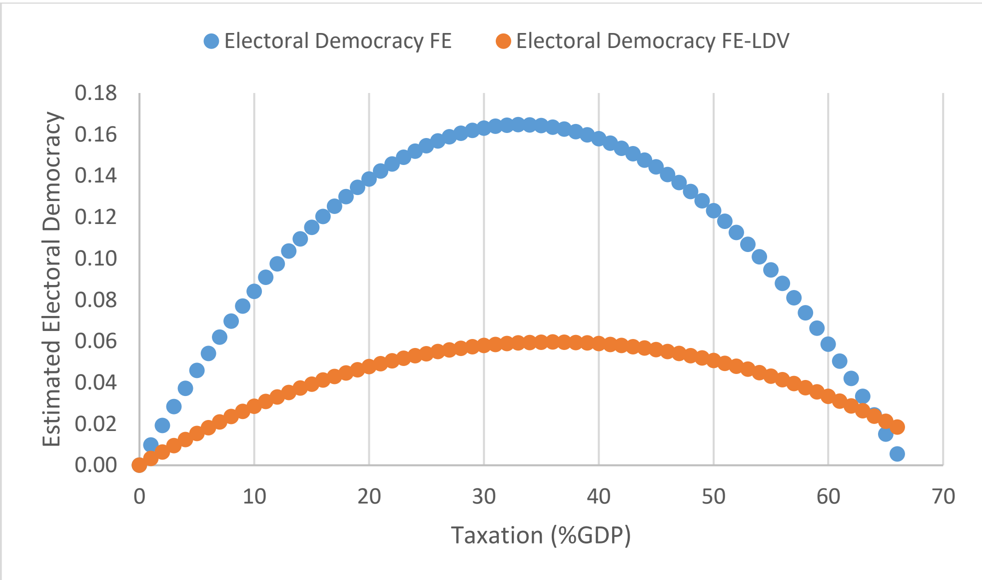
Now looking at the results of the regressions in Table 19, regarding the main variable of interest, tax revenue as percentage of GDP (or taxation), all regressions which are linear in taxation show that it has a positive and statistically significant effect on the electoral democracy index in Africa. The pooled OLS regression reveals that a 1 percentage point increase in taxation leads to 0.0051 increase in the electoral democracy index; whereas for the fixed effect the increase is 0.0049, and for the FE-LDV, the increase is 0.012.

The control variable non-tax revenue as a percent of GDP, which represents government revenues (in percent of GDP) that comes mainly from royalties from natural resources (such as oil, mining, and coal exploration), is usually used as a proxy for natural resource (Dom *et al*. 2023). In the regressions the impact of this variable on the electoral democracy index is negative and statistically significant in the pooled OLS and fixed effect estimators without the other control variables. For the case of the pooled OLS, it shows that a 1 percentage point increase in the non-tax revenue ratio to GDP leads to a decrease in the electoral democracy index of 0.005, and for the case of fixed effect, the decrease is of 0.002. As for the aid as a percent of GDP, it has a positive impact on the electoral democracy index, with 1 p.p. increase leading to an increase of 0.0015. The impact of GDP *per capita* seems to be contradictory in this regression model.

The nonlinear relationship hypothesis between the electoral democracy and taxation is confirmed in both the FE and FE-LDV estimators, since the coefficient of the tax revenue ratio to GDP squared is negative and statistically significant, showing that after a certain point of tax revenue ratio to GDP, a further percentage increase in taxation leads to a decrease in the electoral democracy index, representing an inverted U shape.

In Table 19 the threshold of tax revenue ratio to GDP that yields the greatest level of democracy index was computed according to the formula in equation (8). For the FE regression the threshold is 33.3%, meaning that in Africa the tax revenue to GDP ratio that will result in greatest democracy index and after which additional taxation will result in a decreased electoral democracy index is of 33.3%. For the case of FE-LDV the threshold is 36.1%. The average tax revenue to GDP ratio in Africa between 1980 and 2021 was 14%, and as of 2021 the average ratio was 13%, so one can see that there still room for further increase in taxation for some countries[50] in the continent to boost electoral democracy. Dropping all other estimated terms, Figure 45 presents the estimated nonlinear relationship between taxation and electoral democracy index according to the FE and FE-LDV regressions.

Figure 45 - Estimated Relationship Between Electoral Democracy Index and Taxation



Looking at the impact of the lagged value of electoral democracy index on the current electoral democracy index, one can see that it is positive and statistically significant, showing that electoral democracy index of the past years does affect the current index in about 0.751 and 0.735. This result shows the persistence of the electoral democracy index.

Estimated Individual and Time Fixed Effects

The unobserved country-specific characteristics that influence electoral democracy index were extracted from the FE-LDV2 regression, and are presented in Table 20. It can be seen that Mauritius, Cabo Verde, Botswana, Ghana, Senegal, South Africa, Ghana, São Tome, Namibia, and Liberia have systematically higher electoral democracy indices compared to the average country in the continent. The countries with the greatest individual effects are those that generally have the most functional institutions on the continent, and with reasonably good governance, which affects the level

[50] As shown in Figure 32, there are countries that have tax revenues ratio to GDP greater than the average.

of tax collection and in turn increases the civic awareness of citizens, which contributes positively to levels of democracy.

Table 20 - Estimated Individual Fixed Effects (of Electoral Democracy Index)

Countries	Estimate	Countries	Estimate
Angola	0.054	Lesotho	0.088
Benin	0.133	**Liberia**	**0.137**
Botswana	**0.178**	Madagascar	0.084
Burkina Faso	0.120	Malawi	0.109
Burundi	0.036	Mali	0.105
Cabo Verde	**0.180**	Mauritania	0.087
Cameroon	0.058	**Mauritius**	**0.186**
Central Africa Republic	0.080	Morocco	0.041
Chad	0.054	Mozambique	0.076
Comoros	0.100	**Namibia**	**0.139**
Congo Democratic R	0.058	Niger	0.116
Congo Republic	0.071	Rwanda	0.043
Djibouti	0.038	**Sao Tome and Principe**	**0.151**
Egypt	0.030	**Senegal**	**0.167**
Equatorial Guinea	0.034	Seychelles	0.114
Eswatini	0.014	Sierra Leone	0.109
Ethiopia	0.038	**South Africa**	**0.159**
Gabon	0.094	Sudan	0.055
Gambia	0.065	Tanzania	0.096
Ghana	**0.150**	Togo	0.085
Guinea-Bissau	0.113	Tunisia	0.092
Guinea-Conakry	0.050	Uganda	0.070
Ivory Coast	0.102	Zambia	0.092
Kenya	0.094	Zimbabwe	0.073

For instance, Botswana, Ghana, Mauritius, Seychelles, and South Africa are the countries with the highest democracy indices in the continent (See Table 15, Figures 21, 23, 25, 27, and 29) and they are classified as liberal democracies, with satisfactory rule of law and liberal principles. In these countries the institutions function reasonably well, with a separation of powers. That is why they have higher individual fixed effects than the other countries in the sample.

The time-specific fixed effects are presented in Table 21, which illustrates that compared to the average time period, the electoral democracy index was notably higher in the period between 1989 – 1992 (time when the Berlin Wall fell), 2000 – 2003 (beginning of the new century), 2011 – 2015 (era of the Arab Spring, when populations in Arab African countries rose up against their governments).

Table 21 - Estimated Time Fixed Effects (of Democracy Index)

Years	Estimate	Years	Estimate
1982	0.124	**2000**	**0.133**
1983	0.112	**2001**	**0.151**
1984	0.101	**2002**	**0.158**
1985	0.102	**2003**	**0.141**
1986	0.120	2004	0.119
1987	0.127	2005	0.115
1988	0.117	2006	0.109
1989	**0.125**	2007	0.108
1990	**0.123**	2008	0.096
1991	**0.124**	2009	0.103
1992	**0.125**	2010	0.113
1993	**0.109**	**2011**	**0.124**
1994	0.097	**2012**	**0.135**
1995	0.048	**2013**	**0.131**
1996	0.049	**2014**	**0.131**
1997	0.054	**2015**	**0.140**
1998	0.063	2016	0.129
1999	0.092	2017	0.107
		2018	0.075
		2019	0.058
		2020	0.053
		2021	0.058

2.5.1.2 The Instrumental Variable (IV) Regressions

In the case of a possible reverse causality between taxation and GDP and democracy, the Instrumental Variable (IV) estimators are also used to address the issue of endogeneity.

Table 22 - Effect of Taxation on Electoral Democracy Index, 2SLS Regression

	2SLS	2SLS	2SLS
Tax Revenues (% GDP)	**0.0074**	**0.0631**	**-0.0041**
Std. Error	(0.0023)	(0.0209)	(0.0072)
p-value	0.000	0.003	0.570
Non-Tax Revenues (% GDP)	**-0.006**	**-0.002**	**-0.001**
Std. Error	(0.001)	(0.002)	(0.001)
p-value	0.000	0.356	0.111
Log GDP *per capita*	**0.043**	**-0.024**	**0.011**
Std. Error	(0.005)	(0.027)	(0.009)
p-value	0.000	0.383	0.229
Aid (% GDP)	**0.007**	**0.006**	**0.002**
Std. Error	(0.002)	(0.002)	(0.001)
p-value	0.000	0.000	0.005
Tax Revenues^2 (% GDP)		**-0.0013**	**0.000**
Std. Error		(0.0004)	(0.000)
p-value		0.003	0.556
Taxation Threshold (% GDP)		**24.4**	
Lag of elect democracy			**0.924**
Std. Error			(0.012)
p-value			0.000
N	1296	1296	1255
R-Squared	0.818	0.760	0.976
Diagnostic tests			
Weak Instruments			
statistic	95.1	13.0	11.0
p-value	0.000	0.000	0.000
Wu-Hausman			
statistic	8.8	10.1	0.506
p-value	0.003	0.002	0.477
Sargan			
statistic	6.4	3.530	2.277
p-value	0.012	0.060	0.131

Looking at the diagnostic tests presented in Table 22, especially at the Wu-Hausman (1978) test for endogeneity, one can see that the null hypothesis is rejected, confirming in this way the endogeneity. Only at the regression in the last column, where the lagged dependent variable is used, is endogeneity rejected, demonstrating that using lagged dependent variable helps to address endogeneity. The F test for the weak instruments, which checks if the instruments are correlated with the endogenous regressor, show a rejection of the null, which indicates that the instruments used (the foreign trade (export+imports) to GDP ratio and a dummy variable that represents the establishment of a semi-autonomous revenue authority (RA) in each country) are not weak, demonstrating a strong correlation between them and the endogenous regressor taxation. The Sargan's (1958) test for the validity of over-identifying restrictions, is also confirmed especially in the models in column 3 (at 5%) and in column 4.

Besides using the IV estimator without individual or time effects, we also used IV with the Fixed Effect estimator presented in Table 23 and the GMM estimator presented in Table B2 of the appendix. As one can see, in all IV models it is clear that taxation affects the electoral democracy index in

Africa positively, up to a certain taxation ratio, after which a further increase reduces the democracy index.

Table 23 - Effect of Taxation on Electoral Democracy Index, IV Regression

	2SLS-FE	2SLS-FE	2SLS-FE	2SLS-FELDV
Tax Revenues (% GDP)	**0.0144**	**0.1284**	**0.1292**	**0.0340**
Std. Error	(0.0014)	(0.0513)	(0.0223)	(0.0114)
p-value	0.000	0.012	0.000	0.003
Non-Tax Revenues (% GDP)	**-0.007**	**0.006**	**0.000**	**0.000**
Std. Error	(0.001)	(0.007)	(0.003)	(0.001)
p-value	0.000	0.397	0.945	0.971
GDP *per capita*		**-0.176**	**-0.063**	**-0.029**
Std. Error		(0.118)	(0.033)	(0.014)
p-value		0.137	0.053	0.038
Aid (% GDP)		**0.013**	**-0.004**	**0.000**
Std. Error		(0.006)	(0.002)	(0.001)
p-value		0.042	0.114	0.902
Tax Revenues^2 (% GDP)			**-0.00237**	**-0.001**
Std. Error			(0.000)	(0.000)
p-value			0.000	0.003
Taxation Threshold (% GDP)			**27.3**	**27.2**
Lag of elect democracy				**0.738**
Std. Error				(0.029)
p-value				0.000
Countries	47	45	45	45
N	1553	1296	1296	1271
R-Squared	0.066	0.010	0.073	0.634

Notes: Due to significant missing data, seven countries were excluded in the first regression results: Algeria, Djibouti, Eritrea, Libya, Nigeria, Somalia, and South Sudan; and in the second column nine countries were excluded: Algeria, Djibouti, Eritrea, Libya, Nigeria, Somalia, Ethiopia, South Sudan, and São Tome e Principe.

Looking at Table 23 in the third column, one can see that the increase in tax revenues to GDP ratio, leads to an increase in the electoral democracy index up to a taxation level of 27.3%, and after this a further increase results in a lower democracy index, holding constant all other variables. Comparing the IV FE results with those of IV without fixed effects, the FE taxation coefficients are generally higher, suggesting, as Dom *et al.*, (2023) also noted when studying taxation and accountability in Africa, that unobserved country-specific or time-specific factors lead to a downward bias in the OLS results.

As for the control variables, the coefficients of the non-tax revenues to GDP ratio (in the first column of Tables 22 and 23) indicate that a 1 percentage increase in this variable can lead to a decrease in the electoral democracy index of about 0.006. As for the impact of the *per capita* GDP on electoral democracy index, it is not clear since the coefficients have contradictory signs, positive and negative (in Table 22), but looking at Table 23 it shows that *per capita* GDP has a negative impact. As for the Aid to GDP ratio, a 1 p.p. increase in this variable can lead to a 0.007 increase in the democracy index, *ceteris paribus*.

The IV regressions also confirm the nonlinearity relationship between democracy and taxation, since the coefficient of taxation squared is negative and statistically significant. The threshold is in the range of 24.4% and 27.3%. The coefficient of the lagged electoral democracy index (0.738) demonstrates how persistent the democracy index is.

2.5.2 Fractional Regressions Results for the Electoral Democracy Index

Now considering that the dependent variable, democracy index, has values within the unit interval, we also used fractional regression models to see if the results are similar to those of previous models. The first model that was used is the regression analysis of panel fractional responses, using fractional Cloglog regression model from the R package frmpd (using the GMMpfe estimator type) especially designed for panel data by Ramalho and Ramalho (2016). Since this package does not allow missing values, the sample was reduced by excluding the pairs of country/year with no data in all variables. We ended up with a balanced panel with 48 countries[51] and 1474 observations.[52] The second model is the Generalized Linear Models (GLM) with the Cloglog link function. The results are presented in the appendix in Table B4 and are quite similar to the other regression estimations results.

The results of the regression are presented in Table 24. As one can see, the sign of the coefficients of the regressors are in general the same as those obtained in the linear regression models reported above. For the case of the independent main variable of interest, the tax revenue to GDP ratio or taxation, its coefficient is positive and statistically significant (columns 1 and 2), showing that an increase in taxation causes an increase in the electoral democracy index, *ceteris paribus*. The non-tax revenues to GDP ratio coefficients have a negative and significant effect on the democracy index, the same effect obtained in the standard models.

Table 24 - Effect of Taxation on Electoral Democracy Index, frmpd Regression

	Cloglog	Cloglog	Cloglog
Tax Revenues (% GDP)	**0.0222**	**0.0016**	**0.0166**
Std. Error	(0.0048)	(0.0020)	(0.0060)
p-value	0.000	0.409	0.006
Non-Tax Revenues (% GDP)	**-0.009**	**-0.018**	**-0.018**
Std. Error	(0.005)	(0.003)	(0.003)
p-value	0.003	0.000	0.000
Log GDP *per capita*		**0.290**	**0.267**
Std. Error		(0.025)	(0.024)
p-value		0.000	0.000
Aid (% GDP)		**0.026**	**0.025**
Std. Error		(0.004)	(0.004)
p-value		0.000	0.000
Tax Revenues^2 (% GDP)			**-0.00031**
Std. Error			(0.000)
p-value			0.006
Taxation Threshold (% GDP)			**26.5**
N	1474	1474	1474

[51] Due to missing values and significant lack of data, six countries were excluded: Algeria, Eritrea, Libya, Nigeria, Somalia, and South Sudan.
[52] See Table B7 in the appendix for the complete statistical description.

The impacts of *per capita* GDP and of the Aid in percent of GDP on the democracy index are also positive and statistically significant, as obtained in the linear model as well. Even the nonlinearity relationship between taxation and democracy is also confirmed in the fractional regression, showing that a further increase in taxation after reaching the threshold of tax revenue to GDP ratio of 26.5%, can lead to a decrease in the democracy index thereafter. The threshold taxation ratio of 26.5% from the fractional model, which is the appropriate regression model taking into account the nature of the dependent variable, is close to that of the IVFE regression model 27.2% (Table 23, last column). So, we can conclude that, all the rest remaining constant, the tax revenue to GDP ratio that yields the highest democracy index in the continent is around 26% to 27%.

Linear Transformation of Fractional Responses Variable

The linear regression, which results from the linearly transformed electoral democracy index, as a fractional response variable, are presented in Tables 25 and 26.

Table 25 - Effect of Taxation on Electoral Democracy, Logit Transformed Index

	OLS	FE	FE	FE-LDV	FE-LDV
Tax Revenues (% GDP)	**0.0222**	**0.0227**	**0.0416**	**0.0074**	**0.0153**
Std. Error	(0.0028)	(0.0032)	(0.0086)	(0.0021)	(0.0058)
p-value	0.000	0.000	0.000	0.001	0.009
Non-Tax Revenues (% GDP)	**-0.023**	**-0.007**	**-0.002**	**-0.002**	**-0.002**
Std. Error	(0.005)	(0.004)	(0.005)	(0.003)	(0.004)
p-value	0.000	0.110	0.660	0.487	0.610
Log GDP *per capita*			**-0.066**		**-0.043**
Std. Error			(0.047)		(0.032)
p-value			0.160		0.182
Aid (% GDP)			**-0.0001**		**0.0003**
Std. Error			(0.003)		(0.002)
p-value			0.985		0.891
Tax Revenues^2 (% GDP)			**-0.00051**		**-0.00021**
Std. Error			(0.000)		(0.000)
p-value			0.002		0.059
Lag of elect democracy				**0.741**	**0.730**
Std. Error				(0.015)	(0.017)
p-value				0.000	0.000
Countries	50	50	48	50	48
N	1825	1825	1475	1772	1448
R-Squared	0.038	0.029	0.023	0.597	0.574

As reported in both Tables 25 and 26, the impact of taxation on the linear transformed democracy index (using either Logit or Cloglog) is positive and statistically significant, the results being similar to those obtained in the linear regressions without the transformation of the dependent variable shown in Table 24. Even the nonlinear concave relationship between taxation[53] and democracy is

[53] Since the dependent variable was transformed, there is no interest in computing the taxation threshold because its value would not reflect the true democracy index score, but that of the transformed index.

also evident in this regression with transformed fractional response variable, since the coefficient of squared tax revenues ratio to GDP is negative and statistically significant.

Table 26 - Effect of Taxation on Electoral Democracy, Cloglog Transformed Index

	OLS	FE	FE	FE-LDV	FE-LDV
Tax Revenues (% GDP)	**0.0160**	**0.0172**	**0.0300**	**0.0063**	**0.0116**
Std. Error	(0.0023)	(0.0026)	(0.0068)	(0.0017)	(0.0046)
p-value	0.000	0.000	0.000	0.000	0.012
Non-Tax Revenues (% GDP)	**-0.019**	**-0.005**	**-0.0004**	**-0.0014**	**-0.001**
Std. Error	(0.004)	(0.003)	(0.004)	(0.002)	(0.003)
p-value	0.000	0.138	0.926	0.545	0.727
Log GDP *per capita*			**-0.074**		**-0.034**
Std. Error			(0.037)		(0.025)
p-value			0.045		0.178
Aid (% GDP)			**0.0002**		**0.0003**
Std. Error			(0.003)		(0.002)
p-value			0.925		0.872
Tax Revenues^2 (% GDP)			**-0.00038**		**-0.00016**
Std. Error			(0.000)		(0.000)
p-value			0.005		0.075
Lag of elect democracy				**0.731**	**0.720**
Std. Error				(0.015)	(0.017)
p-value				0.000	0.000
Countries	50	50	48	50	48
N	1825	1825	1475	1772	1448
R-Squared	0.034	0.026	0.020	0.590	0.565

The control variable non-tax revenues to GDP ratio has, as in the regression without the transformation, negative impact on the electoral democracy, but is significant in only the OLS model. The persistence of democracy is also confirmed, since the coefficient of past electoral democracy index is positive and statistically significant, as in the earlier regression models.

2.5.3 Effect of Taxation on Various Democracy indices (Standard and Fractional Regressions)

We now present the regression results that show how taxation and the other explanatory variables affect each component of democracy, namely the electoral, liberal, participatory, deliberative, and egalitarian indices. Each index was set as the response variable one at time, using taxation, non-tax revenues, GDP *per capita*, and aid as regressors. The electoral democracy index is the main dependent variable discussed in the previous sections, whereas here we present the results, just for the sake of comparison, with the other indices.

Table 27- Effect of Taxation on Democracy Indices, IV Regression 2SLS-FE

	Electoral	Liberal	Participatory	Deliberative	Egalitarian
Tax Revenues (% GDP)	**0.1292**	**0.1091**	**0.0716**	**0.1077**	**0.0826**
Std. Error	(0.0223)	(0.0188)	(0.0123)	(0.0189)	(0.0144)
p-value	0.000	0.000	0.000	0.000	0.000
Non-Tax Revenues (% GDP)	**0.000**	**-0.001**	**-0.001**	**-0.001**	**-0.001**
Std. Error	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)
p-value	0.945	0.708	0.511	0.734	0.585
Log GDP per capita	**-0.063**	**-0.061**	**-0.020**	**-0.049**	**-0.038**
Std. Error	(0.033)	(0.028)	(0.018)	(0.028)	(0.021)
p-value	0.053	0.028	0.267	0.079	0.073
Aid (% GDP)	**-0.004**	**-0.004**	**-0.001**	**-0.003**	**-0.003**
Std. Error	(0.002)	(0.002)	(0.001)	(0.002)	(0.002)
p-value	0.114	0.037	0.359	0.203	0.025
Tax Revenues^2 (% GDP)	**-0.0024**	**-0.002**	**-0.00130**	**-0.00198**	**-0.001**
Std. Error	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
p-value	0.000	0.000	0.000	0.000	0.000
Taxation Threshold (% GDP)	**27.3**	**27.5**	**27.6**	**27.2**	**27.5**
Countries	45	45	45	45	45
N	1296	1296	1296	1296	1296
R-Squared	0.073	0.104	0.122	0.076	0.075

Table 27 shows the results of the 2SLS-FE regression[54] and it clearly demonstrates that taxation has a positive impact on all democracy indices up to a certain level, after which a further increase lowers the democracy indices, since the coefficient of tax revenues to GDP ratio (taxation) squared is negative and statistically significant, which shows that the relationship between taxation and democracy indices in Africa is nonlinear and concave. For the case of the electoral democracy index that threshold is estimated to be 27.3%, for the liberal index 27.5%, for the participatory democracy index 27.6%, for the deliberative index 27.2%, and for the egalitarian democracy index 27.5%.

Regarding the control variables, the non-tax revenues to GDP ratio is not statistically significant on all democracy indices. The impact of GDP *per capita* on the democracy indices is negative and statistically significant in all indices except for the participatory; its coefficients show that a 1 percentage point increase in this variable leads to a decrease of 0.063 in the electoral democracy, 0.061 in the liberal, 0.049 in the deliberative, and 0.038 in the egalitarian democracy index, holding all other variables constants. As for the aid, its effect is negative and statistically significant for only the liberal and egalitarian indices, with a 1 p.p. increase in the aid to GDP ratio causing a decrease of 0.004 and 0.003 in the liberal and egalitarian democracy indices, respectively.

The fractional regression results reported in Table 28 confirm those of the standard regressions above, namely the concave relationship between taxation and democracy indices. These results show that for the case of the egalitarian democracy index, the taxation rate that would yield the

[54] The results of the FE-LDV regression in Table B4 and B5 in the appendix are also similar, showing that the impact of taxation on democracy indices is nonlinear concave and statistically significant. The results of IV GMM regression in Table B6 also show that taxation has a positive and statistically significant impact on democracy indices.

greatest index is 37.3% of tax revenues to GDP ratio, for the liberal democracy index the tax rate is 30.3%, for the electoral democracy index is 26.5%, for the participatory index is 26.4%, and for the deliberative democracy index the tax rate is of 24.7%. After these rates a further increase in the taxation would decrease the democracy indices. It is interesting that the Egalitarian index seems to require a higher taxation threshold to maximize its index in comparison to the other indices. Perhaps the complexity of the egalitarian type of democracy (which demands that rights and freedoms of individuals be protected equally across all social groups, the resources be distributed equally across all social groups, and groups and individuals enjoy equal access to power) might explain this.

Table 28 - Effect of Taxation on Democracy Indices, Fractional Regression (frmpd Cloglog)[55]

	Electoral	Liberal	Participatory	Deliberative	Egalitarian
Tax Revenues (% GDP)	**0.0166**	**0.0470**	**0.0306**	**0.0414**	**0.0286**
Std. Error	(0.0060)	(0.0027)	(0.0012)	(0.0028)	(0.0022)
p-value	0.006	0.000	0.000	0.000	0.000
Non-Tax Revenues (% GDP)	**-0.0180**	**-0.0252**	**-0.0191**	**-0.0222**	**-0.028**
Std. Error	(0.003)	(0.001)	(0.001)	(0.001)	(0.001)
p-value	0.000	0.000	0.000	0.000	0.000
GDP *per capita*	**0.267**	**0.272**	**0.228**	**0.260**	**0.218**
Std. Error	(0.024)	(0.012)	(0.006)	(0.014)	(0.009)
p-value	0.000	0.000	0.000	0.000	0.000
Aid (% GDP)	**0.0252**	**0.0285**	**0.0256**	**0.0232**	**0.0258**
Std. Error	(0.004)	(0.002)	(0.001)	(0.002)	(0.001)
p-value	0.000	0.000	0.000	0.000	0.000
Tax Revenues^2	**-0.00031**	**-0.00078**	**-0.00058**	**-0.00084**	**-0.00038**
Std. Error	(0.00011)	(0.00005)	(0.00002)	(0.00005)	(0.00005)
p-value	0.006	0.000	0.000	0.000	0.000
Taxation Threshold	**26.5**	**30.3**	**26.4**	**24.7**	**37.3**
N	1474	1474	1474	1474	1474

As for the other explanatory variables, the fractional results show that the non-tax revenues as a percent of GDP have a negative and significant impact on the democracy indices (with greatest impact on the egalitarian), meaning reliance on the non-tax revenues is detrimental to democracy indices. The nominal GDP *per capita* and the aid in percent of GDP have both positive and significant effect on all democracy indices (with the impact of GDP *per capita* being lower on the egalitarian index, and of the aid in percent of GDP being higher on the liberal democracy index, followed by the egalitarian).

2.6 Discussion of the Main Results and Policy Implications

The coefficients of tax revenue to GDP ratio in all regression models presented above show unequivocally that taxation has been contributing positively to increases in all democracy indices in Africa (be it electoral, liberal, participatory, deliberative, or egalitarian) up to a certain threshold, after which a further increase in taxation leads to a reduction in the democracy indices. These results differ somewhat from what have been so far reported in the literature. In the literature the

[55] The fractional regression model for panel data (frmpd) R package developed by Ramalho and Ramalho (2016) was used.

relationship between taxation and democracy is usually presented as linear and positive. For instance, Braütigam *et al.* (2008) found evidence of a positive relationship between taxation and State-building in Developing Countries around the World, and Baskaran (2013) found that general government tax revenues (as percentage of GDP) had a mild positive impact on democracy indicator (measured by POLITY IV democracy index) in developing countries, and Dom *et al.* (2023) found that taxation increased accountability indices in Sub-Saharan African countries. In our case, however, we found a concave relationship between taxation and democracy.

The regressions showed that the relationship between tax revenue to GDP ratio and democracy indices in Africa is nonlinear (concave), presenting an inverted U shape. The threshold, which depends on the regression method and on the type of democracy index, is most likely around 26%-27%. Comparing it with the observed average tax revenue to GDP ratio in the continent of 14% (Figure 33), it shows that there is still room for the increase of taxation in Africa for countries with lower taxation, before it starts having a decreasing impact on democracy. In fact, Africa is the continent with the lowest tax revenue to GDP ratio in the world. Addison and Levin (2007), in their paper on the Determinants of Tax Revenue in Sub-Saharan Africa, documented using IMF data from 1990 to 2005 that the fiscal revenues to GDP ratio in Africa were the lowest among other continents such as Europe, Asia, and America. This is still true today; data from Global Revenue Statistic Database from the OECD (2023) show that revenue collection in Africa remains lower in comparison to other regions, being 16% as of 2021, while in Asia is 20%, in the Pacific, Latin America, and Caribbean is 22%, and is 34% in the OECD countries.

The estimated individual fixed effects revealed that countries with the greatest individual fixed effects are those that generally have the most functional institutions on the continent, and with reasonably good governance, which affects the level of tax collection and in turn increases the civic awareness of citizens, which contributes positively to levels of democracy. For instance, Mauritius, Cabo Verde, Botswana, Ghana, Senegal, South Africa, Ghana, São Tomé, Namibia, Liberia, and Seychelles have made considerable advances in creating effective and transparent institutions that serve their citizens well, and these countries are references of good governance in the continent. Therefore, creating and maintaining good institutions that foster good governance is crucial for the democratization process in Africa and enforcement of tax collection.

The negative and significant impact of the non-tax revenues in percent of GDP on the democracy indices found particularly in the fractional regressions (Table 28) reveals that in the case of Africa, higher non-tax government revenues compromises the democratization process. Taking into account that these revenues (generally being royalties paid to the government by international companies from natural resources explorations) do not come from the local citizens and companies, the government does not have an incentive to improve democracy. As Dom *et al.* (2023) pointed out, countries with access to natural resource rents have less incentive to increase taxes and this can hinder internal democratization processes. In fact, Ross (1999) calls this fact “the political resource curse”. Prichard *et al.* (2018) also found evidence of the political resource curse when they studied the relationship between taxation, non-tax revenue, and democracy in developing countries, arguing that natural resources wealth is anti-democratic in both autocracies and democracies, and this curse is driven mainly by oil wealth, and governments are usually good at translating oil wealth into government revenues, which in turn drives the political resource curse.

The positive and significant effect of *per capita* GDP on all democracy indices (Table 28) shows that economic income indeed matters for democracy in Africa. The results accord with those of other studies in the literature. For instance, using historical and comparative methods and correlation analysis covering 47 countries, Lipset (1959) revealed that an increased and enlarged middle class stimulates democracy, since educated people and those with higher income are in general more demanding and better informed when it comes to the voting process. Barro (1999) studied the determinants of democracy in a panel of 138 countries from different continents covering the period between 1960 and 1995 and concluded that improvements in *per capita* GDP increased the propensity for democracy (as measured by electoral rights indicator). Both Baskaran (2013) and Dom *et al.* (2023) also found that nominal GDP *per capita* has a positive impact on democracy in the countries that they studied. Democracy as a political system to function well requires money in order to finance the various institutions required to keep it working. Without proper funding those institutions will not work effectively. That is why higher GDP *per capita* affects democracy positively, including in Africa. Policies aiming at the overall economic growth of the African countries will help the continent to improve democracy indicators.

Also, the mildly positive and significant effect of aid in percent of GDP on all democracy indices (Table 28) in Africa is an indication that development aid in percent of GDP influences democracy indicators in the continent. It is an undeniable fact that the Western countries require good governance and democracy when giving aid to developing countries, especially in Africa. This result confirms the claim by Cilliers (2023) that the demand for democracy and good governance by the Western countries has resulted in the early democratization of Africa, since many countries on the continent have higher levels of democracy *vis-à-vis* other countries in the world of similarly low levels of education and income. These results highlight that Western countries that want to see working democracies in Africa should help the countries in the continent to better collect taxes, in view of its positive impact on democracy indices, since internal factors such as tax revenues' collection can in a more sustainable way boost democracy than does the external factor of aid.

2.7 Conclusion

Here in Chapter 2 we used several econometric methods to analyse the impact of taxation (measured as tax revenue to GDP ratio) on the democratization process in Africa (measured by various democracy indices: electoral, liberal, participatory, deliberative and egalitarian). The findings reveal that taxation affects all democracy indices in the continent positively up to a certain threshold, after which a further increase in taxation leads to a reduction in the democracy indices. That threshold was found to be, depending on the method and type of democracy index, close to 26%-27%, which is much higher than the historical average tax revenue to GDP ratio in the continent of 14%. The robustness of the results was also confirmed by using fractional regression models, a novelty in this type of literature.

These results show clearly that taxing the population has the potential to increase the awareness of citizen participation in the public discourse, leading to greater democracy indices. It is thus crucial for both African policymakers and citizens to understand that taxation is not just a matter of collecting revenues for the government, but is also a matter of civil participation in the public affairs of the country, helping the society to become more democratic. Among the control variables used, non-tax revenues as a percent of GDP showed a negative impact on democracy indices, confirming the political "resource curse" nature of the natural resource's wealth pointed out in the literature by Ross (1999) and Prichard *et al.* (2018). The impact of the *per capita* GDP in the fractional regression proved to be positive, showing that GDP *per capita* does impact democracy in Africa, which is in line with the literature (Lipset, 1959; Barro, 1999; Acemoglu *et al.*, 2008; Baskaran, 2013). As for aid in percent of GDP, it has a mildly positive impact on all democracy indices.

In this research we were able to assess the impact of taxation on democracy indices in Africa only as a whole. Future research needs also to peer into each country using time series data to see how the dynamic of taxation is affecting that country's scores of democracy alone, not in combination with other countries. Also, with regard to the taxation it will also be of great interest to study how different taxes (direct taxes – on profits, on personal income, on property – and indirect taxes – on consumption, VAT, on imports, and exports) affect the various democracy indices in Africa.

3. Estimation of the Laffer Curve for a Panel of African Countries

Executive Summary: in Chapter 3 we study the Laffer curve for the three main tax revenue categories (corporate, labour, and indirect) using a panel of 25 African countries in the period of 2011-2021 using parametric, semi-parametric, and nonparametric regression methods. The three regression approaches revealed the evidence of a Laffer curve for the corporate, labour, and indirect tax revenues (both in USD, and as ratio to GDP). The Revenues Maximizing (RM) tax rates for the corporate tax revenues in USD using the semi-parametric and nonparametric regressions are of 26%-27%, and of around 27%, respectively. The indirect tax revenues are 13%-14% according to the semi-parametric regressions, and 15.2% according to the parametric. In the case of labour tax revenues the RM tax rates are much larger, with values of 45% according to the semi-parametric model, and 40.8% according to the parametric model. Comparing the estimated RM tax rates with the current average rates in 2021, for the case of corporate taxes, the current average rate is at the prohibitive range of the Laffer curve; as for the indirect taxes the current average rate is very close to the top of the Laffer curve; for the case of labour taxes, the actual average tax rate is below the RM tax rate. We also studied the impact of the shadow economy on each tax revenue category and found a negative effect of the informal economy on all three tax revenue categories.

Keywords: Africa, Laffer curve, Tax revenues, Tax rates, Shadow economy, Nonparametric and parametric regression.
JEL codes: C20,E62,H21,O55

3.1 Motivation and Main Findings

African countries collect lower tax revenues as a percentage of GDP in comparison to developed countries, and to other continents such as Latin America and Asia. Because of this, they are urged to increase tax revenues on one hand and to decrease tax rates on the other in order to attract more foreign investment. The international competition for foreign direct investment leads countries to lower corporate tax rates to attract investment that might boost the economic activities and generate employment, but countries also need to raise taxes in order to increase tax revenues to satisfy the growing demand for public services and infrastructures. To offset lower corporate tax rates some countries increase the rates for the labour, and indirect (consumption) taxes.

How can African countries meet this seemingly contradicting goal of collecting more tax revenues while lowering tax rates? The notion of a Laffer curve can help us to understand and answer this question. The Laffer curve, presented as a theoretical result, establishes a concave (inverted U-shaped) relationship between tax rates and tax revenues collected by the government. The curve shows the basic idea that changes in tax rates have two effects on tax revenues: the arithmetic effect and the economic effect. According to Arthur Laffer (2004), the economist after which the curve is named, the arithmetic effect is when tax rates are lowered, tax revenues (*per* dollar of tax base) will be lowered by the amount of the decrease in the rate. As for the economic effect, the reduced tax rates can have a positive impact on the tax base by increasing the incentive of the economic agents to work, consume, and produce more, which can boost taxable income.

Several studies have been undertaken on the empirical evidence of the Laffer curve in different countries and regions of the world, as the literature review below shows. Nevertheless, we are not aware of any studies that focus specifically on the relationship between tax rates and tax revenues in Africa. It is important to study this relationship for the case of African countries because in this era of competition for investments between countries, in which countries are urged to lower certain taxes and raise others, it is essential for them to know in which range of the Laffer curve their tax rates are, to see if it is feasible to reduce them or not. Our purpose in this chapter is therefore to investigate if there is any empirical evidence of the Laffer curve for some specific taxes in Africa such as corporate, personal income, and indirect taxes (consumption or value added taxes). We study a panel of up to 25 African countries, using data from 2011 to 2021. We use parametric, semi-parametric, and nonparametric regression models to gauge the relationship between tax rates and tax revenues in those countries. Using nonparametric regression models for the Laffer curve, which does not pre-assume any specific functional form, as parametric regressions do, is also one of our contributions to the literature. In the regressions, we also control for the effects of the informal economy by using in the models the size of the shadow economy as percent of GDP for each country in the sample.

The results from the parametric, semi-parametric, and nonparametric approaches show clear evidence of the existence of the Laffer curve in the three tax categories. For the corporate taxes we found the RM tax rates to lie in the range of 26% to 27% for the panel of African countries, being relatively lower than that of the OECD countries (26% to 34%) estimated by Clausing (2007); and that of China 40%, estimated by Lin and Jia (2019). For the labour and indirect taxes, the RM tax rates are 40% to 45% and 13% to 15.2%, respectively. We also studied the impact of the shadow economy on each tax revenue category and found a negative and statistically significant effect of the informal economy in all three tax revenue categories (corporate, labour, indirect), showing that reducing informality can boost tax revenues in Africa.

The rest of the chapter is organized as follows: in Section 3.2 we present the concept of the Laffer curve and a brief review of the literature, Section 3.3 describes the data and the methodology, Section 3.4 has the estimation results, Section 3.5 discusses the main results and some policy implications, and in Section 3.6 the main conclusions are presented.

3.2 The Laffer Curve and a Literature Review

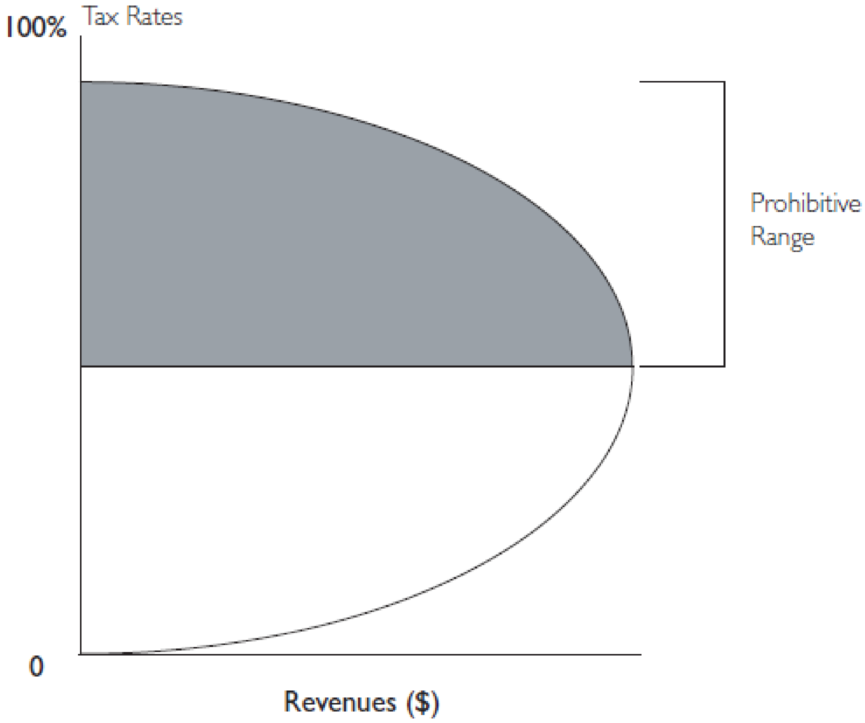
Governments around the world need tax revenues to finance public expenditures related to the fulfilment of their roles, and in attempting to raise more tax revenues most of them increase tax rates in the belief that higher rates will yield greater tax revenues. But is it true that higher tax rates will always increase fiscal revenues? This question was addressed in the 18th century by the English economist Adam Smith in his book *Wealth of Nations* (1776, chapter 2, p. 78), in which he argued that increasing tax rates can sometimes lead to smaller revenues in comparison to the revenues that more moderate rates would generate, because high taxes can encourage smuggling and can even reduce the incentive for people and businesses to produce more, reducing in this way the taxable base.

In view of the fact that high tax rates can sometimes result in lower tax revenues, the American economist Arthur Laffer continued the analysis. In December of 1974, when discussing President Gerald Ford's proposal for tax increases to reduce inflation with Donald Rumsfeld (the Chief of Staff to the President at the time) and other economists, Laffer sketched a curve demonstrating the trade-off between tax rates and tax revenues, claiming that there is a certain optimal tax rate that maximizes revenues, after which a further increase in the rate would result in lower tax revenues (Laffer, 2004). This curve, showing the concave relationship between tax rates and tax revenues, was named as the "Laffer Curve" by Jude Wanniski in the article "Taxes, Revenues, and the Laffer Curve" (Wanniski, 1978).

Regarding the concept of the trade-off between tax rates and revenues, Laffer himself acknowledged that it was not invented by him and said that the 14th century Muslim philosopher Ibn Khaldun had this notion and expressed it in his book the *Muqaddimah*, in which he wrote, as quoted by Laffer (2004), "It should be known that at the beginning of the dynasty, taxation yields a large revenue from small assessments. At the end of the dynasty, taxation yields a small revenue from large assessments." Laffer also cited John Keynes as being aware of this trade-off when he wrote that "…taxation may be so high as to defeat its object, and that, given sufficient time to gather the fruits, a reduction of taxation will run a better chance than an increase of balancing the budget", *The Collected Writings of John Maynard Keynes* (1972). In fact, in the Keynesian model of IS and LM, tax is an important policy variable that is usually used to stimulate both consumption and production, since lower tax rates increase the disposable income that can be spent on more investment or consumption, and that can increase the production of goods and services.

In theoretical conceptualization the Laffer curve establishes a concave (or inverted U-shaped) relationship between taxes rates and the volume of tax revenues collected by the government. According to Laffer (2004) the curve shows the basic idea that changes in tax rates have two effects on tax revenues: the arithmetic effect and the economic effect. The arithmetic effect is simply that if tax rates are lowered, tax revenues (per dollar of tax base) will be lowered by the amount of the decrease in the rate; and the reverse is true for an increase in tax rates. As for the economic effect, the reduced tax rates can have a positive impact on the tax base by increasing the incentive of the economic agents to work, consume and produce more, causing more economic activities, taking into account that with lower rates, their disposable income will increase. Now, when the tax rates are increased the economic activity will be penalized since the economic agents will have lower incentive to consume, to work, and to produce more in view of having lower disposable income. Laffer argues that the arithmetic effect is always opposite to the economic effect, so when both effects are combined the result of the change in tax rates on total tax revenues is no longer so obvious, and a rigorous assessment needs to be performed to determine which effect prevails. To better understand the concept of the Laffer curve and the relationship between tax rates and tax revenues consider a graph sketched by Laffer (2004) that illustrates how the trade-off between these two variables theoretically works.

Figure 46 - Graphical Representation of the Laffer Curve



Source: Arthur B. Laffer

As shown in Figure 46, theoretically there are two extreme tax rates that result in zero or non-collection of tax revenues, the rate at 0% and the rate at 100%. Assuming that there is no lump sum tax, with the zero tax rate there will be no tax revenue since no proportion of income will be received by the treasury. In like manner with a tax rate of 100 percent no economic agent will be willing to work or produce anything because the government will take all his/her income or profit, and so there will be no tax revenue collection.

Between these two extremes rates there are two tax rates that will generate the same amount of tax revenue: a high tax rate on a small tax base and a low rate on a large tax base. There is also an optimal tax rate that will result in the collection of the maximum amount of tax revenue. After this rate, an additional increase in the rate will reduce the amount of tax collected, causing smaller fiscal revenues, which will turn out to be the same as those generated from a lower rate but with a larger tax base, so a government would minimize total tax burden by choosing the lower rate of the normal range (Fullerton, 1980).

Any rate after the optimal tax rate will fall into the prohibitive range that Figure 46 depicts. So, if the existing tax rate is in the prohibitive range (the grey area), being too high, a tax-rate cut would result in increased tax revenues, since in this case the economic effect of the tax cut would outweigh the arithmetic effect. If the tax rate is in the upward-sloping normal range, tax revenue will increase when the tax rate is raised (Hsing, 1996).

Since the Laffer curve was explicitly presented by Arthur Laffer in the 1970s, several empirical studies have been carried out, presenting evidence of this relationship for some countries. For instance, in his paper on Swedish tax rates, labour supply, and tax revenues, using a two sector model parameterized to the Swedish economy, Stuart (1981) showed for the case of Sweden in 1979 that the income tax revenues were maximized at the average marginal rate of 70%, although in that particular year the average income tax was about 80%, well above the prohibitive range of the Laffer curve, meaning that a cut in tax rate would increase both labour supply and tax revenues.

Fullerton (1982) studied the US economy using a general equilibrium model for the US, plotting the Laffer curve for several elasticities of labour supply, and found that the revenue-maximizing tax rate or the optimal tax rate varied inversely with the labour supply elasticities, the estimated RM tax rate being of 78.8%, taking into account the labour supply elasticity of 0.15. Fullerton concluded that the US could have been operating in the prohibitive range of the Laffer curve, where lower tax rates would have increased tax revenues.

Lindsey (1987), also studying the US economy, measured the response of taxpayers to the US personal income rate cut from 1982 to 1984, with a baseline income distribution model created to describe what level and distribution could be expected in the absence of tax changes, and concluded that between 1/6 and 1/4 of revenue loss due to the rate reductions was recovered by changes in taxpayers behaviour, since tax cuts increased personal income by about 2% as a result of the increased economic activity. The study also revealed that the federal income tax revenue would have been maximized at a total tax rate of about 40%, pointing out that for the low and middle income taxpayers as a whole, the US tax system was operating on the upward-sloping range of the Laffer curve, whereas the richest income group was on the prohibitive range.

Van-Ravestein and Vijlbrief (1988) studied the Netherlands using a simple general equilibrium model, corresponding in large part with the Stuart (1981) models for Sweden and the Stuart model (1984) for the USA, to compute the welfare cost of higher tax rates and estimate the Laffer curve. The authors found that the country tax system was operating on the upward normal sloping portion of the Laffer curve in 1985, since the RM tax rate was estimated to be of 70% and the verified tax rate at that year was 67%, 3 percentage points below the revenue maximizing tax rate, showing that the Dutch economy was nearing the limits of taxation on income.

Taking into account that Fullerton (1982) and Lindsey (1987) reached different conclusions regarding the optimal tax rate that maximized tax revenues in the USA and the impact of changes in tax rates on tax revenues, Hsing (1996) re-examined the Laffer curve for the USA using time-series data between 1959 and 1991. The author specified total personal income tax as a quadratic function of the income tax rate and regressed it applying different functional forms such as the linear, the log-log, and the semi-log. The linear and log-log regressions showed better results than the semi-log regressions in terms of the explanatory power, the significance of the coefficients, and the expected signs consistent with the Laffer curve. The findings revealed that the concave relationship between tax revenues and tax rates was statistically significant and that the revenue-maximizing (RM) tax rate was between 32.67% and 35.21%. With these results the author advised that the increase in the maximum personal income tax rate from 31% to 36%, which was expected in the Budget Reconciliation Bill at that time passed by the Congress, was expected to push the US position on the Laffer curve toward the maximum point, and would reduce income tax revenue collected from the highest income group.

Clausing (2007) showed evidence of the Laffer curve for 29 OECD countries regarding corporate income tax revenues, using data from 1979 to 2002 and applying a fixed effect (FE) regression estimator. The research revealed that a parabolic relationship existed between tax rates and revenues, implying a revenue-maximizing corporate income tax rate of 33% for the whole sample. The optimal corporate tax rate was found to decrease as economies are smaller and more integrated with the global economy. Brill and Hassett (2007) replicated Clausing's study, also using the FE regression covering the period 1980-2005 for the same 29 OECD countries and obtained the same results. They also revealed that the revenue maximizing corporate tax rate was about 34% in the late 1980s, and that this optimal rate has fallen steadily to about 26% for the most recent period.

Lin and Jia (2019) studied the case of direct tax on labour income in China, and showed evidence of Laffer curve for this country when applying a Computable General Equilibrium (CGE) model. Their results showed that the optimal tax rate that maximizes personal income tax revenues was estimated to be of 35%, and at present the comprehensive direct tax rate is less than 10%. Hence, they advised that technically speaking, if China wants to increase government tax revenue, it is feasible to increase the income tax rate, since the country is still in the upward normal sloping side of the Laffer curve, and it has less impact on economic output when the rate is under 20%.

Ferreira-Lopes, Martins, and Espanhol (2020) estimated the Laffer curve for Eurozone member countries, using panel data over the period 1995-2011 and applying Seemingly Unrelated Regression (SUR) models focusing on the value added tax (consumption), corporate income tax, and the labour income tax. The authors also estimated the RM tax rates of the value added tax, for Greece (between 22% and 26%), Portugal (35%), and Slovakia (between 13.4 % and 15.6%), and for the majority of the Eurozone countries, for direct taxes.

Using a two-sector neoclassical growth model with the introduction of the informal economy, Alba and Macknight (2022) characterize the Laffer curves under labour, consumption, and capital income taxation. They presented evidence of Laffer curve for five Latin American countries (Brazil, Chile, Colombia, Mexico, and Peru) and quantified how informality affects the fiscal space under each tax rate. For the case of Colombia, Mexico, and Peru they concluded that these countries can only increase tax revenues within the range of 2% to 4%, while Chile could maximally increase tax revenues by 11% with higher labour taxes; and Brazil can increase tax revenues by 6% by cutting labour taxes.

Ntertsou and Liapis (2022) used the FE estimator to study the relationship between corporate and personal incomes tax rates and tax revenues in the Euro Area over the period 2000-2018. They found that there are two different effects of a tax rate increase on respective tax revenues: the positive arithmetic effect of the tax rate increase and the negative economic effect of the tax base erosion, captured by the size of shadow economy. Their estimation confirmed the positive relationship between tax revenues and corresponding tax rates, as well as the negative effect of the size of the shadow economy on tax revenues. In Table 29 we summarize the main empirical studies on the evidence of the existence of a Laffer curve for some countries.

Table 29 - Main Studies on Empirical Evidence of the Laffer Curve

Dependent Variable	Main explanatory Variables	RM Tax Rates (%)	Period	Countries	Estimation Method	Authors
Personal Income Tax Revenues	Labour Income Tax Rates	80	1978-1980	Sweden	Parameterized Two Sector Model	Stuart (1981)
Labour Tax Revenues	Labour Tax Rates	78.8		USA	General Equilibrium Model	Fullerton (1982)
Labour Tax Revenues	Labour Tax Rates	40	1982-1984	USA	Baseline Income Distribution Model	Lindsey (1987)
Personal Income Tax Revenues	Labour Tax Rates	70	1970-1987	The Netherlands	Simple General Equilibrium Model	Van Ravestein and Vijlbrief (1988)
Personal Income Tax Revenues	Personal income tax rates	35.21	1959	USA	Time series Regression Model	Hsing (1996)
Corporate Income Tax Revenues (% GDP)	Corporate Tax Rates	26/34	1979-2002	29 OECD countries	FE Regression Model	Clausing (2007)
Direct Tax (Corporate and Labour) Revenues	Direct Tax Rates	40		China	Computable General Equilibrium Model	Lin and Jia (2019)
Corporate income tax Labour income tax Value Added Tax	Tax Rates and Business Cycle	VAT(13.4/35) LT(14/67) CT(14/50)	1995-2011	18 Eurozone member countries	Seemingly Unrelated Regression (SUR)	Ferreira-Lopes, Martins and Espanhol (2020)
Labour Tax Revenues	Labour Tax Rates	na		Brazil, Chile, Colombia, Mexico and Peru	Two Sector Neoclassical Growth Model	Alba and Macknight (2022)
Corporate Income Tax Revenues Personal Income Tax Revenues (% GDP)	Corporate, Personal Tax Rates, and Shadow Economy % of GDP	na	2000-2018	Euro Zone	FE Regression Model	Ntertsou and Liapis (2022)

Taking into account that we are not aware of any empirical study on the evidence of a Laffer curve in African countries, in this research we fill this gap, contributing to the literature on the topic. Our aim is to investigate if there is any econometric evidence of the Laffer curve for some specific taxes, such as corporate, personal income, and indirect taxes in a panel of up to 25 African countries using parametric, semi-parametric, and nonparametric regressions methods.

3.3 Data and Methodology

In this section we present the variables and data sources used to investigate if there is econometric evidence of a Laffer curve for a panel of African countries, and the econometric methodology that is applied.

3.3.1 Data and Variables

Table 30 summarizes the variables and the data sources that we use. In the next subsections we describe the variables in detail.

Table 30 - Variables and Data Sources for the Laffer Curve Study

Variables	Brief Definition	Period	Sources
Corporate Tax Revenues	It encompasses tax on income, profit, and capital gains of all enterprises in US dollars, and as % GDP	2011-2019 2011-2021	UNU-WIDER Government Revenues Dataset[56]
Labour Tax Revenues	Payroll of workforce tax revenues in US dollars, and as % GDP	2011-2019 2011-2021	UNU-WIDER Government Revenue Dataset
Tax Revenues on Goods and Services	It includes indirect taxes on sales, consumption, and also VAT in US dollars, and as % GDP	2011-2019 2011-2021	UNU-WIDER Government Revenue Dataset
Corporate Tax Rates	It is the statutory corporate income tax rates	2011-2021	KPMG[57]
Labour Tax Rates	It is the individual labour income tax rates	2011-2021	KPMG
Indirect Tax rates	The average tax rates on Goods and Services and also VAT	2011-2021	KPMG
Shadow Economy Estimates	Model-based and survey-based measures of informality as % of GDP	2011-2020	Elgin et al. (2021)

3.3.1.1 Dependent Variables

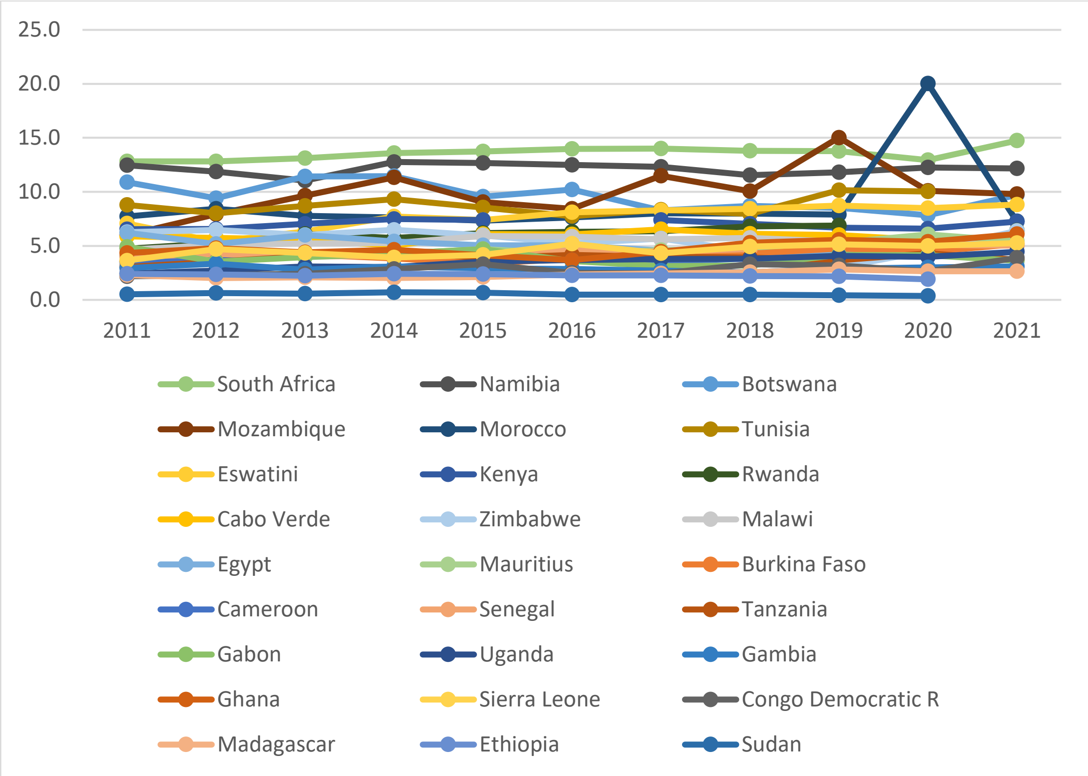
In this chapter we use different tax revenue categories as response variables, such as the corporate tax revenues, the labour tax revenues, and the indirect/consumption tax revenues, all as percent of GDP, and in millions of USD converted from the original database of UNU-WIDER in local currency unit using the exchange rates from Penn World Tables database available up to 2019.

3.3.1.1.1 Corporate Tax Revenues

The data from the United Nations University World Institute for Development Economics Research (UNU-WIDER) on corporate tax revenues for 25 African countries (the full database has data for the 52 African countries, but we selected only the 25 countries for which we were able to obtain the respective corporate tax rates). Figure 47 shows that South Africa, Namibia, Botswana, Mozambique, Morocco, and Tunisia are the countries in the panel that collect the highest corporate tax revenues to GDP ratio, whereas Sudan, Ethiopia, Madagascar, Democratic Republic of Congo, and Sierra Leone are the countries that mobilize the lowest corporate tax revenues.

[56] UNU WIDER : GRD – Government Revenue Dataset.
[57] Tax Rates Online - KPMG Brasil.

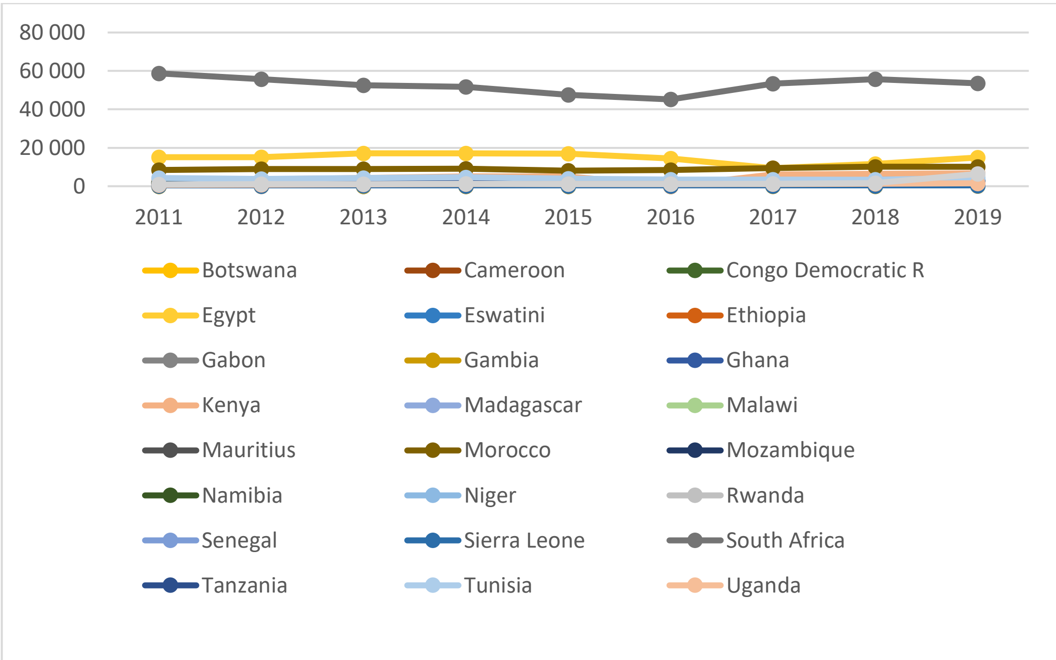
Figure 47 - Corporate Tax Revenues (% GDP)



Source: [UNU WIDER : GRD – Government Revenue Dataset.]

Looking at the corporate tax revenues in monetary values (in USD), Figure 48 shows that South Africa, Egypt, Morocco, Kenya, and Tunisia are the top countries in collecting corporate tax revenues in absolute value of USD.

Figure 48 - Corporate Tax Revenues (USD million)

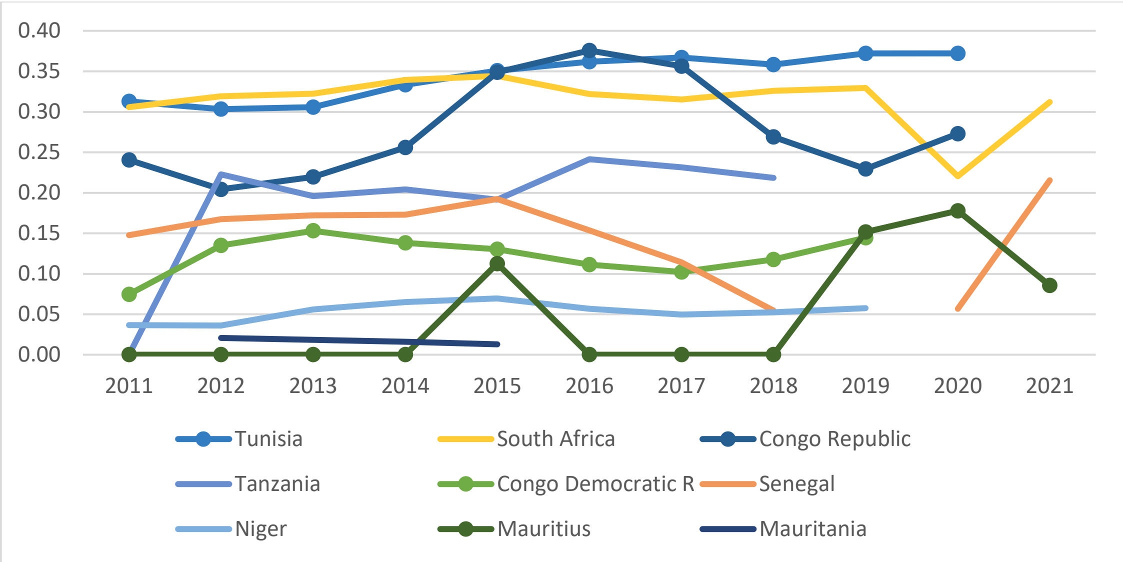


Source: Computed by the author using data from UNU-WIDER and Penn World Table.

3.3.1.1.2 Labour Tax Revenues

Looking at Figure 49 we see that few countries in Africa are high in collecting labour tax revenue to GDP ratio. In fact, the data from UN-WIDER show only 19 countries out of 42 countries in the dataset that are able to collect labour tax revenues, with the rest of the countries collecting actually zero percent. And out of 19 countries, there are only 9 for which we are able to obtain the respective labour tax rates. The high level of unemployment in the continent as a whole, and the high level of the informal economy in each country, might explain the low collection of labour tax revenues.

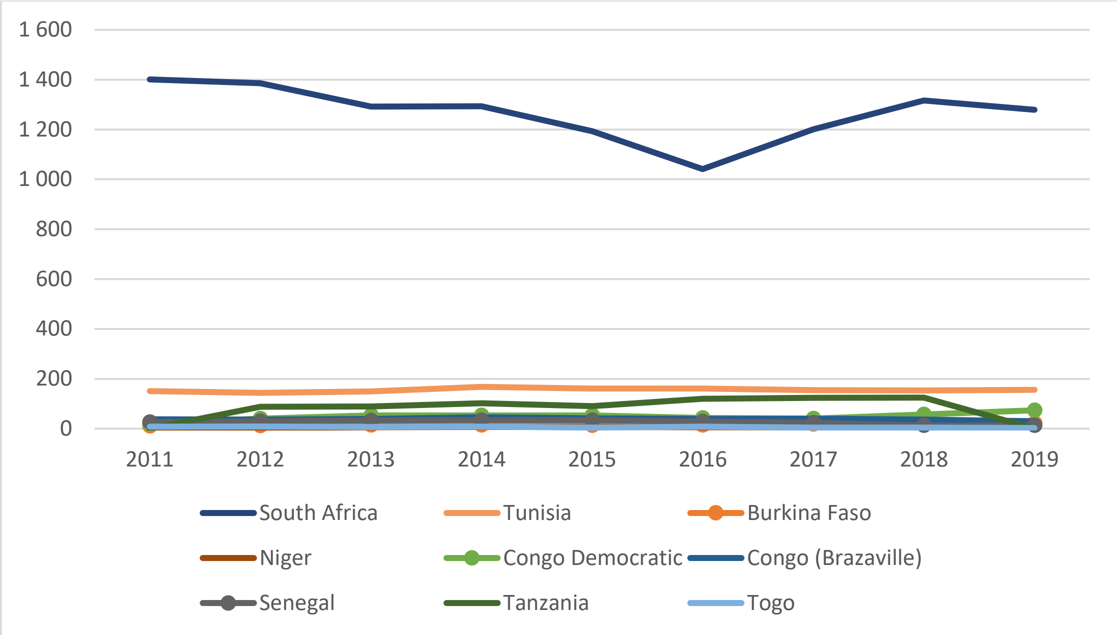
Figure 49 - Labour Tax Revenues as % of GDP



Source: [UNU WIDER: GRD – Government Revenue Dataset.]

Figure 50 shows the labour tax revenues in USD, with South Africa being the top collector with yearly average revenues of around USD 1.2 billion, followed by Tunisia, with average of USD 155 million.

Figure 50 - Labour Tax Revenues in Millions of USD



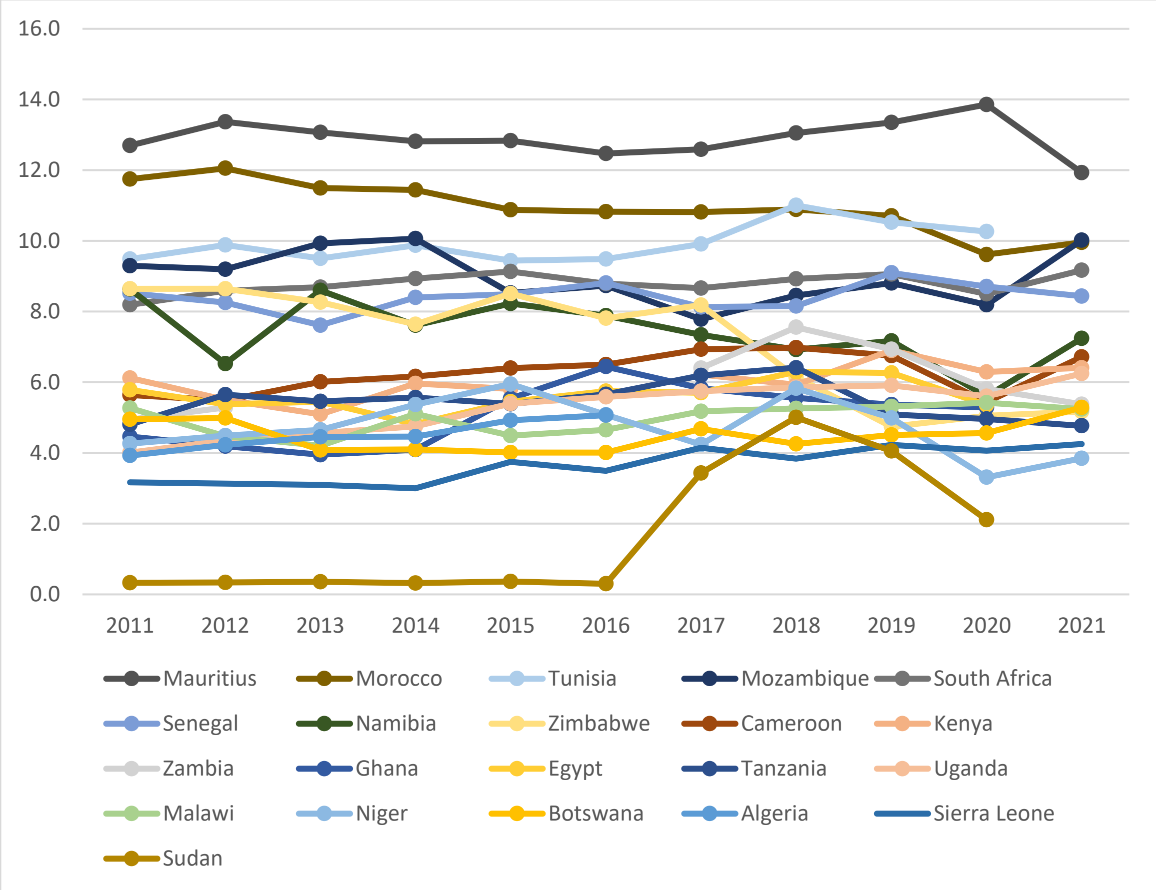
Source: Computed by the author using data from UNU-WIDER and Penn World Table.

3.3.1.1.3 Indirect Tax Revenues

The indirect tax revenues are the revenues of taxes on goods and services, which in some countries are classified as value added tax, and in others as consumption tax.

The data presented in Figure 51 show the indirect tax revenues as percent of GDP for 21 countries in the continent. Mauritius, Morocco, Tunisia, Mozambique, and South Africa are the countries with the highest collection of indirect tax revenues, whereas Sudan, Sierra Leone, Algeria, Botswana, and Niger are the countries with lowest collection. Almost all the countries in the sample collect sizeable indirect tax revenues as percent of GDP, on average being far greater than that of labour tax revenues.

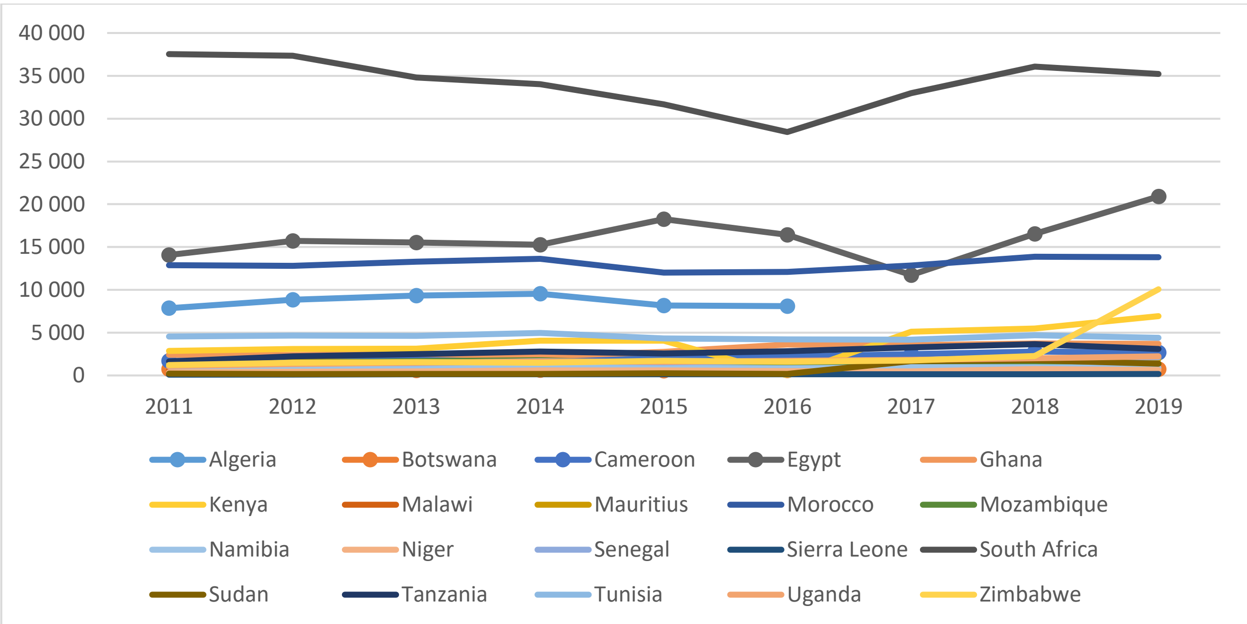
Figure 51 - Indirect Tax Revenues (Goods and Services) as % of GDP



Source: [UNU WIDER : GRD – Government Revenue Dataset]()

Figure 52 presents the data in monetary value of USD. South Africa, Egypt, Morocco, Algeria, and Tunisia have the largest nominal collection of indirect tax revenues in the continent.

Figure 52 - Indirect Tax Revenues (Goods and Services) in Millions of USD



Source: Computed by the author using data from UNU-WIDER and Penn World Table.

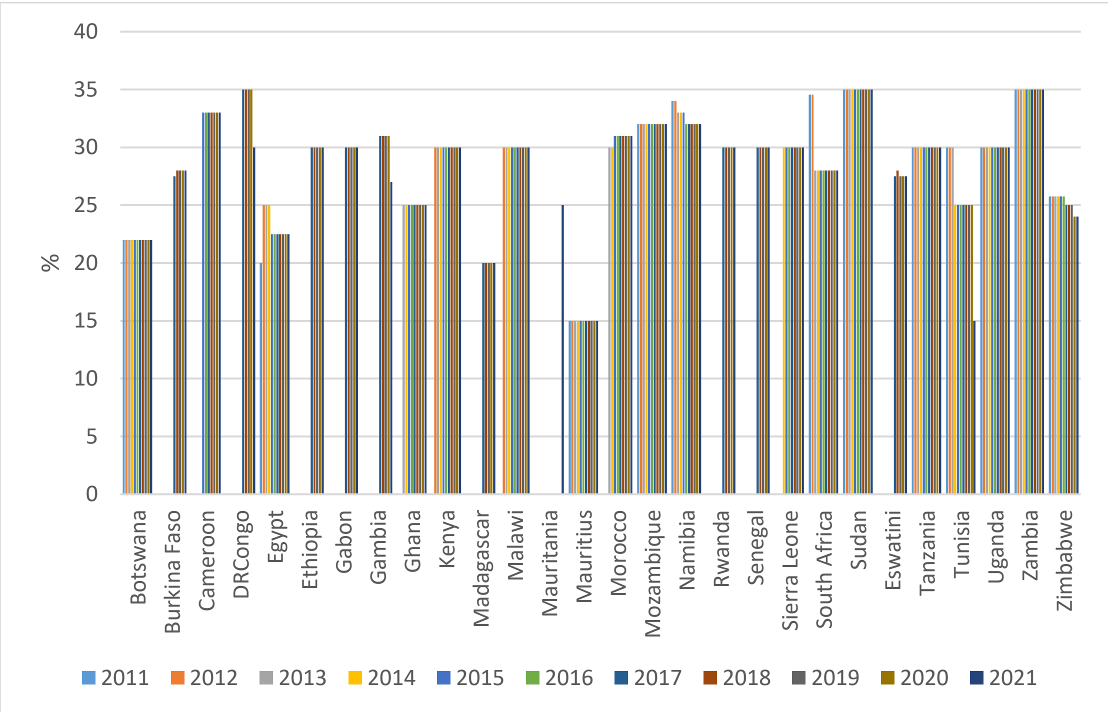
3.3.1.2 Independent Variables

We use the corresponding tax rates for each type of tax revenue, the squared tax rates, and the size of shadow economy estimates as the explanatory variables for the estimation of the Laffer curve.

3.3.1.2.1 Corporate Tax Rates

As presented in Figure 53, the KPMG dataset, which is an international consulting firm that operates in most of the African countries, contains corporate tax rates for only 28 African countries over the period 2011-2021. The average tax rate is 28.15%, with some of the countries gradually reducing the tax rate over time. The countries with corporate tax rates above the average are Cameroon, Democratic Republic of Congo, Morocco, Mozambique, Namibia, Sudan, and Zambia. The countries with lower corporate tax rates are Mauritius, Botswana, Egypt, and South Africa.

Figure 53 - Corporate Tax Rates in 28 African Countries

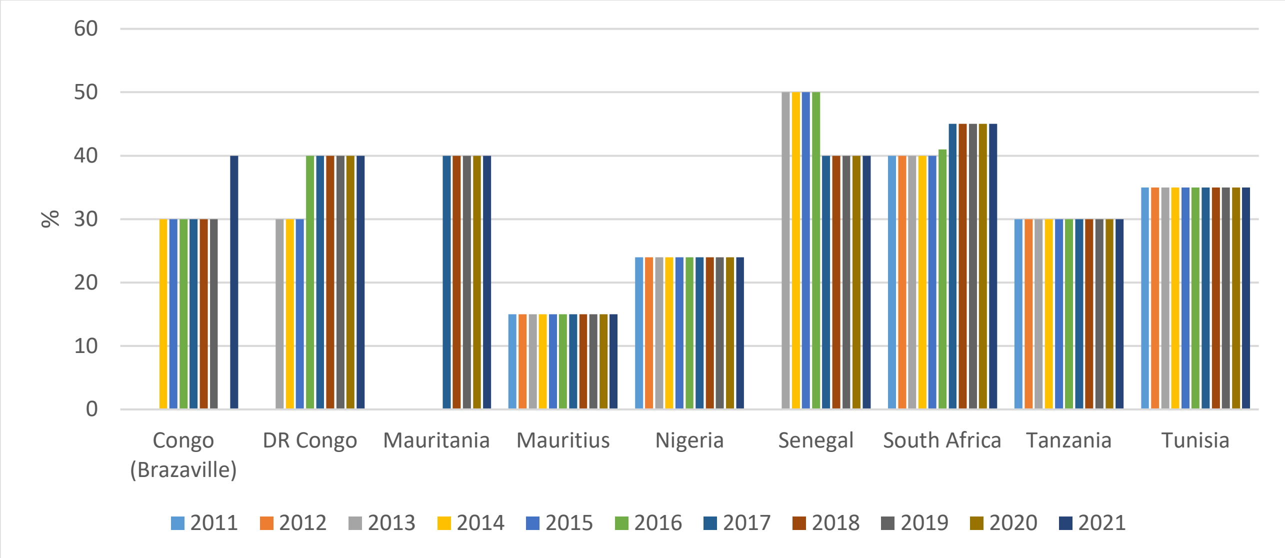


Source: [Corporate tax rates Table - KPMG Brazil.]()

3.3.1.2.2 Personal Income tax Rates

The personal income or labour tax rates presented in Figure 54 are taken from the KPMG dataset. In some countries the personal income tax rate has been changing, while in other countries has remained almost constant over the period 2011-2021. The average labour tax rate is 31%. South Africa, Senegal, Mauritania, and the Democratic Republic of Congo (DR Congo) have the highest labour tax rates.

Figure 54 - Personal Income Tax Rates

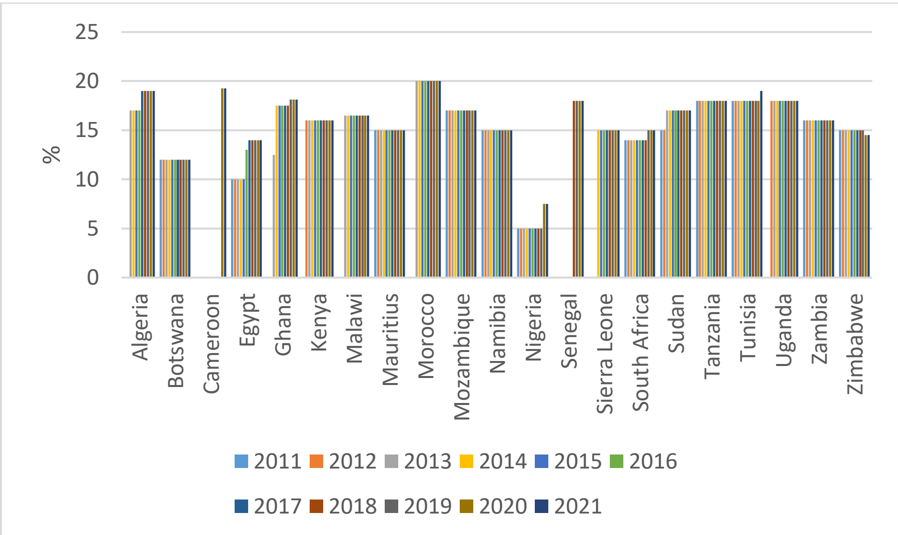


Source: [Individual income tax rates Table - KPMG Brazil.]

3.3.1.2.3 Tax Rates on Goods and Services

The tax rates on good and services in most of the African countries is the rate of the Value Added Tax (VAT). Figure 55 presents the tax rates for 21 countries in the continent. The average tax rate is 14.6%. The countries with the highest indirect tax rates are Algeria, Cameroon, Morocco, Mozambique, Senegal, Tanzania, Tunisia, and Uganda.

Figure 55 - Indirect Tax Rates



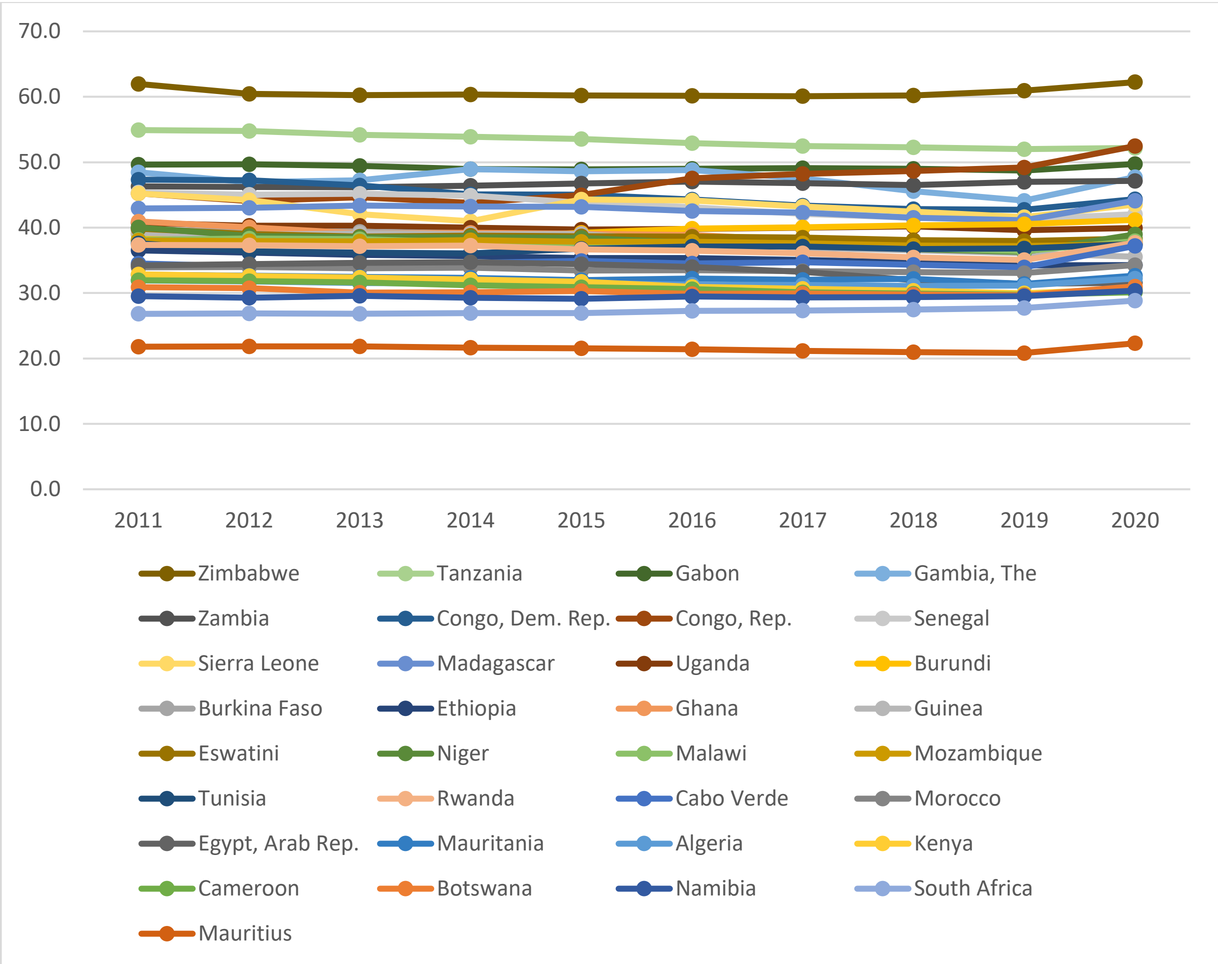
Source: [Indirect tax rates Table - KPMG Brazil.]

3.3.1.2.4 Shadow Economy Estimates

The size of the shadow economy of each country is taken from the comprehensive database of informal economic activity, computed by Elgin *et al*. (2021), using multiple indicators multiple causes model-based estimates of the informal sector output as percent of the official GDP. The database covers more than 160 countries of all continents[58] between 1990 and 2020.

Looking at Figure 56 one can see the size of the informal economy of the panel of African countries that is being studied. The countries with the highest shadow economy size are Zimbabwe, Tanzania, Gabon, Gambia, Zambia, and the two Congos, whereas Mauritius, South Africa, Namibia, Botswana, Cameroon, and Kenya are the countries with lowest informal economy size (in percent of GDP).

Figure 56 - Shadow Economy Size Estimates (% GDP)



Source: Elgin *et al.* (2021).

Comparing the data on corporate tax revenues (Figures 47 and 48) with that of the shadow economy in Figure 56, one can note that countries with lower informal economy (South Africa, Namibia, Botswana) have higher corporate tax revenues, and countries with higher informal economy (Gabon, Gambia, and the two Congos) have lower corporate tax revenues. The same is true for the other tax revenues, showing that informality erodes tax collection.

Table 31 presents the summary of descriptive statistics of all variables used to estimate the Laffer curve of different taxes in our panel of 25 African countries. We are dealing with an unbalanced panel because regarding the independent and control variables there are some countries with no

[58] For the African continent there are estimates for 48 countries, but we present the data for only the panel of countries that are being studied.

data, which reduces the total number of observations[59]. In Table 31, N represents the total number of observations, lowercase n is the number of countries, and T is the average number of years being studied over the period 2011-2021.

Table 31- Descriptive Statistics of the Main Variables (for the Laffer Curve Study)

Variables	Dimensions	Mean	Standard Deviation	Min	Max	Observations	
			Dependent (Y)				
	overall		10,547	38	58,749	N	212
Corporate Tax Revenues (USD millions)	between	4,347	10,394	43	52,688	n	25
	within		1,097	1,182	10,408	T	9
	overall	5.54	3.41	0.01	20.03	N	187
Corporate Tax Revenues (% GDP)	between		3.20	0.11	13.57	n	27
	within		1.04	0.81	16.69	T	9
	overall	262	443	0	1401	N	48
Labour Tax Revenues (USD millions)	between		429	0	1267	n	7
	within		43	36	396	T	7
	overall	0.20	0.064	0	0.427	N	56
Labour Tax Revenues (% GDP)	between		0.027	0	0.336	n	9
	within		0.056	0.0013	0.290	T	7
	overall	3,937	7,272	44	37,536	N	158
Goods Services Tax Revenues (USD millions)	between		7,183	68	34,230	n	19
	within		985	2079	11,430	T	9
	overall	6.34	3.36	0.069	18.298	N	159
Goods Services Tax Revenues (% GDP)	between		3.358	0.143	15.438	n	21
	within		0.946	1.762	10.341	T	9
			Independent (X)				
	overall	28.50	4.765	15	35	N	243
Corporate Tax Rates (%)	between		4.508	15	35	n	28
	within		0.92	22.6	33.6	T	9
	overall	31.83	8.962	15	51.5	N	183
Labour Tax Rates (%)	between		8.46	15	47.0	n	9
	within		2.641	20.2	38.1	T	8
	overall	15.44	3.237	5	20	N	177
Indirect Tax Rates (%)	between		3.211	5	20	n	21
	within		0.748	12	17.8	T	9
	overall	38.95	9.0	20.8	62.0	N	231
Shadow Economy Estimates (% GDP)	between		9.1	21.5	60.5	n	26
	within		0.8	35.7	41.4	T	9

[59] The countries with the available data included in the sample regressions for the **corporate taxes** are the following: 1 Botswana, 2 Cameroon, 3 Democratic Republic of Congo, 4 Egypt, 5 Eswatini, 6 Ethiopia, 7 Gabon, 8 Gambia, 9 Ghana, 10 Kenya, 11 Malawi, 12 Mauritius, 13 Madagascar, 14 Morocco, 15 Mozambique, 16 Namibia, 17 Nigeria, 18 Rwanda, 19 Senegal, 20 Sierra Leone, 21 South Africa, 22 Tanzania, 23 Tunisia, 24 Uganda, and 25 Zimbabwe. The period is from 2011 to 2019. For the **indirect taxes**, the following countries were included in the sample: 1 Algeria, 2 Botswana, 3 Egypt, 4 Eswatini, 5 Ghana, 6 Kenya, 7 Malawi, 8 Mauritius, 9 Morocco, 10 Mozambique, 11 Namibia, 12 Nigeria, 13 Senegal, 14 Sierra Leone, 15 South Africa, 16 Tanzania, 17 Tunisia, 18 Uganda, and 19 Zimbabwe. As for the **labour taxes**, the countries with the available data included in the sample are: Democratic Republic of Congo (Kinshasa), Eswatini, Mauritius, Senegal, South Africa, Tanzania, and Tunisia.

3.3.2 Methodology

We use two approaches to estimate the Laffer curve: the nonparametric and the parametric. For the latter we follow Hsing (1996; in estimating the Laffer curve for the USA) using a quadratic function that specifies the relationship between tax revenues and tax rates in the panel of African countries. In view of the concept of the Laffer curve presented above and the optimization theory, the different tax revenues in their general form are expressed as a quadratic function of their respective tax rates. In this case the general function can be expressed as:

$$\mathbf{TAX\ REVENUE} = \mathbf{f}(\mathbf{TAXRATE}, \mathbf{TAXRATE}^{2}, \mathbf{Shadow\ economy}) \quad (13)$$

Taking into consideration a linear functional form in the coefficients, equation (13) can be expressed as:

$$\mathbf{TAXREVENUE_{it}} = a_i + \delta_t + \boldsymbol{\beta_1}\mathbf{TAXRATE_{it}} + \boldsymbol{\beta_2}\mathbf{TAXRATE^2_{it}} + \boldsymbol{\beta_3}\mathbf{Shadoweconomy_{it}} + \boldsymbol{\xi_{it}} \quad (14),$$

where TAX REVENUE represents either the corporate tax revenues, the personal income tax revenues, or the indirect tax revenues (in USD or as percent of GDP); i is the country; t is the time period; $\boldsymbol{a_i}$ accounts for country-specific time invariant unobservable such as the geographic area of a country; δ_t takes into account global time developments, which affect countries similarly; the TAXRATE is the corporate tax rates, personal income tax rates, and the indirect tax rates. The coefficients β_1 and β_2 both measure the impact of the variation of the tax rates on the tax revenues, and when both are significant and β_2 is negative the evidence of the Laffer curve will be established and the curve will have a bell shape or inverted U shape, demonstrating a concave relationship; whereas if β_2 is positive the curve will be contrary to the concept of the Laffer curve and it will have a U shape, showing a convex relationship instead of concave. β_3 measures the impact of the size of the informal economy as percent of GDP on tax revenues.

In equation (14) if the concave relationship is established between tax revenues and tax rates, the Revenue Maximizing (RM) Tax Rate, which maximizes tax revenues, can be obtained by taking the first derivative of the equation (14) with respect to the rate and set it equal to zero. In this case the RM tax rate will have the following expression:

$$\mathbf{RM\ Tax\ Rate} = \frac{-\boldsymbol{\beta}\mathbf{1}}{\mathbf{2}*\boldsymbol{\beta}\mathbf{2}} \quad (15)$$

Above this rate any further additional increase in the tax rate will result in lower tax revenues, since the tax system is operating in the downward sloping prohibitive area of the Laffer curve, whereas below the optimal rate the tax system is in the normal upward sloping area of the Laffer curve and an increase in the tax rates can result in more tax revenues.

Since this is an empirical study, besides the linear functional specification we also use other functional forms such as log-log, log-linear, and linear-log to see which among them will best fit the data sample in analysis, as Hsing (1996) also did in the case of the USA economy:

Log-Log

$$\mathbf{lnTAXREVENUE_{it}} = \boldsymbol{\beta_1}\mathbf{lnTAXRATE_{it}} + \boldsymbol{\beta_2}(\mathbf{lnTAXRATE_{it}})^2 + \boldsymbol{\beta_3}\mathbf{ln(Shadoweconomy_{it})} + \boldsymbol{\xi}\mathbf{2_{it}} \quad (16),$$

Log-Linear
$$\mathbf{lnTAXREVENUE_{it} = \alpha_1 TAXRATE_{it} + \alpha_2 TAXRATE_{it}^2 + \beta_3 Shadoweconomy_{it} + \xi 3_{it}} \quad (17),$$

Linear-Log
$$\mathbf{TAXREVENUE_{it} = \delta_1 lnTAXRATE_{it} + \delta_2 (lnTAXRATE_{it})^2 + \beta_3 ln(Shadoweconomy_{it}) + \xi 4_{it}} \quad (18).$$

Regarding the econometric estimation methods to be used to assess the evidence of the Laffer curve, it is the Fixed Effect estimator since we are dealing with panel data. This estimation method was also used by Clausing (2007) when studying the OECD countries and by Ntertsou and Liapis (2022) when they studied the Euro Zone Countries.

Nonparametric Regression Models

In the FE parametric regression methods, it is assumed that the functional form of the relationship between tax revenues and tax rates is parametric and quadratic, but that may not be the case. For that reason we also use the nonparametric regression. In this more flexible approach of the non-parametric regression, no predetermined parametric functional form is generally assumed, but instead the functional form will be determined according to the information derived from the data. According to Fox (2000), the general nonparametric regression model does not specify the function form of the predictors or independent variables. In a panel the equation is set as:

$$\begin{aligned} Y_{it} &= a_i + \delta_t + \mathbf{f\ (X_{it})} + \varepsilon_{it} \\ &= f\ (x_1, x_2, \ldots, x_p) + \varepsilon \end{aligned} \quad (19)$$

where Y is the response variable (in our case the tax revenues); X is vector of the covariates (tax rates and the shadow economy); p is the number of the covariates; *i* is the country; *t* is the time period; α_i accounts for country-specific time invariant unobservable; $ş_t$ takes into account global time developments that affect countries similarly. The main objective of the nonparametric regression is to estimate the function $f(X_{it})$ directly rather than estimate the parameters (Fox, 2000). It is assumed that the function f is smooth and continuous, and the error term is normally and independently distributed.

There is a special case of the general model (19), which is called nonparametric simple regression, when only one covariate or predictor is used. This simple regression is also known as scatterplot smoothing due to the fact that it is easier to trace a smooth curve through a scatterplot of the response variable y against the covariate x.

Considering that it is a very complex issue to fit the general nonparametric regression model when there are many covariates and it is not easy to display the fitted model when there are more than two covariates, restrictive models have been developed (Fox, 2000). One such model is the additive regression model

$$y = \beta_0 + f_1(x_1) + f_2(x_2) + \ldots + f_p(x_p) + \varepsilon \quad (20)$$

where the partial-regression functions $f_p(x_p)$ are assumed to be smooth and are estimated from the data. According to Fox (2000) the model (20) is more restrictive than the general nonparametric model (19) but less restrictive than the linear regression model, which assumes all the partial-regression functions to be linear.

There are variations of the additive regression model called semiparametric models, in which some covariates enter linearly in the equation such as

$$y = \beta_0 + \beta_1 x_1 + f_2(x_2) + \dots + f_p(x_p) + \varepsilon \tag{21}$$

and a more general version allows for the selected interactions between the covariates as shown in the equation

$$y = \beta_0 + f_{12}(x_1, x_2) + f_3(x_2) + \dots + f_p(x_p) + \varepsilon \tag{22}$$

Estimation Methods of the Nonparametric Regression

As for the estimation of the nonparametric regressions, there are two main approaches: the local polynomial regression, and the smoothing splines. In the estimation of the results in both approaches the data are in panel with individual and time fixed effects.

In the local polynomial regression for the simple nonparametric regression, with only one covariate, the following model is fitted $y_{it} = \alpha_i + ş_t + f(x_{it}) + \varepsilon_{it}$ evaluating the regression function at a particular x-value, x_0. Fitting the model at a representative range of values of x or simply at the various cases, x_i, by performing a nth-order weighted least squares polynomial regression of y on x

$$y = b_0 + b_1(x - x_0) + b_2(x - x_0)^2 + \dots + b_n(x - x_0)^n + e \tag{23}$$

where the cases are weighted in relation to their distance from the focal value x_0, using a tricube common weight function (Fox, 2000)

$$W(z) = \begin{cases} (1 - |z|^3)^3 & \text{for } |z| < 1 \\ 0 & \text{for } |z| \geq 1 \end{cases}$$

where $z = (x - x_0)/h$, and h is the smoothing parameter that determines the smoothness of the fit. According to Fox (2000) the value of h is either fixed for all values of x_0 to provide a fixed window width, or else it is adjusted for each x_0 to include a fixed fraction of the data. In our study we adopted a fixed h, h=0.5.

The estimation of the nonparametric multiple regression model of equation (20) is done by defining a multivariate neighbourhood around a focal point $X'_0 = (x_{01}, x_{02}, \dots, x_{0k})$ using the scaled Euclidean distance

$$D(\mathbf{x}_i, \mathbf{x}_0) = \sqrt{\sum_{j=1}^{k} (z_{ij} - z_{0j})^2}$$

with the z_j being the standardized covariates,

$$z_{ij} = \frac{x_{ij} - \overline{x}_j}{s_j}$$

where x_i is the covariate vector for the ith case, x_{ij} is the value of the jth covariate for the ith case, x_j bar is the mean of the jth covariate, and s_j is its standard deviation. As for the k, in our study it equals 2, referring to the tax rates and the shadow economy.

The weights are defined using the following scaled distances

$$w_i = W\left[\frac{D(\mathbf{x}_i, \mathbf{x}_0)}{h}\right]$$

where $W(_i)$ is a weight function such as the tricube in which case h is the half-width radius of the neighbourhood.

The smoothing splines estimation approach of the nonparametric regression is the solution to the following simple regression problem, which finds the function m(x) with two continuous derivatives that minimizes the penalized sum of the squares

$$\mathrm{SS}^*(h) = \sum_{i=1}^{n} [y_i - m(x_i)]^2 + h \int_{x_{\min}}^{x_{\max}} [m''(x)]^2 \, dx$$

where h is a smoothing parameter, the first term on the right-hand side is the sum squared, the second term is a roughness penalty which is large when the integrated second derivative of the regression function m''(x) is large; the endpoints of the integral enclose the data. Fox (2000) argues that smoothing splines are more elegant mathematically than the local polynomial regression, but it is more difficult to generalize smoothing splines to multiple regression.

3.4 Estimation Results

3.4.1 Parametric Estimation Results

For the parametric regressions three functional specifications were used to estimate the Laffer curve (linear, log-log, and semi-logs) as specified in the equations 14, 16, 17, and 18.

Corporate Tax Revenues

For the corporate tax revenues we first tested for the existence of individual effects using the R package *plm* and the null hypothesis was rejected[60]. Then we used the Hausman test to compare the random and fixed effects specifications, and the fixed effect was selected[61]. The Lagrange Multiplier test was also applied to check for the presence of both individual (country) and time effects and the presence of significant time effects was confirmed, so the FE regressions include only time (year) fixed effects.

[60] Results of the pooling test: F = 2.052, df1 = 9, df2 = 200, p-value = 0.0355.
[61] Hausman test results: chisq = 127.93, df = 3, p-value = 0.000.

Table 32 - Effect of Tax Rates on Corporate Tax Revenues (in USD), FE Regression

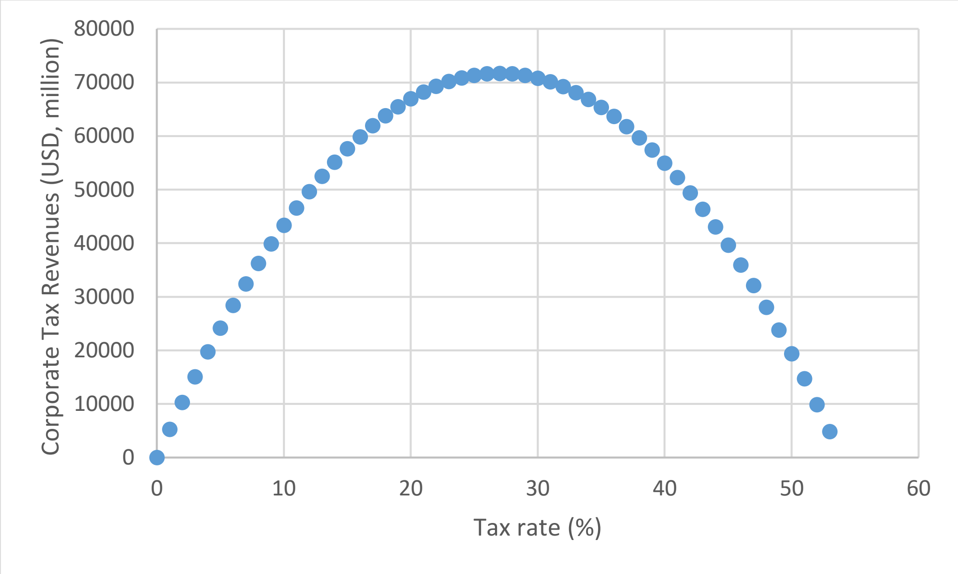
	Linear	Log-log	Linear-log	Log-linear
Corporate tax rates	**5,317.17**	**79.21**	**1,035,443.30**	**0.400**
Std. Error	(1,426.14)	(12.94)	(222,901.60)	(0.0837)
p-value	0.000	0.000	0.000	0.000
Corporate tax rates^2	**-98.62**	**-28.14**	**-365,820.40**	**-0.008**
Std. Error	(27.51)	(4.67)	(80,485.90)	(0.002)
p-value	0.000	0.000	0.000	0.000
Shadow economy (% GDP)	**-527.67**	**-1.61**	**-25,301.10**	**-0.034**
Std. Error	(87.70)	(0.20)	(3,471.30)	(0.005)
p-value	0.000	0.000	0.000	0.000
RM tax rate	**26.96**			**26.57**
Countries	25	25	25	25
N	212	212	212	212
R-Squared	0.162	0.267	0.219	0.196

The regression results in Table 32 include estimates without the intercept with time effects, with corporate tax revenues in millions of USD[62]. The regressions without the intercept follow more closely the theoretical concept of the Laffer curve presented in Figure 46, assuming that there is no lump sum tax, with the zero-tax rate yielding no tax revenues.

As seen in Table 32, all functional specifications regression results show that both the coefficients of corporate tax rate (β1) and that of its square (β2), which measure the impact of the variation of the tax rates on the corporate tax revenues are statistically significant, with β2 being negative. These results establish the evidence of existence of the Laffer curve for the panel of 25 African countries. Looking at the linear specification regression model in the first column, *ceteris paribus*, the increase of the corporate tax rate leads to an increase in corporate tax revenues up to a certain tax rate after which a further increase would decrease the corporate tax revenues. Considering shadow economy estimates being zero, the revenue maximizing (RM) corporate tax rate that yields the maximum corporate tax revenue is estimated to be 26.96% (see Figure 57) to USD 71 billion, a further increase in the rates after that value results in the reduction in the corporate tax revenues.

[62] The results with the corporate tax revenues as percent of GDP are presented in Table C1 in the appendix, with the coefficients being similar. The main difference is that the optimal corporate tax rate with the tax revenues in percent of GDP is 3.p.p higher (29.9%) than that of the tax revenues in USD (26.96%).

Figure 57 - Estimated Laffer Curve for Corporate Taxes



The coefficient of the size of the shadow economy (informal economy) in all regressions is negative and statistically significant, illustrating how detrimental the increase of the size of the informal economy is to the mobilization of corporate tax revenues. The linear specification regression results show that an increase of 1 percentage point in the size of the shadow economy leads, holding all other variables constant, to a reduction in the corporate tax revenues of USD 527.67 million. These results also suggest that a reduction in the size of the informal economy would boost corporate tax revenues, since it would potentially increase the tax base, as the enterprises that operate in the informal sector would migrate to the formal sector and come under the umbrella of the tax system.

Estimated Time Fixed Effects

The unobserved time-specific characteristics that influenced corporate tax revenues were extracted from the linear form regression.

Table 33 - Corporate Taxes Extracted Time Effects (Parametric Regression)

Years	Estimate
2011	**1,015.88**
2012	**876.15**
2013	**253.72**
2014	-116.96
2015	-390.60
2016	-592.12
2017	-397.50
2018	-440.97
2019	-225.02

The time-specific fixed effects are presented in Table 33, which illustrates that compared to the average time period, the corporate tax revenues were higher in the period between 2011– 2013, whereas in the remaining years the tax revenues were lower. It is important to highlight that between 2014 and 2019, Sub-Saharan African countries experienced lower GDP growth in comparison to the years before 2014 according to the World Bank (2024) data[63].

Indirect Tax Revenues (Goods and Services)

For the indirect tax revenues, we also tested for the existence of individual effects and the null hypothesis was rejected[64]. Then we used the Hausman test to compare the random and fixed effects specifications, and the random effect was selected[65]. The estimations of the Laffer curve related to the indirect tax revenues in USD[66] are reported in Table 34. All regression results show that the coefficient of the indirect tax rates is positive and statistically significant, and that of indirect tax rates to square is negative and statistically significant as well, thus establishing the evidence of the Laffer curve for the panel of 19 African countries. The results from the linear regression in the first column reveal that the increase in indirect tax rates causes an increase of indirect tax revenues up to a certain indirect tax rate after which a further increase would reduce the indirect tax revenues. The RM indirect tax rate that yields the maximum goods and services tax revenues is estimated to be of 15.2% (Figure 58), considering shadow economy estimates being zero.

Table 34 - Effect of Tax Rates on Indirect Tax Revenues (USD), RE Regression

	Linear	Log-log	Linear Log	Log-Linear
Indirect tax rates	**1,611.29**	**12.96**	**80,553.80**	**0.4502**
Std. Error	(604.29)	(2.34)	(26,817.50)	(0.06)
p-value	0.008	0.000	0.003	0.000
Indirect tax rates^2	**-52.961**	**-5.714**	**-35,247**	**-0.015**
Std. Error	(23.75)	(1.13)	(12,883.30)	(0.002)
p-value	0.026	0.000	0.006	0.000
Shadow economy (% GDP)	**-192.93**	**-1.1008**	**-11,184.50**	**-0.0035**
Std. Error	(90.49)	(0.33)	(3,815.20)	(0.009)
p-value	0.033	0.001	0.003	0.692
RM tax rate (%)	**15.2**			**14.9**
Countries	19	19	19	19
N	158	158	158	158
R-Squared	0.039	0.103	0.062	0.003

[63] See GDP growth (annual %) - Sub-Saharan Africa | Data (worldbank.org)
[64] Results of the pooling test: F = 6.074, df1 = 9, df2 = 143, p-value = 0.000.
[65] Hausman test results: chisq = 4.473, df = 3, p-value = 0.215.
[66] The results with the indirect tax revenues as percent of GDP are presented in Table C2 in the appendix, with the coefficients being similar. The main difference is that the optimal tax rate with the tax revenues in percent of GDP is 2 p.p higher (17.2%) compared to that of the tax revenues in USD (15.2%).

Figure 58 - Estimated Laffer Curve for Indirect Taxes

Estimated Individual Random Effects

The unobserved country-specific characteristics that influenced indirect tax revenues were extracted from linear form regression, and are presented in Table 35.

Table 35 - Indirect Tax Revenues Estimated Individual Random Effects (Parametric Regression)

Countries	Estimate
Algeria	**2,763.92**
Botswana	-5,209.18
Egypt	**11,117.99**
Eswatini	-4,550.27
Ghana	-1,413.95
Kenya	-1,781.33
Malawi	-4,397.11
Mauritius	-6,429.56
Morocco	**8,442.09**
Mozambique	-3,424.02
Namibia	-5,627.36
Nigeria	**4,435.78**
Senegal	-1,766.29
Sierra Leone	-3,779.85
South Africa	**27,218.83**
Tanzania	**1,192.40**
Tunisia	-236.87
Uganda	-2,395.73
Zimbabwe	**1,989.17**

One can see in Table 35 that Algeria, Egypt, Morocco, Nigeria, South Africa, Tanzania, and, Zimbabwe have indirect tax revenues higher compared to the continent's average, whereas the rest of the countries have lower indirect tax revenues than the average. The countries with the highest individual random effects in the indirect taxes are in fact among the biggest economies in terms of GDP in Africa; as of 2021 Nigeria was the biggest[67], Egypt the second, South Africa the third, followed by Algeria and Morocco.

Labour Tax Revenues (Payroll Workforce)

The data on the labour tax revenues is very limited as we were able to obtain compete information for only seven countries, with the total number of observations of 48. The results of regressions in USD[68] presented in Table 36, looking especially at the linear regression (in the first column), reveal evidence of the Laffer curve, taking into account that the coefficient of the labour tax rates is positive and statistically significant, and the coefficient of the labour tax rate to square is negative and also statistically significant. The estimated RM labour tax rate, considering shadow economy being zero, is of 40.8% (Figure 59), which reveals that an increase in the labour tax rate above this value would result in a reduction of the labour tax revenues.

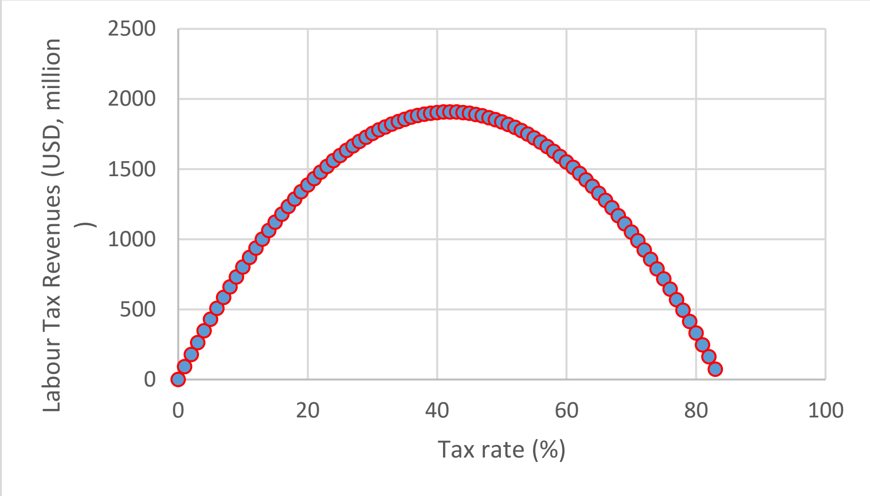
Table 36 - Effect of Tax Rates on Labour Tax Revenues (USD), FE Regression

	Linear	Log-log	Linear-log	Log-linear
Labour tax rates	**111.47**	**33.33**	**23,580.15**	**0.160**
Std. Error	(37.95)	(18.74)	(6,635.18)	(0.0957)
p-value	0.006	0.084	0.001	0.103
Labour tax rates^2	**-1.365**	**-10.588**	**-7421.180**	**-0.002**
Std. Error	(0.527)	(6.319)	(2,238.020)	(0.001)
p-value	0.014	0.102	0.002	0.140
Shadow economy (% GDP)	**-39.47**	**-2.028**	**-1,730.23**	**-0.044**
Std. Error	(5.725)	(0.551)	(195.170)	(0.014)
p-value	0.000	0.001	0.000	0.004
RM tax rate	**40.8**			**39.9**
Countries	7	7	7	7
N	48	48	48	48
R-Squared	0.606	0.299	0.709	0.242

[67] 10 richest African countries in 2021 based on gross domestic product (GDP) | Business Insider Africa

[68] The results with the labour tax revenues as percent of GDP are presented in Table C3 in the appendix, with the coefficients being similar. The main difference is that the optimal tax rate with the tax revenues in percent of GDP is 4.3 p.p lower (36.5%) compared to that of the tax revenues in USD (40.8%).

Figure 59 - Estimated Laffer Curve for Labour Taxes



Looking at the coefficient of the size of the shadow economy, it is also clear that it has a negative effect on the labour tax revenues (payroll work force). The linear regression in the first column shows that a 1 percentage increase in the size of the shadow economy would result in the reduction of the labour tax revenues by about USD 39.47 million. Since the majority of the work force in Africa is unemployed or works in the informal sector, the personal income tax from labour collected in most of the countries is very low, taking into account the lower level of formal employment. Reducing the size of the informal economy and making sure that those who work in the informal sector gain formal employment can contribute to a boost in the labour tax revenues in the continent.

Estimated Time Fixed Effects

The unobserved time-specific characteristics that influenced labour tax revenues were extracted from the linear form regression.

Table 37 - Labour Tax Revenues Estimated Time Fixed Effects (Parametric Regression)

Years	Estimate
2011	-8.76
2012	**51.53**
2013	**103.81**
2014	**63.31**
2015	-4.21
2016	-5.03
2017	-11.69
2018	**0.11**
2019	-165.45

The time-specific fixed effects are presented in Table 37, which illustrates that compared to the average time period, the labour tax revenues were especially high in the period between 2012–2014, whereas in the remaining years the labour tax revenues were lower. In the period from 2012-2014 Sub-Saharan African countries experienced higher GDP growth in comparison to the years after 2015, according to the data from the World Bank (2024), so this might explain the higher labour tax revenues in this period.

3.4.2 Nonparametric Estimation Results

One particularity of this method of estimation, which is the main objective of the nonparametric regression, is the estimation of the function f(X) directly, rather than the estimation of the parameters of the regression. The curvature of the function give us an indication of the relationship between the response variable tax revenues and the covariates tax rate and shadow economy. The nonparametric regressions were estimated assuming both the country and time random effects.

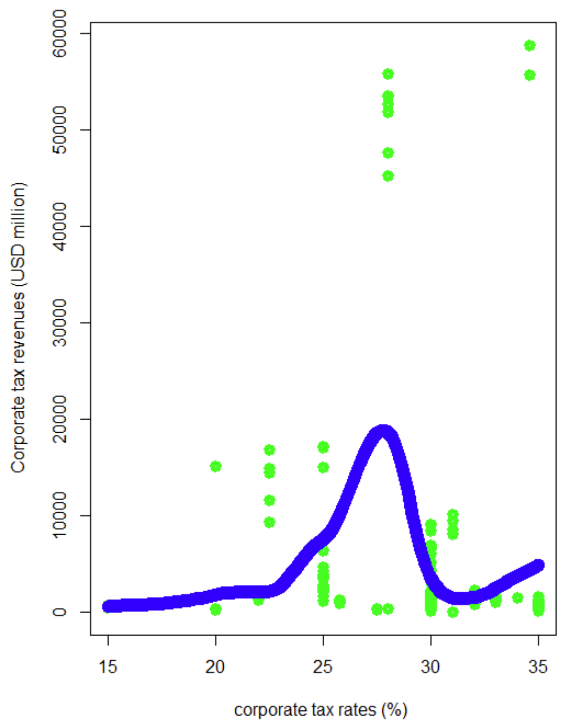
Corporate Tax Revenues

We started with the local polynomial regression for the case of the simple nonparametric regression of corporate tax revenues with only one covariate, the corporate tax rates, using equation 24:

$$\text{Corporate tax revenues}_{it} = f\,(\text{corporate tax rate}_{it}) + \varepsilon_{it}. \quad (24)$$

The results are presented in Figure 60, the blue curve.

Figure 60 - Local Polynomial Fitted Simple Regression of Corporate Tax Revenues (USD) on Corporate Tax Rates



The green dots in Figure 60 result from the simple plot of data of corporate tax revenues of 25 African countries with the respective corporate tax rates; and the data show that the relationship between them is indeed nonlinear since for corporate tax rates greater than between 25% and 27%, the corporate tax revenues start to decrease. The blue curve depicts the estimated results of the local nonparametric simple regression of corporate tax revenues in USD[69] on corporate tax rates (R

[69] Figure C1 in the appendix shows the results using corporate tax revenues percent of GDP as dependent variable. In this case there are two local maximum points, one at the corporate tax rate of 26%, and the other at the corporate tax rate of about 33%, right after these points the revenues to GDP ratio starts to decrease.

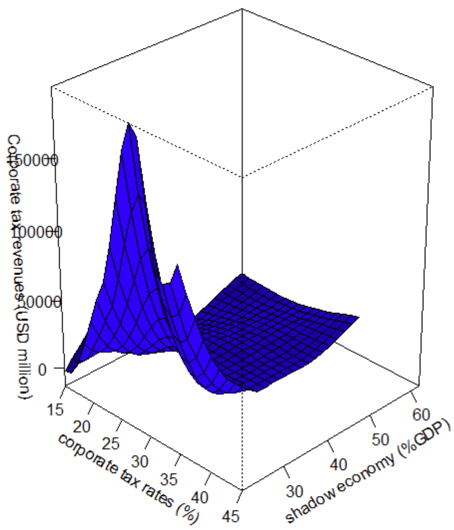
function *loess* was used to estimate the regression, the number of observations is 221, the equivalent number of parameters 5.87 and the residual standard error 9,537). The blue line clearly shows a locally concave relationship between corporate tax revenues and corporate tax rates in Africa, pointing to evidence of the Laffer curve. Looking at the blue line in Figure 60, the local maximum points of the corporate tax rate is between 26%-27%. Right after these points the revenues start to decrease and increase again but without reaching another local maximum point.

Adding one more variable to the equation, we used the general nonparametric regression model with two covariates (the corporate tax rates and the shadow economy), following the equation 25:

$$\text{Corporate Tax Revenues}_{it} = f\,(\text{corporate tax rate}_{it}, \text{shadow economy}_{it}) + \varepsilon_{it}. \qquad (25)$$

This included one more covariate in the nonparametric regression (R function *loess* was used to fit the local polynomial regression with the two covariates; number of observations = 212, the equivalent number of parameters = 14.77 and the residual standard error = 5,467). We obtained a three dimensional surface in Figure 61, presenting the relationship between corporate tax revenues with the two covariates (corporate tax rates and shadow economy).

Figure 61 - Fitted Surface for Local Multiple Regression of Corporate Tax Revenues (USD) on Corporate Tax Rates and on Shadow Economy



Looking first at the relationship of corporate tax revenues to corporate tax rates, it is clearly nonlinear locally concave, since Figure 61 shows that the corporate tax revenue increases as the rates increase, reaching a maximum tax rate between 26% and 27% after which the corporate tax revenues start to decrease. The shape of the curvature shows evidence of the existence of the Laffer curve in the panel of 25 African countries.

Now looking at the relationship of corporate tax revenues with the size of the shadow economy, one can see from Figure 61 that the relationship seems to be linear, but the picture is not clear enough, the semi-parametric where the shadow economy is treated as linear could be clearer (Table 40).

To check if each of the two covariates has a real effect on the corporate tax revenues, the ANOVA test was run to compare the model with the two covariates (model 1)- corporate rates and shadow economy against the models with only one covariate – tax rates (model 2) and then with shadow only (model 3).

Table 38 - ANOVA Test Results for Corporate Taxes

	Number of Parameters	Sum of Squares	F-value	Pr(>F)
Model 1	15	5,729.8		
Model 2	6	19,462.0	20.63	0.000
Model 3	4	18,114.0	29.92	0.000

The results in Table 38 clearly show that each covariate has a real effect on corporate tax revenues since the null hypothesis of no difference in the means of the models is rejected, showing that the two independent variables are statistically significant.

In order to be able to obtain the partial effect of each covariate, an additive nonparametric regression model was also estimated with the following equation 26:

Corporate Tax Revenues$_{it}$ = β + f(corporate tax rate$_{it}$) + f(shadow economy$_{it}$) +ε_{it}, (26)
with the two covariates (corporate tax rates and the size of shadow economy) fitted with a smoothing spline using the gam() R function in the *mgcv* package. This procedure allows presenting the partial-regression functions of each covariate and their plots in two dimensions, showing the relationship of each regressor with the response variable.

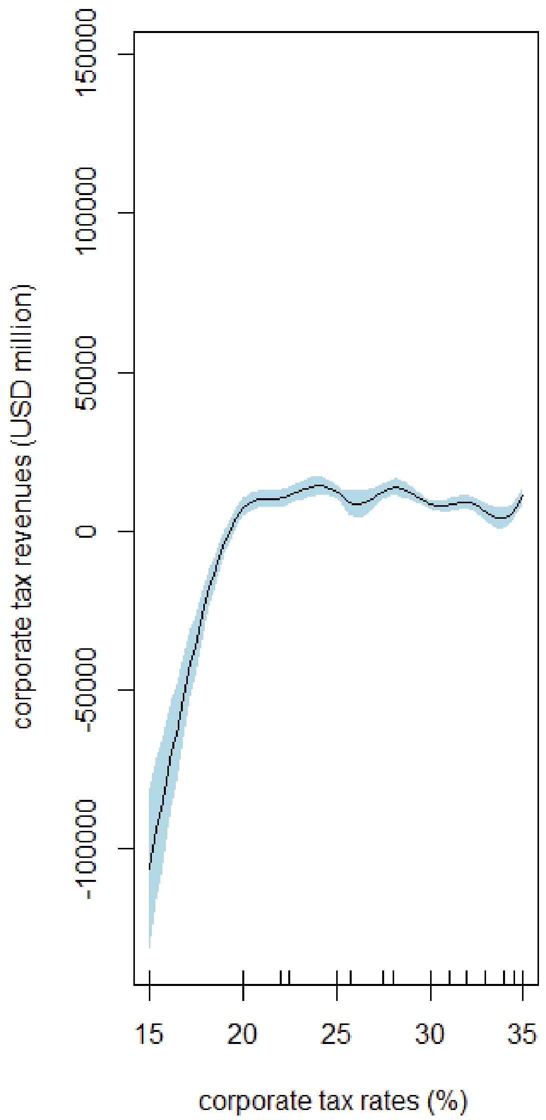
The results of the additive nonparametric regression are presented in Table 39 and show that both the intercept and the smoothing terms of the corporate tax rates and of the shadow economy are significant. The values of the effective degree of freedom (edf) express the complexity of the curvature of the covariate, with value of 1 meaning a straight line, value of 2 a quadratic curve, and higher values expressing more wavy curves. The statistics ref.df and F are used to compute the p-value that tests the overall significance of the smoothness of the curves. The adjusted coefficient of the determination (88.1%) and the deviance explained (89.1%) shows that the model explains the corporate tax revenues reasonably well.

Table 39 - Additive Nonparametric Regression Results for Corporate Taxes

Parametric coefficient				
	Estimate	std.error	t value	Pr(>|t|)
Intercept	4,518.90	254.30	17.77	0.000
Approximate significance of smooth terms				
	edf	ref.df	F	p-value
s(corptaxrates)	8.74	8.97	15.55	0.000
s(shadoweconomy)	8.89	8.99	122.96	0.000
R-sq.(adj)	0.881	Deviance explained		89.10%
GCV	15,028	Scale est.	13,707	
N	212			

The partial effect of the corporate tax rates on the corporate tax revenues in Figure 62 shows that there is evidence of the Laffer curve with multiple local RM tax rates (of about 22%, 26%, and 27%) that maximize the corporate fiscal revenues.

Figure 62 - Partial Effects Plots of the Corporate Tax Rates



We estimated the same additive model now assuming that the relationship of the shadow economy with the tax revenues is linear, that is, using a **semi-parametric model**:

Corporate Tax Revenues = β + shadow economy$_{it}$ + f(corporate tax rates$_{it}$) +ε_{it}. (27)

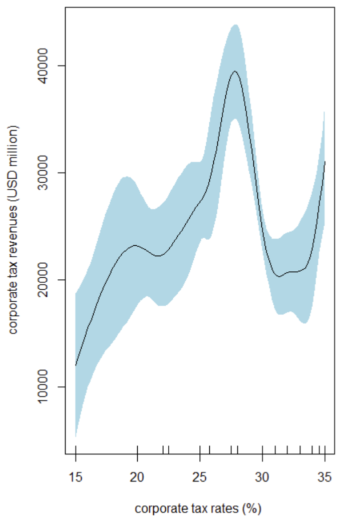
The results are presented in Table 40. As can be seen, the parametric coefficient of the size of the shadow economy is negative and statistically significant meaning that, *ceteris paribus*, an increase of the size of the informal economy by 1 percentage point leads to a reduction in the corporate tax revenues of USD 530 million; the effective degree of freedom (edf) of the corporate tax rates is statistically significant and shows the complexity of the curvature of this variable, as seen in Figure 63.

Table 40 - Additive Semi-parametric Regression Results for Corporate Tax Revenues (USD)

Parametric coefficient				
	estimate	std.error	t value	Pr(>|t|)
Intercept	24,968.55	3,725.47	6.70	0.000
Shadow economy	-530.09	95.28	-5.56	0.000
Approximate significance of smooth terms				
	edf	ref.df	F	p-value
s(corptaxrates)	8.012	8.618	8.694	0.000
R-sq.(adj)	0.322	Deviance explained		35.10%
GCV	82,055	Scale est.	78,180	
N	212			

The partial effect of the corporate tax rates on corporate tax revenues, assuming that the shadow economy is at its average value, from the semi-parametric model is showed in Figure 63. The evidence of the Laffer curve is also clear, with the local RM corporate tax rate of between 26% and 27% yielding the local maximum corporate tax revenue in USD[70].

Figure 63 - Partial effects Plot of the Corporate Tax Rates from the Semi-parametric Regression



Estimated Individual Random Effects from the Nonparametric Regression

The unobserved country-specific characteristics that influenced corporate tax revenues extracted from the nonparametric regression are presented in Table 41.

[70] Figure C2 in the appendix shows the results of semi-parametric regression using corporate tax revenues percent of GDP as dependent variable. In this case there seems to be one local maximum point of about 27% in the corporate tax rates that yields the maximum corporate tax revenues to GDP ratio.

Table 41 - Estimated Individual Random Effects for Corporate Taxes (Nonparametric Regression)

Countries	Estimate
Botswana	-1,234.7
Cameroon	-6,512.7
Congo (Kinshasa)	-6,315.9
Egypt	**11,085.3**
Eswatini	-1,980.9
Ethiopia	-3,740.4
Gabon	-2,381.0
Gambia	-4,025.5
Ghana	-1,586.1
Kenya	-636.9
Madagascar	-1,880.3
Malawi	-4,235.4
Mauritius	-4,929.0
Morocco	**3,220.1**
Mozambique	-4,838.6
Namibia	-6,544.1
Nigeria	**3,498.1**
Rwanda	-4,404.9
Senegal	-2,930.4
Sierra Leone	-3,694.5
South Africa	**47,116.3**
Tanzania	-348.2
Tunisia	-808.9
Uganda	-3,282.5
Zimbabwe	**1,391.1**

As seen in Table 41, Egypt, Morocco, Nigeria, South Africa, and Zimbabwe have the highest corporate tax revenues compared to the average in the continent, whereas the rest of the countries have lower tax revenues. The countries with higher individual random effects are among the biggest economies in the continent.

Estimated Time Random Effects

The unobserved time-specific characteristics that influenced corporate tax revenues extracted from the nonparametric regression model are shown in Table 42 for each country, also for the average, and the median of the panel.

Table 42 - Estimated Time Effects for Corporate Taxes (Nonparametric Regression)

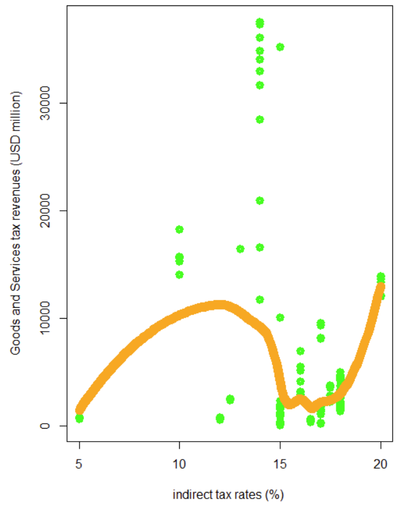
Countries/Year	2011	2012	2013	2014	2015	2016	2017	2018	2019
Botswana	13.5	-4.3	6.3	13.6	-8.9	0.3	-9.9	-3.6	-7.5
Cameroon	-6.9	0.9	7.1	12.4	4.4	-6.3	-11.4	-0.5	-2.9
Congo (Kinshasa)	-6.1	-1.3	0.3	2.1	12.8	-10.8	-18.2	8.4	9.6
Egypt	25.7	-53.3	51.3	49.6	168.0	43.1	-214.0	-111.4	46.4
Eswatini	10.7	0.5	-1.4	2.4	-0.6	-0.4	1.2	-11.7	-1.7
Ethiopia	-22.9		-12.7	-12.7	-1.8	6.5	13.0	15.2	13.7
Gabon							-4.3	-1.6	4.7
Gambia	8.4	-3.3	-1.3	12.1	9.5	11.2	0.9	-14.2	-25.3
Ghana	-3.8	7.7	4.2	-7.9	-32.5	-34.1	-9.2	32.8	42.1
Kenya	-90.3	-60.7	-31.1	5.4	6.2		41.5	60.0	68.5
Madagascar	1.4	0.8	4.7	3.2	2.3	-1.0	-0.7	-5.3	-6.3
Malawi	4.2	-4.2	-4.1	1.1	2.4	-4.9	-0.4	2.4	1.5
Mauritius	-2.7	-1.8	-0.2	0.3	-0.3	-2.9	0.0	1.3	3.9
Morocco	-5.2	20.3	20.6	25.4	-70.7	-48.5	-1.4	31.2	30.0
Mozambique	-30.0	-9.3	7.5	27.3	-2.6	-24.4	-1.0	-5.2	35.3
Namibia	-26.2	-28.3	-10.6	-0.7	-9.6	10.6	21.9	21.6	18.1
Nigeria	69.1	49.0	63.0				-179.3		
Rwanda	-3.4	-0.3	2.4	2.9	1.0	0.6	-0.8	-2.1	-2.5
Senegal	5.5	5.3	6.6	6.7	-5.4	-4.0	-8.7	-6.1	-1.1
Sierra Leone	12.6	8.1	-7.3	-16.6	8.6	8.8	-0.6	-4.7	-10.7
South Africa	98.5	-52.3	53.2	13.1	-196.0	-312.0	96.2	217.5	104.5
Tanzania	-30.9	-14.1	3.5	20.7	-2.3	5.2	4.2	7.9	5.4
Tunisia	14.0	-17.8	2.7	35.3	2.4	-18.4	-14.7	-23.6	19.7
Uganda	-15.6	-10.6	-2.9	-2.2	-4.8	-0.1	4.7	11.3	18.6
Zimbabwe	-19.6	-20.7	-20.3	-13.5	-18.3	-24.4	-56.4	-33.6	207.6
Average Time Effects	-0.001	-8.24	**5.90**	**7.82**	-5.92	-18.45	-13.89	**7.75**	**23.81**
Median Time Effects	-3.05	-3.34	**2.54**	**3.17**	-0.64	-1.94	-0.76	-1.02	**7.50**

Looking at Table 42, for the case of Botswana one can see that corporate tax revenues were higher in the years 2011, 2013, 2014, and 2016, whereas in the remaining years the tax revenues were lower than the average of the time period; and for the case of Zimbabwe that the country had corporate tax revenues higher than the average of the time period only in 2019. Now looking at the panel of countries as a whole, it can be seen that in the years 2013, 2014, 2018, and 2019 corporate tax revenues were higher due to time-specific fixed effects.

Indirect Tax Revenues (Goods and Services)

The result of local polynomial regression of the simple nonparametric equation of goods and services tax revenues on indirect tax rates is presented in Figure 64. The green dots represent the data, whereas the orange curve is the estimation from the nonparametric local polynomial regression using data from 19 African countries.

Figure 64 - Local Polynomial Simple Regression of Indirect Tax Revenues (USD) on Indirect Tax Rates



Looking at the orange curve, one can see evidence of the Laffer curve between the indirect tax revenues and the indirect tax rates, with the local RM indirect tax rate around 13%-15% yielding the maximum indirect tax revenues in USD[71]. An increase of the indirect tax rate after the optimal rate results, in general, in a drop of the goods and services tax revenues. Although after the indirect tax rate of around 17.5% a further rise of the rate seems to cause an increase of tax revenues, it does not reach a new maximum.

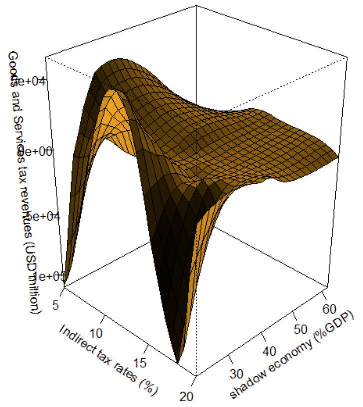
Nonparametric regression of indirect tax revenues on indirect tax rates and on the size of the shadow economy:

$$\text{Indirect Tax Revenues}_{it} = f(\text{indirect tax rate}_{it}, \text{shadow economy}_{it}) + \varepsilon_{it} \quad (28)$$

Using now two covariates, indirect tax rates, and the size of the informal economy we estimated the nonparametric multiple regression of the indirect tax revenues, the results of which are presented in Figure 65. One can see that the relationship between indirect tax revenues and the respective tax rates is locally a bell-shaped nonlinear one, showing evidence of the Laffer curve. The local RM indirect tax rate appears to be around 13%-15%, the point that seems to yield the maximum indirect tax revenues. Looking at the relationship between indirect tax revenues and the size of the informal or shadow economy, it seems to be slightly linear.

[71] Figure C3 in the appendix shows the results using indirect tax revenues percent of GDP as dependent variable. In this case the local maximum point is at the indirect tax rate of 15%. Right after this point the indirect tax revenues to GDP ratio starts to decrease.

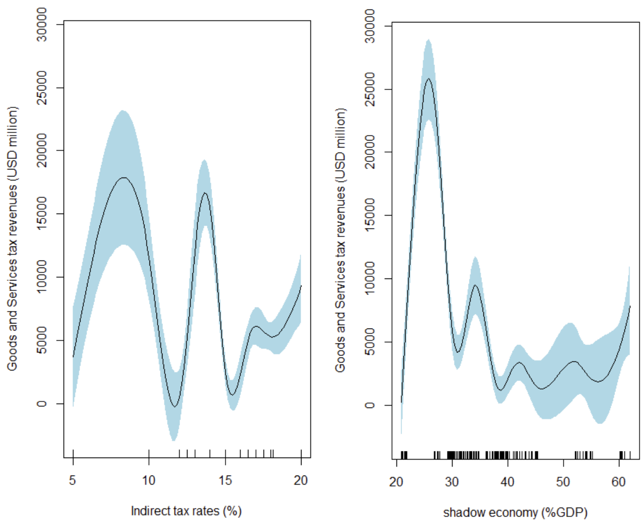
Figure 65 - Fitted Surface for the Local Multiple Regression of Indirect Tax Revenues (USD) on Indirect Tax Rates and Shadow Economy



To better understand the relationship between the indirect tax revenues with the two covariates, an additive nonparametric regression was used, which allows obtaining the partial effect of each explanatory variable:

$$\text{Indirect Tax Revenues}_{it} = \beta + f(\text{indirect tax rate}_{it}) + g(\text{shadow economy}_{it}) + \varepsilon_{it}. \quad (29)$$

Figure 66 - Partial Effects Plots of Indirect Tax Rates and of Shadow Economy



The results of the partial effects of the covariates on the indirect tax revenues presented in Figure 66 demonstrate that for the case of the indirect tax rates, it has in general a positive nonlinear impact, having multiple local maximums, one around 8%, another around 13%-14%, and the other around 17%. The partial effect of the size of the shadow economy shown on the right side of Figure 66 reveals a nonlinear impact on the indirect tax revenues with clear negative trend.

Now assuming a linear relationship of shadow economy, the following semi-parametric regression was estimated:

$$\text{Indirect Tax Revenues}_{it} = \beta + \text{shadow economy}_{it} + f(\text{indirect tax rate}_{it}) + \varepsilon_{it}. \quad (30)$$

Table 43 - Additive Semi-Parametric Regression Results of Indirect Tax Revenues (USD)

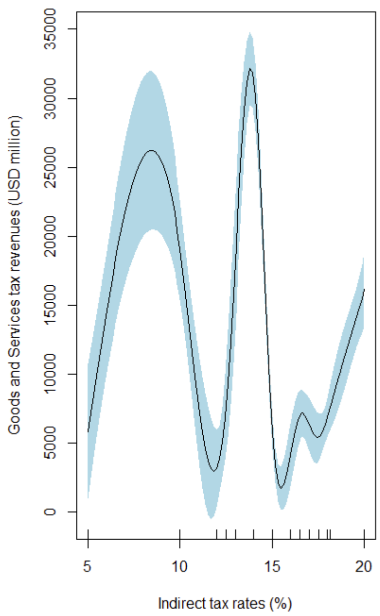
Parametric Coefficient				
	Estimate	std.error	t value	Pr(>|t|)
Intercept	8,862.11	1,555.38	5.70	0.000
Shadow economy	-94.88	40.36	-2.35	0.084
Approximate significance of smooth terms				
	edf	ref.df	F	p-value
s(indirtaxrate)	8.81	8.983	50.21	0.000
R-sq.(adj)	0.768	Deviance explained		78%
GCV	17,657	Scale est.	16,449	
N	158			

As seen from Table 43, the parametric coefficient of the size of the shadow economy is negative and statistically significant, meaning that, *ceteris paribus*, an increase of the size of the informal economy of 1 percentage point leads to a decrease in indirect tax revenues of USD 94.88 million; the effective degree of freedom (edf) of the indirect tax rates is statistically significant and shows the complexity of the curvature of this variable as presented in Figure 67. The adjusted coefficient of determination shows that 76.8% of the variation in indirect tax revenues is explained by the two covariates used in the semi-parametric model. The deviance explained value of 78% shows the proportion of the total measure of error accounted for by the semi-parametric model.

Looking at the partial effects of the indirect tax rates presented in Figure 67, taken from the semi-parametric regression with the shadow economy having a linear impact, the evidence of the Laffer curve can also be seen, with multiple maximums but with the local optimal indirect tax rate that yields the maximum indirect tax revenues in USD[72] being around 14%-15%.

[72] Figure C4 in the appendix shows the results of semi-parametric regression using indirect tax revenues percent of GDP as dependent variable. In this case there seems to be one local maximum point of about 15% of the indirect tax rate that yields the maximum indirect tax revenues to GDP ratio.

Figure 67 - Partial Effects Plot of Indirect Tax Rates from the Semi-Parametric Regression



Estimated Individual Random Effects from the Nonparametric Regression

The unobserved country-specific characteristics that influenced indirect tax revenues extracted from the nonparametric regression are presented in Table 44.

Table 44 - Estimated Individual Random Effects for Indirect Taxes (Nonparametric Regression)

Countries	Estimate
Algeria	**1,172.48**
Botswana	-8,013.57
Egypt	**9,826.34**
Eswatini	-3,255.77
Ghana	-392.32
Kenya	-3,195.21
Malawi	-3,321.28
Mauritius	-12,866.22
Morocco	**6,977.37**
Mozambique	-2,449.09
Namibia	-8,236.83
Nigeria	-174.38
Senegal	-461.66
Sierra Leone	-2,124.22
South Africa	**23,319.28**
Tanzania	**2,038.14**
Tunisia	**251.14**
Uganda	-1,218.81
Zimbabwe	**2,124.61**

As seen in Table 44, Algeria, Egypt, Morocco, South Africa, Tanzania, Tunisia, and Zimbabwe have the highest indirect tax revenues compared to the average in the continent, whereas the rest of the countries have lower tax revenues than the average. South Africa, Egypt, Morocco, Algeria, and Tanzania are among the biggest economies in the continent.

Estimated Time Random Effects

The unobserved time-specific characteristics that influenced indirect tax revenues extracted from the nonparametric regression model are reported in Table 45 for each country, and for the average of the panel.

Table 45 - Estimated Time Effects for Indirect Taxes (Nonparametric Regression)

Estimated Time Effects for Indirect Taxes									
Countries/Year	2011	2012	2013	2014	2015	2016	2017	2018	2019
Algeria			93.21	108.34	-81.55	-115.78			
Botswana	93.03	66.80	-24.36	-11.48	-7.68	-42.55	-18.95	-36.62	-47.03
Egypt	-237.40	24.61	17.71	-17.76	404.24	97.34	-667.16	-84.90	498.67
Eswatini	34.66	23.15	-0.41	6.31	-2.34	-4.83	-5.30	-27.99	-34.97
Ghana	1.10	-42.55	-71.28	-88.63	-17.05	95.95	35.98	57.36	27.72
Kenya	-80.97	-70.79	-91.26	14.80	-23.76		9.27	28.70	202.50
Malawi	35.20	1.25	-4.46	24.56	14.25	-24.76	-21.20	-10.49	-26.30
Mauritius	0.60	19.25	23.32	15.32	-15.94	-26.93	-23.81	-12.35	-25.77
Morocco	17.59	11.50	62.00	125.30	-159.16	-142.53	-49.35	92.18	67.57
Mozambique	14.09	31.37	56.51	81.72	3.95	-43.03	-61.51	-51.88	-40.03
Namibia	32.03	-29.69	33.63	-12.60	-34.95	-9.45	-7.38	-6.45	5.21
Nigeria	-0.14	-0.47	-0.02						
Senegal	22.09	7.07	7.29	33.47	-13.60	-5.34	-30.53	-24.62	2.49
Sierra Leone	44.28	25.96	-27.34	-66.37	33.74	27.12	7.38	-13.98	-38.43
South Africa	467.01	445.92	64.51	-40.43	-392.65	-837.71	-155.37	314.32	218.34
Tanzania	-132.46	-47.58	-18.40	18.93	-22.41	3.92	65.67	113.64	26.02
Tunisia	67.00	-2.37	-24.44	16.27	-27.12	-18.79	-25.02	26.98	-11.60
Uganda		-42.62	-24.30	-11.68	-32.17	-12.15	13.26	49.35	55.93
Zimbabwe	-210.40	-160.70	-144.90	-158.76	-126.78	-140.55	-118.44	-41.68	1109.84
Average Time Effects	**9.84**	**14.45**	-3.84	**2.07**	-27.83	-70.59	-61.91	**21.86**	**117.07**
Median Time Effects	**17.59**	**4.16**	-0.41	**10.56**	-19.73	-18.79	-21.20	-10.49	**5.21**

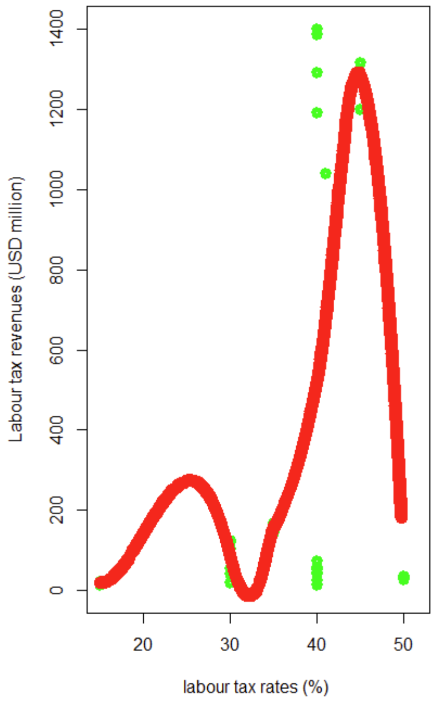
Looking at Table 45, for the case of Botswana one can see that indirect tax revenues were higher in the years 2011 and 2012 whereas in the remaining years the tax revenues were lower than the average period. For the case of Tunisia, only in 2011 and 2018 did the country have indirect tax revenues higher than that of the average period. Now looking at the panel of countries as a whole, in 2011, 2013, 2018, and 2019 indirect tax revenues were on average higher in comparison to the other years.

Labour Tax Revenues (Payroll Workforce)

The result of local polynomial regression of the simple nonparametric equation of labour tax revenues on labour tax rates is presented in Figure 68. The green dots represent the simple plot of the data, whereas the red curve is the estimation from the nonparametric local polynomial regression using data from seven African countries.

$$\text{Labour Tax Revenues}_{it} = f(\text{labour tax rate}_{it}) + \varepsilon_{it} \qquad (31)$$

Figure 68 - Local Polynomial Simple Regression of Labour Tax Revenues (USD) on Labour Tax Rates



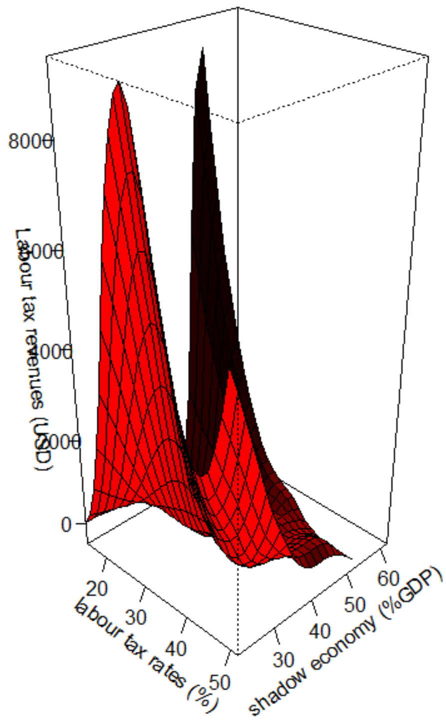
The simple nonparametric regression estimation of labour tax revenues on labour tax rates showed in the red curve presents two local RM labour tax rates, one around 25%, and the other around 45%. The one that seems to yield the highest labour tax revenues in USD[73] is the tax rate of 45%.

$$\text{Labour Tax Revenues}_{it} = f(\text{labour tax rate}_{it}, \text{shadow economy}_{it}) + \varepsilon_{it} \qquad (32)$$

Now with two covariates, labour tax rates and the size of the informal economy, we estimated the nonparametric multiple regression of labour tax revenues, according to equation 32, with results presented in Figure 69. One can see that the relationship between labour tax revenues and the respective tax rates is of a bell-shaped nonlinear locally, showing evidence of the Laffer curve.

[73] Figure C5 in the appendix shows the results using labour tax revenues percent of GDP as dependent variable. In this case there are two local maximum points, one at the labour tax rate of around 25%, and the other at the labour tax rate of about 36%. Right after these points the revenues to GDP ratio starts to decrease.

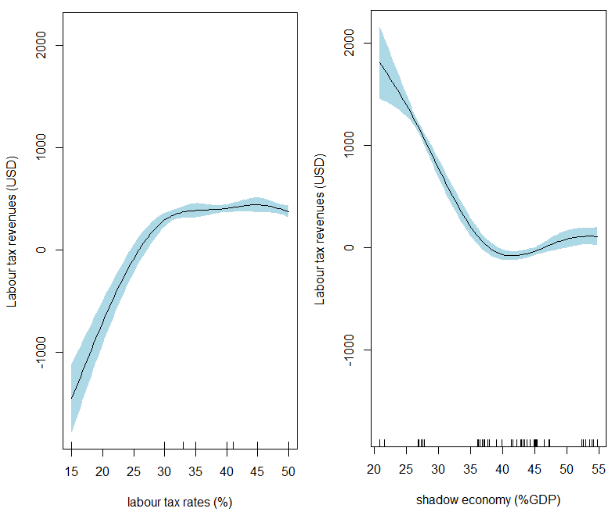
Figure 69 - Fitted Surface for the Local Multiple Regression of Labour Tax Revenues (USD) on Labour Tax Rates and Shadow Economy



To better understand the relationship between the labour tax revenues with the two covariates, an additive nonparametric regression was also used, which allows us to obtain the partial effect of each explanatory variable:

$$\text{Labour Tax Revenues}_{it} = \beta + f(\text{labour tax rate}_{it}) + g(\text{shadow economyi}_{t}) + \varepsilon_{it} \qquad (33)$$

Figure 70 - Partial Effects Plots of Labour Tax Rates and Shadow Economy



The results of the partial effects of the covariates on labour tax revenues presented in Figure 70 demonstrate that for the case of the labour tax rates, it has in general a nonlinear positive impact, having at least two local maximums, one around 25% and the other around 45%, which seems to be the highest. The partial effect of the size of the shadow economy showed on the right-hand side of Figure 70 reveal in general a negative impact on labour tax revenues.

Now assuming that the relationship between the labour tax revenues and the size of the shadow economy is linear, the following semi-parametric regression was also estimated:

$$\text{Labour tax revenues}_{it} = \beta + \text{shadow economy}_{it} + f(\text{labour tax rate}_{it}) + \varepsilon_{it} \quad (34)$$

Table 46 - Additive Semi-Parametric Regression Results of Labour Tax Revenues

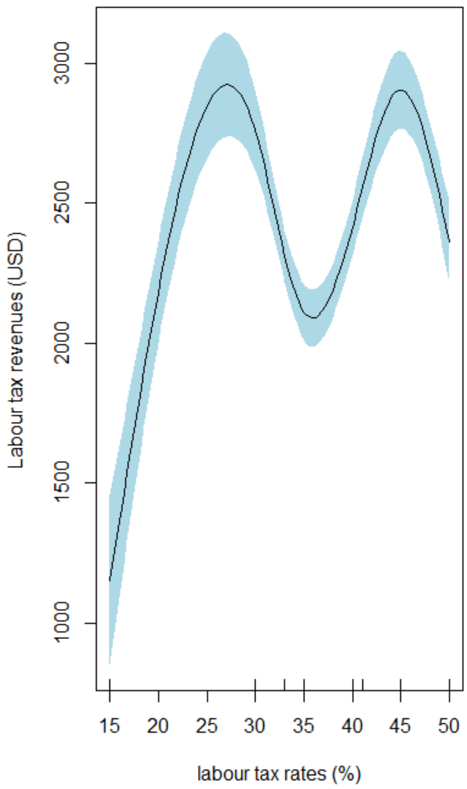
Parametric Coefficient				
	Estimate	std.error	t value	Pr(>|t|)
Intercept	2,397.5	178.3	13.5	0.000
Shadow economy	-52.94	4.44	-11.91	0.000
Approximate significance of smooth terms				
	edf	ref.df	F	p-value
s(labortaxrate)	3.98	4	4.74	0.000
R-sq.(adj)	0.85	Deviance explained		86.90%
GCV	38,022	Scale est.	33,283	
N	48			

The results in Table 46 show that the parametric coefficient of the size of the shadow economy is negative and statistically significant, meaning that*, ceteris paribus*, an increase of the size of the informal economy of 1 percentage point leads to a decrease in labour tax revenues of 52.94 million USD; the effective degree of freedom (edf) of the labour tax rates is statistically significant and shows the complexity of the curvature of this variable, as presented in Figure 71. The adjusted coefficient of determination shows that 85% of the variation in labour tax revenues is explained by the two covariates used in the semi-parametric model.

The partial effects plot, presented in Figure 71, of the labour tax rates on the labour tax revenues from the semi-parametric regression reveals that in general the impact of the tax rates is positive up to certain point, with higher rates leading to higher labour tax revenues, reaching a local maximum labour tax rate of about 45%, after which labour tax revenues in USD[74] start to decrease.

[74] Figure C6 in the appendix shows the results of semi-parametric regression using labour tax revenues percent of GDP as dependent variable. In this case there seems to be three local maximum points of about 22%, 31%, and 45%, being the highest that yields the maximum labour tax revenues to GDP ratio.

Figure 71 - Partial Effects Plot of Labour Tax Rates from the Semi-Parametric Regression



Estimated Individual Random Effects from the Nonparametric Regression

The unobserved country-specific characteristics that influenced Labour tax revenues extracted from the nonparametric regression are presented in Table 47.

Table 47 - Estimated Individual Random Effects for Labour Taxes (Nonparametric Regression)

Estimated Individual Random Effects for Labour Tax	
Countries	Estimate
Congo (Kinshasa)	-144.11
Eswatini	-223.36
Mauritius	-292.54
Senegal	-185.67
South Africa	**958.16**
Tanzania	-27.15
Tunisia	-85.33

As can be seen in Table 47, only South Africa has higher labour tax revenues compared to the average in the Continent, whereas the rest of the countries have lower labour tax revenues.

Estimated Time Random Effects

The unobserved time-specific characteristics that influenced labour tax revenues extracted from the nonparametric regression model are showed in Table 48 for each country, also for the average and the median of the panel as a whole; and the effects are residual, taking into account that the coefficients are practically zero.

Table 48 - Estimated Time Effects for Labour Taxes (Nonparametric Regression)

Estimated Time Effects for Labour Taxes									
Countries/Year	2011	2012	2013	2014	2015	2016	2017	2018	2019
Congo (Kinshasa)	-0.0000029	0.0000066	0.0000104	0.0000009	0.0000004	-0.0000062	-0.0000100	-0.0000039	0.0000037
Eswatini	0.0000022	-0.0000003							-0.0000035
Mauritius					-0.0000020				-0.0000001
Senegal	0.0000031	0.0000038	0.0000056	0.0000055	0.0000023	-0.0000019	-0.0000018	-0.0000089	-0.0000091
South Africa	0.0000638	0.0000570	0.0000126	0.0000134	-0.0000337	-0.0001046	-0.0000316	0.0000234	0.0000065
Tanzania		-0.0000045	-0.0000054	-0.0000003	-0.0000066	0.0000055	0.0000057	0.0000056	
Tunisia	0.0000003	-0.0000066	-0.0000046	0.0000038	0.0000026	0.0000036	0.0000008	-0.0000011	0.0000005
Average Time Effects	**0.00001330**	**0.00000934**	**0.00000373**	**0.00000465**	-0.00000618	-0.00002073	-0.00000739	**0.00000303**	-0.00000033
Median Time Effects	**0.00000216**	**0.00000176**	**0.00000561**	**0.00000384**	-0.00000082	-0.00000190	-0.00000184	-0.00000106	**0.00000018**

3.5 Discussion of the Main Results and Policy Implications

The estimation results from parametric, semi-parametric, and nonparametric regressions showed empirical evidence of the existence of Laffer curve in the three categories of tax revenues (corporate, labour, and indirect) studied for the selected panel of African countries over the period 2011-2019, for tax revenues in USD, and 2011-2021 for tax revenues to GDP ratio. We were also able to estimate the possible revenue maximizing (RM) tax rate for each tax category, and Tables 49 and 50 summarize the main findings according to each regression approach and present the most recent available average tax rate of each tax revenue.

Table 49 - Estimates of RM Tax Rates, with Dependent Variables in USD

RM Tax Rates (%) / Regressions	Parametric	Semi-parametric	Nonparametric	Average Tax Rates in 2019
Corporate	27	26-27	26-27	28.23
Indirect	15.2	13-14	12-13	15.55
Labour	40.8	45	45	31.96

Looking at the corporate tax revenues in USD, one can see that the estimates of the RM tax rate from the parametric, nonparametric, and semi-parametric are almost in the same range, about 27%. Comparing the estimates with the actual average corporate tax rate, it can be seen that the average rate is outside of the range of the optimal tax rate, meaning that the rates are in the prohibitive range, after the top of the Laffer curve, and a further increase in the rates beyond the range of the optimal estimated rate could, *ceteris paribus*, potentially diminish the corporate tax revenues.

Regarding the indirect taxes, nonparametric and semi-parametric regressions present RM indirect tax rates slightly lower than that of the parametric regression. Focusing on the estimates from the nonparametric and semi-parametric and comparing them with the estimates of the optimal rates with the average indirect tax rates in 2019, it can be noticed that the current rates are very close to the top of the Laffer curve of the indirect taxes, hence further increase beyond the RM rate could also potentially diminish the indirect tax revenues. The parametric regression showed that the current indirect tax rates are in the prohibitive range of the Laffer curve.

The labour tax optimal rates estimate from parametric regression is 4 percentage points lower than that from the nonparametric and semi-parametric approaches; and comparing them with the current average tax rate, the average is below the RM rates, showing potential room for increasing the rates without theoretically affecting the labour tax revenues negatively. However, it is important to bear in mind that in Africa only very few workers have employment in the formal sector of the economy pay the labour tax; most of the workforce operating in the informal sector are not under the umbrella of the tax system, so they do not pay the labour tax. Hence the increase in the labour tax rates affects individuals working in the formal sector almost the same, and it is a genuine burden for them. Instead of increasing the tax rate, the better approach is to increase the tax base by setting conditions that allow more informal workers to move into formal employment.

Now looking at the RM tax rates computed with each dependent variable (corporate, labour, and indirect tax revenues) as percent of GDP, presented in Table 50, and comparing them with the average rates in 2021, one can see that the average tax rates are very close to the estimated RM tax rates of all three categories, leaving little room to increase tax rates, since a further increase could reduce the tax revenues to GDP ratios, *ceteris paribus*.

Table 50 - Estimates of RM Tax Rates, with Dependent Variables as % of GDP

RM Tax Rates (%) / Regressions	Parametric	Semi-parametric	Nonparametric	Average Tax Rates in 2021
Corporate	29.9	27	27-33	27.45
Indirect	17.2	15	15-17.5	15.36
Labour	36.5	45	25-36	31.98

Although Africa is not a single country in which one common fiscal policy influences the economy, the different countries in the continent can and should cooperate, taking into account the empirical evidence showing that in the two main tax categories (corporate, and indirect) the current rates are in the prohibitive range, that is, past the top of the Laffer curve, and further increase could cause tax avoidance and diminish tax revenues*, ceteris paribus*.

The countries in Africa are not homogeneous but instead are very diverse, with different sizes of economy and law enforcement which affect each country's ability to collect more tax revenues. For instance, in the parametric regression for the indirect taxes, the individual random effects in Table 35 showed that 3 out of 4 North African Arab countries in the sample has positive individual random effect (Algeria, Egypt, and Morocco) and one country (Tunisia) has negative individual random effect. In the Sub-Saharan region only Nigeria, South Africa (the biggest economies), Tanzania, and Zimbabwe presented positive individual random effect, whereas the majority of the countries of the region in the sample presented negative individual effects. In the nonparametric regression, the estimated individual random effects for the corporate tax revenues showed in Table 41 revealed that the two North African Arab countries (Egypt and Morocco) have positive random effect, whereas for the Sub-Saharan region only Nigeria, South Africa, and Zimbabwe have positive effects, the rest of the countries have negative individual random effects. In the nonparametric regression for the case of indirect taxes, the individual random effects in Table 44 showed that all the Arab North African countries, which are also among the biggest economies in the continent, in the sample (Algeria, Egypt, Morocco, and Tunisia) had positive individual random effect, presenting indirect tax revenues higher than the continent's average. In the Sub-Saharan region, South Africa (the biggest economy), Tanzania, and Zimbabwe presented positive individual random effect, whereas the majority of the countries of the region in the sample presented negative individual random effects.

Comparing the RM tax rates presented in the literature for the other regions and countries with that we obtained for the panel of African countries (but with the due caution because of the different time period of each study) it can be seen that for the case of the corporate taxes the RM tax rate from 26%-27% (with taxes in USD) for the African countries, is relatively lower than that of the OECD countries, in the range of 26% to 34%, estimated by Clausing (2007). But looking at the RM corporate tax rates, with corporate tax revenues as percent of GDP, the same approach taken by Clausing (2007), the RM rates especially from the nonparametric regression are almost in the same range as that of the OECD countries. The RM corporate tax rates obtained for African countries are lower than that of China, with optimal corporate tax rates of 40% estimated by Lin and Jia (2019).

When it comes to the **impact of the size of the shadow or informal economy on the tax revenues** all estimations approaches (nonparametric, parametric, and semiparametric) showed that the shadow economy has a negative impact in all three tax categories, as reported in Tables 51 and 52. This means that reducing the size of the informal economy could have a tremendous positive impact on tax revenues, since it would increase the tax bases and therefore the level of revenues.

Table 51 - Estimated Impact of Shadow Economy on Tax Revenues in USD

Tax Revenues / Regressions	Parametric	Simi-parametric	Nonparametric
Corporate	-527.67	-530.10	Generally negative
Indirect	-192.93	-94.88	concave nonlinear
Labour	-39.47	-52.94	Generally negative

Table 52 - Estimated Impact of Shadow Economy on Tax Revenues as % of GDP

Tax Revenues / Regressions	Parametric	Simi-parametric	Nonparametric
Corporate	-0.214	-0.179	Generally negative
Indirect	-0.115	-0.113	Generally negative
Labour	-0.004	-0.002	Generally negative

The parametric and the semi-parametric regressions give the coefficient estimates that illustrate the estimated magnitude of the impact on tax revenues of the size of the shadow economy. As showed in Table 51 with coefficients in millions of USD and in Table 52 with coefficients in percent of GDP, the informal economy has a greater negative impact first on the corporate tax revenues, followed by the indirect tax revenues, and then on the labour taxes.

Studying the case of five Latin American countries (Brazil, Chile, Colombia, Mexico, and Peru) Alba and Macknight (2022) also found that informal economy had negative impacts on labour, capital, and consumption tax revenues, the impact being greater on the labour taxes, followed by the capital and consumption taxes. For the case of the Euro Zone, Ntertsou and Liapis (2022) also found negative impact of the informal economy on corporate, and personal income tax revenues. Comparing the results of the impact of informal economy on tax revenues amongst the regions (Africa, Latin America, and Euro Zone), we noticed that in Africa the negative impact is greater, being the region with the highest informal economy estimates to GDP ratio in comparison to other continents.

The negative impact of the informal economy on the tax revenues collection highlights the need for the policy makers in African countries to create an environment conducive to the formalization of the informal business activities, since this would broaden the tax base, and increase tax revenues. Policy makers should do this instead of increasing tax rates that burden the same formal agents; the authorities should bring into the tax system the informal sector by giving them conditions to operate in the formal sector and not under the shadow of it.

3.6 Concluding Remarks

In this chapter we used a panel of up to 25 African countries with data on corporate, labour, and goods and services (indirect) tax revenues and their respective tax rates, and on the size of the shadow economy over the period 2011-2021 to study whether there is empirical evidence of the existence of the Laffer curve for each tax category. We use parametric, nonparametric, and semi-parametric regression approaches. The results of the three regression approaches showed evidence of the existence of the Laffer curve in the three tax categories.

The econometric evidence of the Laffer curve presented in this chapter for some specific taxes in Africa such as corporate, personal income, and indirect taxes, might be helpful for the African governments to consider the feasibility of increasing or decreasing tax rates, as each country tries to lower taxes in order to attract more foreign direct investments, taking into account the range or side of the Laffer curve at which each specific tax rate is. For the case of the corporate tax revenues, estimated RM tax rate is in the interval of 26%-27%. Comparing this value with the current average tax rate of 27.45% in 2021, one can see that the current average rate is in the prohibitive range, right after the RM tax range, showing that further increase in the corporate tax rates could reduce tax revenues. As for the indirect tax revenues, the nonparametric estimation presented a RM indirect tax rate of around 13%-14%, the parametric estimation was of 15.2%; and comparing them with the 2021 average indirect tax rate of 15.36%, it can be seen that according to the nonparametric approach the current average rate is very close to the top of the Laffer curve. In the case of labour tax revenues, the semi-parametric and nonparametric regressions showed a RM tax rate of about 45%, whereas the parametric estimation is 40.8%, and the 2021 average labour tax rate is 31.98%, being below the RM tax rate.

We also studied the impact of the shadow economy on each tax revenue category and found a negative effect of the informal economy on all three tax revenue categories (corporate, labour, and indirect). The negative impact being greater for the case of the corporate tax revenues, followed by taxes on goods and services, and lastly by the labour tax revenues.

Since in this study we analysed the evidence of the Laffer curve using data from a panel of countries, the policy implications of the findings need to be interpreted with caution taking into account that a panel of countries were used and not one specific country. The panel is not homogeneous since the individual effects revealed that countries such as Egypt, Morocco, Nigeria, South Africa, and Zimbabwe have higher corporate tax revenues compared to the average in the Continent, whereas the rest of the countries have lower tax revenues than the average. Future research needs to address this limitation by studying the evidence of the Laffer curve for each specific African country. Doing so would allow us to see how the specific dynamics of tax rates are affecting the tax revenues and draw particular policy implications.

4. General Conclusions

In these three essays we looked at the following three topics: how tax reforms affected non-oil tax revenues in Angola, at the effects of taxation on democracy indices in Africa, and at the assessment of the existence of a Laffer curve for three main tax categories in a panel of countries of this continent.

The econometric regressions used **in the first essay (Chapter 1)** to assess the impact of the tax reform and the determinants of non-oil tax revenues in Angola between 2008 and 2021, showed that the fiscal reforms had positive and significant impact on the non-oil fiscal revenues collection. The regression models revealed that the establishment of a single entity responsible for tax collection in 2015 (General Tax Administration – AGT) yielded greater impact on the non-oil tax revenues collection than the introduction of a new indirect tax (VAT) in 2019, and this can signify that for developing countries such as Angola, reforms that aim at better organization of tax administrations might result in greater revenues collection rather than creating new taxes. The case of Nigeria studied by Ebi and Ayodele (2017) also revealed that the tax reforms (such as the establishment of Federal Inland Revenue Service in 1992) had a positive and significant impact on the mobilization of tax revenues in this African oil producing country. So, a well-organized and unified tax administration can better collect tax revenues and increase fiscal revenues by effectively making sure that the existing taxes are collected from the economic agents.

Regarding the determinants of the non-oil tax revenues in Angola, variables such as the formal exchange rate, non-oil GDP, number of registered taxpayers, and the control of corruption index are negatively affecting the non-oil tax revenues mobilization in Angola, whereas inflation and government effectiveness index are influencing positively. In the case of the non-oil GDP, since it is the tax base of the non-oil fiscal revenues, it was expected to have a positive effect, but the negative non-oil tax buoyancy we detected reveals that the non-oil tax revenues are not a close function of the local economy, and the number of tax exemptions granted might explain this negative tax buoyancy.

The government granted tax exemptions to selected companies in the non-oil sector and other companies benefitted from tax reduction. Although those tax measures were aimed at increasing investment and the overall economic activity, it seems that they also had a negative side effect of loss of tax revenues. It is therefore important for the government to perform a cost-benefit analysis before granting tax exemptions and also to undertake an assessment of the benefits for the economy of all the tax exemptions and benefits granted to date.

The negative impact of the exchange rate on the non-oil tax revenues highlights the importance of stabilizing the foreign exchange market and avoiding a highly volatile currency in order to ensure higher non-oil fiscal revenues. The negative effect of the number of registered taxpayers showed that it is not enough to register more taxpayers, but also ensure that they also actually pay taxes. A better system of tax surveillance is therefore needed.

We also find that oil production is causing an eviction effect on the non-oil tax revenues in Angola, since both ARDL and RU-MIDAS regressions models presented negative coefficients. These findings confirm those of Crivelli and Gupta (2014), who found that for each additional percentage point of GDP in resource revenues, there is a drop in non-resource revenues of about 0.3 percentage points of GDP in resource-rich countries. But it does not need to be the case, since Botlhole *et al*. (2012) argued that additional resource revenues reduce tax revenues when institutions are poor in the countries, whereas in countries with good institutions, more resources revenues contribute to more internal tax revenues mobilization. So, it should be important for the Angola government to have strong institutions that would guarantee that oil revenues are channelled toward the genuine promotion and development of local production for the sake of local job generation, and more collection of non-oil fiscal revenues, which can affect democracy indices positively.

In general, African countries that implemented tax reforms such as Angola, Nigeria, Senegal, Ghana, and Kenya experienced an increase in tax revenue collection. What is not clear is whether this increase in tax collection was responsible for change in the political regimes of these economies and the perception people had in the democratization process. The standard and fractional econometric methods used **in the second essay (Chapter 2)** to investigate the impact of taxation (measured as tax revenue to GDP ratio) on the democratization process in Africa (measured by five democracy indices: electoral, liberal, participatory, deliberative, and egalitarian) showed that taxation impacts all democracy indices in the continent positively up to a certain threshold, after which a further increase in taxation leads to a decrease in the democracy indices. That threshold was found to be, depending on the method, and on type of democracy index, on the order of 26%-27%, which is much higher compared with the historical average tax revenue to GDP ratio in the continent of 14%.

The robustness of the results was confirmed by using fractional regression models, a novelty in this type of literature. These results revealed clearly that taxing the population has the potential to increase the awareness of citizen participation in the public debate, leading to greater democracy indices, at least until that tax level threshold is attained. It is therefore crucial for both African policymakers and citizens to understand that taxation is not just a matter of collecting revenues for the government, but is also a matter of civil participation in the public affairs of the country, helping society to become more democratic.

Among the control variables used, non-tax revenues in percent of GDP showed a negative impact on democracy indices, confirming the political resource curse nature of the natural resource's wealth pointed out in the literature by Ross (1999) and Prichard *et al.* (2018). The impact of the *per capita* GDP in the fractional regression proved to be positive, showing that GDP *per capita* does impact democracy in Africa, a double causality in fact, since democracy also impacts *per capita* GDP, which is in line with the literature (Lipset, 1959; Barro, 1999; Acemoglu *et al.*, 2008; Baskaran, 2013). As for aid in ercent of GDP, it has a mildly positive impact on all democracy indices, meaning that Western countries' goal of enhancing democratic regimes through aid has been less effective than wished in the case of Africa. These results highlight that Western countries wishing to see working democracies in Africa should help the countries there to better collect tax revenues in view of its positive impact on democracy indices, since internal factors such as tax collection can boost democracy in a more sustainable way than does the external factor of aid.

As a result of the concave relationship between taxation and democracy in Africa, an important question to ask is whether there still room to increase tax revenue collection by increasing the tax rates? The parametric, nonparametric, and semi-parametric regression approaches used **in the third essay (Chapter** 3) to test for the Laffer curve for a panel of African countries showed evidence of its existence in the three tax categories (corporate, labour, and goods and services taxes). The econometric evidence of the Laffer curve presented in the chapter might be helpful for the African governments to consider the feasibility of increasing or reducing tax rates as each country tries to lower taxes in order to attract more foreign direct investments.

The lowering and raising of tax rates should take into account the range or side of the Laffer curve that each specific tax rate occupies. For the case of the corporate tax revenues, the current average rate of 27.45% in 2021 was in the prohibitive range, right after the RM tax range, showing that further increase in the corporate tax rates could reduce tax revenues. As for the indirect tax revenues, the 2021 average indirect tax rate of 15.36% was very close to the top of the Laffer curve, thus also leaving no room for increasing the tax rates. In the case of labour tax revenues, the 2021 average labour tax rate of 31.98% was below the RM tax rate, showing that there is still room to increase the labour tax rates to maximize tax revenues.

We also studied the impact of the shadow economy on each tax revenue category and found a negative effect of the informal economy on all three tax revenue categories. The negative impact was greatest for the case of the corporate tax revenues, followed by the indirect. Hence, a serious administrative reform aimed at reducing the size of the informal economy, by bringing into the formal sector the economic agents who operate under the shadow of the formal economy, could increase the tax base, and boost tax revenues, which in turn can improve democracy indices in the continent in view of the positive impact of taxation on democracy.

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Appendix A (Chapter 1)

Unit Roots Tests[75]

Table A1 - Unit Roots Tests Results of Non-oil Tax Monthly Revenues

	ADF (lags 4)			PP			KPSS		
Variable	None	drift	drift and trend	none	drift	drift and trend	none	drift	drift and trend
notaxes	1.13	-0.77	-2.42	0.24	-18.50	-86.60	0.93	1.57	0.19
	(0.93)	*(0.78)*	*(0.40)*	*(0.74)*	*(0.02)*	*(0.01)*	*(0.10)*	*(0.01)*	*(0.02)*
First difference	-9.30	-9.47	-9.47	-185.00	-185.00	-185.00	0.20	0.02	0.02
	(0.01)	*(0.01)*	*(0.01)*	*(0.01)*	*(0.01)*	*(0.01)*	*(0.10)*	*(0.10)*	*(0.10)*

Source: computed by the author using R package

Table A2 - Unit Roots Tests Results of Non-oil Tax Quarterly Revenues

	ADF (lags 3)			PP			KPSS		
Variable	None	drift	drift and trend	none	drift	drift and trend	none	drift	drift and trend
notaxes	2.23	0.35	-1.04	1.12	-2.81	-22.60	0.22	0.42	0.12
	(0.99)	*(0.98)*	*(0.92)*	*(0.92)*	*(0.67)*	*(0.02)*	*(0.10)*	*(0.07)*	*(0.10)*
First difference	-3.04	-3.53	-3.60	-74.80	-73.50	-73.10	0.68	0.10	0.08
	(0.01)	*(0.01)*	*(0.04)*	*(0.01)*	*(0.01)*	*(0.01)*	*(0.10)*	*(0.10)*	*(0.10)*

Source: computed by the author using R package

Table A3 - Unit Roots Tests Results of Quarterly Nominal Non-oil GDP

	ADF (lags3)			PP			KPSS		
Variable	none	drift	drift and trend	none	drift	drift and trend	none	Drift	drift and trend
nnogdp	7.92	5.64	3.07	2.88	3.51	3.72	0.04	0.04	0.11
	(0.99)	*(0.99)*	*(0.99)*	*0.99*	*(0.99)*	*(0.99)*	*(0.10)*	*(0.10)*	*(0.10)*
First difference	-3.74	-6.13	-8.76	-39.50	-48.50	-37.10	0.79	0.37	0.06
	(0.09)	*(0.01)*	*(0.01)*	*0.01*	*(0.01)*	*(0.01)*	*(0.10)*	*(0.09)*	*(0.10)*

Source: computed by the author using R package

Table A4 - Unit Roots Tests Results of Annual Nominal Non-oil GDP

	ADF (lags 2)			PP			KPSS		
Variable	none	drift	drift and trend	none	drift	drift and trend	none	drift	drift and trend
nnogdp	2.94	2.92	1.58	2.42	2.63	6.41	0.12	0.10	0.08
	(0.99)	*(0.99)*	*(0.99)*	*(0.99)*	*(0.99)*	*(0.99)*	*(0.10)*	*(0.10)*	*(0.10)*

[75] In each table the numbers in the first row are the test statistics and the numbers in the second row are the respective p-values.

First difference	1.63	0.54	-1.78	4.48	0.85	-19.10	0.06	0.38	0.12
	(0.97)	*(0.98)*	*(0.64)*	*(0.99)*	*(0.98)*	*(0.04)*	*(0.10)*	*(0.09)*	*(0.10)*

Table A5 - Unit Roots Tests Results of the Monthly Inflation Rate

	ADF (Lags 4)			PP			KPSS		
Variable	none	drift	drift and trend	none	drift	drift and trend	none	drift	drift and trend
inflation	-0.45	-1.94	-2.51	-2.30	-20.30	-31.30	1.07	0.67	0.11
	(0.51)	*(0.35)*	*(0.36)*	*(0.38)*	*(0.01)*	*(0.01)*	*(0.10)*	*(0.02)*	*(0.10)*
First difference	-7.62	-7.62	-7.60	-181.00	-181.00	-181.00	0.06	0.03	0.03
	(0.01)	*(0.01)*	*(0.01)*	*(0.01)*	*(0.01)*	*(0.01)*	*(0.10)*	*(0.10)*	*(0.10)*

Source: computed by the author using R package

Table A6 - Unit Roots Tests Results of the Quarterly Inflation Rate

	ADF (Lags 3)			PP			KPSS		
Variable	none	drift	drift and trend	none	drift	drift and trend	none	Drift	drift and trend
inflation	0.26	-1.55	-2.29	-0.72	-8.99	-13.70	0.30	0.25	0.07
	(0.57)	*(0.50)*	*(0.45)*	*(0.53)*	*(0.21)*	*(0.26)*	*(0.10)*	*(0.10)*	*(0.10)*
First difference	-3.23	-3.23	-3.21	-59.70	-59.80	-59.70	0.09	0.05	0.05
	(0.01)	*(0.02)*	*(0.10)*	*(0.01)*	*(0.01)*	*(0.01)*	*(0.10)*	*(0.10)*	*(0.10)*

Source: computed by the author using R package

Table A7 - Unit Roots Tests Results of the Annual Inflation Rate

	ADF (Lags 2)			PP			KPSS		
Variable	none	drift	drift and trend	none	drift	drift and trend	none	drift	drift and trend
inflation	-0.13	-1.35	-2.58	-0.54	-6.80	-8.89	0.26	0.21	0.06
	(0.60)	*(0.56)*	*(0.34)*	*(0.56)*	*(0.33)*	*(0.48)*	*(0.10)*	*(0.10)*	*(0.10)*
First difference	-2.74	-2.65	-2.42	-11.50	-11.50	-11.60	0.11	0.07	0.07
	(0.01)	*(0.10)*	*(0.40)*	*(0.01)*	*(0.07)*	*(0.33)*	*(0.10)*	*(0.10)*	*(0.10)*

Source: computed by the author using R package

Table A8 - Unit Roots Tests Results of the Monthly Formal Exchange Rate

	ADF (Lags 4)			PP			KPSS		
Variable	none	drift	drift and trend	none	drift	drift and trend	none	drift	drift and trend
fexchanger	0.48	-0.45	-1.70	1.86	1.18	-1.83	0.29	0.34	0.16
	(0.78)	*(0.89)*	*(0.70)*	*(0.98)*	*(0.99)*	*(0.97)*	*(0.10)*	*(0.10)*	*(0.04)*
First difference	-2.44	-2.53	-2.33	-91.10	-100.00	-107.00	1.05	0.50	0.12
	(0.02)	*(0.12)*	*(0.43)*	*(0.01)*	*(0.01)*	*(0.01)*	*(0.10)*	*(0.04)*	*(0.09)*

Source: computed by the author using R package

Table A9 - Unit Roots Tests Results of the Quarterly formal Exchange Rate

	ADF (Lags3)			PP			KPSS		
Variable	none	drift	drift and trend	none	drift	drift and trend	none	drift	drift and trend
Fexchanger	-0.43	-1.36	-2.32	1.99	1.25	-2.13	0.20	0.27	0.13
	(0.52)	*(0.57)*	*(0.44)*	*(0.99)*	*0.99*	*(0.96)*	*(0.10)*	*(0.10)*	*(0.09)*
First difference	-1.93	-2.06	-1.81	-21.20	-26.90	-33.30	0.64	0.28	0.10
	(0.05)	*(0.31)*	*(0.65)*	*(0.01)*	*0.01*	*(0.01)*	*(0.10)*	*(0.10)*	*(0.10)*

Source: computed by the author using R package

Table A10 - Unit Roots Tests Results of the Annual Formal Exchange Rate

	ADF (Lags 2)			PP			KPSS		
Variable	none	drift	drift and trend	none	drift	drift and trend	none	drift	drift and trend
fexchanger	1.08	0.26	-0.64	3.09	3.05	0.24	0.19	0.21	0.11
	(0.92)	*(0.97)*	*(0.96)*	*(0.99)*	*(0.99)*	*(0.99)*	*(0.10)*	*(0.10)*	*(0.10)*
First difference	-0.87	-1.28	-2.24	-3.88	-6.11	-12.10	0.42	0.26	0.11
	(0.36)	*(0.59)*	*(0.46)*	*(0.23)*	*(0.37)*	*(0.30)*	*(0.10)*	*(0.10)*	*(0.10)*

Source: computed by the author using R package

Table A11 - Unit Roots Tests Results of Monthly Oil Price

	ADF (Lags 4)			PP			KPSS		
Variable	none	drift	drift and trend	none	drift	drift and trend	none	drift	drift and trend
oilprice	-1.27	-2.50	-2.49	-1.23	-9.49	-12.20	0.07	0.09	0.06
	(0.22)	*(0.13)*	*(0.37)*	*(0.47)*	*(0.19)*	*(0.35)*	*(0.10)*	*(0.10)*	*(0.10)*
First difference	-5.93	-5.93	-5.98	-86.00	-86.00	-85.90	0.06	0.03	0.03
	(0.01)	*(0.01)*	*(0.01)*	*(0.01)*	*(0.01)*	*(0.01)*	*(0.10)*	*(0.10)*	*(0.10)*

Source: computed by the author using R package

Table A12 - Unit Roots Tests Results of Quarterly Oil Price

	ADF (Lags 3)			PP			KPSS		
Variable	none	drift	drift and trend	none	drift	drift and trend	none	drift	drift and trend
oilprice	-0.11	-1.74	-2.52	-0.97	-7.88	-10.10	0.10	0.12	0.08
	(0.61)	*(0.43)*	*(0.36)*	*(0.49)*	*(0.28)*	*(0.44)*	*(0.10)*	*(0.10)*	*(0.10)*
First difference	-3.86	-3.78	-3.75	-43.60	-43.80	-44.20	0.26	0.10	0.06
	(0.01)	*(0.01)*	*(0.03)*	*(0.01)*	*(0.01)*	*(0.01)*	*(0.10)*	*(0.10)*	*(0.10)*

Source: computed by the author using R package

Table A13 - Unit Roots Tests Results of Annual Oil Price

	ADF (Lags 2)			PP			KPSS		
Variable	none	drift	drift and trend	none	drift	drift and trend	none	drift	drift and trend
oilprice	-0.56	-1.24	-1.86	-0.79	-6.12	-7.63	0.11	0.14	0.08
	(0.47)	*(0.60)*	*(0.61)*	*(0.51)*	*(0.37)*	*(0.57)*	*(0.10)*	*(0.10)*	*(0.10)*
First difference	-1.87	-1.81	-1.51	-11.20	-11.10	-11.20	0.13	0.12	0.11
	(0.06)	*(0.40)*	*(0.75)*	*(0.01)*	*(0.08)*	*(0.35)*	*0.10*	*(0.10)*	*(0.10)*

Source: computed by the author using R package

Table A14 - Unit Roots Tests Results of Monthly Oil Production

	ADF (Lags 4)			PP			KPSS		
Variable	none	drift	drift and trend	none	drift	drift and trend	none	drift	drift and trend
oilproduction	-1.58	-0.46	-1.82	-0.43	-1.77	-12.10	0.15	0.37	0.22
	(0.11)	*(0.89)*	*(0.65)*	*(0.59)*	*(0.79)*	*(0.36)*	*(0.10)*	*(0.09)*	*(0.01)*
First difference	-5.76	-5.97	-5.98	-217.00	-215.00	-215.00	0.48	0.10	0.04
	(0.01)	*(0.01)*	*(0.01)*	*(0.01)*	*(0.01)*	*(0.01)*	*(0.10)*	*(0.10)*	*(0.10)*

Source: computed by the author using R package

Table A15 - Unit Roots Tests Results of Quarterly Oil Production

	ADF			PP			KPSS		
Variable	none	drift	drift and trend	none	drift	drift and trend	none	drift	drift and trend
oilproduction	-1.75	0.22	-1.19	-0.44	-0.10	-6.12	0.24	0.22	0.14
	(0.08)	*(0.97)*	*(0.90)*	*(0.59)*	*(0.95)*	*(0.71)*	*(0.10)*	*(0.10)*	*(0.06)*
First difference	-4.37	-4.88	-5.47	-42.80	-43.80	-43.60	0.51	0.11	0.05
	(0.01)	*(0.01)*	*(0.01)*	*(0.01)*	*(0.01)*	*(0.01)*	*(0.10)*	*(0.10)*	*(0.10)*

Source: computed by the author using R package

Table A16 - Unit Roots Tests Results of Annual Oil Production

	ADF (Lags 2)			PP			KPSS		
Variable	none	drift	drift and trend	none	drift	drift and trend	none	drift	drift and trend
oilproduction	-1.28	1.47	-0.09	-0.44	1.78	-1.17	0.26	0.13	0.12
	(0.21)	*(0.99)*	*(0.99)*	*(0.58)*	*(0.99)*	*(0.98)*	*(0.10)*	*(0.10)*	*(0.09)*
First difference	-0.13	-0.71	-1.56	-3.54	-6.48	-7.26	0.22	0.29	0.07
	(0.60)	*(0.78)*	*(0.73)*	*(0.26)*	*(0.35)*	*(0.60)*	*(0.10)*	*(0.10)*	*(0.10)*

Source: computed by the author using R package

Table A17 - Unit Roots Tests Results of Quarterly Number of Taxpayers

	ADF			PP			KPSS		
Variable	none	drift	drift and trend	none	drift	drift and trend	none	drift	drift and trend
Taxpayers	2.99	1.47	-1.83	1.88	0.93	-5.48	0.51	0.15	0.08
	(0.99)	*(0.99)*	*(0.64)*	*(0.98)*	*(0.98)*	*(0.76)*	*(0.10)*	*(0.10)*	*(0.10)*
First difference	-1.90	-2.77	-3.09	-54.00	-54.30	-53.50	1.48	0.31	0.06
	(0.06)	*(0.07)*	*(0.14)*	*(0.01)*	*(0.01)*	*(0.01)*	*(0.07)*	*(0.10)*	*(0.10)*

Source: computed by the author using R package

Table A18 - Unit Roots Tests Results of Annual Number of Taxpayers

	ADF (Lags 2)			PP			KPSS		
Variable	none	drift	drift and trend	none	drift	drift and trend	none	drift	drift and trend
Taxpayers	1.33	0.83	-1.74	2.17	1.27	-3.38	0.57	0.16	0.07
	(0.95)	*(0.99)*	*(0.66)*	*(0.99)*	*(0.99)*	*(0.91)*	*(0.10)*	*(0.10)*	*(0.10)*
First difference	-0.35	-1.48	-2.02	-5.24	-10.20	-12.50	0.84	0.28	0.09
	(0.53)	*(0.52)*	*(0.55)*	*(0.11)*	*(0.10)*	*(0.28)*	*(0.10)*	*(0.10)*	*(0.10)*

Source: computed by the author using R package

Table A19 - Unit Roots Tests Results of Control of Corruption Index (Quarterly Transformed)

	ADF			PP			KPSS		
Variable	none	drift	drift and trend	none	drift	drift and trend	none	drift	drift and trend
ccorruption index	-1.25	1.90	0.84	-0.45	2.62	-0.43	0.48	0.35	0.11
	(0.23)	*(0.99)*	*(0.99)*	*(0.59)*	*(0.99)*	*(0.99)*	*(0.10)*	*(0.10)*	*(0.10)*
First difference	-4.04	-4.34	-5.69	-54.00	-54.30	-53.50	0.24	0.57	0.07
	(0.01)	*(0.01)*	*(0.01)*	*(0.01)*	*(0.01)*	*(0.01)*	*(0.10)*	*(0.03)*	*(0.10)*

Source: computed by the author using R package

Table A20 Unit Roots Tests Results of Control of Corruption Index (Annual Original Data)

	ADF (Lags 2)			PP			KPSS		
Variable	none	drift	drift and trend	none	drift	drift and trend	none	drift	drift and trend
ccorruption index	-0.88	0.73	0.69	-0.46	5.05	2.48	0.41	0.38	0.11
	(0.36)	*(0.99)*	*(0.99)*	*(0.58)*	*(0.99)*	*(0.99)*	*(0.10)*	*(0.08)*	*(0.10)*
First difference	0.63	0.19	-0.87	-5.18	-7.07	-12.70	0.31	0.37	0.15
	(0.82)	*(0.96)*	*(0.94)*	*(0.11)*	*(0.31)*	*(0.26)*	*(0.10)*	*(0.09)*	*(0.05)*

Source: computed by the author using R package

Table A21 - Unit Roots Tests Results of Government Effectiveness Index (Quarterly Transformed)

	ADF (Lags 3)			PP			KPSS		
Variable	none	drift	drift and trend	none	drift	drift and trend	none	drift	drift and trend
govefectiv index	-0.25	-2.89	-2.86	-0.13	-13.70	-13.80	0.06	0.08	0.08
	(0.57)	*(0.06)*	*(0.23)*	*(0.66)*	*(0.05)*	*(0.26)*	*(0.10)*	*(0.10)*	*(0.10)*
First difference	-5.27	-5.23	-5.16	-54.00	-54.00	-54.00	0.05	0.05	0.04
	(0.01)	*(0.01)*	*(0.01)*	*(0.01)*	*(0.01)*	*(0.01)*	*(0.10)*	*(0.10)*	*(0.10)*

Source: computed by the author using R package

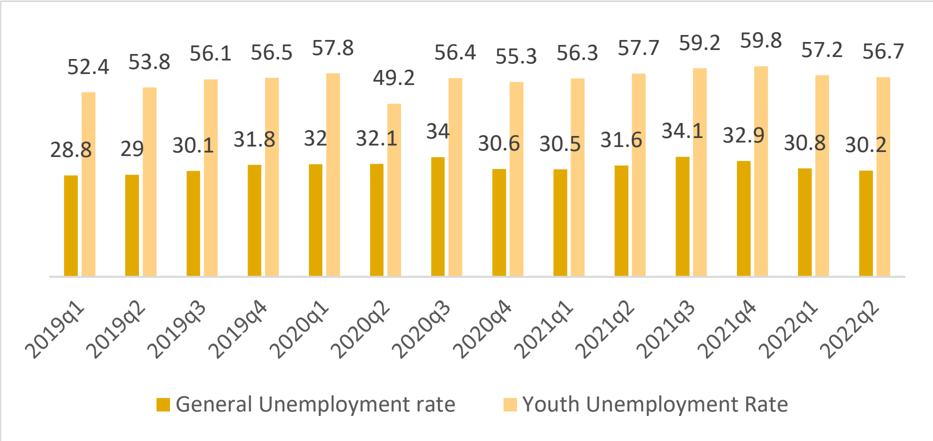
Table A 22 - Unit Roots Tests Results of Government Effectiveness Index (Annual Original Data)

	ADF (Lags 2)			PP			KPSS		
Variable	none	drift	drift and trend	none	drift	drift and trend	none	drift	drift and trend
govefectiv index	-0.01	-1.40	-1.22	-0.06	-10.60	-10.60	0.10	0.10	0.10
	(0.63)	*(0.54)*	*(0.87)*	*(0.67)*	*(0.09)*	*(0.38)*	*(0.10)*	*(0.10)*	*(0.10)*
First difference	-1.64	-1.51	-1.68	-15.80	-15.90	-15.80	0.14	0.11	0.11
	(0.69)	*(0.51)*	*(0.09)*	*(0.01)*	*(0.02)*	*(0.09)*	*(0.10)*	*(0.10)*	*(0.10)*

Source: computed by the author using R package

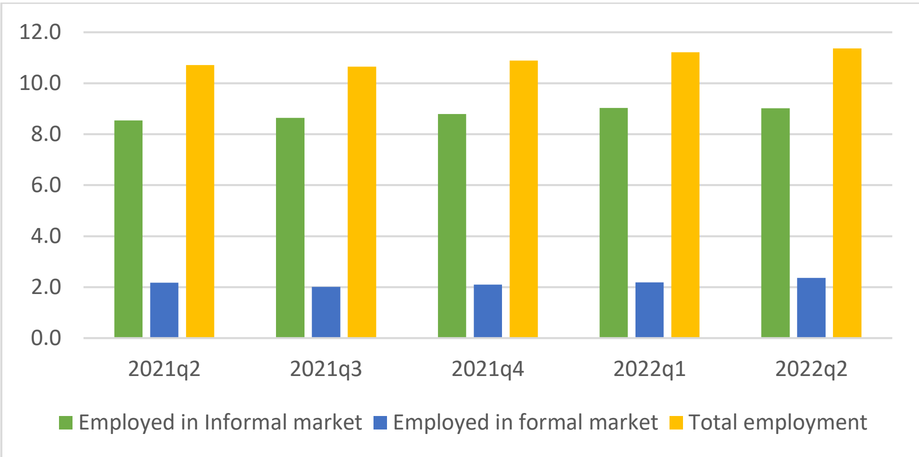
Unemployment and Employment Data

Figure A1 - Quarterly Unemployment Rate (%)



Source: INE-Angola - Indicadores sobre Emprego e Desemprego

Figure A 2 - Number of Employed Persons (in millions)



Source: INE-Angola - Indicadores sobre Emprego e Desemprego

ARDL Regression Results

Results of the Long-run and Short-run of ARDL regression model with the non-oil tax revenues as dependent variable, capital L stands for lags and ln natural logarithm and d stands for difference.

Table A23 - Long-run Relationships of ARDL (5,6,6,6,6,5)

Variable	Coeffi-cient	Standard error	t-Statis-tic	p-value
Intercept	133.441	19.372	6.888	0.006
Trend	1.409	0.279	5.051	0.015
L (lnnotaxes, 1)	-1.010	0.132	-7.640	0.005
L (lnnotaxes, 2)	-0.477	0.129	-3.699	0.034
L (lnnotaxes, 3)	-0.029	0.165	-0.178	0.870
L (lnnotaxes, 4)	0.340	0.147	2.308	0.104
L (lnnotaxes, 5)	0.464	0.111	4.176	0.025
lnoilprice	-0.330	0.125	-2.645	0.077
L (lnoilprice, 1)	1.294	0.155	8.334	0.004
L (lnoilprice, 2)	-0.302	0.077	-3.906	0.030
L (lnoilprice, 3)	-0.506	0.158	-3.206	0.049
L (lnoilprice, 4)	-0.295	0.094	-3.128	0.052
L (lnoilprice, 5)	0.296	0.087	3.406	0.042
L (lnoilprice, 6)	-0.636	0.084	-7.541	0.005
lnoilproduction	-4.677	0.731	-6.399	0.008
L (lnoilproduction, 1)	-1.399	0.562	-2.487	0.089
L (lnoilproduction, 2)	0.004	1.051	0.003	0.998
L (lnoilproduction, 3)	-1.331	0.496	-2.683	0.075
L (lnoilproduction, 4)	-3.421	0.552	-6.195	0.008
L (lnoilproduction, 5)	-4.161	0.607	-6.850	0.006
L (lnoilproduction, 6)	3.932	0.861	4.565	0.020
lnfexchanger	-2.592	0.334	-7.757	0.004
L (lnfexchanger, 1)	1.803	0.457	3.945	0.029
L (lnfexchanger, 2)	-1.249	0.362	-3.455	0.041
L (lnfexchanger, 3)	1.137	0.377	3.017	0.057
L (lnfexchanger, 4)	-0.718	0.350	-2.049	0.133
L (lnfexchanger, 5)	-0.652	0.370	-1.762	0.176
L (lnfexchanger, 6)	-2.064	0.424	-4.864	0.017
linflation	0.099	0.077	1.277	0.292
L(lninflation, 1)	0.328	0.067	4.886	0.016
L(lninflation, 2)	-0.298	0.065	-4.606	0.019
L(lninflation, 3)	-0.373	0.086	-4.330	0.023
L(lninflation, 4)	0.033	0.052	0.626	0.576
L(lninflation, 5)	-0.112	0.080	-1.400	0.256
L(lninflation, 6)	0.228	0.078	2.921	0.061
lnnogdp	-2.041	0.299	-6.815	0.006
L(lnnogdp, 1)	-1.276	0.309	-4.124	0.026
L(lnnogdp, 2)	-0.823	0.361	-2.282	0.107
L(lnnogdp, 3)	-0.439	0.463	-0.949	0.413
L(lnnogdp, 4)	-0.979	0.278	-3.526	0.039
L(lnnogdp, 5)	0.214	0.311	0.690	0.540
Ln taxpayers	-1.053	0.261	-4.037	0.027
ccorruption	-1.084	0.292	-3.719	0.034
govefect	-0.088	0.221	-0.397	0.718
reform2011	0.406	0.142	2.860	0.065
reform2015	1.405	0.334	4.212	0.024
reform2019	1.156	0.127	9.12	0.003
R^2	0.9995			
Adjusted R^2	0.991			
F-statistic	119.500			
p-value	0.001			

Table A 24 - Short-run Relationship Results of ARDL (5,6,6,6,6,5)

Variable	Coefficient	Standard error	t-Statistic	p-value
Intercept	133.441	5.242	25.458	0.000
Trend	1.409	0.054	26.045	0.000
d(L(lnnotaxes, 1))	-0.297	0.091	-3.250	0.012
d(L(lnnotaxes, 2))	-0.774	0.080	-9.666	0.000
d(L(lnnotaxes, 3))	-0.804	0.055	-14.553	0.000
d(L(lnnotaxes, 4))	-0.464	0.039	-11.826	0.000
d(lnoilprice)	-0.330	0.031	-10.592	0.000
d(L(lnoilprice, 1))	1.443	0.066	21.948	0.000
d(L(lnoilprice, 2))	1.141	0.065	17.607	0.000
d(L(lnoilprice, 3))	0.635	0.041	15.480	0.000
d(L(lnoilprice, 4))	0.340	0.035	9.629	0.000
d(L(lnoilprice, 5))	0.636	0.037	17.420	0.000
d(lnoilproduction)	-4.677	0.284	-16.466	0.000
d(L(lnoilproduction, 1))	4.977	0.539	9.231	0.000
d(L(lnoilproduction, 2))	4.980	0.265	18.767	0.000
d(L(lnoilproduction, 3))	3.650	0.316	11.560	0.000
d(L(lnoilproduction, 4))	0.229	0.210	1.087	0.309
d(L(lnoilproduction, 5))	-3.932	0.327	-12.009	0.000
d(lnfexchanger)	-2.592	0.136	-19.008	0.000
d(L(lnfexchanger, 1))	3.547	0.172	20.655	0.000
d(L(lnfexchanger, 2))	2.297	0.141	16.343	0.000
d(L(lnfexchanger, 3))	3.434	0.185	18.545	0.000
d(L(lnfexchanger, 4))	2.717	0.201	13.520	0.000
d(L(lnfexchanger, 5))	2.064	0.116	17.771	0.000
d(lninflation)	0.099	0.030	3.307	0.011
d(L(lninflation, 1))	0.521	0.029	17.725	0.000
d(L(lninflation, 2))	0.223	0.034	6.594	0.000
d(L(lninflation, 3))	-0.149	0.027	-5.508	0.001
d(L(lninflation, 4))	-0.117	0.036	-3.219	0.012
d(L(lninflation, 5))	-0.228	0.034	-6.691	0.000
d(lnnogdp)	-2.041	0.141	-14.523	0.000
d(L(lnnogdp, 1))	2.027	0.238	8.508	0.000
d(L(lnnogdp, 2))	1.204	0.242	4.971	0.001
d(L(lnnogdp, 3))	0.765	0.175	4.365	0.002
d(L(lnnogdp, 4))	-0.214	0.127	-1.680	0.131
Ln taxpayers	-1.053	0.146	-7.196	0.000
ccorruption	-1.084	0.074	-14.566	0.000
govefect	-0.088	0.093	-0.947	0.371
reform2011	0.406	0.059	6.911	0.000
reform2015	1.405	0.185	7.581	0.000
reform2019	1.156	0.059	19.481	0.000
ect	-1.713	0.080	-21.289	0.000
R^2	0.9981			
Adjusted R^2	0.989			
F-statistic	103.800			
p-value	0.000			

ARDL Regression results using as the dependent variable non-oil tax revenues as percentage of total GDP (notaxesgdp).

Table A 25 - Long-Run Multipliers Coefficients of ARDL (4,2,6,6,6,6)

Dependent Variable: Non-oil Tax Revenues as % of Total GDP				
Regressors	Coefficients	Standard error	t-Statistic	p-value
Intercept	83.676	10.603	7.892	0.000
Trend	1.108	0.216	5.123	0.001
Ln oilprice	0.013	0.114	0.116	0.911
Ln oilproduction	-5.547	0.763	-7.270	0.000
Ln fexchanger	-2.322	0.317	-7.323	0.000
Ln inflation	0.050	0.097	0.517	0.621
Ln nnogdp	-5.616	1.183	-4.746	0.002
Ln taxpayers	-1.066	0.523	-2.038	0.081
ccorruption	-1.391	0.587	-2.371	0.050
govefect	-0.062	0.355	-0.175	0.866
reform2011	-0.127	0.273	-0.466	0.655
reform2015	1.678	0.652	2.571	0.037
reform2019	0.790	0.233	3.392	0.012

Table A 26 - Short-Run Multipliers Coefficients of ARDL (4,2,6,6,6,6)

Dependent Variable: Non-oil Tax Revenues as % of Total GDP				
Variable	Coefficient	Standard error	t-Statistic	p-value
Intercept	168.584	28.686	5.877	0.001
Trend	2.232	0.467	4.784	0.002
Ln oilprice	-0.349	0.157	-2.219	0.062
Ln oilproduction	-3.056	1.237	-2.471	0.043
Ln fexchanger	-2.910	0.548	-5.314	0.001
Ln inflation	-0.042	0.117	-0.356	0.732
Ln nnogdp	-2.389	0.522	-4.572	0.003
Ln taxpayers	-1.066	0.345	-3.087	0.009
ccorruption	-1.391	0.166	-8.361	0.000
govefect	-0.062	0.169	-0.368	0.719
reform2011	-0.127	0.163	-0.780	0.450
reform2015	1.678	0.430	3.898	0.002
reform2019	0.790	0.116	6.784	0.000
ect	-2.015	0.223	-9.038	0.000

ARDL Regression results using as the dependent variable non-oil tax revenues as percentage of non-oil GDP (notaxesnogdp)

Table A27 - Long-Run Multipliers Coefficients of ARDL (5,6,6,6,6,5)

Dependent Variable: Non-oil Tax Revenues as % of Non-oil GDP				
Regressors	Coefficients	Standard error	t-Statistic	p-value
Intercept	82.522	13.852	5.625	0.009
Trend	0.823	0.227	3.625	0.036
Ln oilprice	-0.280	0.154	-1.819	0.166
Ln oilproduction	-6.454	0.881	-7.324	0.005
Ln fexchanger	-2.532	0.408	-6.206	0.008
Ln inflation	-0.055	0.097	-0.573	0.607
Ln nnogdp	-4.120	1.104	-3.733	0.034
Ln taxpayers	-1.053	0.261	-4.037	0.027
ccorruption	-1.084	0.292	-3.719	0.034
govefect	-0.088	0.221	-0.397	0.718
reform2011	0.406	0.142	2.860	0.065
reform2015	1.405	0.334	4.212	0.024
reform2019	1.156	0.127	9.12	0.003

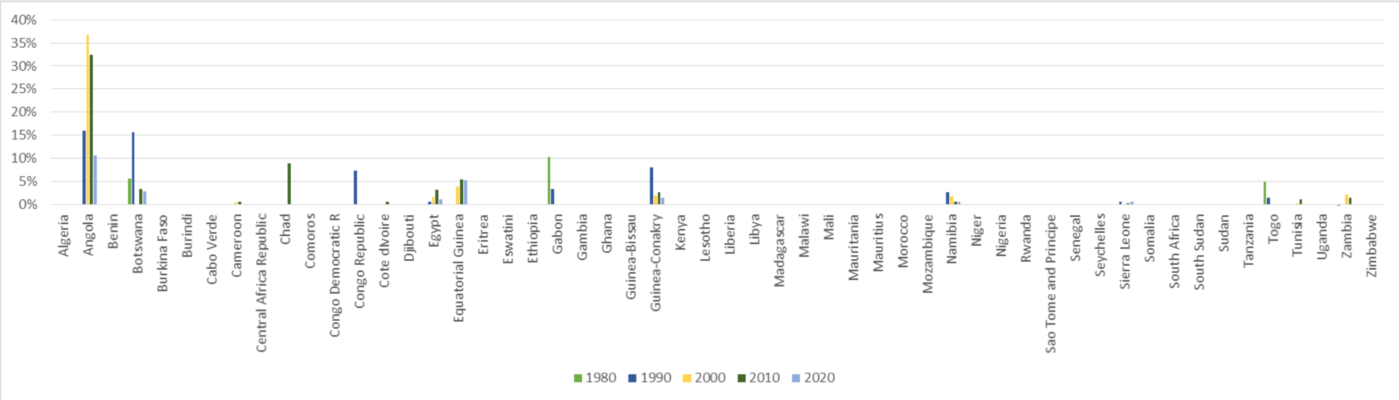
Table A28 - Short-Run Multipliers Coefficients ARDL (5,6,6,6,6,5)

Dependent Variable: Non-oil Tax Revenues as % of Non-oil GDP				
Variable	Coefficient	Standard error	t-Statistic	p-value
Intercept	141.328	20.637	6.848	0.006
Trend	1.409	0.279	5.051	0.015
Ln oilprice	-0.330	0.125	-2.645	0.077
Ln oilproduction	-4.677	0.731	-6.399	0.008
Ln fexchanger	-2.592	0.334	-7.757	0.004
Ln inflation	0.099	0.077	1.277	0.292
Ln nnogdp	-3.041	0.299	-10.155	0.002
Ln taxpayers	-1.053	0.146	-7.196	0.000
ccorruption	-1.084	0.074	-14.566	0.000
govefect	-0.088	0.093	-0.947	0.371
reform2011	0.406	0.059	6.911	0.000
reform2015	1.405	0.185	7.581	0.000
reform2019	1.156	0.059	19.481	0.000
ect	-1.713	0.080	-21.289	0.000

Appendix B (Chapter 2)

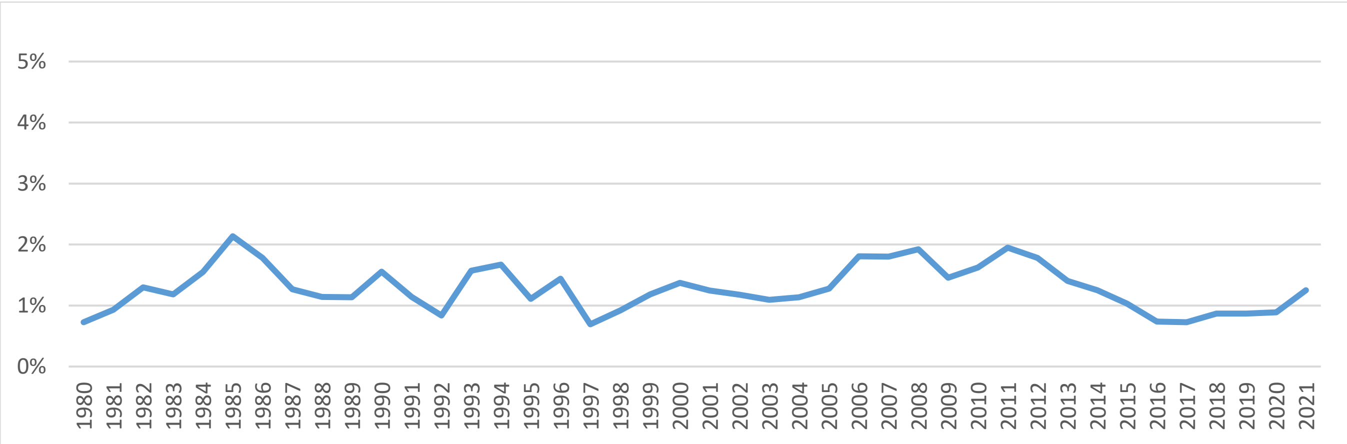
Resources Tax Revenues

Figure B1 - Resources Tax Revenues as % of GDP



Source: UNU-WIDER Government Revenue Dataset

Figure B2 - Average Resources Tax Revenues as % of GDP in Africa



Source: Computed by the author based on the UNU-WIDER Government Revenue Dataset

Countries with a Revenue Authority

Table B1 - Countries with a Revenue Authority in Africa

Countries with Revenue Authority	Year implemented
Angola	2015
Burundi	2009
Botswana	2005
Egypt	2004
Ethiopia	2008
Ghana	2009
Gambia	2007
Kenya	1995
Liberia	2014
Lesotho	2003
Mozambique	2006
Mauritius	2005
Malawi	2000
Namibia	2017
Nigeria	2007
Rwanda	1998
Sierra Leone	2002
Eswatini	2011
Seychelles	2010
Togo	2013
Tanzania	1996
Uganda	1991
South Africa	1997
Zambia	1994
Zimbabwe	2001

Source: Fjeldstad and Moore (2009); Dom (2017), and some RA's websites

GMM IV Regression

Table B2 - Effect of Taxation on Electoral Democracy Index, GMM Regression

	1	2	3	4
Tax Revenues (% GDP)	**0.0053**	**0.0017**	**0.0004**	**0.0010**
Std. Error	(0.0003)	(0.0003)	(0.0013)	(0.0018)
p-value	0.000	0.000	0.777	0.604
Non-Tax Revenues (% GDP)	**0.000**	**-0.002**	**-0.002**	**0.000**
Std. Error	(0.000)	(0.001)	(0.000)	(0.000)
p-value	0.007	0.001	0.000	0.393
Log GDP *per capita*		**0.077**	**0.074**	**0.555**
Std. Error		(0.006)	(0.008)	(0.005)
p-value		0.000	0.000	0.052
Aid (% GDP)		**0.001**	**0.001**	**0.000**
Std. Error		(0.000)	(0.000)	(0.000)
p-value		0.002	0.002	0.555
Tax Revenues^2 (% GDP)			**0.00003**	**-0.00001**
Std. Error			(0.000)	(0.000)
p-value			0.180	0.821
Lag of elect democracy				**0.760**
Std. Error				(0.019)
p-value				0.000
Countries	50	50	50	50
N	1733	1381	1381	1381
Diagnostic tests				
Sargan test				
chisq	48.96	40.10	38.88	40.82
p-value	1	1	1	1
Autocorrelation test (1)				
normal	3.03	2.62	2.53	-3.53
p-value	0.002	0.009	0.011	0.000
Autocorrelation test (2)				
normal	-1.821	-2.356	-2.382	-3.482
p-value	0.07	0.02	0.02	0.00
Wald test for coefficients				
chisq	257.46	303.71	4580.99	8652.47
p-value	0.000	0.000	0.000	0.000

Generalized Linear Model (GLM) Regression- with glm2 R package

Table B 3 - Effect of Taxation on Electoral Democracy Index, GLM Regression[76]

	Cloglog	Cloglog	Cloglog
Tax Revenues (% GDP)	**0.0147**	**-0.0011**	**0.0116**
Std. Error	(0.0021)	(0.0024)	(0.0080)
p-value	0.000	0.649	0.146
Non-Tax Revenues (% GDP)	**-0.007**	**-0.022**	**-0.021**
Std. Error	(0.004)	(0.004)	(0.004)
p-value	0.102	0.000	0.000
Log GDP *per capita*		**0.264**	**0.249**
Std. Error		(0.020)	(0.022)
p-value		0.000	0.000
Aid (% GDP)		**0.018**	**0.018**
Std. Error		(0.003)	(0.003)
p-value		0.000	0.000
Tax Revenues^2 (% GDP)			**-0.00029**
Std. Error			(0.000)
p-value			0.092
Taxation Threshold (% GDP)			**20%**
N	1474	1474	1474
Dispersion parameter	0.160	0.144	0.143

FE-LDV Regression of All Democracy Indices

Table B4 - Effect of Taxation on Democracy indices, FE-LDV Regression

	Electoral	Liberal	Participatory	Deliberative	Egalitarian
Tax Revenues (% GDP)	**0.0033**	**0.0021**	**0.0017**	**0.0011**	**0.0015**
Std. Error	(0.0012)	(0.0010)	(0.0007)	(0.0010)	(0.0008)
p-value	0.008	0.034	0.016	0.278	0.044
Non-Tax Revenues (% GDP)	**-0.001**	**-0.0008**	**-0.0007**	**-0.0009**	**-0.001**
Std. Error	(0.001)	(0.001)	(0.000)	(0.001)	(0.000)
p-value	0.421	0.171	0.117	0.150	0.250
Log GDP *per capita*	**-0.009**	**-0.009**	**-0.007**	**-0.012**	**-0.004**
Std. Error	(0.007)	(0.005)	(0.004)	(0.006)	(0.004)
p-value	0.169	0.102	0.096	0.030	0.299
Aid (% GDP)	**0.0002**	**0.0002**	**0.0002**	**0.0000**	**-0.00001**
Std. Error	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
p-value	0.726	0.670	0.451	0.915	0.970
Tax Revenues^2 (% GDP)	**-0.00005**	**-0.00003**	**-0.00002**	**-0.00002**	**-0.00002**
Std. Error	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
p-value	0.058	0.102	0.151	0.339	0.158
Taxation Threshold (% GDP)	**36.1**				
Lag of elect democracy	**0.735**	**0.797**	**0.753**	**0.794**	**0.780**
Std. Error	(0.018)	(0.016)	(0.018)	(0.017)	(0.017)
p-value	0.000	0.000	0.000	0.000	0.000
Countries	48	48	48	48	48
N	1448	1448	1448	1448	1448
R-Squared	0.572	0.654	0.592	0.636	0.633

[76] The generalized linear model 2 (glm2) R package developed by Marschner (2011) was used.

FE Regression of All Democracy Indices

Table B 5 - Effect of Taxation on Democracy Indices, FE Regression

	Electoral	Liberal	Participatory	Deliberative	Egalitarian
Tax Revenues (% GDP)	**0.0097**	**0.0097**	**0.0081**	**0.0099**	**0.0064**
Std. Error	(0.0018)	(0.0016)	(0.0011)	(0.0016)	(0.0012)
p-value	0.000	0.000	0.000	0.000	0.000
Non-Tax Revenues (% GDP)	**-0.0014**	**-0.0022**	**-0.0014**	**-0.0018**	**-0.002**
Std. Error	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
p-value	0.226	0.029	0.036	0.077	0.023
Log GDP *per capita*	**-0.006**	**0.005**	**-0.004**	**-0.005**	**0.003**
Std. Error	(0.010)	(0.009)	(0.006)	(0.009)	(0.007)
p-value	0.520	0.577	0.469	0.607	0.594
Aid (% GDP)	**0.0003**	**0.0001**	**0.0004**	**0.0001**	**-0.0001**
Std. Error	(0.001)	(0.001)	(0.000)	(0.001)	(0.000)
p-value	0.623	0.913	0.287	0.838	0.753
Tax Revenues^2 (% GDP)	**-0.00012**	**-0.00012**	**-0.00009**	**-0.00014**	**-0.00006**
Std. Error	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
p-value	0.001	0.000	0.000	0.000	0.006
Taxation Threshold (% GDP)	**41.5**	**39.9**	**43.0**	**35.6**	**49.6**
Countries	48	48	48	48	48
N	1475	1475	1475	1475	1475
R-Squared	0.029	0.038	0.062	0.033	0.039

Note: Due to lack of data, six countries were excluded: Algeria, Eritrea, Libya, Nigeria, Somalia, and South Sudan. The period studied is from 1988-2021.

GMM Regression of All Democracy Indices

Table B6 - Effect of Taxation on Democracy Indices, GMM Regression

	Electoral	Liberal	Participatory	Deliberative	Egalitarian
Tax Revenues (% GDP)	**0.0017**	**0.0014**	**0.0013**	**0.0004**	**0.0012**
Std. Error	(0.0003)	(0.0002)	(0.0002)	(0.0003)	(0.0002)
p-value	0.000	0.000	0.000	0.185	0.000
Non-Tax Revenues (% GDP)	**-0.002**	**-0.002**	**-0.002**	**-0.002**	**-0.002**
Std. Error	0.001	0.000	0.000	0.001	0.000
p-value	0.001	0.000	0.002	0.000	0.000
Log GDP *per capita*	**0.077**	**0.058**	**0.049**	**0.067**	**0.052**
Std. Error	0.006	0.004	0.005	0.004	0.003
p-value	0.000	0.000	0.000	0.000	0.000
Aid (% GDP)	**0.001**	**0.001**	**0.001**	**0.001**	**0.001**
Std. Error	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
p-value	0.002	0.000	0.001	0.004	0.002
Countries	50	50	50	50	50
N	1381	1381	1381	1381	1381
Diagnostic tests					
Sargan test					
chisq	38.88	38.97	39.91	39.06	40.29
p-value	1	1	1	1	1
Autocorrelation test (1)					
normal	2.53	3.04	3.27	3.18	2.77
p-value	0.011	0.002	0.001	0.001	0.006
Autocorrelation test (2)					
normal	-2.382	-1.310	-1.880	-0.835	-1.666
p-value	0.02	0.19	0.06	0.40	0.10
Wald test for coefficients					
chisq	4580.99	466.14	642.76	652.42	461.23
p-value	0.000	0.000	0.000	0.000	0.000

Descriptive Statistics of the Variables Used in the Fractional Regression, with frmpd package

Table B7 - Descriptive Statistics of the Variables Used in the Fractional Regression Model

Variables	Dimensions	Mean	Standard deviation	Min	Max	Observations	
Dependents (Y)							
Electoral Democracy	overall	0.396	0.199	0.071	0.806	N	1474
	between		0.153	0.126	0.737	n	48
	within		0.127	0.307	0.814	T	31
Liberal Democracy	overall	0.281	0.187	0.032	0.723	N	1474
	between		0.155	0.056	0.633	n	48
	within		0.106	0.160	0.669	T	31
Participatory Democracy	overall	0.232	0.128	0.027	0.534	N	1474
	between		0.104	0.05	0.476	n	48
	within		0.079	0.162	0.506	T	31
Deliberative Democracy	overall	0.303	0.19	0.028	0.723	N	1474
	between		0.153	0.061	0.671	n	48
	within		0.113	0.189	0.691	T	31
Egalitarian Democracy	overall	0.275	0.151	0.033	0.653	N	1474
	between		0.127	0.073	0.595	n	48
	within		0.083	0.224	0.59	T	31
Independents (X)							
Taxation (TaxratioGDP)	overall	13.956	7.977	0.6	60.946	N	1474
	between		7.295	5.552	38.644	n	48
	within		3.284	12.687	40.386	T	31
Taxratio^2	overall	258.372	341.679	0.36	3714.467	N	1474
	between		299.609	31.555	1553.437	n	48
	within		161.255	306.779	2419.402	T	31
Nontaxrevenues (%GDP)	overall	3.082	4.397	0.008	43.943	N	1474
	between		3.753	0.19	19.598	n	48
	within		2.28	5.364	41.837	T	31
Aid (%GDP)	overall	3.046	4.96	-0.193	123.251	N	1474
	between		3.413	0.021	20.562	n	48
	within		3.89	8.100	105.735	T	31
GDP *per capita* ($ nominal)	overall	1555.734	2,150.43	98.60	16,851.12	N	1474
	between		1,702.78	190.20	9,078.35	n	48
	within		1,175.32	3,547.55	9,328.51	T	31

Appendix C (Chapter 3)

Parametric Regression Results with Dependent Tax Revenues Variables as % of GDP

Table C1 - Effect of Tax Rates on Corporate Tax Revenues (as % of GDP)

	Linear	Log-log	Linear-log	Log-linear
Corporate tax rates	**1.501**	**19.298**	**273.952**	**0.102**
Std. Error	0.4067	4.4746	61.9903	0.0291
p-value	0.000	0.000	0.000	0.001
Corporate tax rates^2	**-0.025**	**-6.666**	**-93.582**	**-0.002**
Std. Error	0.008	1.618	22.414	0.001
p-value	0.002	0.000	0.000	0.002
Shadow economy (% GDP)	**-0.214**	**-0.655**	**-9.694**	**-0.015**
Std. Error	0.025	0.072	0.993	0.002
p-value	0.000	0.000	0.000	0.000
Optimal tax rate	**29.9**			**29.0**
Countries	27	27	27	27
N	187	187	187	187
R-Squared	0.311	0.332	0.370	0.284

Table C2 - Effect of Tax Rates on Indirect Tax Revenues (as % of GDP)

	Linear	Log-log	Linear-log	Log-linear
Indirect tax rates	**0.749**	**12.009**	**-12.815**	**0.330**
Std. Error	(0.4001)	(1.1626)	(18.647)	(0.027)
p-value	0.063	0.000	0.493	0.000
Indirect tax rates^2	**-0.011**	**-4.685**	**12.378**	**-0.010**
Std. Error	(0.014)	(0.549)	(8.812)	(0.001)
p-value	0.445	0.000	0.162	0.000
Shadow economy (% GDP)	**-0.115**	**-0.294**	**-5.413**	**-0.008**
Std. Error	(0.019)	(0.045)	(0.720)	(0.001)
p-value	0.000	0.000	0.000	0.000
Optimal tax rate				**17.2**
Countries	21	21	21	21
N	159	159	159	159
R-Squared	0.342	0.770	0.414	0.700

Table C3 - Effect of Tax Rates on Labour Tax Revenues (as % of GDP)

	Linear	Log-log	Linear-log	Log-linear
Labour tax rates	**0.021**	**2.811**	**0.771**	**0.017**
Std. Error	(0.0052)	(11.2998)	(0.3661)	(0.0501)
p-value	0.000	0.805	0.040	0.740
Labour tax rates^2	**-0.000286**	**-0.950**	**-0.211**	**0.000**
Std. Error	(0.000)	(3.863)	(0.150)	(0.001)
p-value	0.003	0.807	0.166	0.790
Shadow economy (% GDP)	**-0.004**	**-0.410**	**-0.128**	**-0.004**
Std. Error	(0.002)	(0.344)	(0.068)	(0.008)
p-value	0.050	0.241	0.064	0.580
Optimal tax rate	**36.5**			
Countries	9	8	9	8
N	56	52	56	52
R-Squared	0.10	0.04	0.08	0.01

Nonparametric Regression Results with Dependent Tax Revenues Variables as % of GDP

Figure C1 - Local Polynomial Fitted Regression of Corporate Tax Revenues (% GDP) on Corporate Tax Rates

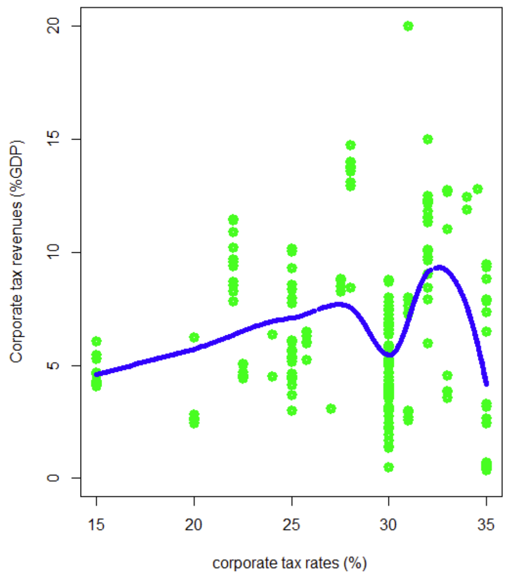


Figure C2 - Partial Effects Plot of the Corporate Tax Rates from the Semi-Parametric Regression

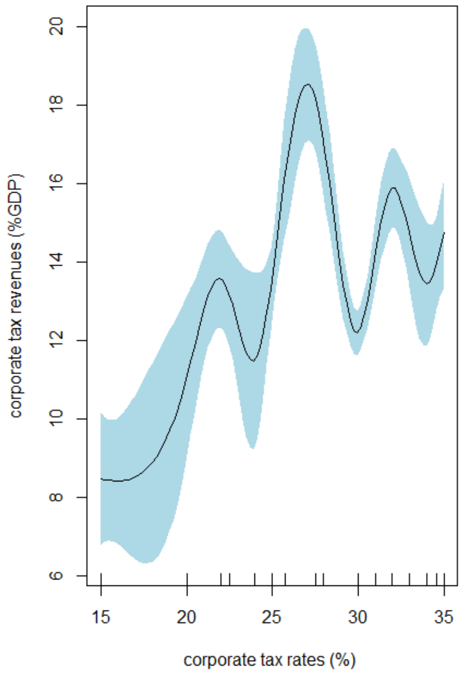


Figure C 3 - Local Polynomial Simple Regression of Indirect Tax Revenues (% GDP) on Indirect Tax Rates

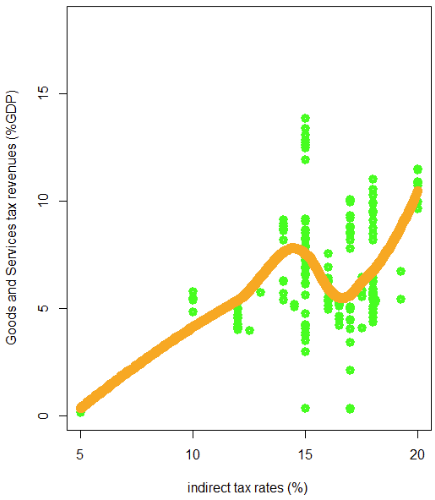


Figure C4 - Partial Effects Plot of the Indirect Tax Rates from the Semi-Parametric Regression

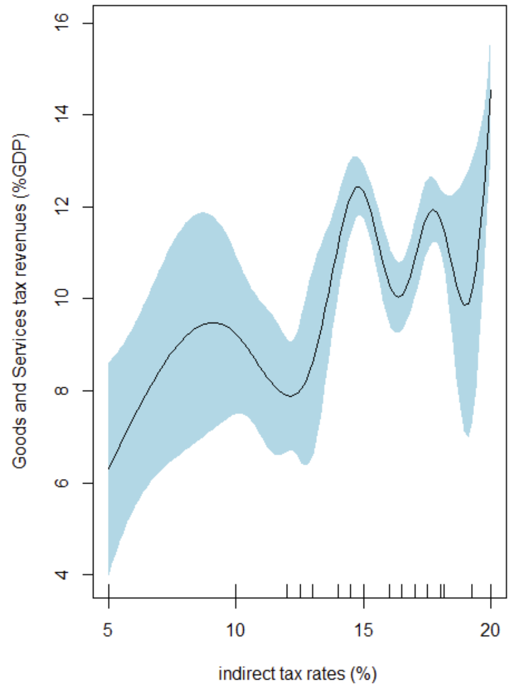


Figure C5 - Local Polynomial Simple Regression of Labour Tax Revenues (% GDP) on Labour Tax Rates

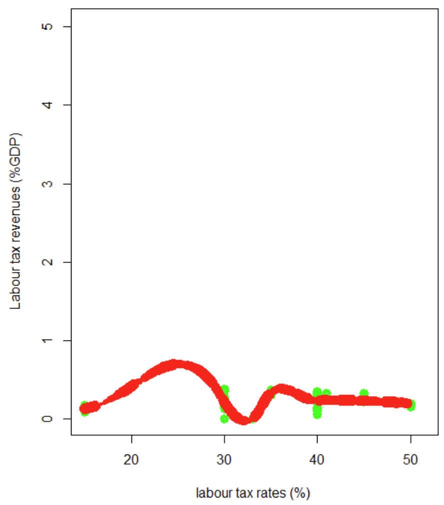


Figure C 6 - Partial Effects Plot of the Labour Tax Rates from the Semi-Parametric Regression