Can Tax Buoyancy in Sub-Saharan Africa Help Finance the Sustainable Development Goals?

Sanjeev Gupta and Jianhong Liu

Abstract

In this paper, we estimate short- and long-term tax buoyancy for 44 sub-Saharan African (SSA) countries during 1980-2017 using time series and panel techniques. The buoyancy of the tax system captures the response of tax revenues to changes in national income including discretionary changes. We find that the long-term tax buoyancy is either one or slightly above one for most SSA countries. Fragile states have a lower short-term tax buoyancy reflecting their institutional weaknesses. Short-term buoyancy of personal income tax is significantly less than one. Both short- and long-run tax responses are lower than those reported in previous cross-country studies, which can be interpreted as a reduced power of both automatic stabilization in the short-run and fiscal sustainability in the long-run. Our results are robust to discretionary tax changes. We find that central government debt and shadow economy exert a downward pressure on tax buoyancy. An important implication of these results is that the current tax systems in SSA would not be able generate domestic revenues to the extend needed for financing the Sustainable Development Goals (SDGs). This is illustrated for the entire region and two SSA countries, Benin and Rwanda.

Keywords: Tax buoyancy, Sustainable Development Goals, Error Correction Model, fiscal sustainability, sub-Saharan Africa

JEL: E62, H20, H24, H25

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Sanjeev Gupta
Center for Global Development

Jianhong Liu
Center for Global Development

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The data used in this paper is available at https://www.ictd.ac/dataset/grd/.
More information on CGD's research data and code disclosure policy can be found here: www.cgdev.org/page/research-data-and-code-disclosure.

Center for Global Development
2055 L Street NW
Washington, DC 20036

202.416.4000
(f) 202.416.4050

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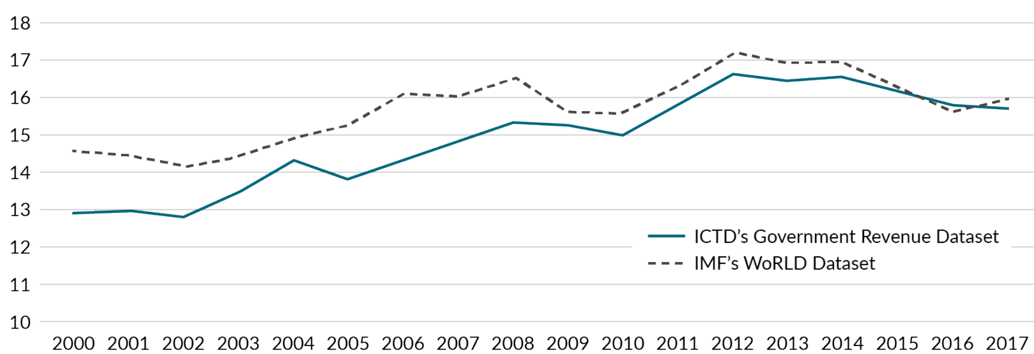
1. Introduction

One of the seven actions adopted under the Addis Ababa Action Agenda in 2015 calls on developing countries to mobilize more revenues domestically. The underlying rationale is that these additional resources, when supplemented with limited external flows, would help finance the Sustainable Development Goals (SDGs) by 2030.[1] The IMF estimates (Gaspar et al., 2019) that on average, low-income countries (LIC) will need additional resources amounting to 15.4 percent of GDP to finance the SDGs in education, health, roads, electricity, and water by 2030. These resource requirements are even greater in sub-Saharan Africa than in a typical LIC: the median sub-Saharan African country faces additional spending of about 19 percent of GDP. Benin and Rwanda, for example, would require additional resources amounting to 21.3 percent of GDP and 18.7 percent of GDP, respectively. In the average LIC, the IMF estimates that of the required additional financing, 5 percentage points of GDP would have to come from domestic taxes.

SSA countries have, on average, made progress in mobilizing more taxes since 2000 (see Figure 1). On average, tax revenues have grown by between two and three percentage points of GDP between 2000 and 2017 depending on the data source. However, country performance varies: for 17 out of 29 countries in the ICTD dataset, the 2017 tax-to-GDP ratio was less than the average of 16 percent.[2] In more than half of countries (15), the tax-to-GDP ratio is less than 15 percent.[3] The latter tax capacity is viewed essential for the state to become viable and ensure sustainable growth (Gaspar et al., 2015).

Figure 1. Average tax revenue to GDP (%) in sub-Saharan Africa, 2000–2017



Note: South Sudan is excluded because of non-avalability of data.

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[1] The 17 Sustainable Development Goals (SDGs) with 169 targets were adopted by United Nations Member States in 2015 to end poverty, protect the planet and ensure that all people enjoy peace and prosperity by 2030.

[2] The seventeen countries comprise: Central African Republic, Equatorial Guinea, Ethiopia, Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Liberia, Madagascar, Mali, Niger, Rwanda, Sierra Leone, Tanzania, Uganda, Zimbabwe.

[3] The fifteen countries comprise: Central African Republic, Equatorial Guinea, Ethiopia, Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Madagascar, Niger, Rwanda, Sierra Leone, Tanzania, Uganda, Zimbabwe.

The improved revenue performance in SSA is primarily driven by higher revenues from the VAT and excises, despite a fall in tariff revenues. On average, the VAT now constitutes roughly one-third of total tax collections in SSA. Revenues from corporate income taxes have remained buoyant at 3 percent of GDP, while revenues from personal income tax have grown slowly in the region.

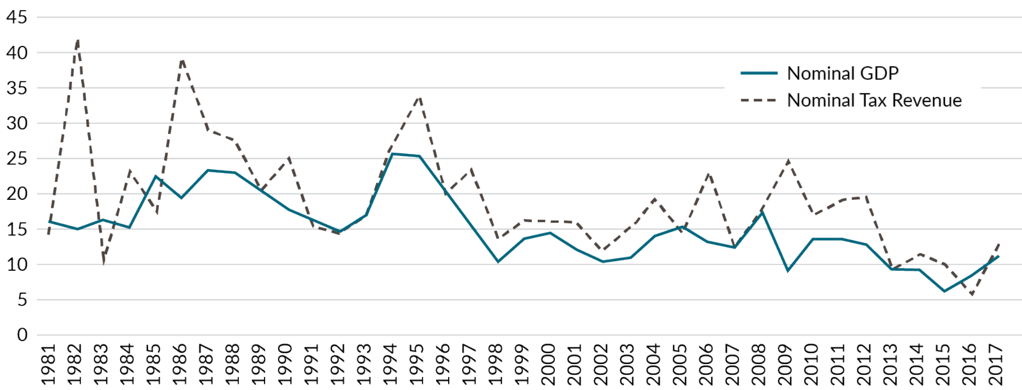
The question that arises is whether tax revenues in SSA would continue to grow in the future with economic growth. This would depend on the buoyancy of the tax system, which captures the response of tax revenues to changes in national income including discretionary changes made by countries to their tax systems. A tax buoyancy of one would imply that a 1 percent increase in GDP would increase tax revenues by 1 percent thus leaving the tax-to-GDP ratio unchanged. A tax buoyancy exceeding one would result in tax revenues rising by more than the increase in GDP. A buoyancy greater than unity is a desirable if the country would like to raise more revenues and to strengthen fiscal stability and support economic development over time.[4] This should be the case for sub-Saharan Africa. Discretionary changes may be used to compensate a low tax buoyancy in a country, but then actual buoyancy may lag the long-term trend. It would be expected that long-run tax buoyancy is greater than one for progressive taxes (such as personal income tax) and lower than one for taxes are that are mostly regressive (such as the value-added tax).

The overall tax revenue and GDP growth for SSA countries is displayed in Figure 2. In general, nominal revenues seem to have grown faster than nominal GDP. This suggests that on average, tax buoyancy has been greater than one for most years from 1981 to 2017. This is consistent with increases in tax-to-GDP ratios from 2000 to 2017. The question is whether this holds for all countries, and for all taxes.

The purpose of this paper is to estimate tax buoyancies for as many SSA countries as possible using both time series and panel data techniques. It relies on the most recent and comprehensive cross-country revenue dataset available. For robustness, it tests the validity of results on an alternative IMF database. The paper also ascertains whether the recent tax reforms in SSA countries have improved tax buoyancy since the late 1990s. It then concludes that additional tax revenues generated by 2030 using estimated tax buoyancies for SSA and two countries, Benin and Rwanda, would fall short of resources needed to finance the SDGs.

[4] A sustained tax buoyancy of greater than one would imply that the ratio of taxes-to-GDP would increase indefinitely, while a value lower than one would mean that the same ratio would fall continuously. Both cases do not represent a long-run equilibrium for the sustainability of public finances.

Figure 2. Growth in nominal GDP and tax revenue (%) in sub-Saharan Africa, 1981–2017



Source: ICTD's Government Revenue Dataset.

Note: South Sudan, Angola and Democratic Republic of the Congo are excluded due to data non-availability, and result remains unchanged if we exclude Nigeria and South Africa.

The rest of the paper is structured as follows: Section 2 provides an overview of the literature, particularly that covers SSA. Section 3 presents the data and econometric framework. Section 4 discusses the results for the long and short-run tax buoyancies for the SSA as well as for specific countries. Section 5 reports robustness checks. Section 6 explore what considerations affect tax buoyancy across countries. Section 7 uses the tax buoyancy estimates to calculate additional revenues that would be generated by 2030 in SSA and two countries, Benin and Rwanda and how they compare with projected resource needs. Section 8 concludes with policy implications and suggestions for future research.

2. Literature review

There are several country-specific studies and two cross-country studies for SSA that estimate tax buoyancy. Several cross-country studies exist for the OECD countries.

Among the country-specific studies, Bayu (2015) estimated buoyancies of direct, indirect, and foreign trade taxes in Ethiopia using annual data from 1974 to 2010 by means of Ordinary Least Squares (OLS). He found that tax revenues were not buoyant in Ethiopia, pointing to the need for enhancing the efficiency of revenue administration by widening the tax net. Kargbo and Egwaikhide (2012) examined the base elasticity of the tax system in Sierra Leone during 1977 and 2009. They found that buoyancy estimates were higher than elasticity estimates; and that short-run elasticities were lower than the long-run ones. The results further showed that discretionary tax measures were effective in mobilizing additional tax revenues. Sheefeni, Kakujaha-Matundu and Kaulihowa (2019) estimated tax buoyancy in Namibia during 2001 to 2014 and found that its tax system was income inelastic and not buoyant. Osoro (1993) estimated tax buoyancy and elasticity in Tanzania during 1969–1990. He found that the tax system had a buoyancy of 1.06 against tax elasticity of 0.76. The major factor behind growth of tax revenues was discretionary changes, particularly the increase in tax rates over the period.

There are several studies on Ghana, covering the period 1970–2013. Bekoe, Danquah and Senahey (2016) and Twerefou et al. (2010) estimated tax buoyancies and elasticities of the overall tax system and of individual taxes during the pre- and post-tax reform periods in Ghana. The results showed that in general, tax reforms had a positive influence on the overall tax structure and on the individual tax handles as evidenced in the more than unity buoyancy and elasticity. But the short-term buoyancy was lower. Similar results were obtained by Kusi (1998) who found that, all the individual taxes, except for cocoa export tax and excise duties, showed buoyancies and elasticities of more than unity. The elasticity coefficients which were generally less than unity became greater than one after the reform.

Brückner (2011) estimated the tax revenue elasticity of sub-Saharan African countries based on the instrumental variables approach. He found that there is a quantitatively large response of tax revenues collected by SSA governments to exogenous GDP shocks: a 1 percent decrease in GDP reduced tax revenues by up to 2.5 percent, which points to high tax revenue elasticities in the region. The only cross-country study on tax buoyancy on SSA covers 37 countries during 1990–2015 (Jalles, 2017). It finds that short-and long-run buoyancies are substantially more than one.

Since our paper is cross-country nature, it summarizes some of the most recent studies on the OECD countries. Belinga et al. (2014) estimates short- and long-term buoyancy in OECD countries during 1965 and 2012. They find that for aggregate tax revenues, short-run tax buoyancy does not significantly differ from one in the majority of countries and that long-run buoyancy exceeds one in about half of the OECD countries. Deli et al. (2018) find that total tax revenue buoyancy estimates are not different from unity, corporate income tax buoyancies exceed unity both in the long- and the short-run, while personal income tax buoyancies are smaller than unity for a panel of 25 OECD countries during 1965 and 2015. Dudine and Jalles (2018) estimated both short- and long-run tax buoyancy for a large heterogeneous panel including advanced, emerging and low-income countries for the period of 1980–2014. They found that for low-income countries, both short- and long-term buoyancy are significantly larger than one. Long-term buoyancy of PIT and CIT are significantly smaller than one. A most recent study (Lagravinese et al., 2020) finds both short- and long-term buoyancy in the OECD countries to be less than one—a result that is starkly different from earlier studies.

In this paper, we estimate short and long-term tax buoyancies of tax revenues and its components for 44 SSA countries by using a more comprehensive dataset covering a longer time period of 1980–2017 compared to the other cross-country study of SSA countries (Jalles, 2017).

3. Data and econometric framework

3.1 Data

For time series analysis, we have annual tax revenue data for 44 sub-Saharan African countries between 1980 and 2017 from the publicly available Government Revenue Dataset from the International Center for Tax and Development (ICTD).[5] For panel analysis, we use data covering 40 sub-Saharan African countries in order to balance the panel.[6] Apart from aggregate tax revenues, we focus on four tax categories, namely, personal income tax (PIT), corporate income tax (CIT), tax on goods and services (TGS) and trade taxes. Disaggregated data by tax types are available for smaller number of countries and are of shorter duration. We test the robustness of our results with those obtained by using the IMF database.

3.2 Empirical framework

As a starting point, we calculated the year-to-year tax buoyancy for every SSA country during 1980–2017 and averaged the yearly estimates. The yearly estimates vary widely from -667 to 113 because of the high inflation and GDP rebasing in many countries, suggesting that it is important to model the autoregressive properties of the time series which captures the dynamic relationship between tax revenue and GDP.[7]

We then specified an Autoregressive Distributed Lag model (ARDL) shown as equation (1). $Tax_{i,t}$ denotes tax revenue in country *i* in year *t*, $GDP_{i,t}$ stands for its level of GDP, μ_i is the country-specific effect and ε_{it} is the error term--both the tax variables and GDP are expressed in logs.

$$lnTax_{i,t} = \sum_{j=1}^{p} \lambda_{ij} lnTax_{i,t-j} + \sum_{j=0}^{q} \delta_{ij} lnGDP_{i,t-j} + \mu_i + \varepsilon_{it} \qquad (1)$$

We follow the existing literature (Belinga et al., 2014; Deli et al., 2018; Dudine and Jalles, 2018) and use the optimal lag length to be equal to 1 for both p and q in equation (1), which gives us $equation$ (2).[8] It suggests that developments in tax revenue can be explained by GDP of the current and preceding period, and by tax revenue in the preceding period.

$$lnTax_{i,t} = \lambda_i lnTax_{i,t-1} + \delta_{i,0} lnGDP_{i,t} + \delta_{i,1} lnGDP_{i,t-1} + \mu_i + \varepsilon_{it} \qquad (2)$$

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[5] South Sudan are excluded because of non- availability of sufficiently long time series.

[6] Angola, Eritrea, Liberia, Nigeria and South Sudan are excluded because of non-availability of sufficiently long time series.

[7] GDP refers to nominal GDP series.

[8] We extended the lag length to p=q=2. Results are shown in the Appendix Table C.

Equation (2) can be transformed into a single Error Correction Model (ECM) of equation (3), which shows that changes in tax can be explained by changes in GDP and corrections made in response to the disequilibrium from last period given in the parenthesis.

$$\Delta lnTax_{i,t} = \gamma_i\left(lnTax_{i,t-1} - \beta_i lnGDP_{i,t-1}\right) + \theta_i \Delta lnGDP_{i,t} + \mu_i + \varepsilon_{it} \qquad (3)$$

θ_i measures the instantaneous effect of a change in GDP on tax revenue, reflecting the short-term buoyancy of the tax. The parameter β_i denotes the long-run buoyancy. The parameter γ_i measures the speed of adjustment, i.e. how fast the system converges to its long-run equilibrium.

Application of error correction model requires that tax revenues and GDP be cointegrated. Before estimating equation (3), it is thus essential to diagnose the stationarity and cointegration properties of the series.

4. Empirical results

4.1 Time series regression

For individual countries, we estimate short- and long-term buoyancy for total tax revenues by using time series techniques provided taxes and GDP are found to be cointegrated. [9] Since sufficiently long disaggregated data on specific tax types are not available, we skip time series estimates for them. We then test whether the long- and short-term buoyancy equals one. Table 1 and Figure 3 display the estimates for 25 out of 44 SSA countries which passed the cointegration test.[10] We also report the estimates for the remaining 19 countries in Appendix (Table A).[11]

[9] Results of cointegration test are available upon request.

[10] Newey-West estimator is applied to overcome autocorrelation and heteroskedasticity in the error terms.

[11] We excluded South Sudan because of non-availability of data. The failure to pass the cointegration tests is probably a reflection structural changes taking place in these countries.

Table 1. Buoyancy of total tax revenue by country, 1980–2017

	Long-term buoyancy	p-value[12]	Short-term buoyancy	p-value[13]	Speed of adjustment	# Observations
Angola	1.014*** (0.006)	0.035	1.073*** (0.043)	0.100	-0.461** (0.176)	32
Benin	1.179*** (0.048)	0.001	0.658* (0.331)	0.309	-0.351** (0.143)	37
Burkina Faso	1.290*** (0.016)	0.000	1.299*** (0.259)	0.257	-0.522*** (0.153)	38
Burundi	0.989*** (0.015)	0.476	0.876*** (0.214)	0.568	-0.597*** (0.170)	33
Cameroon	1.252*** (0.061)	0.000	0.992** (0.419)	0.985	-0.532*** (0.163)	29
Cape Verde	1.198*** (0.026)	0.000	1.363*** (0.226)	0.118	-0.277** (0.118)	38
Central African Republic	0.677*** (0.071)	0.000	1.694*** (0.209)	0.002	-0.297** (0.126)	38
Chad	1.400*** (0.086)	0.000	0.496 (0.314)	0.121	-0.580*** (0.132)	31
Comoros	1.068*** (0.039)	0.092	0.735 (0.577)	0.649	-0.687*** (0.171)	36
Congo, Dem. Rep.	0.986*** (0.011)	0.194	0.751*** (0.039)	0.000	-0.254*** (0.056)	37
Equatorial Guinea	0.900*** (0.017)	0.000	0.351** (0.164)	0.000	-0.689*** (0.141)	38
Gabon	0.851*** (0.176)	0.410	1.246*** (0.282)	0.400	-0.156 (0.171)	17
Ghana	1.156*** (0.016)	0.000	1.585*** (0.202)	0.007	-0.650*** (0.110)	34
Guinea-Bissau	1.103*** (0.110)	0.352	0.984*** (0.338)	0.962	-0.551*** (0.169)	37
Kenya	1.051*** (0.008)	0.000	0.981*** (0.264)	0.942	-0.537*** (0.155)	38
Madagascar	1.023*** (0.013)	0.087	1.190*** (0.252)	0.457	-0.558*** (0.150)	38
Mali	1.225*** (0.017)	0.000	0.591*** (0.180)	0.030	-0.499*** (0.125)	38
Mauritius	0.992*** (0.012)	0.500	0.874*** (0.211)	0.556	-0.174* (0.101)	38
Mozambique	1.093*** (0.021)	0.000	0.824*** (0.098)	0.081	-0.185** (0.091)	38
Niger	1.310*** (0.051)	0.000	0.978*** (0.229)	0.924	-0.255*** (0.091)	36)
Rwanda	1.130*** (0.027)	0.000	2.103*** (0.150)	0.000	-0.040 (0.123)	38
Senegal	1.159*** (0.028)	0.000	0.581*** (0.187)	0.032	-0.554*** (0.115)	37
Uganda	1.130*** (0.034)	0.001	0.851*** (0.182)	0.418	-0.538*** (0.149)	37
Zambia	0.963*** (0.004)	0.000	0.937*** (0.054)	0.249	-0.750*** (0.173)	37
Zimbabwe	1.066*** (0.033)	0.051	1.075*** (0.024)	0.004	-0.180 (0.140)	34

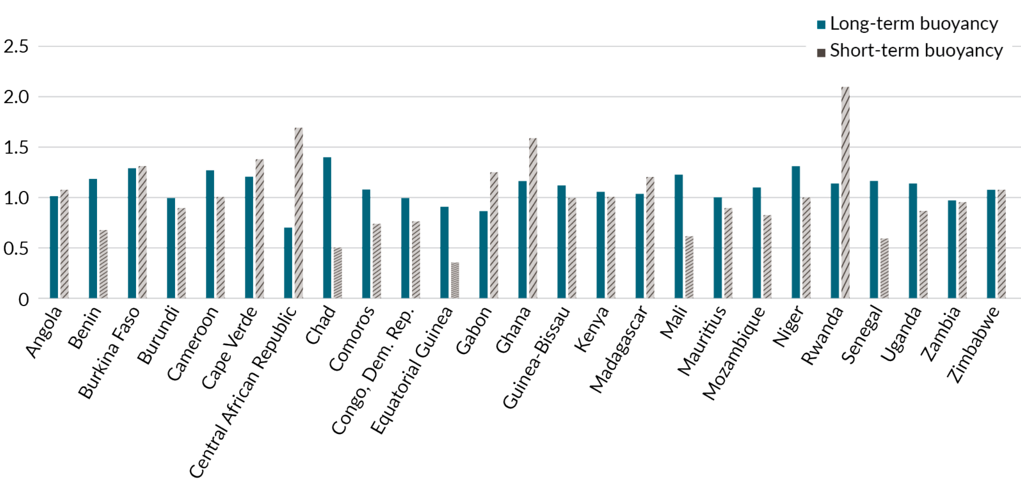
Standard errors in parentheses.

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

[12] Test of whether estimated long-term buoyancy equals one.

[13] Test of whether estimated short-term buoyancy equals one.

Figure 3. Country-specific buoyancy of total tax revenue



The results suggest an average long-term buoyancy of 1.088. It is significantly smaller than one in three countries (Central African Republic, Equatorial Guinea and Zambia). In five countries (Burundi, Democratic Republic of Congo, Gabon, Guinea-Bissau and Mauritius) the coefficient is not significantly different from one, which means for these eight countries, tax revenue is not growing faster than GDP growth. In the remaining 17 countries, it exceeds one by a small margin.

The results suggest an average short-term buoyancy of 1.004 which is smaller than the long-term buoyancy. It is significantly smaller than one in 5 countries (Democratic Republic of Congo, Equatorial Guinea, Mali, Mozambique and Senegal). In 14 countries the coefficient is not significantly different from one (Benin, Burkina Faso, Burundi, Cameroon, Cape Verde, Chad, Comoros, Gabon, Guinea-Bissau, Kenya, Madagascar, Mauritius, Niger, Uganda and Zambia). This suggests that tax revenue has not been working as a good automatic stabilizer in these countries. In the remaining six countries, it significantly exceeds one by a small margin. The cross-country variation in short-term buoyancy ranges from 0.351 in Equatorial Guinea to 2.103 in Rwanda. There is greater variation in short-term buoyancy among countries than long-term buoyancy.

The speed of adjustment is negative for all countries and statistically significant for most of them, consistent with convergence to a long-term relationship.

We group buoyancy estimates into three country groups: fragile, foreign-aid dependent and natural-resource rich and take the mean of individual country estimates.[14] In theory, the fragile states have less developed fiscal institutions and thus a weaker capacity to implement taxes. This would suggest that they may have lower tax buoyancies than other countries in the region. The aid-dependent countries may face different incentives in collecting their taxes compared to those who receive little or no aid (Gupta et al., 2004; Benedict et al., 2014). In these countries, there may be a disincentive to mobilize domestic revenues because of the availability of aid flows. In the same vein, the tax system of natural-resource rich countries tends to rely heavily on natural resource revenues which could have implications for non-resource domestic taxes and thus for overall and tax specific buoyancies (Crivelli and Gupta, 2014). Empirically, the results are broadly similar except for fragile states, where short-term buoyancy is somewhat lower (Table 2).

Table 2. Buoyancy of total tax revenue across different groups

	Long-term buoyancy	Short-term buoyancy
All countries	1.088	1.004
Fragile	1.067	0.892
Foreign-aid dependent	1.089	1.043
Natural-resource rich	1.069	0.969

4.2 Panel regression

We estimate Equation (3) for total tax revenue using panel regressions. Before proceeding, we conduct panel stationarity test for GDP and tax revenues. We cannot reject the null hypothesis that variables are nonstationary which means that all these series have a unit root process (Appendix Table B1). After taking first difference, all the non-stationary series are transformed into stationary series of order 1 (Appendix Table B2). We then performed the cointegration tests since tax revenues and GDP are integrated by the same order, and the results are reported in Appendix (Table B3). We conclude that tax revenues are cointegrated with GDP.

The Pooled Mean Group (PMG) (Pesaran et al., 1999) estimator allows for heterogenous short-term coefficient across countries but constrains the long-run coefficients to be equal. That is, it assumes that the long-term relationship between dependent and independent

[14] Fragile state is defined as the one which has a CPIA country rating is 3.2 or less, and/or when there is the presence of a UN and/or regional peacekeeping or political/peace-building mission during the last three years. (The CPIA measures a country's effort to improve its institutions and policies to reduce poverty; country performance is rated on a scale of 1 to 6, with 1 being weak and 6 being strong.) Foreign aid dependent countries are those which receive aid larger than the median of the sample. When exports of non-renewable natural resources such as oil, minerals and metals account for more than 25 percent of the value of the country's total exports, it is defined as natural-resource rich.

variable is the same across countries. The Mean Group (MG) (Pesaran and Smith, 1995) estimator allows for full parameter heterogeneity; that is, a separate regression is estimated for each country and an average reported. Both MG and PMG are appropriate for the analysis of dynamic panels with both large time and cross-section dimensions, and they have the advantage of accommodating both the long-run equilibrium and the possibly heterogeneous dynamic adjustment process. At the other end of the scale, dynamic fixed effects estimation constrains all short-run and long-run coefficients to be equal across countries (Table 3).

Table 3. Parameter restrictions for different estimators

Estimator	Short-term coefficient	Long-term coefficient
Mean group (MG)	Heterogeneous	Heterogeneous
Pooled mean group (PMG)	Heterogeneous	Homogeneous
Dynamic fixed effect (DFE)	Homogeneous	Homogeneous

To justify the use of PMG or MG estimator on total tax revenue and tax components, Hausman test was performed.[15] Table 4 displays the estimated coefficients using a full panel of 40 SSA countries for long-term, short-term and the speed of adjustment using both PMG and MG and the resulting Hausman test statistics. For CIT, the PMG procedure produces estimates that are consistent and more efficient and thus, it is preferred. MG estimator is preferred for rest of the tax components and total tax revenue. Furthermore, the coefficient estimates for total tax revenue and PIT under both PMG and MG are broadly similar.

We find that the long-term buoyancy for total tax revenue and most tax components is higher than one, which suggests that most of the levies are progressive, except for trade taxes. Estimates of corporate income tax buoyancies are in the same range as in the OECD countries. The short-term buoyancy is generally lower and in one case, personal income tax, it is significantly lower than one. Possible reason can be wage rigidity in the formal sector. However, for trade taxes, short-term buoyancy is significantly higher than long-term buoyancy. The speed of adjustment for trade taxes is the lowest among all taxes, i.e., speed of adjustment towards its long-term equilibrium is slow.

[15] We follow the same approach as used by McNabb (2018).

Table 4. Hausman test: Pooled mean group and mean group estimation

	MG	PMG	MG	PMG	MG	PMG
	Long-term buoyancy		Short-term buoyancy		Speed of adjustment	
Total tax revenue	1.087***	1.078***	0.960***	0.955***	-0.410***	-0.277***
	(0.048)	(0.007)	(0.094)	(0.086)	(0.032)	(0.027)
Hausman test: Chi2 (1): 39.19; p = 0.000						
CIT	1.107***	1.235***	1.033***	0.949***	-0.676***	-0.519***
	(0.154)	(0.011)	(0.310)	(0.206)	(0.078)	(0.055)
Hausman test: Chi2 (1): 4.14; p = 0.247						
PIT	1.304***	1.231***	0.641***	0.652***	-0.459***	-0.335***
	(0.177)	(0.015)	(0.142)	(0.127)	(0.038)	(0.046)
Hausman test: Chi2 (1): -24.03. chi2<0 ➔ model fitted on these data fails to meet the asymptotic assumption of the Hausman test						
TGS	1.241***	1.094***	1.142***	0.805***	-0.453***	-0.272***
	(0.077)	(0.011)	(0.266)	(0.136)	(0.050)	(0.034)
Hausman test: Chi2 (1): 164.88; p = 0.000						
Trade taxes	0.655***	1.003***	1.213***	1.118***	-0.396***	-0.287***
	(0.136)	(0.013)	(0.183)	(0.170)	(0.041)	(0.035)
Hausman test: Chi2 (1): 54.81; p = 0.000						

Standard errors in parentheses.

*** p<0.01, ** p<0.05, * p<0.1

We further studied whether tax buoyancies have changed over time in sub-Saharan Africa against the background of tax reforms introduced by many countries since the late 1990s. We divided our sample evenly into two periods, 1980–1998 and 1999–2017. This way we get the largest number of observations for each segment which allows us to better perform dynamic fixed effect estimation. If the estimates in the latter time period turned out to be higher, it would suggest that tax reforms implemented since 1999 have contributed to enhancing tax buoyancy. Because the resulting two time periods are relatively short, it is not possible to use MG or PMG. We use DFE estimator. Results are displayed in Table 5.

Table 5. Panel estimation period 1980–1998 and 1999–2017 via dynamic fixed effect (DFE)

	Tax Revenue		CIT		PIT		TGS		Trade Taxes	
	1980–1998	**1999–2017**	**1980–1998**	**1999–2017**	**1980–1998**	**1999–2017**	**1980–1998**	**1999–2017**	**1980–1998**	**1999–2017**
Long-term buoyancy	0.974***	1.152***	1.047***	1.258***	1.093***	1.128***	1.097***	1.211***	1.048***	0.857***
	(0.012)	(0.023)	(0.048)	(0.033)	(0.054)	(0.054)	(0.043)	(0.042)	(0.032)	(0.066)
Short-term buoyancy	0.777***	0.800***	0.820***	0.793***	0.921***	0.777***	0.889***	0.791***	0.933***	0.795***
	(0.027)	(0.050)	(0.092)	(0.121)	(0.064)	(0.147)	(0.057)	(0.081)	(0.557)	(0.099)
Speed of adjustment	-0.346***	-0.362***	-0.426***	-0.586***	-0.284***	-0.232***	-0.262***	-0.295***	-0.365***	-0.225***
	(0.027)	(0.024)	(0.058)	(0.098)	(0.043)	(0.089)	(0.026)	(0.029)	(0.034)	(0.040)
Estimator	DFE	DFE	DFE	DFE	DFE	DFE	DFE	DFE	DFE	DFE

Standard errors in parentheses.

*** p<0.01, ** p<0.05, * p<0.1

The results suggest that for overall taxes and most tax components, there is an increase in long-term buoyancy during 1999–2017 period, except for trade taxes. The latter result is understandable given declining reliance on trade taxes in SSA countries. The results suggest that structural improvements in tax systems in the second period are having a tangible impact on tax buoyancies.

5. Robustness check

5.1 Controlling for inflation

For robustness check, we added inflation as a control variable to assess whether tax buoyancy is independent of price changes. If it is, the same relationship would be obtained if real variables were used instead. Results in Table 6 show the coefficients for long-term buoyancy remain unchanged from before. Hence, long-term tax buoyancy appears neutral with respect to inflation, meaning long-term tax buoyancy in real terms is not significantly different from its nominal value. However, the coefficients of short-term buoyancy of total tax revenue, tax on goods and services and trade taxes are now smaller than before, meaning that tax buoyancy in real terms is smaller than the corresponding nominal value for these taxes. Short-term tax buoyancy of personal income tax and corporate income tax remains unchanged.

Table 6. Robustness check: Controlling for inflation

	Tax Revenue		CIT		PIT		TGS		Trade Taxes	
	No control	**Control**	**No control**	**Control**	**No control**	**Control**	**No control**	**Control**	**No control**	**Control**
Long-term buoyancy	1.087***	1.094***	1.235***	1.230***	1.304***	1.309***	1.241***	1.179***	0.655***	1.014
	(0.048)	(0.078)	(0.011)	(0.012)	(0.177)	(0.312)	(0.077)	(0.045)	(0.136)	(0.734)
Short-term buoyancy	0.960***	0.806***	0.949***	1.069***	0.641***	0.694***	1.142***	0.839***	1.213***	1.066***
	(0.094)	(0.124)	(0.206)	(0.240)	(0.142)	(0.237)	(0.266)	(0.144)	(0.183)	(0.228)
Long-term price effect		0.020		0.000		-0.090		0.013		-0.015
		(0.012)		(0.000)		(0.089)		(0.010)		(0.023)
Short-term price effect		0.002		-0.002		0.008		0.002		0.001
		(0.001)		(0.003)		(0.005)		(0.002)		(0.002)
Speed of Adjustment	-0.410***	-0.403***	-0.519***	-0.376***	-0.459***	-0.493***	-0.453***	-0.455***	-0.396***	-0.388***
	(0.032)	(0.034)	(0.055)	(0.098)	(0.038)	(0.069)	(0.050)	(0.041)	(0.041)	(0.046)
# Countries	40	39	37	36	40	39	40	37	40	39
# Observations	1,349	1,328	783	761	818	801	1,066	1,045	1,104	1,097
Estimator	MG	MG	PMG	PMG	MG	MG	MG	MG	MG	MG

Standard errors in parentheses.

*** p<0.01, ** p<0.05, * p<0.1

5.2 Controlling for tax rate

A second robustness exercise pertains to controlling for discretionary tax changes made by governments during the period under study. Due to the limited availability of tax rate data, we only estimate tax elasticity of personal income and corporate income taxes. We compiled data of changes in these two taxes during 1990–2017. [16] Results including and excluding tax rates as a control are displayed in table 7. Long-term buoyancy shows a slight decline after controlling for tax rates. The rest of the results remain broadly the same.

[16] We chose dynamic fixed effect (DFE) after performing Hausman test. Another reason for choosing DFE estimator is that PMG requires longer time span for which we lack data.

Table 7. Robustness check: Controlling for tax rate

	CIT		PIT	
	No control	**Control**	**No control**	**Control**
Long-term buoyancy	1.093***	1.082***	1.205***	1.166***
	(0.025)	(0.028)	(0.058)	(0.047)
Short-term buoyancy	0.861***	0.854***	0.941***	0.950***
	(0.062)	(0.065)	(0.059)	(0.064)
Speed of adjustment	-0.423***	-0.437***	-0.173***	-0.246***
	(0.028)	(0.030)	(0.022)	(0.030)
Estimator	DFE	DFE	DFE	DFE

Standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

5.3 IMF WoRLD dataset

A third robustness check was conducted by using International Monetary Fund's (IMF's) World Revenue Longitudinal Dataset (WoRLD) with dynamic fixed effect estimator. Results are reported in Table 8. We find that estimates using IMF's data are higher for both short-term and long-term buoyancy, with one difference: IMF dataset starts from 1990. For tax components, because there are many gaps in data and because a different estimation technique is used, the results are not necessarily comparable (Appendix: Table D).

Table 8. Robustness check: IMF's WoRLD dataset

	Tax Revenue	
	IMF	**ICTD**
Long-term buoyancy	1.185***	1.087***
	(0.048)	(0.048)
Short-term buoyancy	1.119***	0.960***
	(0.121)	(0.094)
Speed of adjustment	-0.452***	-0.410***
	(0.044)	(0.032)
Estimator	MG	MG

Standard errors in parentheses.

*** p<0.01, ** p<0.05, * p<0.1

6. What considerations affect tax buoyancy across countries

In this section, we study the factors that influence cross-country differences in long-term buoyancy. The first variable included in the analysis is the share of value added by agriculture (as a share of GDP). Tanzi and Zee (2000) suggest that a large share of agriculture is associated with a smaller PIT and TGS. Same conclusions were reached by Ahmad and Stern (1991), Teera and Hudson (2004) and Stotsky and Wolde-Mariam (1997). Since agriculture is a difficult sector to tax, we expect a high share of agriculture to be associated with low tax buoyancy. The second variable we consider is the size of shadow economy. Shadow economy comprises economic activity that is undeclared to the tax authorities. An economy with a high share of shadow economy is likely to be associated with low tax buoyancy. The third variable included in our analysis is the size of central government debt as a share of GDP. A high level of debt reflects weak fiscal discipline and concerns about fiscal sustainability. It could suggest excessive government spending which does not add to economic growth. These considerations could adversely impact taxpayers' incentive to honor their tax obligations (Gupta and Plant, 2019). Finally, we test whether prevalence of corruption—defined as the abuse of public office for private gain—affects tax buoyancy. A high incidence of corruption reflects weak government institutions. [17]

We estimate country-specific average of each indicator and then compute the cross-country median for each country in our sample. We then split the sample between those countries above or below the median and create a dummy variable taking value 1 when the level of the indicator is above the median. Finally, we take the estimated long-term buoyancy coefficients presented in Table 1 as our dependent variable. We estimate the following regression by OLS:

$$\hat{\beta}_i = \alpha_i + \varphi_1 debt + \varphi_2 corruption + \varphi_3 agriculture + \varphi_4 shadow\ economy + \varepsilon_i \qquad (4)$$ [18]

$\hat{\beta}_i$ is an estimate of the long-term tax buoyancy of country *i*, α_i is constant, ε_i is the error term. Central government debt, corruption index, share of agriculture in value added and the size of shadow economy are dummy variables created above. φ_1-φ_4 are coefficients of interest. Results are displayed in Table 9. Both central government debt and shadow economy have a negative impact on tax buoyancy. The coefficients attached to the share of agriculture and corruption are not statistically significant. Thus, the institutional quality as

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[17] Data on share of agriculture and central government debt are taken from WDI database. Data on shadow economy are taken from Medina, Jonelis and Cangul (2017). Corruption Perceptions Index (CPI) data is taken from Transparency International. The CPI, with its 0–100 scale, scores and ranks countries/territories based on how corrupt a country's public sector is perceived to be by experts and business executives, where a 0 equals the highest level of perceived corruption and 100 equals the lowest level of perceived corruption. We then take the inverse of CPI as our indicator of corruption.

[18] We also used weighted OLS. The results—available from the authors—are virtually the same.

captured by corruption index is not particularly relevant to reactions of taxes to GDP changes in SSA countries.

Table 9. Determinants of tax buoyancy: Total tax revenue

Specification	(1)	(2)	(3)	(4)	(5)	(6)
Central government debt	-0.199***	-0.233***	-0.194***	-0.229***	-0.233***	-0.228***
	(0.050)	(0.049)	(0.050)	(0.043)	(0.049)	(0.057)
Share of agriculture	0.035				0.055	0.059
	(0.049)				(0.043)	(0.042)
Shadow economy		-0.082*		-0.079	-0.082*	-0.077
		(0.048)		(0.047)	(0.048)	(0.048)
Corruption			-0.0518	-0.016		-0.026
			(0.050)	(0.044)		(0.042)
Constant	1.165***	1.234***	1.207***	1.240***	1.204***	1.211***
	(0.041)	(0.044)	(0.030)	(0.041)	(0.057)	(0.057)
#Observations	25	24	25	24	24	24
R-squared	0.4359	0.5650	0.4513	0.5676	0.5965	0.6030

Note: Estimation by OLS. Standard errors in parentheses.

*** p<0.01, ** p<0.05, * p<0.1

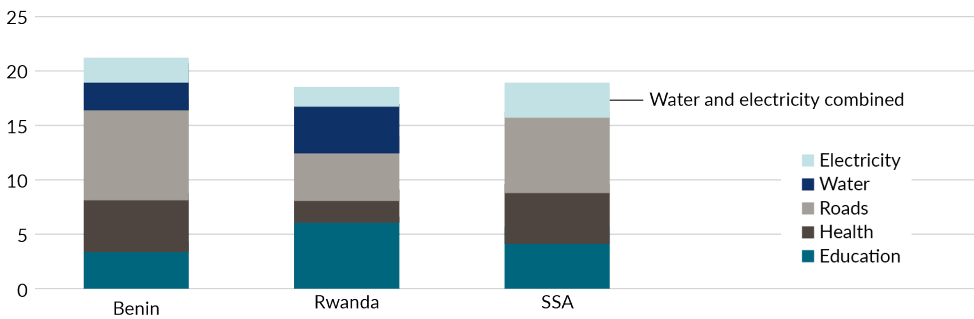
7. Estimation of additional revenue generated by 2030

As mentioned earlier, the IMF has estimated that financing the SDGs in LICs will require tax-to-GDP ratios to grow by at least by 5 percent by 2030. An average of 21.3 percent of GDP and 18.7 percent of GDP of additional spending are required for Benin and Rwanda, respectively, in order to achieve the SDGs in five areas (education, health, roads, electricity, water and sanitation) by 2030.

Benin would need to spend additional 3.2 percent of its GDP on education, 5.1 percent of its GDP on health and 2.5 percent of GDP on water (Figure 4).[19] For Rwanda, required spending to meet the SDGs is the largest in education, estimated at 6.2 percent of 2030 GDP. Additional required spending is estimated at about 4 percent of 2030 GDP on roads, 2 percent of GDP on health, 2 percent of GDP on electricity and 4.5 percent of GDP on water (Figure 4).

[19] Prady and Sy (2019).

Figure 4. Estimates for the additional spending in 2030, by sector (Percent of 2030 GDP)



Note: The median SSA country faces additional spending of about 19 percent of GDP. SSA country average estimates are only available for education, health and roads.

Given the tax-to-GDP ratio for 2016, the projected GDP growth, and our estimates of long-term buoyancy, we can calculate tax revenue growth for sub-Saharan Africa, Benin, and Rwanda during 2016 and 2030 (Table 10). [20][21]

Table 10. Projected increases in tax-to-GDP ratio by 2030 in SSA, Benin, and Rwanda

	Tax-to-GDP ratio in 2016 (in percent)	Estimated tax buoyancy	Projected tax-to-GDP ratio in 2030 (in percent)	Increase in tax-to-GDP ratio
SSA	15.8	1.08	16.6	0.8
Benin	9.2	1.18	10.6	1.4
Rwanda	15.5	1.13	18.7	3.2

The tax-to-GDP ratio in Benin would grow to 10.6 percent (an increase of 1.4 percent) and in Rwanda to 18.7 percent (an increase of 3.2 percent). The tax-to-GDP ratio for SSA the region would grow modestly by 0.8 percent. In all cases, incremental taxes generated by 2030 would fall short of the average 5 percent of GDP additional revenues needed by LICs to finance the SDGs, and the shortfall would be large for two countries (Rwanda and Benin) for which detailed resource estimates exist. This suggests that it is imperative that countries in sub-Saharan Africa continue to implement tax reforms to make their systems more

[20] We are assuming that the downward revisions in SSA growth are temporary.

[21] $(\frac{Tax}{GDP})_{i,n} = (\frac{Tax}{GDP})_{i,m} * \prod_{j=m+1}^{n}\left(\frac{1+buoyancy_i*GDP\ growth\ rate_{ij}}{1+GDP\ growth\ rate_{ij}}\right), j = m+1, \dots n$

$(\frac{Tax}{GDP})_{i,n}$ denotes tax-to-GDP ratio of country *i* in year *n*, $(\frac{Tax}{GDP})_{i,m}$ denotes tax-to-GDP ratio of country *i* in year *m*, $buoyancy_i$ denotes the long-term buoyancy estimated for country *i*, $GDP\ growth\ rate_{ij}$ *denotes GDP growth rate of country i in year j. In our specification, m=2016, n=2030. GDP growth data comes from International Monetary Fund, World Economic Outlook Database, October 2019. We use a simple ten-year (2009–2018) moving average as the predicted GDP growth rate after 2018. Tax-to-GDP ratio in year 2016 comes from ICTD dataset.*

responsive to income changes. At the same time, policymakers in Africa must complement tax-enhancing efforts with those directed at improving the quality of spending. It is possible generate up to 3 percent of GDP in resources by focusing on improving the efficiency of existing budget allocations (Gupta, 2018).

8. Concluding remarks and future research

In this paper, we estimated the short- and long-term tax buoyancies of 44 SSA countries between 1980 and 2017 using both time series and panel data techniques. The short-and long-term buoyancy of tax revenues is not as high as estimated by another study on SSA (Jalles, 2017) using a different dataset—this explains why revenues in SSA are not growing as fast. Short-term buoyancy of PIT is significantly less than one. This could be attributable to wage rigidity in the formal sector and to changing tax brackets in response to growing incomes. The estimated long-term buoyancy suggests that most taxes are progressive, except for those on trade taxes. Overall, the robustness checks show that tax buoyancy is neutral to discretionary tax changes. The good news is that there is an increase in long-term buoyancy in more recent period in reflection of tax reforms implemented by SSA countries. The future tax reforms would need to capture the changing economic structure to improve buoyancy. The cross-country determinants of long-term tax buoyancy suggest that both central government debt and shadow economy exert a downward pressure on tax buoyancy. Our estimates suggest that domestic tax revenues generated by 2030 would not be adequate to cover spending needed to achieve the SDGs in SSA and two countries, Benin and Rwanda. The revenue shortfall could be larger should the spread of Coronavirus were to dampen SSA's growth prospects over a long period. It could also delay implementation of critical tax reforms as countries seek to mitigate the virus' impact through a fiscal stimulus.

The future research could study how tax buoyancy is affected by tax reforms by estimating time-varying long-term tax buoyancies in SSA countries and then assessing their determinants, including discretionary tax reforms.

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Appendix.

Table A. Buoyancy of total tax revenue by country

	Long-term buoyancy	p-value[22]	Short-term buoyancy	p-value[23]	Speed of adjustment	# Observations
Botswana	1.017***	0.124	0.646***	0.102	-0.800***	30
	(0.011)		(0.209)		(0.200)	
Congo, Rep.	0.658***	0.011	-0.054	0.000	-0.190*	34
	(0.127)		(0.238)		(0.087)	
Cote d'Ivoire	0.840***	0.001	1.090***	0.552	-0.095	33
	(0.044)		(0.150)		(0.106)	
Eritrea	0.903***	0.375	1.321***	0.404	-1.056***	11
	(0.104)		(0.361)		(0.220)	
Eswatini	1.072***	0.007	0.711	0.554	-0.537***	36
	(0.025)		(0.482)		(0.155)	
Ethiopia	1.090***	0.000	0.748***	0.140	-0.277**	38
	(0.015)		(0.166)		(0.110)	
Gambia, The	1.084***	0.001	0.787***	0.305	-0.254**	38
	(0.023)		(0.204)		(0.108)	
Guinea	1.220***	0.000	1.987***	0.021	-0.387***	38
	(0.045)		(0.409)		(0.137)	
Lesotho	1.071***	0.030	1.116**	0.830	-0.330**	36
	(0.031)		(0.538)		(0.147)	
Liberia	1.346***	0.001	1.496***	0.107	-0.515*	18
	(0.084)		(0.288)		(0.251)	
Malawi	1.085***	0.000	0.220	0.000	-0.350***	35
	(0.017)		(0.146)		(0.083)	
Namibia	1.052***	0.000	0.854***	0.640	-0.585***	37
	(0.013)		(0.309)		(0.173)	
Nigeria	1.142***	0.004	0.841	0.745	-0.845**	16
	(0.041)		(0.478)		(0.286)	
Sao Tome and Principe	1.138***	0.005	0.027	0.000	-0.442***	32
	(0.046)		(0.198)		(0.076)	
Seychelles	0.925***	0.006	0.782***	0.305	-0.240**	37
	(0.026)		(0.209)		(0.118)	
Sierra Leone	1.108***	0.006	0.527***	0.005	-0.552***	36
	(0.037)		(0.158)		(0.097)	
South Africa	1.068***	0.000	1.319***	0.101	-0.502***	38
	(0.007)		(0.189)		(0.142)	
Tanzania	1.024***	0.011	0.865***	0.444	-0.407***	38
	(0.009)		(0.174)		(0.139)	
Togo	1.030***	0.745	1.662***	0.004	-0.104	38
	(0.091)		(0.211)		(0.073)	

Standard errors in parentheses.

*** p<0.01, ** p<0.05, * p<0.1

[22] Test of whether estimated long-term buoyancy equals one.

[23] Test of whether estimated short-term buoyancy equals one.

Table B1. Panel Unit Root test results[24]

Fisher-type tests (combining p-values)												
	GDP		Tax revenue		CIT		PIT		TGS		Trade	
	Statistic	p-value	Statistic	p-value	Statistic	p-value	Statistic	p-value	Statistic	p-value	Statistic	p-value
Inverse chi-squared(80) P	110.0163	0.0147	65.3875	0.8811	72.7209	0.5203	70.8058	0.7591	97.0566	0.0943	71.5522	0.7388
Inverse normal Z	1.4887	0.9317	3.4047	0.9997	2.8974	0.9981	3.0632	0.9989	1.2251	0.8897	2.2241	0.9869
Inverse logit t(204) L*	1.3911	0.9171	3.7412	0.9999	2.642	0.9955	2.9476	0.9982	1.0089	0.8429	2.0107	0.9771
Modified inv. chi-squared Pm	2.373	0.0088	-1.1552	0.876	-0.1051	0.5419	-0.7269	0.7663	1.3484	0.0888	-0.6679	0.7479

Table B2. Panel Unit Root test results at first difference[25]

Fisher-type tests (combining p-values)												
	GDP		Tax revenue		CIT		PIT		TGS		Trade	
	Statistic	p-value	Statistic	p-value	Statistic	p-value	Statistic	p-value	Statistic	p-value	Statistic	p-value
Inverse chi-squared(80) P	251.6227	0	303.9707	0	311.228	0	212.8325	0	238.1128	0	375.9331	0
Inverse normal Z	-8.8261	0	-11.119	0	-11.2566	0	-6.8387	0	-8.9224	0	-12.6323	0
Inverse logit t(204) L*	-9.9992	0	-12.6377	0	-14.21	0	-7.8542	0	-9.7739	0	-15.9476	0
Modified inv. chi-squared Pm	13.568	0	17.7064	0	19.5	0	10.5013	0	12.4999	0	23.3956	0

Table B3. Cointegration Test of GDP and Tax Revenues[26]

Kao Test for Cointegration										
	Tax revenue		CIT		PIT		TGS		Trade Taxes	
	Statistic	p-value	Statistic	p-value	Statistic	p-value	Statistic	p-value	Statistic	p-value
Modified Dickey-Fuller t	-3.823	0.0001	-2.8475	0.0022	-2.5287	0.0057	-3.3238	0.0004	1.3072	0.0956
Dickey-Fuller t	-4.1235	0	-4.8875	0	-3.426	0.0003	-5.7813	0	1.0803	0.14
Augmented Dickey-Fuller t	-2.9933	0.0014	-3.5483	0.0002	-1.3086	0.0953	-5.399	0	1.8619	0.0313
Unadjusted modified Dickey-Fuller t	-6.7612	0	-8.5165	0	-3.2183	0.0006	-6.1853	0	-0.9052	0.1827
Unadjusted Dickey-Fuller t	-5.4082	0	-7.5058	0	-3.7727	0.0001	-7.0608	0	-0.6834	0.2472
Number of panels	40		37		40		40		40	
Avg. number of periods	33.1		19.9		19.3		26		26.9	

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[24] We chose Fisher-type tests approach because it doesn't require strongly balanced data. Table B1 shows that all variables are non-stationary at level since the computed statistics (in absolute terms) are less than the critical values given both at 1% and 5% level of significances. This necessitates differencing the variables until it becomes stationary.
[25] Table B2 shows that all the variables are stationary after first differencing as the computed statistics (in absolute terms) are greater than the critical values at both 1% and 5% level of significance. Thus, we conclude that all of the six variables stated above are integrated of order one or I (1) series.
[26] We are able to reject the null hypothesis of no cointegration at 1%, 5% and 10% level by using Kao test.

Table C. Panel regression: Lag length p=q=2[27]

	Total tax revenue		CIT		PIT		TGS		Trade taxes	
	p=q=2	p=q=1	p=q=2	p=q=1	p=q=2	p=q=1	p=q=2	p=q=1	p=q=2	p=q=1
Long-term buoyancy	1.158***	1.087***	0.877***	1.235***	1.204***	1.304***	1.353***	1.241***	0.832***	0.655***
	(0.039)	(0.048)	(0.280)	(0.011)	(0.109)	(0.177)	(0.145)	(0.077)	(0.119)	(0.136)
Short-term buoyancy	0.936***	0.960***	0.845***	0.949***	0.341*	0.641***	1.207***	1.142***	1.078***	1.213***
	(0.095)	(0.094)	(0.254)	(0.206)	(0.181)	(0.142)	(0.300)	(0.266)	(0.182)	(0.183)
Speed of adjustment	-0.440***	-0.410***	-0.775***	-0.519***	-0.555***	-0.459***	-0.493***	-0.453***	-0.431***	-0.459***
	(0.040)	(0.032)	(0.087)	(0.055)	(0.084)	(0.038)	(0.069)	(0.050)	(0.045)	(0.038)
Estimator	MG	MG	MG[28]	PMG	MG	MG	MG	MG	MG	MG

[27] Tax buoyancies are not sensitive to lag length in the case of total tax revenue. For tax components, the results vary.

[28] PMG estimator is not feasible.

Table D. Estimation using IMF's world dataset

	CIT		PIT		TGS		Trade Taxes	
	IMF	**ICTD**	**IMF**	**ICTD**	**IMF**	**ICTD**	**IMF**	**ICTD**
Long-term buoyancy	1.136***	1.226***	0.952***	1.244***	1.104***	1.091***	0.698***	1.014***
	(0.033)	(0.012)	(0.224)	(0.016)	(0.038)	(0.011)	(0.047)	(0.013)
Short-term buoyancy	1.298***	0.872***	0.552***	0.675***	0.900***	0.811***	0.676***	1.087***
	(0.128)	(0.190)	(0.214)	(0.138)	(0.100)	(0.108)	(0.131)	(0.173)
Speed of adjustment	-0.484***	-0.507***	-0.131***	-0.346***	-0.321***	-0.249***	-0.341***	-0.291***
	(0.040)	(0.058)	(0.038)	(0.046)	(0.033)	(0.026)	(0.028)	(0.034)
Estimator	DFE	DFE	DFE	DFE	DFE	DFE	DFE	DFE