JOURNAL
OF EUROPEAN ECONOMY
Vol. 11. Special issue – 2012
Publication of Ternopil National Economic University

Thuto D. BOTLHOLE

NATURAL RESOURCES, INSTITUTIONS AND TAX REVENUE MOBILIZATION IN SUB-SAHARA AFRICA

Abstract

Whether natural resources improve or impede the collection of taxes is still unclear in the literature. Using a sample of Sub-Sahara African countries, this study asserts that the missing link to explaining these differences is the quality of institutions. Using an interaction term for natural resources and institutional quality, we show that institutions are decisive for the contribution of natural resources to tax revenue mobilisation. Our results suggest that more resource revenues impede tax revenue collection only in the absence of good governing institutions. This finding is robust to different econometric specifications, alternative measure of quality of institutions and the type of natural resources.

Key words:

Tax revenue mobilisation, institutional quality, natural resources.

JEL: H200.

Botlhole Thuto Dineo, PhD Candidate, School of Economics, University of Queensland, Brisbane Australia.

1. Introduction

One of the common challenges that confront the developing nations of Sub-Sahara Africa (SSA) is the ability to mobilise sufficient domestic revenue. Yet one of the salient features of many of these countries is an apparent under-provision of public goods, large fiscal deficits, and over-dependence on foreign assistance[1]. The disparity between foreign sources of revenue and domestic revenue is quite striking. On average, foreign aid accounts for 53 percent of GDP, compared to only 16 percent from tax revenue. One thing worth noting is that the issue of domestic revenue mobilisation is not only pertinent to SSA, but is also relevant to most developing countries. However, developing regions like North Africa and the Middle East have had significant growth in domestic revenue mobilization of about 87 percent, while the growth for SSA has only been 8 percent.[2] This then poses a very pertinent question: *What are the underlying factors behind this poor performance in tax revenue mobilisation in SSA?*

The answer as provided by existing studies lies in among other factors, the countries' available tax bases, that is, economic sectors. SSA countries are abundant in natural resources; as a result, the mineral sector provides a potentially significant tax base. However, the effect of the mining sector on tax revenue collection has yielded mixed results, hence makes further investigation a very important and timely issue. In this paper we argue that this is because the impact of natural resources on tax revenue is non-monotonic. Based on a sample of SSA countries, we provide evidence that natural resources are only detrimental to tax revenue mobilisation in the absence of good governing institutions. This result holds true after controlling for the effect of omitted variables. It is also robust to alternative measures of institutional quality and types of natural resources.

The remainder of the paper is organised as follows. Section 2 provides a synthesis of the literature. Section 3 outlines the theoretical basis for this study. This is followed by a description of the data and the empirical strategy in Section 4. Section 5 presents and discusses the empirical results, finally, Section 6 concludes.

[1] Thirty-three of Sub-Saharan Africa's 48 countries are classified by the World Bank as low income. On average, per capita GDP is less than $939 (World Bank, 2008). Twenty-eight countries in the region are classified as severely indebted, and only 5 countries in the region have had budget surpluses since 1990.
[2] These figures relate to the period over 1990–2007.

2. Literature review

Early researchers associated tax revenue mobilization only with economic tax handles (Pryor (1967); Lotz and Morss (1970); Bahl (1971); Tait, Gratz, and Eichengreen (1972); and Chelliah (1971)). Focussing on cross-country relationships between tax ratio and economic tax handles, the studies generally concur that per capita income, the shares of international trade (or the degree of openness) and mining in GDP are positively linked to tax ratio performance; whereas a higher share of value added in agriculture lowers it. Later empirical research stresses that an evaluation of tax revenue should take into account not only the available revenue bases, but also the cultural and institutional factors. As a result, the more recent investigations of tax revenue mobilization have used panel data and have also found that non-structural factors matter for tax revenue mobilization (Leuthold (1991); Tanzi, (1992); Ghura (1998); Stotsky and Wolde-Mariam (1997); Agbeyegbe *et al.* (2004). The new evidence appears to generally, concur with earlier findings on the effect of most economic tax handles[3]. The evidence on the effect of natural resource revenues on the other hand, is not entirely unanimous. For example, studies by Tanzi (1989); Ghura (1998) and Stotsky and WoldeMariam (1997) concur with the early literature that the share of mining, as measured by the mineral exports to GDP ratio, positively affects the tax ratio. On the contrary, Leuthold (1991) and Stotsky and Wildemariam (1997) find that the ratio of valued added in mining to GDP in SSA significantly hampers tax revenue mobilization. They conjecture that this may be a result of the tax concessions granted to multinational mining companies in most of these countries. Tax incentives in the form of tax holidays, lower tax rates, and other concessions are more widely used compared to two centuries ago (Keen and Mansour 2009). Most countries are considered «high risk», therefore the common incentive used to attract «high risk capital» to invest in mining operations is to shift to lower taxes and grant other tax concessions. The result of the tax concessions is to undermine the potential tax collection from mining. In line with this argument, Eltony (2002) also found that there is a strong negative relationship between the tax ratio and exports in oil exporting Arab countries. The offsetting effect from minerals has also been found to be particularly significant for mineral rich countries. Bornhorst et al. (2009) reveals that countries rich in hydrocarbon revenues collect less tax revenue from other sources. They attribute this result to a less pressing need for governments of resource rich countries to extract revenues from other potential revenues sources since they have a relatively easy inflow of revenue from the natural resource sector.

[3] Agbeyegbe *et al.* (2004) interestingly find that agriculture positively affects tax ratio for SSA. In support of this finding, they argue that in countries where most of the agricultural output is exported, agriculture is a more convenient tax handle. The authors also found that as a result of trade liberalization since the 1990's, the international trade sector tends to be insignificant.

While the argument of tax concession is one certainly worth exploring empirically, a lack of access to the necessary data has precluded such an analysis. Nevertheless, a link between the demand for tax concessions by multinational companies and institutions can be established. For the companies, tax concessions hedge against the risk of a high probability of political instability and the general lack of sound governing institutions found in most resource rich countries. Essentially, countries that are less risky have good institutions give less tax concessions and therefore collect more tax revenues.

Given the existing uncertainty of the true effect of natural resources on tax revenues, this paper endeavours to shed more light on this effect. It is unlikely that as predicted by existing studies, the effect of natural resources on tax revenue is monotonic. This notion is motivated by two existing pieces of evidence. First, there is glaring cross-country evidence which suggests that for every resource rich country with high tax revenues, there is also a resource rich country with low tax revenues. Existing studies have not been able to explain these differences because they tend to predict a monotonic effect of resources on tax revenues. The second piece of evidence is from the clear cut results in the literature on the effect of the quality of institutions on tax collection efforts. Through various subjective institutional measures, it has been demonstrated that good institutions are an essential pre-condition for tax revenue mobilization.[4] In light of these facts, the task in this paper is to explore this channel of the quality of institutions, through which natural resources could affect tax revenue performance in SSA.

At this juncture, it is important to acknowledge a similar type of analysis by Bornhorst *et al.* (2009). The study investigated the effect of the interaction between corruption and hydrocarbon revenues on non-hydrocarbon revenues. Even though corruption was found to hamper tax revenue collection, the result from the interaction term was counter intuitive, suggesting that larger amounts of hydrocarbon revenue generate increases in non-hydrocarbon revenues only when corruption is higher. Furthermore, two main differences with the current study are worth noting. Firstly, our dependant variable, total tax-GDP ratio, is different from the former study's non-hydrocarbon revenues. Essentially, this means that the marginal effect of natural resources is investigated for a different variable. Secondly, our measure of natural resources more broadly accounts for the diversity of minerals found in the SSA region, whereas natural resources in the former analysis were restricted to oil and gas. Regarding past studies in general, the approach taken was to measure natural resources in terms of the mining-GDP ratio or the share of primary commodity exports. In re-examining the effect of institutions on natural resource revenues, we adopt a much broader measure of natural resources, which includes minerals, oil, energy and forestry. Moreover, investigations of the institutional effect have only been based on sub-

[4] Bird *et al*. (2006) use corruption, voice and accountability; Davoodi and Grigorian (2007), employ a composite measure of the quality of institutions from the International Country Risk Guide (ICRG); and Madhavi (2008), use the nature of the political regime and the extent of corruption.

jective measures of institutions. These variables are based on an assessment of perception, measuring outcomes and not permanent characteristics (Glaeser et al. (2004). Our empirical regression model employs both subjective and objective measures of institutional quality to validate the outcome of the interaction effect. Turning to the main empirical analysis, most existing studies have employed the Generalised Methods of Moments Estimator (GMM). GMM is appropriate especially because it enables both endogeneity and the persistence of tax revenues to be accounted for. Understandably, the Instrumental variable two-stage–least-squares (IV-2SLS) technique has not been the preferred method of analysis because obtaining suitable instruments is an exercise fraught with difficulty. Despite this difficulty, we find a fairly comprehensive list of instruments and adopt an IV-2SLS technique to estimate the tax revenue performance of a sample of 43 SSA countries. A lagged term of the dependant variable (tax-GDP ratio) is used to capture the persistence of tax revenues.

3. Theoretical overview

The interaction effect between natural resources and institutions is used to capture the main essence of the study that political incentives generated by natural resources are key to understanding how they influence tax revenue collection efforts. It is postulated that, in countries with bad institutions, the available revenue breeds individual rent-seeking behaviour and provides leaders with ample opportunity to pursue their perverse incentives. Revenue from natural resources therefore acts as a disincentive to invest in the capacity to collect additional revenues in the form of taxes. On the other hand, natural resource rich countries with good institutions aspire to invest in education, health, infrastructure and other productive investments. The incentive to raise sufficient funds for a nation's public expenditures is likely to induce further investment in the capacity to mobilise more revenues from taxes. Resource rich countries with good institutions are therefore likely to develop a stronger apparatus for tax revenue collection. On the other hand, resource rich countries with bad institutions, by focusing more on exploiting natural resource rents for self gratification and less on overall development, will tend to have weaker apparatus for tax collection capacity.

3.1 Theoretical background

The important works of Mehlum *et al*., (2004) has provided sound theoretical underpinnings of this study. It is assumed the economy consists of grabbers (e_g) and producers (e_p), giving a total number of entrepreneurs of $E = e_g + e_p$. Grabbers target rents from natural resources and try to appropriate as much as possible of this rent. The extent to which grabbing succeeds depends on the

quality of institutions (φ). In countries where institutions are poor (φ is low), the relative resource gain from specializing in grabbing given by $1/\varphi$ is large, and rent appropriation and production become competing activities. In countries where institutions are good (φ is high), the two activities may be complementary.

Total income (Y) consists of resource rents (NR) and the value added in production (Xx), which is given by the product of the quantity of goods (x) and the types of goods (X). Y is also equal to the sum of wage income (L) and the sum of profits to producers and grabbers, which may be written as:

$$Y = NR + My = e_p + NR + L, \text{, where } e_p = \alpha E \qquad (1)$$

Where M is the total number of goods and y is product price. We assume a flat tax rate τ is levied on total income Y,[5] to derive total tax revenue (TR),

$$TR = \tau Y = \tau(NR + My) = \tau(e_p\pi + NR + L) \qquad (2)$$

There is an institutional quality threshold (ϕ^*) that determines in which of the two equilibria an economy ends up. ϕ^* is implicitly defined by $\pi_p = \pi_g$ and $\alpha = 1$.

$$\phi^* \equiv \frac{NR}{E\pi(E) + NR}. \qquad (3)$$

A natural resource threshold (R^*) can be defined using the institutional threshold ϕ^* as follows:

$$\phi = \phi^* \equiv \frac{NR}{NR + \bar{E}\pi(\bar{E})}. \qquad (4a)$$

$$NR^* = \frac{\phi}{1-\phi}\bar{E}\pi(\bar{E}). \qquad (4b)$$

Based on the foregoing, we can sum up the implications of resource abundance and institutions on tax revenue in the following manner. Assuming two countries P and R have the same quality of institutions and the same initial tax revenue level. Country P is resource poor and has a high number of producers while country R is resource rich with only few producers. Country P starts out with low tax revenues (tr_0) and ends up with higher tax revenue (tr_2), meanwhile, country R ends up with lower tax revenue (tr_1) compared to country P. Thus, the resource rich country ends up collecting lower tax revenues than the resource poor country. Because of its lack of resources, country P ends up in the production equilibrium, while country R because of its resource abundance, ends up in the grabber equilibrium. Accordingly, tax revenue collection is lowest in the natu-

[5] Total tax revenue divided by total income is the tax rate.

ral resource rich country *R*, but could increase its tax revenue collection if it had fewer natural resources (Proposition 2).

If we instead assume that country *R* has better institutions than country *P*. The resource rich country, now immune to grabbing, can beef up its tax revenue collection. Country *R* therefore ends up with higher tax revenues (tr_3) compared to *P*'s tr_2. Thus, with bad institutions, country *R* converges to a lower level of tax revenue (tr_1), while with good institutions, it converges to a much higher level (tr_3). Furthermore, with better institutions, the resource rich country *R* outperforms the resource poor country *P* (*tr3 > tr2)*.

4. Data description, stylized facts and empirical model

This section presents the variables and data sources, the stylized facts and also describes the empirical model and estimation strategy used in the paper.

4.1. Data description

We employ a sample of 45 SSA countries covering the period 1990–2007. Our measure of natural resource rents was obtained from the World Bank's Adjusted Net Savings dataset (Hamilton and Clemens, 1999)[6]. The natural resource measure from the World Bank adjusted net savings dataset is expressed in current US dollar terms, therefore to obtain constant values, the GDP values in current US dollars were deflated each country's GDP deflator[7]. The Economic Freedom of the World (EFW) index is employed to measure institutional quality. This index measures the degree to which the policies and institutions of countries are supportive of economic freedom, hence constitutes a good proxy for the theoretical notion of institutional quality. One particular component of the index

[6] Rents from a particular natural resource are calculated by subtracting country or region specific average costs of extraction from the world price for the resource in question, expressed in current U.S. dollars. Natural resource rents per unit of output are then multiplied by the total volume extracted. Resources include energy resources (oil, gas, hard coal and soft coal), minerals (bauxite, copper, lead, nickel, phosphate, tin, zinc, gold, silver and iron ore) and forestry. An aggregate measure of all the resources is then obtained and divided by GDP for each year.

[7] We refrain from the popular measures used by Sachs and Warner (1995; 1997), which restricts the natural resources measure to a country's primary export share of GDP (or exports). This measure does not take into account the different roles payed by mining and agricultural sectors. It is also possible that, the total revenues from sales may exceed export revenues by a substantial margin in some countries (Knack, 2008).

relevant to this study is «size of government expenditures, taxes, and enterprises», which indicates the extent to which countries rely on the political process to allocate resources and goods and services.[8] This index covers a large number of countries and data is available for the entire time-dimension covered in this study. The index is defined such that a high value corresponds to good institutions and therefore high tax revenues. Botswana, Namibia and Mauritius have the highest scores overall, indicating they have good quality of institutions. At the lower end, Central African Republic has the lowest score indicating poor institutions. Data for the dependant variable, the tax revenue to GDP ratio, were taken from the African Development indicators (ADI) and the World Development Indicators (WDI) published by the World Bank. The rest control variables were obtained from the WDI online database.

4.2. Stylized facts

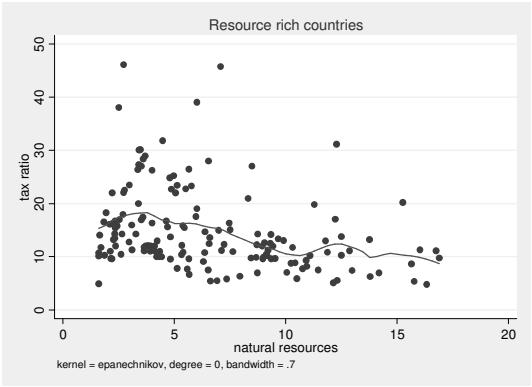
To motivate the regression results, it is instructive to examine scatter plots of the tax-GDP ratio (*y*-axis) against resource rents and institutional quality (*x*-axis).[9] In panels (a) and (b) of Figure 1, it can be observed that there is negative relationship between the tax-GDP ratio and natural resource rents. In panel (c), a positive relationship can be observed between natural resource rents and institutional quality. The correlation becomes stronger at indices above 4. This gives a preliminary indication that a sufficiently good quality of institutions is an essential pre-condition for countries wanting to collect more tax revenue. It must be noted however that the simple correlations shown in the above figures do not allow one to infer whether the quality of institutions are decisive in how natural resources affect the tax-GDP ratio. Further empirical estimation is therefore warranted to confirm this hypothesis.

[8] Other components include quality of the legal structure and security of property rights; access to sound money; freedom to trade internationally and quality of regulation of credit, labour, and business.

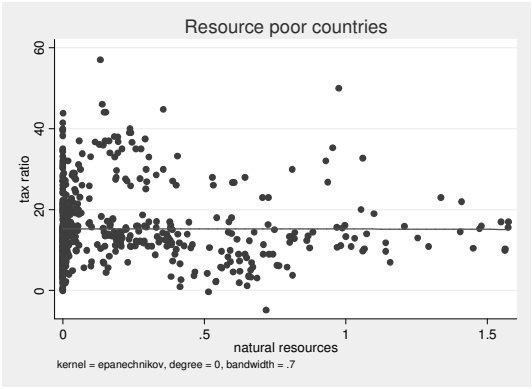
[9] The fitted lines are obtained from a local polynomial regression with bandwidth based on the nearest neighbours (Cleveland 1994).

Figure 1

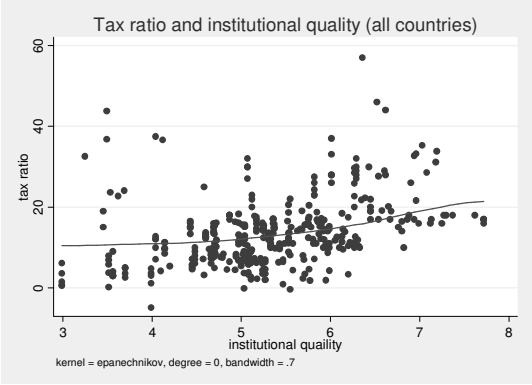
Non-parametric relationships



(a)



(b)



(c)

Note: (a) and (b) Tax Ratio and Natural Resources. (c) Tax Ratio and Institutional Quality.

4.3 Empirical model

The question we seek to answer is whether institutional quality is the missing channel behind understanding the effect of natural resources on tax revenue collection. We specify the following standard linear panel model:

$$TR_{it} = \beta_0 + \beta_1 NR_{it} + \beta_2 (NR * INSTQ)_{it} + \beta_3 INSTQ_{it} + \phi X'_{it} + \mu_i + \varepsilon_{it}. \quad (5)$$

where TR_{it} denotes the tax-GDP ratio of country i at time t, $INSTQ_{it}$ denotes institutional quality, NR_{it} denotes natural resource rents, $NR*INSTQ_{it}$ is the interaction term which takes explicit account of the interplay between resource revenues and the quality of institutions, X_{it} is a vector of the following control variables, μ_i is the unobserved country specific effects, γ_t is the time effect and e_{it} is a white noise disturbance term. The vector X_{it} is defined as follow:

$$X_{it} = (ly_{it}, aid_{it}, agr_{it}, trade_{it}, manuf_{it}, informal_{it}). \quad (6)$$

where, *ly* is log of per capita income; *aid* is external aid% GDP; *agr* is value added in agriculture% GDP; *trade* is the ratio of exports plus imports to GDP; *manuf* is value added in manufacturing% GDP; and *informal* is a measure of the informal economy.[10]

We also consider the possibility that some of the some right-hand side variables in Equation 8 could be endogenous to the tax-GDP ratio. This risk is especially pronounced in the relationship between tax revenue and institutions, log of per capita GDP and foreign aid[11]. In the likely event that there is endogeneity, using OLS would produce inconsistent and inefficient parameter estimates. We therefore conduct the empirical estimations using the instrumental variable two-stage least squares method (IV-2SLS)[12]. This approach is more efficient, provided that the instruments used are correlated with the endogenous regressors but uncorrelated with ε (hence uncorrelated with the tax-GDP ratio). The following section presents the instrument set, later on in section 5, a discussion of the instrument validity tests is undertaken.

[10] We use employment quota as a proxy for the informal economy.

[11] More precisely, a high level of GDP per-capita provides a larger tax base and potentially a higher tax ratio. In turn, a high tax ratio could avail the necessary tax revenues to advance development. Endogeneity could also stem from the quality of institutions; relying less on domestic tax revenues mobilisation reduces the possibilities of establishing or maintaining well functioning institutions. Furthermore, countries which struggle to mobilise domestic tax revenues may rely more heavily on foreign aid than those with a higher tax revenue mobilisation.

[12] We also considered that since natural resources include forestry, possible endogeneity could arise. Using the lagged value of natural resources as an instrument, a p-value of 0.84 from the Hausman test rejects the null hypothesis that natural resources are endogenous.

4.4. Choice of instruments

We use malaria ecology (*ME*), an ecologically-based variable proposed by Sachs (2003), as an instrument for GDP per-capita. For institutional development, Acemoglu *et al.* (2001) and Rodrick *et al.* (2004) propose European settler mortality rate as an instrument. Ethnic, linguistic and religious fractionalization indices have also been suggested by La Porta *et al.* (1999) and Alesina *et al.* (2003).[13] Much of the variation in current institutions has also been explained by geography-related variables (coastal land-land area within 100 km of the coast, latitude and mean temperature in ^{0} C) and historical factors such as colonial legacy and the origin of the legal system (Hall and Jones, 1999; La Porta *et al*., 1999; Acemoglu *et al*., 2001). To instrument the interaction term, we use the product of natural resources and the instruments for institutional quality. Our instrument for foreign aid is the proportion of the population that speaks English and the major languages of Western Europe (Eurofrac) obtained from Hall and Jones (1999)[14].

4.5 Additional controls

Controlling for the effect of other potential determinants of tax effort is important in order to ensure that the estimated effects of natural resources and institutions are not biased and/or do not reflect spurious correlations. In selecting the control variables, we were guided by two main considerations: First, was the need to provide a sufficiently comprehensive selection of the various determinants that previous research has shown to be relevant. In fact, omitting important controls would result in an omitted variables problem, which would bias the estimates. Second, despite the aspiration to be comprehensive, the number of variables identified in the literature is quite substantial, hence poses an increased risk of multicollinearity, which would in turn, reduce the precision of the statistical estimates. With these issues in mind, we ended up with six key control variables recently discussed in the literature (e. g., see Gupta, 2007; Mahdavi, 2008; Stotsky, 1997)[15]. We briefly discuss the interpretation and *à priori* expectations for the sign of each of the controls.

[13] Both studies suggest that fractionalization leads to political instability, poor quality of institutions and badly designed economic policy.

[14] This is based on the idea that, if a higher proportion of the population still speaks the language of the former colonial master, then to some extent, this reflects that some ties are may still be maintained, hence opening up the possibility of more aid disbursements to the former colony.

[15] Despite the wide variation in their values, variables which such as external debt, military expenditure and inflation turned out to be consistently insignificant and were dropped accordingly.

In general, there is consensus in the literature on the beneficial role of the level of development of a country (proxied by GDP per-capita), the international trade sector (share of exports plus imports in GDP) and the value added in manufacturing in generating tax revenue[16]. This is because high income countries tend to have a more monetized economy; better tax administration and, therefore higher tax revenues (Agbeyegbe *et al*., 2004). Greater openness is typically associated with higher rates of productivity, economic growth and therefore more efficient taxation (Edwards, 1998; Frankel, 1999). Economies that are characterized by established manufacturing sectors typically follow better accounting practices, and also have more easily identifiable and accessible taxpayers than those which are largely agrarian or comprise of small traders. Furthermore, countries with strong manufacturing sectors tend to be more developed, have more efficient production which could in turn generate large taxable incomes (Eltony, 2002). On the other hand, the agricultural sector is usually associated with a low tax-GDP ratio. In developing countries, the scope for taxing the sector is often limited the dominant small-scale farmers with a lack of proper or non-existent book-keeping and use of inefficient, low level farming technologies. Furthermore, VAT exemptions or zero rating of most basic foodstuffs (for example, locally produced tea and coffee in Tanzania and transport and building materials in Kenya) escape taxation altogether.

Other predictors of tax revenue mobilisation are external aid and the informal sector. These variables are expected to negatively affect the tax revenue mobilization. The problem with excessive reliance on aid, as frequently pointed out in the development literature (Remmer, 2004; Brautigman & Knack, 2004), is that, it drives out the incentive to set up the administrative and bureaucratic structures needed to collect domestic taxes. A high ratio of external aid to GDP has mostly been found to be a deterrent to tax revenue collection (Leuthold, 1991; Tanzi, 1992; Madhavi, 2008). However, one consideration by Gupta (2007) is that quite possibly, if aid is in the form of loans, future loan repayments obligations could induce policy makers to mobilize higher tax revenues However, aid in the form of grants may decrease the incentive to increase the tax base[17]. The informal sector, broadly defined as, «…those economic activities and the income derived from them that circumvent or otherwise government regulation, taxation or observation» (Schneider, 2005). Even though one of the general economic obstacles in SSA is frequently attributed to the informal sector, the effect

[16] No study that has considered the impact of value added in the manufacturing sector in SSA is known to the authors. The measure of the share of manufacturing does not include mining hence positive outcome can be expected.

[17] While differentiating grants from loans would have made our analysis more informative, a lack of access to disaggregated data compelled us to use a composite measure.[17] We emphasise however that the measure of aid we employ consists mainly of official loans and a small component of grants. Hence, the interpretations of the effect of aid are made with reference to the former.

for SSA has not been investigated.[18] We find this variable to be especially relevant to SSA, where most citizens are often unable to earn a living wage from the formal economy. The proxy variable we employ for the informal sector is the employment quota, which is a labour market indicator; with the main intuition that increasing participation of workers in the official economy results in decreased participation in the informal sector[19]. Given that the former is relatively easier to tax, higher tax revenues (and vice versa) can be expected[20].

5. Empirical results

This section presents the results from the IV-2SLS estimation, followed by checks for their robustness. A discussion of the results concludes the section.

Ahead of the presentation of the results, it is important to also mention the tests performed to ensure the validity of instruments. Since the number of instruments utilized in the regression equation exceeds the number of endogenous regressors, an identification issue arises which we test using the Hansen *J* test (Hansen, 1982). Under the null hypothesis, the instruments are valid instruments and thus uncorrelated with the error term. To tests for under identification, we report the Kleibergen-Paap rk LM and Kleibergen-Paap Wald-F statistics (Kleibergen & Paap, 2006). Failure to reject the null hypothesis suggests the model is unidentified. For all specifications, the tests confirm that the over identifying restrictions are valid and also lead us to reject the null that the models are under identified. Measures of goodness of fit of the first stage regression also indicate that the chosen instruments are likely to be relevant (see Tables A2 and A3 of the Appendix). Overall, these tests give additional confidence that the presented IV-2SLS regression estimates are not biased and as such inference based on the results is valid.

Table 1 provides the results of a baseline specification including only the variables of immediate interest: natural resource rents; quality of institutions; the interaction term; and the single conditioning variable – the level of GDP per-capita. Starting with column I, we observe that a one standard deviation increase in natural resources generates a decline in the tax-GDP ratio of 0.068 of a standard deviation, which is significant at the 1 per cent level. Our finding on the significant adverse effect of natural resources on the tax-GDP ratio is in line with some of the studies reviewed earlier (Lim, 1988; Leuthold, 1991; Stotsky and

[18] Only Davoodi and Grigorian (2007) for Romania take the variable into account, therefore studies that have investigated this variable are rather scant. Existing studies for SSA have not taken it into account.

[19] Other indicators include monetary and production market indicators. See Schneider and Enste (2000) for a more detailed discussion.

[20] Employment quota is defined as the employment to total population ratio of people aged 15 and above. Schneider and Enste (2000); Togler and Friedrich (2007) find that employment quota is a valid indicator of the informal economy.

Wildemariam, 1997; Bornhorst *et al*., 2009)[21]. A standard deviation increase in institutional quality on the other hand is associated with an increase of one-third of a standard deviation in the tax-GDP ratio. This effect exceeds the impact from natural resources and thus confirms the general finding in the tax effort literature that better institutions are an essential precondition for adequate tax revenue mobilisation. More formally, the coefficient of the interaction term is significant and positive at the one per cent level. This implies that an abundance of natural resources is only detrimental to tax revenue collection if institutions are poor. The combined effect of a one standard deviation increase in the level of natural resources and the quality of institutions, leads to an increase of 0.09 of a standard deviation in tax revenues. This finding is quite intuitive and offers the simple suggestion that the negative contribution of natural resources to tax revenue collection will be less severe if good institutions are in place (see illustration below). The log of per capita GDP also carries the expected positive sign but is insignificant. The impact of a marginal increase in resources on the tax-GDP ratio implied by the regression results in column I can be computed as:

$$\frac{\partial(\textit{tax revenue})}{\partial(\textit{natural resource})} = -0.190 + 0.048\ (\textit{instutional quality}) \quad (7)$$

This formulation indicates that the institutional threshold of not having natural resources adversely affect tax revenues is $-\frac{\beta_1}{\beta_2} = 4.0$.

Table 1

Baseline regression results

Variables	Model I baseline	Model II non-linear effects	Model III fixed effects
	b/se		b/se
natural resources	-0.190***	-0.200***	-0.319*
	(0.05)	(0.07)	(0.17)*
institutional quality	3.114**	3.482	3.177***
	(1.45)	(1.11)	(1.45)
log per-capita gdp	0.865	0.635	-3.494
	(1.14)	(1.00)	(5.32)
natural resource*institutions	0.048**	0.05***	0.083*
	(0.01)	(0.02)	(0.05)
natural resources-sq	..	-0.000	..
		(0.00)	
natural resources*inst-sq	..	0.000	..
		(0.00)	

[21] In some oil exporting countries, revenue is collected in the form of royalties (which may not be classified as tax revenue), instead of taxes on oil companies. This could also explain the low level of tax ratio despite an abundance of natural resources.

Variables	Model I baseline	Model II non-linear effects	Model III fixed effects
	b/se		b/se
Constant	-11.52***	-9.502***	..
	(5.21)	(3.18)	
No of observations	331	331	164
Uncentered R^2	0.83	0.82	0.41
Hansen *J* statistic *p*-value	0.60	0.25	0.17
Kleibergen-Paap rk LM χ^2	40.69	46.94	18.19
Kleibergen-Paap Wald F-	13.28	4.98	2.15
F-test	0.00***	0.00***	0.00***

Notes: 1. The dependent variable is the ratio of tax revenues to GDP during 1990–2007.
2. For the fixed effects specification, we exclude the time invariant instruments, namely, fractionalization indices, legal origin dummies and the log settler mortality.
3. The regression models are estimated using heteroskedastic and autocorrelation consistent standard errors and statistics that are robust to both arbitrary heteroskedasticity and arbitrary autocorrelation.
4. ***, **, and * denote significance of the estimated coefficients at the 1, 5, and 10 per cent confidence levels, respectively.

Table 2

Regression results with control variables

Variables	I all controls	II excl agric	III excl instq	IV excl informal	V locked dummy	VI locked* trade
	b/se	b/se	b/se	b/se	b/se	b/se
natural resources	-6.093*	-6.141*	-7.434**	-5.876*	-3.617	-3.64*
	(3.54)	(3.56)	(3.30)	(3.56)	(2.29)	(1.93)
instq	3.78*	0.144	..	3.593	1.563	0.617
	(2.22)	(1.75)	..	(2.43)	(1.29)	(1.16)
log per-capita gdp	2.64	6.434***	3.824**	2.358	0.022	-0.776
	(1.83)	(1.82)	(1.93)	(1.87)	(1.46)	(1.34)
natural resource*instq	1.146*	1.177*	1.407**	1.106*	0.686*	0.708**
	(0.63)	(0.63)	(0.58)	(0.64)	(0.41)	(0.35)
Controls						
aid	-0.091	-0.043	-0.002	-0.115	-0.262***	-0.298***
	(0.14)	(0.08)	(0.09)	(0.15)	(0.09)	(0.11)
agriculture	-0.253***	..	-0.202**	-0.253***	-0.227***	-0.237***
	(0.08)	..	(0.08)	(0.07)	(0.06)	(0.05)
trade	0.013	0.041	0.045	0.008	0.027	0.067**
	(0.04)	(0.04)	(0.03)	(0.05)	(0.03)	(0.03)
manufacturing	-0.983***	-0.65***	-0.721***	-0.96***	-0.766***	-0.757***
	(0.20)	(0.20)	(0.15)	(0.21)	(0.12)	(0.13)

Variables	I all controls	II excl agric	III excl instq	IV excl informal	V locked dummy	VI locked* trade
	b/se	b/se	b/se	b/se	b/se	b/se
informal sector	0.067*	0.049	0.035	..	..	..
	(0.04)	(0.04)	(0.03)	..	..	..
locked dummy	..	..	..	..	-4.770***	..
	..	..	..	..	(0.69)	..
locked*trade	..	..	..	..	..	-0.105***
	..	..	..	..	..	(0.02)
Constant	-6.696	-28.679	12.525	1.322	26.643***	35.165***
	(11.96)	(12.44)		(14.96)	(8.54)	(7.69)
No of observations	259	259	259	269	280	280
Uncentered R^2	0.77	0.85	0.81	0.77	0.85	0.87
Hansen *J* statistic *p*-value	0.41	0.18	0.18	0.27	0.45	0.48
Kleibergen-Paap rk LM χ^2	53.89	17.53	21.82	41.30	51.81	42.85
Kleibergen-Paap Wald F-	6.76	1.73	4.03	7.68	6.36	5.82
F-test	0.00***	0.00**	0.00***	0.00***	0.00***	0.00***

Notes: Same as Table 1

This threshold implies that above this institutional quality level, the partial contribution of natural resources to tax revenue is higher for a high resource endowed country than for a less endowed one, whereas the reverse holds below the institutional threshold. In short, natural resources will be less of an impediment to tax revenue collection in countries with an institutional quality above 4.0. Using the summary statistics in Table A1.1, Table 3 provides estimates of the marginal effects of a one standard deviation increase in natural resources on tax revenues for various levels of institutional quality. In general,

$$\Delta tax\ revenue = SD_{NR} * (\hat{\beta}_{NRS} + \hat{\beta}_{INSTQ} * INSTQ). \quad (8)$$

where SD_{NR} is the standard deviation of natural resources and *INSTQ* is the country's level of institutional quality.

A one standard deviation increase in natural resources has a negative effect on tax revenues for economies with bad institutions but becomes positive as the institutional quality improves. The results in Table 3 show that for economies with average and good institutions, any negative effect from natural resources is nullified. Therefore, one can conclude that the detrimental effect from natural resources diminishes with institutional quality improvement. For another perspective, take for example Botswana and Ivory Coast which are both resource rich countries. Ivory Coast however has poor quality of institutions, an average index of 3.2 (which is below the mean average of 5.4 for the entire sample), compared

to Botswana with 7. With its current institutions, a 1 point increase in Ivory Coast's resource revenues produces a 0.18 point decrease in the tax-GDP ratio. However, if Ivory Coast could improve the quality of its institutions to match that of Botswana, then there would be a 0.74 point increase in its tax-GDP ratio (a four-fold increase)[22].

Table 3

Summary of marginal effects of natural resources for varying levels of institutional quality[23]

Type of institution	Economic Freedom index	Marginal effect
Bad institutions	2.89	-0.17
Average institutions	5.76	0.28
Good institutions	7.72	0.60

Notes: 1. Standard deviation of NR= 3.31
2. Bad institutions = institutional quality between 2.89 – 3.9.
3. Average institutions = institutional quality between 4.0–5.76.
4. Good institutions = institutional quality between 5.77–7.72.

Source: Authors' calculations based on Table 1, column I results.

The earlier evidence shown in Figure 1 suggests that the relationship between natural resources and the tax-GDP ratio might be non-linear. To allow for a U-shaped relationship between these variables, in column II of Table 1, squared terms are used to estimate the following modified version of Equation 1:

$$tr_{i,t} = \beta_0 + \beta_1 NR_{it} + \beta_2 (NR * INSTQ)_{it} + \beta_3 INSTQ_{it} + \\ + \beta_4 (NR_{it})^2 + \beta_5 (NR * INSTQ_{it})^2 + \mu_i + \gamma_t + \varepsilon_{it} \quad (9)$$

The coefficient of squared natural resources is negative but insignificant, which indicates that the relationship between natural resources and tax revenues is linear. We also test if the interaction effect will also hold for the squared term. The results show that the interaction term is still positive but insignificant.

One practical concern in the present analysis is the parameter heterogeneity resulting from unobserved time-invariant characteristics of each country in the sample. In column III of Table 1, we estimate a fixed effects specification to address this concern. In doing so, we employ some of the instruments from col-

[22] These results follow from $(-0.190 + 0.048(3.2)_{\text{instCot}})5.1_{\text{resrev}} = -0.18$ and $(-0.190 + 0.048(7)_{\text{InstBots}})5.1_{\text{resrev}} = 0.74$.

[23] These thresholds only pertain to the current data and were derived by dividing the indices into three quantiles.

umn I but excluding the time invariant instruments, fractionalisation indices, log of settler mortality and legal origin dummies since any time invariant instrument will be exactly collinear with the fixed effects component. The results show a reduction in the statistical significance of natural resources and the interaction term, on the contrary, that of institutions improves. This suggests that factors specific to SSA countries also play a significant role in the tax ratio-GDP ratio.

5.1 Regression results with control variables

Table 3 reports the regression results from specifically controlling for variables already discussed in Section 4. In so doing, we also test for the sensitivity of the main results to the inclusion of additional controls. A general finding that emerges from the table is that the control variables do not alter the statistical significance of the variables of interest. Turning to specific control variables, it can be seen that larger shares of agricultural, manufacturing and informal sectors as well as a high foreign aid share are associated with lower tax revenues. International trade although insignificant, is the only sector that boosts tax revenue collection. This suggests that tax revenue in SSA is limited by structural factors.

Our results suggest that the effect of the agricultural sector is quite sizeable. Each standard deviation increase in the size of the agricultural sector is associated with a decline in the tax-GDP ratio of nearly 0.5 of a standard deviation. This effect exceeds the impact of a one standard deviation increase in any other control variable. The manufacturing sector has a larger negative effect compared to external aid and the informal sector. Each standard deviation increase in the size of the manufacturing sector leads to a decline in tax revenue of 0.2 of a standard deviation, 0.1 for foreign aid and 0.05 for the informal sector.

The result from foreign aid raises some interesting implications. The sign of the coefficient suggests that a large inflow of aid from the international community reduces the incentive for the recipient government to mobilize resources domestically via the tax system. Given that our aid measure constitutes mostly loans and only a small component of grants, we can safely deduce from this outcome that contrary to what Gupta (2007) suggests, the obligation to finance loan repayments does not necessarily prompt SSA governments to increase tax revenue collection. This then leads us to conclude that aid inflows take away the incentives from policy makers to look for other ways of financing their countries' longer term economic development. Even with conditionalities in place, very often, aid flows are diverted to unproductive or grotesque gestures. As Moyo (2009) asserts, large sums of aid and a culture of aid dependency encourages governments to support large and often unproductive public sectors. The author further stresses that the extent to which African countries are dependent on for-

eign aid is so large that were aid to disappear, a country's tax-raising mechanisms would have atrophied to a point of incapacity (Moyo, 2009, p.66).

Interestingly and also contradictory to *ex-ante* expectations, manufacturing enterprises in SSA countries are not necessarily easier to tax as expected. The coefficient is strongly negative and very robust. We consider a few factors which could be driving this outcome. One is the trade liberalization effect of replacing quantitative restrictions with tariffs. A reduction in tariffs on imported goods allows cheaper imports into domestic markets. However, it can also in turn erode the external competitiveness of small and medium-sized domestic enterprises, leaving a predominantly small and weak indigenous private sector at one end of the scale and large and foreign multinational corporations at the other. The weaker firms generate small taxable surpluses, and hence often remain outside the tax net. The problem could also be exacerbated by privatization which took place in most SSA countries during the study period. A further possibility is that, often these foreign corporations are lured to invest through generous tax incentives (e.g. tax credits, tax holidays and exemptions and free economic zones).[24] The result of both factors could be lower generation of tax revenue.

The coefficient for trade openness is insignificant in nearly all of the estimations but carries the expected positive sign. This insignificant outcome is consistent with Agbeyegbe *et al.* (2004) and Davoodi and Grigorian (2007)[25]. As the authors explain, this could be due to the fact that over the last decade, trade-related tax revenues in SSA have been decreasing in the face of trade liberalization. Turning to the informal sector in SSA, a standard deviation reduction in informal economic activity could lead to a 0.05 rise in tax revenue mobilisation. This is slightly lower than the 0.15 rise found by Davoodi and Gregorian (2005) for Romania.

We estimated the correlations of the estimated coefficients from the model in column I, which indicated high correlations between agriculture and per-capita income; trade and institutions; informal sector and foreign aid. Accordingly, from column II to IV, we omit some of the variables. Omitting agricultural in column II makes per capita GDP significant at the 1 per cent significance level, while the informal sector remains positive but loses its significance. This suggests that most of the informal activities in SSA emanate from or can be linked to the agricultural sector. All of the other control variables maintain their sign and significance. Omitting institutions in column III makes no impact on trade as it still remains insignificant. No significant changes in the coefficient for foreign aid are observed by omitting the informal sector in column IV.

We also consider the effect of geographical location, in the sense that we expect that land-locked countries would tend to have a lower tax share than

[24] See Keen and Mansour (2009).
[25] Agbeyegbe et al (2004) employed a different proxy for international trade, the ratio of import duties to the value of imports, still no significant link was found with tax revenue.

coastal countries.[26] From column V, the coefficient for the landlocked dummy variable is negative, relatively large and strongly significant. Controlling for geography reduces the coefficients of natural resources and institutions and completely obliterates their statistical significance. From this result, we can infer that being landlocked is deleterious to overall tax revenue collection. We also consider the effect of geography on the trade variable by introducing the interaction of the dummy with international trade (trade*locked) in column VI[27]. Intuitively, the trade coefficient turns statistically significant and the trade*locked is negative and significant. What this suggests is that landlockedness is a handicap to trade taxes. The log of per capita turns negative but is statistically insignificant. The coefficient for external aid becomes significant and somewhat higher when the dummy is introduced. We see this as indicative of the fact that most landlocked countries are poorer and therefore likely to receive high levels of foreign aid.[28]

Of all the variables, natural resources are by far the most crucial tax base in SSA followed by the agricultural sector. Overall, the estimated coefficients in Table 2 show that tax revenue mobilisation in SSA is largely inhibited by the agricultural sector, external aid, the manufacturing sector, and to a lesser extent, the informal economy. We also find that tax revenue mobilization is stifled by landlockedness and this also affects tax revenue mobilization from the trade sector. The results also indicate that the coefficients of the main variables of interest are robust to the inclusion of additional regressors.

5.2 Robustness checks

As the first exploration of the robustness of the results, we change the model specification into a first order dynamic panel to take into account the fact that rates of taxation tend to be persistent (Table 4). Therefore, in column I, we include the lagged tax ratio (taxratio_1) among the right hand variables. We also emphasise that the problem of serial correlation that would arise as a result of the recognition of this inertia is not of concern in this case since we have employed heteroskedasticity and autocorrelation consistent standard errors and statistics. First, we notice that the tax ratio_1 is positive and significant suggesting that there is persistence of tax revenue over time. The log of per-capita income is negative without being statistically significant.

We use two alternative measures of institutions to check for the robustness of the institutional channel namely, the International Country Risk Guide

[26] The dummy variable of value is used is a country is landlocked and 0 if it's not.
[27] Landlocked countries are not very open to trade, this limits their ability to access larger markets and collect tax revenue. Coastal countries have been shown to outperform all landlocked countries (Collier, 2003).
[28] Njikam (2008) shows that landlocked SSA countries experience less growth compared to coastal countries.

(ICRG) and Contract Intensive Money (CIM) indices. The ICRG index is an aggregate of five ICRG indicators (corruption, bureaucratic quality, law and order, investment profile and government stability). All the variables were transformed into 10 point scales[29]. To be thorough, we also employed an objective measure of institutions CIM, proposed by Clague *et al.* (1999) which addresses the main criticism that subjective indicators measure outcomes and not permanent characteristics[30]. CIM is an objective measure, defined as the part of total money supply that is not currency in circulation outside banks. The main intuition is that if citizens believe that there is sufficient third-party enforcement, they are more likely to allow other parties to hold their money in exchange for some compensation, and CIM is correspondingly higher.[31] The results from columns II and III of Table 4 generally uphold the institutional channel as the missing link to explaining the effect of natural resources. Most of the regressors behave as before except international trade turns significant, agriculture turns positive in column II and the log of per capita GDP has a very large coefficient and is highly significant. This result could however be due to collinearity as omitting the log of per capita GDP restores the original result for agriculture[32]. More pertinent to the analysis is that for both robustness checks, all the key variables retain their signs and significance.

We also consider the question of whether the type of natural resource matters in the relationship between institutions and natural resource rents. Point source non-renewable natural resources such as minerals and oil that are mined from a narrower geographic base tend to be more prone to rent-seeking compared to diffuse renewable natural resources[33]. In Columns IV and V of Table 4, we augment the baseline specification and replace the natural resources variable with minerals and energy and forestry, respectively. For the most part, the signs and significance of the coefficients for both resource types are similar to what we observed in Table 1. The statistical significance of minerals and energy is greater at the 1 percent level compared to that for forestry which is significant at the 10 percent level. Furthermore, a one standard deviation increase in minerals and energy leads to two-thirds of a standard deviation decline in the tax-GDP ratio. The effect from forestry is much smaller, at 0.29 of a standard deviation. On the basis of these results, we conclude that irrespective of the type of natural resources, the quality of institutions is decisive for the impact of natural resources on tax revenue mobilization. However, the effect is much stronger for minerals and energy.

[29] The same aggregation was done by Knack and Keefer (1995).
[30] See Glaeser *et al.* (2004).
[31] The index of institutional quality is computed as the ratio of M2 minus currency in circulation to M2. See also Carmignani (2004).
[32] Not shown but available upon request.
[33] Extraction of point source resources requires highly developed technology and hence tends to be extracted by the elite at the expense of the rest of society (Isham *et al.*, 2005).

Table 4

Robustness tests; lagged valued of natural resources, alternative measures of institutional quality and the type of natural resource

Variables	I tax ratio_1	II ICRG	III CIM	IV minerals & energy	V forestry
		b/se	b/se	b/se	b/se
tax ratio_1	0.737***	..	..	..	..
	(0.08)	..	..	..	..
natural resources	-2.69*	-3.304*	-0.921**	-3.926***	-17.858*
	(1.41)	(2.00)	(0.36)	(1.24)	(10.46)
institutional quality	0.805	0.169	5.395*	3.532**	1.337
	(0.91)	(0.15)	(3.24)	(1.51)	(1.41)
log per-capita gdp	-0.065	13.793***	3.849*	0.227	2.708**
	(1.11)	(1.79)	(1.98)	(1.30)	(1.23)
natural resource*institutions	0.523**	0.145*	2.383**	1.003***	4.257*
	(0.26)	(0.08)	(0.96)	(0.32)	(2.28)
Controls					
aid	-0.072	-0.058	-0.095	..	..
	(0.09)	(0.09)	(0.11)	..	..
agriculture	-0.102**	0.154**	-0.183***	..	..
	(0.04)	(0.07)	(0.07)	..	..
trade	0.016	0.094***	0.072***	..	..
	(0.02)	(0.02)	(0.02)	..	..
manufacturing	-0.321***	-0.449***	-0.347***	..	..
	(0.11)	(0.08)	(0.12)	..	..
informal sector	0.014	0.099**	0.002	..	..
	(0.02)	(0.04)	(0.04)		
Constant	5.050	-96.99***	-8.865	-7.457**	-12.774***
	(7.46)	(15.75)	(15.97)	(3.76)	(4.23)
No of observations	257	299	295	331	331
Uncentered R2	0.94	0.88	0.93	0.80	0.83
Hansen *J* statistic *p*-value	0.71	0.14	0.18	0.52	0.18
Kleibergen-Paap rk LM χ^2	40.46	12.08	22.81	43.32	24.57
Kleibergen-Paap Wald F	6.03	4.67	2.06	10.51	6.20
F-test	0.00***	0.00***	0.00***	0.00***	0.00***

Notes: Same as Table3

6. Concluding remarks

This paper investigated whether the quality of institutions matters for how natural resources affect tax revenue mobilisation in SSA. Our results show that although tax revenue mobilisation declines with a higher level of natural resources, good institutions play a critical role as a buffer to this adverse effect. To be precise, an index greater than 4 would completely obliterate the negative impact of natural resources. This institutional channel proved to be robust to different measures of institutions and types of natural resources. As expected, our results suggest that increase in the size of the agricultural sector and level of external aid reduces tax revenue collection, all other things being equal. Surprisingly, we also found manufacturing to also have a negative effect on tax revenue mobilisation, which we ascribe to the effect of factors such as trade liberalization, privatization and tax concessions. As a first for SSA, our study also showed that the informal sector has a significant effect on tax revenue mobilisation and therefore any efforts to increase tax revenue mobilization should concurrently aim towards curbing informal sector activities. In terms of the geographical effect, it is found that not only is being landlocked deleterious to overall tax revenue mobilisation, it also hampers the mobilization of trade taxes. This suggests that trade reform is particularly crucial for landlocked countries. Overall, our results suggest that any efforts to improve tax revenue collection in SSA must necessarily take into consideration improvement in the quality of institutions, draw the informal sector into the tax net, and also give careful consideration to the granting of tax concessions. We also bear in mind that the effect of control variables in the estimations clearly requires further investigation. For example, it is highly likely that international trade could have different effects on taxes on goods and services as well as trade taxes. Therefore, an analysis using disaggregated total tax revenues may prove quite informative. Further robustness checks remain to be done on the informal sector to produce more consistent results.[34] In addition, the observed result for external aid must be interpreted with caution as we did not account for the conditions under which aid is given, quite possibly, our observed result may be influenced by policy changes induced by aid rather than the levels of aid *per se*.

[34] Togler and Friedrich (2007) find that population density and fiscal burden, measured by the top marginal tax rate, are good proxies for the shadow economic activity.

Appendix

Table A1

Summary statistics

Variable	*Mean*	*Standard Deviation*
tax/GDP	15.64	9.28
natural resources	1.59	3.31
institutions	5.36	0.94
natural resources*institutions	9.06	17.89
Log per-capita income	7.19	1.02
aid	14.26	13.67
agriculture	29.29	16.85
trade	73.13	37.63
manufacturing	10.94	7.06
informal	65.52	11.71

Table A2

Regression Diagnostics for Table 1; Baseline results and Table 4; Robustness tests

	I full sample	II non-linear effects	III fixed effects	IV tax ratio_1	IV minerals and energy	V forestry	VI ICRG	VII CIM
Shea partial R^2								
institutional quality	0.22	0.19	0.23	0.27	0.22	0.31	0.23	0.45
log per-capita gdp	0.25	0.24	0.28	0.46	0.24	0.35	0.43	0.38
natural resource*institu	0.42	0.27	0.14	0.32	0.59	0.41	0.17	0.23
natural resource*institu-sq	..	0.48	..	..	..	..	..	..
aid	..	..	..	0.25	..	..	0.44	0.16
Partial R^2								
institutional quality	0.41	0.44	0.21	0.29	0.43	0.43	0.18	0.47
log per-capita gdp	0.46	0.54	0.29	0.48	0.49	0.54	0.42	0.36
natural resource*institu	0.46	0.25	0.14	0.35	0.68	0.36	0.14	0.25
natural resource*institu-sq	..	0.58	..	..	..	..	..	..

	I full sample	II non-linear effects	III fixed effects	IV tax ratio_1	IV minerals and energy	V forestry	VI ICRG	VII CIM
aid	..	..	..	0.2	..	..	0.39	0.16
F-stat								
institutional quality	24.6***	31.0***	3.4***	16.3***	20.8***	20.4***	4.8***	10.3***
log per-capita gdp	40.4***	75.2***	15.7***	20.1***	36.1***	44.3***	24.7***	6.5***
natural resource*institu	75.7***	45.6***	2.4**	3.1***	5.0***	1.7**	6.3***	2.2***
natural resource*institu-sq	..	109.1***	..	..	..	..	..	..
aid	..	..	..	5.8***	..	..	21.9***	7.0***

Table A3

Regression Diagnostics for Tables 3, Regression with control variables

	I all controls	II agric omitted	III instq omitted	IV informal omitted	V landlocked dummy	VI landlocked dummy*trade
Shea partial R^2						
institutions	0.21	0.31	..	0.16	0.24	0.25
log per-capita gdp	0.47	0.54	0.44	0.37	0.54	0.52
resources*institu	0.28	0.27	0.24	0.23	0.31	0.34
aid	0.24	0.37	0.31	0.24	0.21	0.21
Partial R^2						
institutional quality	0.21	0.27	..	0.16	0.28	0.31
log per-capita gdp	0.50	0.52	0.4	0.35	0.61	0.60
resources*institu	0.23	0.23	0.23	0.23	0.26	0.31
aid	0.23	0.36	0.29	0.23	0.23	0.22
F-stat						
institutional quality	10.0***	14.6***	..	6.9***	17.7***	19.8***
log per-capita gdp	26.5***	8.9***	22.0***	12.1***	66.5***	68.9***
resources*institu	2.8**	2.7**	5.4***	2.8**	3.5***	4.0***
aid	5.5***	6.1***	8.6***	5.5***	5.6***	5.2***

Bibliography

1. Acemoglu, D., Johnson, S., Robinson, J. 2001, «The colonial origins of comparative development: an empirical investigation», *American Economic Review*, vol. 91, pp. 1369–401.
2. Agbeyegbe, T., Stortsky, J. G., and Woldermariam, A. 2004, «Trade liberalization, exchange rate changes, and tax revenue in Sub-Sahara Africa», *IMF Working Paper*, no. WP/04/178. Washington D.C.
3. Alesina, A., Devleeschauwer, A., Easterly, W., Kurlat, S., Wacziarg, R. 2003, «Fractionalization», *Journal of Economic Growth*, vol. 8 pp. 155–94.
4. Auty, R. M. 2001, «The political economy of resource-driven growth», *European Economic Review*, vol. 45, pp. 839–46.
5. Bhattacharyya, S. and Hodler, R. 2008 «Natural Resources, Democracy and Corruption», *European Economic Review*, vol. 54, no. 4, pp. 608–21.
6. Bird, R. M., J. Martinez-Vasquez, and B. Torgler 2006, «'Societal Institutions and Tax Effort in Developing Countries», in: J. Alm and J. Martinez-Vazquez (eds.), *The Challenge of Tax Reform in the Global Economy. Springer-Verlag*.
7. Bird, R. M., Martinez-Vasquez, J. and Torgler, B 2008, «Tax Effort in Developing Countries and High Income Countries: The Impact of Corruption, Voice and Accountability». *Economic analysis and policy*., vol. 38 no. 1.
8. Bornhorst, F., Gupta, S. A. and Thornton, J. 2009, «Natural resource endowments and the domestic revenue effort», *Economic Journal of Political Economy*, vol. 25, pp. 439–46.
9. Bring, J. 1994, «How to Standardize Regression Coefficients», *The America Statistical Association*, vol. 48, no. 3, pp. 209–13.
10. Carmignani, F. 2004, *Efficiency of Institutions, Political Stability and Income Dynamics*, United Nations Economic Commission for Africa, Geneva.
11. Cheeseman, N. and Griffiths, R. 2005, *Increasing Tax Revenue in Sub-Saharan Africa: The case of Kenya*, 6, Oxford Council of Good Governance Economy Analysis. Oxford.
12. Chelliah, R. J. 1971, «Trends in Taxation in Developing Countries», *IMF Staff Papers*, vol. Vol. 18 no. July, No. 2, pp. pp. 254–325.
13. Clague, C., Keefer, P., Knack, S. and Olson, M. 1999, «Contract-Intensive Money: Contract Enforcement, Property Rights and Economic Performance», *Journal of Economic Growth*, vol. 4, pp. 185–211.
14. Cleveland, W. S. 1994, «The Elements of Graphing Data, Summit NJ: Hobart Press».

15. Collier, P. and Hoeffler, A. 2005, «Democracy and Resource Rents», *Global Poverty Research Group*, vol. GPRG-WPS-016.

16. Davoodi, H. R. and Grigorian, D. A. 2007, «Tax Potential vs. Tax Effort: A Cross-Country Analysis of Armenia's Stubbornly Low Tax Collection», *IMF Working Paper*, vol. WP/07/106.

17. Edwards, S. 1998, «Openness, productivity and growth: what do we really know?», *Economic Journal*, vol. 108, pp. 383–98.

18. Eltony, M. N. 2002, «The Determinants of Tax Effort in Arab Countries», *API Publications, Kuwait*.

19. Frankel, J. 1999, «Does trade cause growth?», *American Economic Review* vol. 89, pp. 379–99.

20. Ghura, D. 1998, «Tax Revenue in sub-Sahara Africa: Effects of economic policies and corruption», *International Monetary Fund*, vol. WP/98/135.

21. Gupta, S. A. 2007 «Determinants of Tax Revenue Efforts in Developing Countries», *IMF Working Paper. Washington D.C.*, vol. 07/184.

22. Gwartney, J. and Lawson, R. 2009, *Economic Freedom Dataset*, 2009 edn, Economic Freedom of the World 2009 Annual Report, August 2010, <http://www.freetheworld.com/2009/2009Dataset.xls>.

23. Hall, R. E. and Jones, C. I. 1999, «Why do some countries produce so much more output per worker than others?», *Quarterly Journal of Economics*.

24. Hamilton, K. and Clemens, M. 1999, «Genuine savings rates in developing countries», *World Bank Economic Review*, vol. 13, pp. 333–56.

25. Isham, J., Woolcock, M., Pritchett, L. & Busby, G. 2005, «The Varieties of Resource Experience: Natural Resource Export Structures and the Political Economy of Economic Growth», *The World Economic Review*, vol. 19, no. 2, pp. 141–74.

26. Keen, M. and Mansour, M. 2009, «Revenue Mobilization in sub-Sahara Africa: Challenges from Globalization», *IMF Working Paper*, vol. (09/157).

27. Knack, S. 2008, «Sovereign Rents and the Quality of Tax policy and Administration», *Policy Research Working Paper*, vol. WPS4773.

28. LaPorta, R., Lopez-de-Silanes, F., Shleifer, A. and Vishny, R. 1999, «The quality of government», *Journal of Law, Economics and Organization*, vol. 15, pp. 222–79.

29. Leuthold, J. H. 1991, «Tax Shares in Developing Economies: A Panel Study», *Journal of Development Economics*, vol. 35, no. 1, pp. 173–85.

30. Lim, D. 1988, «Tax Effort and Expenditure Policy in Resource-Rich Countries», *Economic development policies in resource-rich countries*, pp. 128–53.

31. Lotz, J. R. and Morss, E. R. 1969, «Tax Effort» in Developing Countries», *Finance and Development*, vol. 6, no. 3, pp. 36–9.

32. Mahdavi S. 2008, «The level and composition of tax revenue in developing countries: Evidence from unbalanced panel data», *International Review of Economics and Finance*, no. 17, pp. 607–17.

33. Manzano, O. and Rigobon, R. 2001, «Resource Curse or Debt Overhang», *National Bureau of Economic Research Working Paper (Cambridge, MA)*, no. 8390.

34. Mehlum, H., Moene, K. and Torvik, R. 2006, «Institutions and the Resource Curse», *The Economic Journal*, vol. 116, pp. 1–20.

35. Njikam, O. 2008, «Do Resource-rich and Resource-poor Sub-Saharan African Countries Grow Differently?» University of Yaounde.

36. Osinubi, T. S. and Olaleru, O. E. 2006, «Budget Deficits, External Debt and Economic Growth in Nigeria», *Applied Econometrics and International Development*, vol. 6, no. 3, pp. 160–85.

37. Parker, P. M. 1997, *National cultures of the world: A statistical reference.* Greenwood Press, Westport, CT.

38. Sachs and Warner 2007, *General Measures of geography*, Centre for International Development, Harvard College, viewed 25 September 2010, <http://www.cid.harvard.edu/ciddata/geographydata.htm>.

39. — 2007, *Infectious Diseases*, Centre for International Development, Harvard University, viewed 25 September 2010, <http://www.cid.harvard.edu/ciddata/ciddata.html>.

40. Schneider, F. and Buehn, A. 2007, «Shadow Economies and Corruption all over the World: Revised Estimates for 120 Countries», *Economics: The Open-Access, Open-Assessment E-Journal*, vol. 1, no. 2007–9.

41. Stotsky, J. G., Woldermariam, A. 1997, «Tax Effort in Sub-Saharan Africa», *IMF Staff Papers*, vol. WP/97/107.

42. Tanzi, V. 1989, «The impact of macroeconomic policies on the level of taxation and fiscal balance in developing countries», *IMF Staff Papers*, no. 36, pp. 633–56.

43. — 1992, «Structural Factors and Tax Revenue in Developing Countries: A Decade of evidence in Open Economies», *Cambridge University Press, Cambridge*, pp. pp. 267–81.

44. Torgler, B. and Schneider, F. 2007, «Shadow Economy, Tax Morale, Governance and Institutional Quality: A Panel Analysis», *Working Paper Series, Berkeley Program in Law and Economics*.

45. World Bank 2010, World Data Bank, World Development Indicators and Global Development Finance, July–October 2010 various times.