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Good institutions and tax revenue outcomes in resource-rich countries

When 'good' is not enough

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Abstract: Developing countries that experience commodity booms struggle to mobilize sustainable tax revenues. Emerging literature on the subject notwithstanding, there is limited exploration of the specific types of institutions critical for improving fiscal capacity in resource-rich contexts. This paper investigates which types of institutions moderate the adverse effect of natural resource rents on non-resource tax effort. I propose a simple theoretical model and complement its insights with an empirical examination of the mediating role of 12 different measures of institutional quality commonly used in the literature. I find evidence of a mitigating role for 'constraints on executive power' and 'democracy'. Other covariates found to be important are national income per capita, the size of the agricultural sector, and control of corruption. The results suggest that effort to bolster sustainable tax effort in resource-rich contexts must focus not only on building effective political institutions but also on addressing structural constraints.

Key words: natural resource rents, non-resource tax revenue, institutions, sustainability, democracy

JEL classification: Q32, H71, P48, Q01

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1 Introduction

The New Institutionalist view that political power can be exercised in a manner that benefits society has received significant attention (Acemoglu et al. 2018; Bates et al. 2013; North 1981). According to this view, laws can be passed, norms promoted, and 'systems' built to create an enabling environment for enterprise, growth, reduction in inequality, and elimination of extreme poverty. Moreover, the ability of developing countries to mobilize domestic taxes from a broad base can be shaped by the quality of the institutions in place (Masi et al. 2018; Ricciuti et al. 2018). This goal of sustaining fiscal capacity is seen as relevant for improving governance and welfare in developing countries (Kaldor 1963). The fiscal resource curse literature, however, debates how natural resource abundance affects efforts to improve fiscal capacity in developing countries (Bornhorst et al. 2009; Chachu 2020; Chachu and Nketiah-Amponsah 2020; Klomp and de Haan 2016).

Klomp and de Haan (2016) and McGuirk (2013) find that natural resource rents undermine fiscal capacity through their effects on tax collection prior to election. Governments use rents to reduce the tax burden and increase expenditure in lieu of attracting votes. Klomp and de Haan (2016) find this effect present in fledgling democracies. Weak institutions also undermine the possibility of allocating resource rents to productive ends that expand the economy and increase the non-resource tax base. Masi et al. (2018) also find that resource rents and non-resource taxes are negatively associated except when the level of constraints on executive power is high. Botlhole et al. (2012) present similar findings for 45 Sub-Saharan African countries over the period 1990–2007. They find that good quality institutions constrain the adverse effect of resource rents on non-resource tax effort. More recently, Mawejje (2019) finds that country membership of the Extractive Industries Transparency Initiative (EITI) exerts a moderating influence on the deleterious impact of resource revenues on tax revenues, although the effect is weak.

This paper takes a wider and more exploratory approach to examining what types of institutions are relevant for improving non-resource tax effort in the presence of natural resources. It is distinguished from earlier work by the following. First, I propose a simple theoretical model for examining the interactive effect between institutions and resource rents in explaining variations in non-resource tax revenues. Second, I back away from a unidimensional view of institutions, using instead different measures of institutional quality and the extent to which they mediate the relationship between natural resource rents and non-resource tax revenues. Third, I allow for a heterogeneous effect across regions by examining the case for a full (global) sample but also for low-income and lower-middle-income countries, given that the latter are more dependent on natural resources. The main outcome variable of interest, non-resource tax revenues as a percentage of GDP, focuses on the entirety of the sustainable part of the tax base (which would, therefore, exclude natural resource taxes).

The rest of the paper is organized as follows. A theoretical model is proposed in Section 2, followed by a discussion of the empirical strategy and data in Section 3. In Section 4, I discuss the findings and Section 5 concludes.

2 Theoretical framework

I present a simple static model that predicts how institutions affect non-resource tax effort in the presence of natural resources. The set-up comprises an open economy with two sectors: a natural

resource sector made up of tradeable hydrocarbons and minerals (e.g. crude oil, natural gas, diamonds) and a non-resource sector made up of other goods and services. The non-resource sector has a wider and more diversified base. There exists a social planner that determines effort applied to mobilizing revenues from the two sectors. I define effort as the delivery of the relevant policy and administrative infrastructure to mobilize revenues. The social planner further determines the allocation of costs and benefits between two groups in society: elites (the incumbent) and non-elites. The allocation of costs and benefits is influenced by an exogenous constraining parameter, which I proxy as a measure of institutions.

Key definitions and assumptions are:

e_r is revenue collection effort in the natural resource sector.

e_{nr} is the tax collection effort in the non-resource sector.

$T_r = pe_r$ is total revenue in the resource sector and p is the export price for natural resources.

$T_{nr} = e_{nr}$ is total tax revenue in the non-resource sector.[1]

$c(e_r)$ is the total cost of revenue collection effort in the resource sector.

$d(e_{nr})$ is the cost of tax collection effort in the non-resource sector. The cost functions $c(.)$ and $d(.)$ are convex.

W is the social welfare function, which is continuously differentiable.

$V_1(g_1)$ represents benefit to group 1, the non-elites, when g_1 units of total revenue are allocated to them.

$V_2(g_2)$ is the benefit to group 2, the elites or the incumbent group, when g_2 units of total revenue are allocated to them. The utility functions $V_1(.)$ and $V_2(.)$ are strictly concave.

$\alpha \in (0,1)$ is an exogenous parameter that refers to the weight of the non-elites in the society's social welfare function.

E is the aggregate effort of revenue mobilization. So that $E = e_r + e_{nr}$.

Thus, the social planner chooses g_1, g_2, e_r, and e_{nr} to maximize the social welfare function:

$$W = \alpha V_1(g_1) + (1-\alpha)V_2(g_2) - c(e_r) - d(e_{nr}) \quad (1)$$

subject to: $E = e_r + e_{nr}$ and $g_1 + g_2 = T_r + T_{nr}$

We can re-write the constraints $e_r = E - e_{nr}$ and $g_2 = T_{nr} + T_r - g_1$ but also noting that $T_{nr} = e_{nr}$ and $T_r = pe_r$

Thus, the marginal revenue benefits of resource tax effort and non-resource tax effort are respectively:

$\frac{\partial T_r}{\partial e_r} = p$ and $\frac{\partial T_{nr}}{\partial e_{nr}} = 1$

The above results suggest that for the export price $p > 1$, the marginal revenue benefit of resource revenue effort is greater than the marginal revenue benefit of non-resource tax effort. The magnitude of marginal revenue benefits in the resource sector is therefore dependent on the

[1] As a benchmark, prices in the non-resource sector are normalized to 1.

magnitude of the prevailing export price. We interpret $p > 1$ as a sufficiently high export price. This situation could be proxied by a natural resource boom or sufficiently high levels of resource rents. An alternative scenario would be a value for $p \leq 1$ that suggests a relatively low export price level or level of resource rents.

Note that the key derivative of interest that predicts the effect of resource rents on non-resource tax is $\frac{\partial e_{nr}^{*}}{\partial p}$ (see Appendix for further derivations and proofs, supported by a simple simulation exercise).

2.1 Model predictions

1. The quality of institutions (defined by an exogenous constraining parameter) has a moderating influence on the adverse effect of resource rents on non-resource tax effort. This effect is recognizable when export prices or resource rents are low.

2. Resource rents undermine non-resource tax effort when export prices of commodities or the rents from them are sufficiently high. The moderating effect of institutions in such instances is limited.

A weakness of my theoretical model is its restriction of the definition to institutions that favour equity and redistribution. At the same time, different types of institutions may exert different impacts on non-resource tax effort in the face of different levels of export prices. I therefore test for the key predictions of the model by accounting for the role of different types of institutions within an empirical framework. Although I do not formally model the effect of tax evasion and other fiscal malpractices, if tax evasion is equally likely in both sectors, then the sign of $\frac{\partial e_{nr}^{*}}{\partial p}$ should not be affected. On the other hand, if there is tax evasion in, say, the non-resource sector, the social planner would allocate less tax effort there, given that the relative cost of effort there would be higher. This should strengthen the result for $\frac{\partial e_{nr}^{*}}{\partial p}$, especially within the context of a weak institutional base for revenue mobilization.

3 Data and empirical strategy

I test a key insight from the predictions of the model within an empirical framework that proxies the effect of export prices and non-resource tax effort with total resource rents as a percentage of GDP and non-resource tax revenue as a percentage of GDP, respectively $\left(\frac{R^{NR}}{Y}\right)$. The main predictor variable comprises different measures of institutions interacted with resource rents as a percentage of GDP. We specify a base econometric model as follows:

$$\left(\frac{R^{NR}}{Y}\right)_{it} = \beta_0 + \beta_1 \left(\frac{RRT}{Y}\right)_{it} + \beta_2 \left(\frac{RRT}{Y}\right)_{it} * INST_{it} + \beta_3 INST_{it} + \omega'(controls)_{it} + \varphi_i + \tau_t + u_{it} \quad (1)$$

where $\left(\frac{RRT}{Y}\right)_{it}$ measures natural resource rents as a percentage of GDP for country i at time t; $INST_{it}$ measures the quality of institutions in country i at time t; β_2 is the interactive parameter of interest as it measures how institutions moderate the effect of resource rents on non-resource tax revenue; and β_1 then captures the partial effect of resource rents on non-resource tax effort. Thus from equation (1), the marginal effect of resource rents on non-resource tax effort is given by:

$$\partial\left(\frac{R^{NR}}{Y}\right)_{it} / \partial\left(\frac{RRT}{Y}\right)_{it} = \beta_1 + \beta_2 INST_{it} \quad (2)$$

This effect is dependent not only on the parameters β_1 and β_2 but also on the quality of institutions. I evaluate the marginal effect at the mean level but also by type of institutional measure. The list of control variables includes a measure of corruption (*corrupt*) from the International Country Risk Group database. The rest are grants as a percentage of GDP (*grants*), agriculture value-added as a percentage of GDP (*agric2GDP*), log of GDP per capita, and trade openness as a percentage of GDP (*trade2GDP*), all from the World Bank's World Development Indicators database.

The literature provides different perspectives on institutions. For example, Aoki (2001) looks at institutions across four dimensions—political, social, economic, and organizational—while Greif (2006) distinguishes between structural and fundamental institutions. While these categorizations are quite feasible in theoretical discussions, they become more complicated to deal with empirically. Available cross-country data on institutions do not always precisely fit these distinctions (Glaeser et al. 2004). To circumvent this problem, I take a practical approach by defining a set of measures of institutions among the most widely cited in the literature. Thus my main sources of data for these measures of institutions are the International Country Risk Guide (ICRG), Polity IV, and the World Bank's Country Policy Institutional Assessment (CPIA).

3.1 Empirical strategy and robustness checks

I begin by estimating my base model with Pooled Ordinary Least Squares. I introduce my list of control variables, including country-fixed effects and time-fixed effects. I test for a contemporaneous interactive effect between quality of institutions and resource rents on non-resource tax effort using both random-effects and fixed-effects estimators. Except in rare cases such as during revolutions, changes in institutions are incremental and thus rarely discontinuous (North 1990). I use a Hausman test to check for systematic differences between the random-effects and fixed-effects models, if any.

In general, it takes time for institutions to evolve. For instance, Savoia and Sen (2015) note that institutions are persistent and hence require a medium- to long-term view when analysed. Therefore, I examine the interactive effect by transforming the data into five-year non-overlapping averages in a bid to assess the medium- to the long-run effect of institutions. Although I employ both five-year and ten-year averages in order to capture slow changes and the persistent nature of institutions, the five-year averages have the advantage of allowing for episodic variations in our institutional variables of interest in tandem with global political/electoral and business cycles across countries.[2]

While the fixed-effects estimators deal significantly with endogeneity concerns across countries and over time, there is a need to account for the possibility of simultaneity bias. Countries with low levels of non-resource tax effort are more likely to depend on exploiting their natural resources and are prone to corruption. To deal with this bias, I employ internal instruments for the endogenous variables using a generalized method of moments estimator.

[2] McGuirk (2013) finds that, on average, countries follow a 60-month (5-year) political cycle with a standard deviation of about 5 months.

3.2 Data and descriptive statistics

The outcome variable comes from the 2017 version of the UNU-WIDER Government Revenue database. It is computed by deducting natural resources taxes from total tax revenues and excluding social security contributions. The resource rents variable (t_rent2gdp) is obtained from the 2017 version of the World Bank's World Development Indicators Database. It combines available data on rents on oil, gas, coal, minerals, and forests.

Data on institutional variables

The data on institutional variables comprise *polity2*, democracy (*democ*), and constraints on the executive (*exconst*) from the Polity IV Database (Marshall et al. 2016); checks and balances (*checks*), legislative index of electoral competitiveness (*liec*), and executive index of electoral competitiveness (*eiec*) from the Database on Political Institutions (Cruz et al. 2016). The rest are law and order (*laworder*), socioeconomic conditions (*socioecon*), investor profile (*investprof*), and bureaucratic quality (*bureacr*) from the International Country Risk Guide database (Political Risk Services 2015); and effective revenue mobilization (*cpia_erm*) and property rights and rule-based governance (*cpia_prop*) from the World Bank's Country Policy Institutional Assessment (CPIA) database. Except for the CPIA data, the other variables have observations spanning the period between 1984 and 2015 for more than 100 countries. The CPIA data covers the period 2005 to 2015.

The *polity2* score comprises a measure of democracy (*democ*) and autocracy (*autoc*). *Democ* represents a measure of institutionalized democracy. It captures the ability of institutions to guarantee citizens' right to choose their own leaders and express their policy preferences, the existence of institutions to constrain executive authority, and the right of citizens to enjoy civil liberties, especially political participation. *Exconst* is a variable defined by the extent to which the decision-making authority of the executive branch of a state is constrained by other state institutions. Institutions that may impose such constraints include organized groups such as other branches of government, political parties, and other civil society organizations. A lower score suggests unlimited authority exercised by the executive, while a higher score suggests greater constraints on the executive.

Liec measures the extent to which the legislature is competitively composed. It looks at the extent of multi-party participation in legislative elections as well as the composition of the assembly. The higher the score, the greater the participation of multiple parties and the lesser the tendency of one party to control the whole legislative assembly. *Eiec* employs a similar scale as *liec*. It measures the extent to which the ruling executive is elected directly by the citizens or through an electoral college that is elected by the citizens. Countries that have these characteristics score highly. The *checks* variable combines *liec* and *eiec* to assess the level of checks and balances associated with an elected government. The score increases when there is greater control of the legislature by an opposition party.

The variable *laworder* combines two metrics. The 'law' part assesses how impartial the legal system of a country is, while the 'order' part evaluates the extent to which the laws of a country are obeyed. The latter also assesses the extent to which sanctions are applied to the errant. The higher the score the greater the degree of commitment to law and order in any country year. The *investprof* variable captures risk to foreign investment in a country. It comprises three sub-components measuring risk of expropriation, profit repatriation, and payment delays. *Bureacr* measures the extent to which a political system can withstand shocks associated with changes in government. It evaluates the potential for continuity in policy regardless of election cycles. It assesses the effectiveness of the bureaucracy in place. The higher the score, the better the quality of bureaucracy in place. *Socioecon* is made up of three sub-components that describe a country's risk or exposure to societal pressure emanating from levels of unemployment, poverty, and consumer confidence.

It represents factors that fuel social dissatisfaction (Political Risk Services 2015). A higher score signifies lower exposure to these societal pressures.

Cpia_erm provides an overall assessment of the policy and administrative environment for revenue mobilization. It evaluates the existing tax structure, as well as processes to mobilize taxes from all possible sources. The higher the score the more efficient a country's institutions are for revenue mobilization. The variable *cpia_prop* is an index of the existence of a legal basis for the security of property and protection of contract rights; the predictability, transparency, impartiality, and enforcement of laws and regulations affecting economic activity; and the extent of control of crime and violence. The higher the score, the better the protection of property rights and exercise of rule-based governance.

Descriptive statistics

Table 1 presents summary statistics for the variables used in the empirical exercise, including additional control variables for robustness checks.

Table 1: Summary statistics

	(2)	(3)	(4)	(5)	(6)
Variable	**count**	**mean**	**standard dev.**	**min.**	**max.**
tot_nrestax	1,978	14.922	6.890	0.6	37.577
t_rent2gdp	1,978	8.146	10.789	0	63.521
grants	1,978	1.137	2.099	0	24.713
corrupt	1,978	2.753	1.193	0	6
agricval2GDP	1,978	16.000	14.001	0.035	79.042
Log GDP per capita	1,978	8.116	1.473	5.122	11.618
trade2GDP	1,978	89.221	64.210	0.274	455.415
socioecon	1,978	5.377	2.238	0.5	11
laworder	1,978	3.500	1.320	0	6
investprof	1,978	7.599	2.293	0	12
corrupt	1,978	2.753	1.193	0	6
bureacr	1,978	2.036	1.038	0	4
exconst_orig	1,826	2.607	13.659	-88.00	7
exconst	1,815	4.695	2.093	0	7
polity2	1,814	3.298	6.124	-10	10
liec	1,946	6.244	1.584	1	7
eiec	1,946	5.939	1.833	1	7
checks	1,925	2.814	1.728	1	18
lncpi	1,805	3.911	2.169	-24.614	5.855
lnpop	1,978	16.015	1.680	12.366	21.034
democ_orig	1,826	3.045	14.082	-88.000	10
democ	1,815	5.137	3.788	0	10
cpia_prop	328	2.864	0.558	1	3.5
cpia_erm	328	3.477	0.437	2.5	4.5
N	1,978				

*_orig refers to original data.

Source: author's construction.

Following the literature, I make adjustments to the original *democ* and *exconst* data, which contain special values: -66 (representing a country year of foreign interruptions), -77 (representing cases of anarchy), and -88 (other forms of transition following national independence, foreign interruption,

or anarchy). These values usually describe transition periods in the evolution of political institutions. I follow Marshall et al. (2016) in making these adjustments. Whenever an observation in a country year is scored -66, I convert the value to missing. When the value is -77 or -88, I convert it to zero. The latter reflects a country year characterized by a state in transition or an anocracy. While I use the adjusted variables in all estimations, both original and adjusted variables are shown in Table 1. And I include an additional list of covariates: log of consumer price index (*lncpi*) and log of population (*lnpop*) to facilitate robustness checks.

4 Results and discussion

In Table 2, we see a contemporaneous relationship between our variables of interest. I interact resource rents as a percentage of GDP with polity2 score, controlling for key covariates, as suggested by the literature. The first two columns present OLS results. Results from Random-effects Estimators are shown in columns 3 and 4. In column 5 are displayed results from a Fixed-effects Estimator. I employ a Hausman test to determine whether a systematic difference exists between the Random-effects Estimator and the Fixed-effects Estimator. The null hypothesis of no systematic difference in coefficients yields a Chi-squared value of 10.31 with a p-value of 1. The p-value suggests that we fail to reject the null hypothesis. Consequently, there is no sufficient evidence to conclude that coefficients of the Random-effects Estimator are systematically different from coefficients of the Fixed-effects Estimator. I therefore opt for the former.

Table 2: Interactive effect with polity2: global sample

Dependent variable: non-resource tax as a percentage of GDP					
	(1)	**(2)**	**(3)**	**(4)**	**(5)**
Variables	**OLS**	**OLS**	**REE**	**REE**	**FEE**
t_rent2gdp	-0.125***	-0.133***	-0.0545*	-0.0777**	-0.0579*
	(0.0114)	(0.0116)	(0.0315)	(0.0309)	(0.0337)
polity2	0.157***	0.133***	-0.0380	-0.0375	-0.0515
	(0.0305)	(0.0309)	(0.0553)	(0.0561)	(0.0583)
c.t_rent2gdp#c.polity2	0.00637***	0.00476**	0.00622**	0.00423	0.00385
	(0.00227)	(0.00229)	(0.00309)	(0.00301)	(0.00318)
grants	0.0352	-0.0582	0.0539	0.0370	0.0439
	(0.0568)	(0.0572)	(0.0842)	(0.0843)	(0.0852)
corrupt	1.108***	1.624***	0.174	0.372	0.327
	(0.142)	(0.165)	(0.245)	(0.288)	(0.296)
agricval2GDP	-0.00888	7.36e-05	-0.0676**	-0.0620*	-0.0690*
	(0.0144)	(0.0143)	(0.0328)	(0.0342)	(0.0370)
Log GDP per capita	1.303***	1.033***	2.544***	1.719***	1.919**
	(0.180)	(0.186)	(0.617)	(0.558)	(0.965)
trade2GDP	0.00405	0.00247	0.00573	0.00277	0.00271
	(0.00285)	(0.00290)	(0.00668)	(0.00672)	(0.00697)
Country effect	No	No	Yes	Yes	Yes
Time effect	No	Yes	No	Yes	Yes
Observations	1,814	1,814	1,814	1,814	1,814
R-squared	0.412	0.438			0.164
Number of id	92	92	92	92	92

Note: robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Source: author's construction.

In columns 1, 2, and 3, the interaction effect is positive, suggesting a moderating role for political institutions on the adverse effect of resource rents on non-resource tax effort. However, this result is not robust to controlling for country-invariant, time-varying unobserved factors such as global shocks. I account for these by including year dummies in columns 2, 4, and 5. The joint test for the inclusion of time dummies rejects the null hypothesis of no time effects; hence, the inclusion of time effects is justified.

My specification of preference in column 4 suggests that the mediating influence of the polity2 score is not statistically significantly different from zero. Other factors, such as the size of the informal economy (using agricultural sector value-added as a percentage of GDP as a proxy) and the size of the economy, appear to be important in explaining non-resource taxes as a percentage of GDP. To further examine the contemporaneous effect for other types of institutions, I employ the specification in column 4.

Tables 3 and 4 depict results based on the specification in column 4 of Table 2. In Table 3, we find the interactive effect to be positive for democracy and constraints on the executive. This suggests that the quality of democracy and the level of constraints on the executive have a mitigating influence on the adverse effect of resource rents on non-resource tax effort. The effects are statistically significant at conventional levels but small in magnitude. The results are also consistent with Masi et al. (2018), who find a positive and statistically significant coefficient on their interaction term between total resource rents and executive constraints. Their measure of fiscal capacity, the outcome variable of interest, is, however, a variant of our measure. The coefficient of GDP per capita remains positive and statistically significant across all specifications. On average, the larger the overall tax base, the larger the non-resource tax potential of a country. On the other hand, the negative and statistically significant coefficient on agriculture value-added as a percentage of GDP shows that countries with a larger agricultural sector have a challenged fiscal capacity. Control of corruption also appears to be important in explaining non-resource tax outcomes as the variable turns statistically significant in columns 1–3.

None of the interactive effects turns statistically significant in Table 4. The coefficient on agriculture value-added as a percentage of GDP remains negative across all specifications except column 4. The coefficient on GDP per capita is positive for all specifications except in columns 4 and 5, which also happen to be the only specifications where the coefficient on trade openness is positive and statistically significant.

Table 3: Interactive effect with other political institutional variables: global sample

Dependent variable: non-resource tax as a percentage of GDP					
	(1)	**(2)**	**(3)**	**(4)**	**(5)**
Variables	**REE**	**REE**	**REE**	**REE**	**REE**
t_rent2gdp	-0.113***	-0.0858**	-0.0829**	-0.131***	-0.106***
	(0.0302)	(0.0337)	(0.0348)	(0.0306)	(0.0317)
eiec	-0.0881				
	(0.132)				
c.t_rent2gdp#c.eiec	0.00668				
	(0.00653)				
liec		-0.0226			
		(0.178)			
c.t_rent2gdp#c.liec		0.00117			
		(0.00593)			
checks			-0.161		
			(0.101)		
c.t_rent2gdp#c.checks			0.00119		
			(0.00954)		
exconst				0.0253	
				(0.147)	
c.t_rent2gdp#c.exconst_ed				0.0171***	
				(0.00571)	
democ_ed					-0.0672
					(0.0907)
c.t_rent2gdp#c.democ_ed					0.0100**
					(0.00448)
grants	0.0336	0.0322	0.0361	0.00746	0.0302
	(0.0787)	(0.0815)	(0.0792)	(0.0809)	(0.0842)
corrupt	0.435*	0.437*	0.427*	0.344	0.354
	(0.243)	(0.242)	(0.235)	(0.290)	(0.289)
agricval2GDP	-0.0572*	-0.0620*	-0.0724**	-0.0488	-0.0576*
	(0.0317)	(0.0350)	(0.0315)	(0.0319)	(0.0329)
Log GDP per capita	1.690***	1.610***	1.557***	1.742***	1.737***
	(0.545)	(0.539)	(0.553)	(0.547)	(0.552)
trade2GDP	0.00592	0.00656	0.00727	0.00155	0.00264
	(0.00699)	(0.00702)	(0.00696)	(0.00638)	(0.00656)
Country effect	Yes	Yes	Yes	Yes	Yes
Time effect	Yes	Yes	Yes	Yes	Yes
Observations	1,946	1,946	1,925	1,815	1,815
Number of id	96	96	96	92	92

Note: robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Source: author's construction.

Table 4: Interactive effect with measures of effectiveness of government: global sample

Dependent variable: non-resource tax revenue as a percentage of GDP						
Variables	**REE**	**REE**	**REE**	**REE**	**REE**	**REE**
t_rent2gdp	-0.0545	-0.0782	-0.0975*	-0.360	-0.470	-0.00420
	(0.0390)	(0.0531)	(0.0528)	(0.280)	(0.379)	(0.0617)
Bureacr	-0.0310					
	(0.386)					
c.t_rent2gdp#c.bureacr	-0.0207					
	(0.0227)					
Investprof		-0.114				
		(0.135)				
c.t_rent2gdp#c.investprof		-0.000517				
		(0.00769)				
Socioecon			-0.0664			
			(0.128)			
c.t_rent2gdp#c.socioecon			0.00395			
			(0.00903)			
cpia_erm				0.773		
				(1.083)		
c.t_rent2gdp#c.cpia_erm				0.0763		
				(0.0958)		
cpia_prop					-0.0434	
					(0.927)	
c.t_rent2gdp#c.cpia_prop					0.138	
					(0.128)	
Laworder						0.428
						(0.283)
c.t_rent2gdp#c.laworder						-0.0248
						(0.0170)
Grants	0.0289	0.0359	0.0299	0.0769*	0.0668	0.0477
	(0.0804)	(0.0800)	(0.0807)	(0.0455)	(0.0436)	(0.0753)
Corrupt	0.449*	0.469**	0.441*	1.201	1.095	0.251
	(0.238)	(0.234)	(0.233)	(0.944)	(0.798)	(0.214)
agricval2GDP	-0.0631*	-0.0608*	-0.0605*	-0.178*	-0.185*	-0.0621*
	(0.0354)	(0.0356)	(0.0358)	(0.0984)	(0.0959)	(0.0347)
Log GDP per capita	1.696***	1.733***	1.583***	-0.537	-0.733	1.907***
	(0.559)	(0.526)	(0.509)	(1.240)	(1.398)	(0.545)
trade2GDP	0.00515	0.00589	0.00610	0.0489***	0.0494***	0.00610
	(0.00638)	(0.00655)	(0.00636)	(0.0144)	(0.0163)	(0.00632)
Country effect	Yes	Yes	Yes	Yes	Yes	Yes
Time effect	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,978	1,978	328	328	328	1,978
Number of id	98	98	40	40	40	98

Note: robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Source: author's construction.

4.1 Estimating the marginal effects

On the basis of the institutional variables that turn statistically significant in the preferred model specification, I estimate their marginal effects at the mean. For the exconst_ed variable, the marginal effect of resource rents on non-resource tax effort at the mean level of institutional quality is given by

$$\partial\left(\frac{R^{NR}}{Y}\right)_{it} / \partial\left(\frac{RRT}{Y}\right)_{it} = \beta_1 + \beta_2 INST_{it} = -0.13 + (0.017) * (4.7) = -0.05 \quad (3)$$

This suggests that constraints on the executive only reduce the adverse effect of resource rents on non-resource tax effort. The negative relationship is, however, not overturned even if a country moves from the lowest level of institutional quality, measured by exconst_ed, to the highest possible value of 7. The computation of the turning point is shown below:

$$\partial\left(\frac{R^{NR}}{Y}\right)_{it} / \partial\left(\frac{RRT}{Y}\right)_{it} = \beta_1 + \beta_2 INST_{it} = 0 \quad (4)$$

where $-0.13 + 0.017(INST_{it}{}^{*}) = 0$

Therefore, at the turning point: $INST_{it}{}^{*} = 0.13/0.017 = 7.65$

The marginal effect for executive constraints is not qualitatively different from that of the democracy variable (-0.06). This is not surprising given the fact that the exconst variable is a key constituent of the democracy index. The Pearson's correlation coefficient between the two variables is 0.95.

Thus, in the short run (within a year), the quality of democracy or constraints on the executive have a mitigating impact on the adverse effect of resource rents on non-resource tax effort. The marginal effects suggest that the institutional impact is modest relative to the incentives provided by resource rents. Von Haldenwang and Ivanyna (2018) also observe that political institutions (regime-type) seem not to matter in averting the adverse effects of shocks from resource rents on domestic revenues. This is also similar to findings that the quality of institutions is unable to overturn the resource curse in countries that are resource-rich (Eregha and Mesagan 2016). Mawejje (2019)'s results on the weak moderating impact of institutional quality on the effect of resource rents on non-resource revenues further corroborate my findings, although his sample of institutions is limited to members of the EITI.

My results, however, show that other factors—such as the size of the informal economy, size of the economy as a whole, control of corruption, and, to some extent, volume of trade—could be important in explaining non-resource tax effort. The negative relationship between agriculture's share of GDP and tax revenues is also confirmed in studies by Ndikumana and Abderrahim (2010) and Von Haldenwang and Ivanyna (2018). Countries with a large agricultural sector relative to national output tend to have a highly informal economy, where fiscal capacity is greatly handicapped. The evidence of a positive association between the tax base (measured by GDP per capita) and non-resource tax effort but also between volume of trade and non-resource tax effort is demonstrated in Bornhorst et al. (2009), Gupta (2007), and Mawejje (2019). My finding further agrees with Baum et al. (2017) that control of corruption is positively associated with non-resource tax effort. Again, Gupta (2007) finds that improvement in trade is positively associated with non-resource tax effort.

The difficulties associated with raising taxes from the non-resource sector are well documented. In the case of developing countries, it is even more challenging. I re-examine this evidence in Tables 5 and 6 by evaluating the same set of specifications as in Tables 3 and 4 for developing countries. The latter comprise low-income countries (LICs) and lower-middle-income countries (LMICs) according to the World Bank Group's income classifications for countries.

Table 5: Interaction between institutions and resource rents: short-run effects for LICs and LMICS

Dependent variable: non-resource tax as a percentage of GDP					
	(1)	**(2)**	**(3)**	**(4)**	**(5)**
Variables					
t_rent2gdp	-0.0818**	-0.0851***	-0.0631**	-0.0722**	-0.113***
	(0.0351)	(0.0243)	(0.0290)	(0.0321)	(0.0375)
polity2	-0.0112				
	(0.0565)				
c.t_rent2gdp#c.polity2	0.00437				
	(0.00356)				
eiec		0.128			
		(0.140)			
c.t_rent2gdp#c.eiec		-0.000749			
		(0.00756)			
liec			0.236		
			(0.166)		
c.t_rent2gdp#c.liec			-0.00450		
			(0.00775)		
checks				-0.0612	
				(0.115)	
c.t_rent2gdp#c.checks				-0.00450	
				(0.0103)	
exconst_ed					0.202
					(0.199)
c.t_rent2gdp#c.exconst_ed					0.0131*
					(0.00725)
grants	0.190**	0.189**	0.180**	0.193**	0.148**
	(0.0827)	(0.0817)	(0.0817)	(0.0792)	(0.0751)
corrupt	0.171	0.217	0.244	0.217	0.168
	(0.405)	(0.401)	(0.406)	(0.406)	(0.401)
agricval2GDP	-0.0363	-0.0361	-0.0426	-0.0481*	-0.0237
	(0.0305)	(0.0279)	(0.0289)	(0.0288)	(0.0310)
Log GDP per capita	2.765***	2.350***	2.301***	2.577***	2.815***
	(0.756)	(0.664)	(0.650)	(0.718)	(0.733)
trade2GDP	0.0273***	0.0302***	0.0300***	0.0284***	0.0243***
	(0.00935)	(0.00986)	(0.00909)	(0.00934)	(0.00894)
Country effect	Yes	Yes	Yes	Yes	Yes
Time effect	Yes	Yes	Yes	Yes	Yes
Observations	916	915	915	915	917
Number of id	45	45	45	45	45

Note: robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Source: author's construction.

Table 6: Interaction between institutions and resource rents: short-run effects for LICs and LMICS (II)

Dependent variable: non-resource tax as a percentage of GDP						
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Variables						
t_rent2gdp	-0.0899*	-0.0625	-0.170***	-0.403	-0.467	-0.0747
	(0.0508)	(0.0644)	(0.0547)	(0.304)	(0.383)	(0.0640)
bureacr	-0.0833					
	(0.454)					
c.t_rent2gdp#c.bureacr	0.00986					
	(0.0332)					
investprof		0.0897				
		(0.206)				
c.t_rent2gdp#c.investprof		-0.00300				
		(0.0119)				
socioecon			-0.0164			
			(0.206)			
c.t_rent2gdp#c.socioecon			0.0297**			
			(0.0127)			
cpia_erm				0.875		
				(1.221)		
c.t_rent2gdp#c.cpia_erm				0.0913		
				(0.107)		
cpia_prop					0.00893	
					(1.003)	
c.t_rent2gdp#c.cpia_prop					0.140	
					(0.132)	
laworder						-0.0866
						(0.258)
c.t_rent2gdp#c.laworder						-0.00103
						(0.0193)
grants	0.189**	0.185**	0.179**	0.0843*	0.0673	0.186**
	(0.0792)	(0.0753)	(0.0797)	(0.0482)	(0.0446)	(0.0753)
corrupt	0.215	0.182	0.237	1.085	1.074	0.146
	(0.398)	(0.380)	(0.412)	(0.921)	(0.811)	(0.388)
agricval2GDP	-0.0411	-0.0422	-0.0469	-0.169*	-0.186**	-0.0431
	(0.0331)	(0.0300)	(0.0304)	(0.0895)	(0.0947)	(0.0308)
Log GDP per capita	2.635***	2.509***	1.868***	-1.175	-1.379	3.266***
	(0.808)	(0.709)	(0.690)	(1.379)	(1.480)	(0.703)
trade2GDP	0.0274***	0.0276***	0.0251***	0.0509***	0.0498***	0.0286***
	(0.00910)	(0.00857)	(0.00898)	(0.0144)	(0.0163)	(0.00899)
Country effect	Yes	Yes	Yes	Yes	Yes	Yes
Time effect	Yes	Yes	Yes	Yes	Yes	Yes
Observations	917	917	917	315	315	917
Number of id	45	45	45	36	36	45

Note: robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Source: author's construction.

For LICs and LMICs, we continue to find the interactive effect of institutional variables measured by constraints on the executive to be positive and statistically significant. We also find the

interactive term with socioeconomic index to be statistically significantly different from zero. The marginal effect of resource rents on non-resource tax effort at the mean level of exconst is not qualitatively different from that in the full sample (-0.06). Similarly, the marginal effect of resource rents on non-resource tax effort at the mean level of the socioeconomic index (4.08 points) is slightly lower at -0.05.

However, when the socioeconomic index rises past an intermediate level of 5.67 points, the marginal effect of resource rents on non-resource tax effort turns positive (that is, using equations (1) and (2) to derive the turning point). Apart from institutional constraints on the executive, we expect that an improvement in the socioeconomic environment—as characterized by, for example, reduced risks to unemployment and poverty—should contribute to mitigating the adverse effect of resource rents on non-resource tax effort. An environment that improves consumer confidence should boost both consumption and investment. These factors should, in turn, contribute to widening the tax base and increasing non-resource taxes.

Other variables that turn statistically significant for the sample of LICs and LMICs are log of GDP per capita, grants as a percentage of GDP, and trade openness, all of which turn positive in most specifications in Tables 5 and 6. All other things being equal, a larger output base would be associated with higher non-resource taxes. Furthermore, developing countries stand to gain from grant support, especially support allocated to building fiscal capacity and increasing the production base. Many developing countries continue to depend on trade taxes as an important part of their tax base. The positive association between trade openness and non-resource tax effort is therefore not a surprising result for LICs and LMICs. Once again, agriculture value-added turns negative and statistically significant in accordance with our expectation, albeit with respect to only column 4 of Table 5 and columns 4 and 5 of Table 6. A marginal increase in agriculture's percentage of GDP is associated with a reduced non-resource tax effort.

4.2 Marginal effects beyond the short run

In Tables 7 and 8, I go beyond the contemporaneous effect to examine the marginal effects of total resource rents on non-resource tax effort in the medium term by transforming the data into five-year non-overlapping averages. In the medium term, we find that the interaction terms involving all institutional variables except bureaucratic quality and law and order are not statistically significant. These two statistically significant coefficients are, however, negatively signed, contrary to what one would expect. It suggests that an improvement in law and order (as well as bureaucratic quality) exacerbates the deleterious impact of resource rents on non-resource tax effort. Other variables, such as improvement in the control of corruption index score and GDP per capita, are associated with improvements in non-resource tax effort. We also find an increase in agricultural value-added as a percentage of GDP to be associated with a reduction in non-resource tax as a percentage of GDP.

Table 7: Interactive effect with political institutions: beyond the short run

Dependent variable: non-resource tax revenue as a percentage of GDP					
	(1)	**(2)**	**(3)**	**(4)**	**(5)**
Variables	**OLS**	**REE**	**REE**	**REE**	**REE**
t_rent2gdp	-0.133***	-0.0908**	-0.120***	-0.136***	-0.175***
	(0.0230)	(0.0396)	(0.0395)	(0.0452)	(0.0558)
polity2	0.196***	-0.0261	-0.0171		
	(0.0683)	(0.0821)	(0.0868)		
c.t_rent2gdp#c.polity2	0.00286	0.00483	0.00152		
	(0.00549)	(0.00441)	(0.00444)		
democ_ed				-0.0488	
				(0.135)	
c.t_rent2gdp#c.democ_ed				0.00591	
				(0.00678)	
Eiec					-0.0641
					(0.213)
c.t_rent2gdp#c.eiec					0.00883
					(0.00947)
Grants	-0.0635	0.0409	0.00233	-0.00244	-0.0276
	(0.131)	(0.179)	(0.171)	(0.169)	(0.159)
Corrupt	1.145***	0.447	0.794**	0.763*	0.816**
	(0.322)	(0.312)	(0.397)	(0.390)	(0.331)
agricval2GDP	0.00308	-0.0931***	-0.0773***	-0.0755**	-0.0620*
	(0.0322)	(0.0286)	(0.0293)	(0.0297)	(0.0317)
Log GDP per capita	1.164***	1.534***	1.151**	1.208**	1.121**
	(0.407)	(0.587)	(0.572)	(0.577)	(0.545)
trade2GDP	0.00629	0.00513	0.00202	0.00159	0.00464
	(0.00629)	(0.00790)	(0.00805)	(0.00796)	(0.00802)
Country effect	No	Yes	Yes	Yes	Yes
Period effect	No	No	Yes	Yes	Yes
Observations	418	418	418	418	447
R-squared	0.401				
Number of id	93	93	93	93	97

Note: robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Source: author's construction.

Table 8: Interactive effect with other types of institutions: beyond the short run

Dependent variable: non-resource tax revenue as a percentage of GDP					
	(1)	**(2)**	**(3)**	**(4)**	**(5)**
Variables	**REE**	**REE**	**REE**	**REE**	**REE**
t_rent2gdp	-0.1000	-0.125**	-0.140***	-0.0618	0.0514
	(0.0777)	(0.0501)	(0.0495)	(0.0445)	(0.0615)
Liec	0.121				
	(0.295)				
c.t_rent2gdp#c.liec	-0.00546				
	(0.0124)				
Checks		-0.144			
		(0.131)			
c.t_rent2gdp#c.checks		-0.00122			
		(0.0106)			
exconst_ed			0.102		
			(0.266)		
c.t_rent2gdp#c.exconst_ed			0.00739		
			(0.0107)		
Bureacr				0.233	
				(0.451)	
c.t_rent2gdp#c.bureacr				-0.0490*	
				(0.0256)	
Laworder					1.038***
					(0.392)
c.t_rent2gdp#c.laworder					-0.0618***
					(0.0193)
Grants	-0.0197	-0.00627	-0.0234	-0.0233	0.00502
	(0.157)	(0.161)	(0.166)	(0.158)	(0.139)
Corrupt	0.840**	0.836**	0.732*	0.778**	0.638**
	(0.326)	(0.331)	(0.392)	(0.345)	(0.293)
agricval2GDP	-0.0716**	-0.0800**	-0.0709**	-0.0823**	-0.0838**
	(0.0318)	(0.0319)	(0.0308)	(0.0332)	(0.0326)
Log GDP per capita	0.965*	0.957*	1.141*	1.052*	0.747
	(0.546)	(0.558)	(0.585)	(0.540)	(0.529)
trade2GDP	0.00634	0.00606	0.000981	0.000583	-0.000581
	(0.00810)	(0.00796)	(0.00784)	(0.00710)	(0.00714)
Country effect	Yes	Yes	Yes	Yes	Yes
Period effect	Yes	Yes	Yes	Yes	Yes
Observations	447	447	418	453	453
Number of id	97	97	93	99	99

Note: robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Source: author's construction.

In Table 9, none of the interaction terms turns statistically significant. The coefficient on agriculture as a percentage of GDP remains negative and statistically significant across all specifications. Other covariates—such as grants as a percentage of GDP, corruption index, trade openness, and GDP per capita, which captures the size of the economy—turn statistically significant in two specifications each.

Table 9: Interactive effect with measures of effectiveness of government: beyond the short run

Dependent variable: non-resource tax revenue as a percentage of GDP				
	(1)	**(2)**	**(3)**	**(4)**
Variables	**REE**	**REE**	**REE**	**REE**
t_rent2gdp	-0.0639	-0.113**	-0.606	-0.573
	(0.0708)	(0.0512)	(0.374)	(0.372)
investprof	-0.0459			
	(0.187)			
c.t_rent2gdp#c.investprof	-0.00838			
	(0.00818)			
socioecon		-0.0399		
		(0.180)		
c.t_rent2gdp#c.socioecon		-0.00269		
		(0.00985)		
cpia_erm			0.943	
			(2.016)	
c.t_rent2gdp#c.cpia_erm			0.135	
			(0.119)	
cpia_prop				-0.389
				(1.737)
c.t_rent2gdp#c.cpia_prop				0.149
				(0.128)
grants	0.000542	-0.0219	0.334**	0.291**
	(0.164)	(0.160)	(0.136)	(0.140)
corrupt	0.826**	0.796**	-0.485	-0.347
	(0.326)	(0.321)	(0.759)	(0.730)
agricval2GDP	-0.0831**	-0.0721**	-0.130**	-0.168**
	(0.0350)	(0.0314)	(0.0573)	(0.0681)
Log GDP per capita	1.037*	1.107*	0.352	-0.165
	(0.554)	(0.580)	(1.035)	(1.292)
trade2GDP	0.00274	0.00219	0.0725***	0.0774***
	(0.00735)	(0.00731)	(0.0157)	(0.0165)
Country effect	Yes	Yes	Yes	Yes
Period effect	Yes	Yes	Yes	Yes
Observations	453	453	71	71
Number of id	99	99	41	41

Note: robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Source: author's construction.

We re-examine these results for LICs and LMICs in Tables 10 and 11. In Table 10, the interaction terms that turn statistically significant include legislative index of electoral competitiveness and law and order. Both are, however, negatively signed for the developing country sample. This suggests that for developing countries, resource rents undermine bureaucratic quality and law and order. The finding somewhat resonates with the resource rents and governance literature, which finds a 'positive' association between resource rents on one side and conflicts or breakdown in governance on the other (Caselli and Tesei 2016; Collier and Hoeffler 2009; Knutsen et al. 2017; Williams 2011). Natural resource finds trigger contests for ownership and control over exploitation. This breeds conflict—sometimes between state and multinational companies involved in production on one side and citizens on the other. Control of natural resources has also been known to promote

rent-seeking behaviour among elites who control the resources. On the other hand, the coefficient on grants, trade openness and GDP per capita all turn statistically significant at the 1 per cent level.

Table 10: Interactive effect with different types of institutions: LICs and LMICS (beyond the short run)

Dependent variable: non-resource tax as a percentage of GDP						
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Variables	**REE**	**REE**	**REE**	**REE**	**REE**	**REE**
t_rent2gdp	-0.128***	-0.134**	-0.0761	-0.0411	-0.107	0.0323
	(0.0474)	(0.0595)	(0.0767)	(0.0755)	(0.0719)	(0.0917)
polity2	0.0225					
	(0.0794)					
c.t_rent2gdp#c.polity2	0.000570					
	(0.00563)					
democ_ed		0.0195				
		(0.147)				
c.t_rent2gdp#c.democ_ed		0.00300				
		(0.00884)				
Eiec			0.252			
			(0.234)			
c.t_rent2gdp#c.eiec			-0.0109			
			(0.0108)			
Liec				0.388**		
				(0.183)		
c.t_rent2gdp#c.liec				-0.0171*		
				(0.00996)		
exconst_ed					0.337	
					(0.241)	
c.t_rent2gdp#c.exconst_ed					-0.00443	
					(0.0137)	
Laworder						0.912**
						(0.409)
c.t_rent2gdp#c.laworder						-0.0777***
						(0.0301)
Grants	0.424***	0.420***	0.418***	0.408***	0.384***	0.470***
	(0.138)	(0.141)	(0.139)	(0.142)	(0.144)	(0.137)
Corrupt	0.0666	0.0542	0.0808	0.117	0.0514	0.0745
	(0.460)	(0.475)	(0.474)	(0.474)	(0.453)	(0.467)
agricval2GDP	-0.0338	-0.0331	-0.0375	-0.0375	-0.0318	-0.0381
	(0.0264)	(0.0275)	(0.0267)	(0.0250)	(0.0293)	(0.0270)
Log GDP per capita	2.145***	2.184***	1.935***	1.800***	2.039***	1.906***
	(0.745)	(0.746)	(0.689)	(0.638)	(0.707)	(0.592)
trade2GDP	0.0455***	0.0445***	0.0490***	0.0501***	0.0440***	0.0528***
	(0.0111)	(0.0112)	(0.0101)	(0.0101)	(0.0104)	(0.00860)
Country dffect	Yes	Yes	Yes	Yes	Yes	Yes
Time dffect	Yes	Yes	Yes	Yes	Yes	Yes
Observations	212	212	212	212	212	212
Number of id	47	47	47	47	47	47

Note: robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Source: author's construction.

Table 11: Interactive effect with other types of institutions (II): LICs and LMICs (beyond the short run)

Dependent variable: non-resource tax as a percentage of GDP						
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Variables	**REE**	**REE**	**REE**	**REE**	**REE**	**REE**
t_rent2gdp	-0.0787	-0.101	-0.00898	-0.162**	-0.739**	-0.644*
	(0.0509)	(0.0725)	(0.0879)	(0.0825)	(0.357)	(0.363)
Checks	0.116					
	(0.162)					
c.t_rent2gdp#c.checks	-0.0206**					
	(0.00802)					
Bureacr		0.400				
		(0.564)				
c.t_rent2gdp#c.bureacr		-0.0242				
		(0.0394)				
Investprof			0.244			
			(0.260)			
c.t_rent2gdp#c.investprof			-0.0193**			
			(0.00974)			
Socioecon				-0.0238		
				(0.243)		
c.t_rent2gdp#c.socioecon				0.0106		
				(0.0140)		
cpia_erm					1.140	
					(1.986)	
c.t_rent2gdp#c.cpia_erm					0.189*	
					(0.113)	
cpia_prop						-0.242
						(1.867)
c.t_rent2gdp#c.cpia_prop						0.191
						(0.129)
Grants	0.459***	0.440***	0.445***	0.426***	0.369**	0.283*
	(0.131)	(0.140)	(0.134)	(0.135)	(0.150)	(0.146)
Corrupt	0.144	0.0348	0.0521	0.108	-0.831	-0.669
	(0.483)	(0.469)	(0.451)	(0.482)	(0.781)	(0.732)
agricval2GDP	-0.0464*	-0.0313	-0.0499*	-0.0337	-0.143***	-0.185***
	(0.0264)	(0.0285)	(0.0258)	(0.0279)	(0.0518)	(0.0665)
Log GDP per capita	1.914***	2.231***	1.925***	1.986***	-0.210	-0.874
	(0.645)	(0.783)	(0.640)	(0.749)	(0.943)	(1.254)
trade2GDP	0.0503***	0.0442***	0.0498***	0.0442***	0.0689***	0.0756***
	(0.0102)	(0.0114)	(0.00946)	(0.0112)	(0.0155)	(0.0148)
Country effect	Yes	Yes	Yes	Yes	Yes	Yes
Time effect	Yes	Yes	Yes	Yes	Yes	Yes
Observations	212	212	212	212	66	66
Number of id	47	47	47	47	37	37

Note: robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Source: author's construction.

In Table 11, the interaction terms comprising checks and balances and investment profile index turn negative and statistically significant, thus contributing to the fiscal resource curse. For the

developing country sample, the negative association of the interactive term comprising investment profile and non-resource tax effort perhaps reflects increasing concerns about international taxation. Practices engaged in by multinationals to avoid tax include base erosion, corporate profit shifting, and transfer mispricing (Forstater 2018).[3] Countries lacking the capacity to manage large foreign firms operating within their jurisdiction are susceptible to such practices. We also find a statistically significant association between the interactive term comprising institutional efficiency in revenue mobilization and non-resource tax effort. The statistical significance is, however, only at the 10 per cent level. Nonetheless, the finding suggests that the level of institutional efficiency in mobilizing domestic revenues mitigates the adverse impact of resource revenues on non-resource tax effort. Like those of Table 10, most of the specifications in Table 11 for the covariates grants as a percentage of GDP, trade openness, and GDP per capita turn positive and statistically significant at the 1 per cent level. The coefficient on agriculture as a percentage of GDP is negative and statistically significant in most of the specifications as well.

4.3 Robustness checks

First, I examine whether the baseline results are robust to the inclusion of an additional list of control variables. Following Mawejje (2019) and Masi et al. (2018), I control for log of population and log of consumer price index to account for the potential size of the labour force and the general price level prevailing in a country over time. Several studies also account for level of population or population density in explaining tax revenues (e.g. Botlhole et al. 2012). The argument is that countries with higher populations are likely to have a larger labour force and a larger consumer base, which has implications for the tax base and therefore the amount of taxes raised. Furthermore, countries suffering persistent inflation would have a depressed non-resource tax revenue level, as the real value of the taxes raised is in constant decline. This is referred to as the Oliveira-Tanzi effect. Moreover, higher prices, which lead to demands for higher wages, would mean lower demand for labour and therefore lower output for producers. This could translate to a narrower tax base. To test the plausibility of these arguments, I include these additional covariates and reproduce specifications involving interaction terms that turn statistically significant at conventional levels (i.e. from short-run results). These variables include polity2, exconst_ed, democ_ed, liec, and socioecon.

In Table 12, we see that the coefficients of the additional list of control variables are not statistically significantly different from zero. Furthermore, the results are largely consistent with the baseline results. The interaction terms involving polity2, exconst_ed, and democ_ed all turn statistically significant with coefficients of comparable size to our baseline results. The interaction terms with socioecon and checks are, however, not statistically significant. As expected, the coefficients on control of corruption and GDP per capita turn positive and statistically significant at conventional levels.

[3] Forstater (2018) notes, however, that resolving domestic obstructions to revenue mobilization is of greater importance.

Table 12: Robustness checks with additional control variables

Dependent variable: non-resource tax as a percentage of GDP					
	(1)	**(2)**	**(3)**	**(4)**	**(5)**
Variables	**REE**	**REE**	**REE**	**REE**	**REE**
t_rent2gdp	-0.0529	-0.121***	-0.0906***	-0.0891***	-0.0788
	(0.0336)	(0.0325)	(0.0315)	(0.0319)	(0.0679)
polity2	-0.00683				
	(0.0584)				
c.t_rent2gdp#c.polity2	0.00597**				
	(0.00296)				
exconst_ed		0.125			
		(0.134)			
c.t_rent2gdp#c.exconst_ed		0.0208***			
		(0.00556)			
democ_ed			0.00719		
			(0.0921)		
c.t_rent2gdp#c.democ_ed			0.0144***		
			(0.00426)		
Checks				-0.198**	
				(0.0989)	
c.t_rent2gdp#c.checks				0.0132	
				(0.0108)	
Socioecon					-0.109
					(0.135)
c.t_rent2gdp#c.socioecon					0.00562
					(0.0114)
Lncpi	-0.120	-0.102	-0.110	-0.0716	-0.0865
	(0.0875)	(0.0783)	(0.0808)	(0.0753)	(0.0888)
Lnpop	0.639	0.638	0.667	0.629	0.676
	(0.565)	(0.586)	(0.585)	(0.587)	(0.606)
Grants	0.0518	0.0186	0.0415	0.0499	0.0544
	(0.0791)	(0.0748)	(0.0785)	(0.0756)	(0.0766)
Corrupt	0.454*	0.449*	0.434*	0.473***	0.504***
	(0.259)	(0.255)	(0.257)	(0.179)	(0.186)
agricval2GDP	-0.0435	-0.0257	-0.0312	-0.0460	-0.0497
	(0.0386)	(0.0347)	(0.0355)	(0.0353)	(0.0404)
Log GDP per capita	1.728**	1.736**	1.725**	1.762**	1.713**
	(0.710)	(0.686)	(0.692)	(0.695)	(0.764)
trade2GDP	0.00570	0.00457	0.00565	0.00929	0.00931
	(0.00803)	(0.00769)	(0.00786)	(0.00826)	(0.00754)
Country effects	Yes	Yes	Yes	Yes	Yes
Time effects	Yes	Yes	Yes	Yes	Yes
Observations	1,652	1,653	1,653	1,755	1,805
Number of id	91	91	91	95	97

Note: robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Source: author's construction.

I further examine the robustness of the results in the medium term by transforming the data into semi-decadal series. To do this, I employ a Generalized Methods of Moments (GMM) estimator

for the following reasons. First, it enables me to take advantage of internal instruments to correct for possible endogeneity of the explanatory variables of interest. Second, a negative or positive shock to non-resource tax revenues could be persistent over time; hence the need to test for a dynamic effect. Third, there could be an instance of simultaneity bias. Persistently low revenues could incentivize a country's focus on the resource sector and weaken institutions. Finally, the case of large N (number of countries) and short T (due to collapsing the annual time series into semi-decadal series) offers the opportunity to employ an Arellano and Bond estimator to examine the robustness of the results.[4]

In Table 13, the interaction terms with checks and democracy turn positive and statistically significant at the 10 per cent level. The result on democracy is consistent with earlier results. In Table 14, the interaction terms are not statistically significant except for bureaucratic quality, which turns negative.

Once the sample is restricted to LICs and LMICs, the baseline results are largely re-enforced. This is also the case when outliers are removed from the full sample using a two-step revamped Hadi procedure (Billor et al. 2000; Weber 2010)[5] (tables available on request).

[4] For large T, this method would not be appropriate for examining the robustness of the short-term results because, as Roodman (2006) notes, using such an estimator in the case of large T increases the problem of instrument proliferation and weakens the Hansen test.

[5] In the first step, I determine outliers using only non-resource tax as a percentage of GDP and total resource rents as a percentage of GDP. In the second step, I identify outliers from the full sample with the full list of control variables.

Table 13: Interactive effect beyond short run using GMM

Dependent variable: non-resource tax revenue as a percentage of GDP						
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Variables						
L.tot_nrestax	0.804***	0.740***	0.626*	0.279	0.438	0.834***
	(0.170)	(0.225)	(0.340)	(0.717)	(0.307)	(0.216)
t_rent2gdp	-0.0240	-0.107	-0.218	-0.825	-0.407*	-0.0972
	(0.0659)	(0.0930)	(0.214)	(1.838)	(0.227)	(0.0914)
polity2	-0.0795					
	(0.143)					
c.t_rent2gdp#c.polity2	0.00954					
	(0.00774)					
Grants	-0.0307	-0.0375	-0.0643	-0.0156	0.0917	-0.0444
	(0.111)	(0.113)	(0.121)	(0.254)	(0.181)	(0.0888)
Corrupt	0.506	0.509	0.938	0.307	0.0577	0.370
	(0.893)	(0.843)	(0.794)	(1.794)	(0.821)	(0.750)
agricval2GDP	-0.0462*	-0.0324	-0.0177	0.00628	-0.00903	-0.0303
	(0.0245)	(0.0299)	(0.0304)	(0.0699)	(0.0413)	(0.0240)
Log GDP per capita	-0.224	0.121	0.156	1.504	1.259	-0.130
	(0.500)	(0.569)	(0.799)	(2.852)	(1.056)	(0.485)
trade2GDP	-0.00358	-0.00451	-0.000908	0.00531	-0.00201	-0.00354
	(0.00843)	(0.00953)	(0.00729)	(0.0159)	(0.0104)	(0.00664)
democ_ed		-0.224				
		(0.245)				
c.t_rent2gdp#c.democ_ed		0.0230*				
		(0.0128)				
Eiec			-0.287			
			(0.650)			
c.t_rent2gdp#c.eiec			0.0316			
			(0.0308)			
Liec				-1.521		
				(4.643)		
c.t_rent2gdp#c.liec				0.118		
				(0.277)		
Checks					-1.734	
					(1.425)	
c.t_rent2gdp#c.checks					0.107*	
					(0.0575)	
exconst_ed						-0.149
						(0.367)
c.t_rent2gdp#c.exconst_ed						0.0272
						(0.0166)
Country effects	Yes	Yes	Yes	Yes	Yes	Yes
Time effects	Yes	Yes	Yes	Yes	Yes	Yes
AR(1) P-values	0.025	0.04	0.16	0.26	0.24	0.04
AR(2) P-values	0.39	0.54	0.67	0.74	0.67	0.37
Hansen J (P-values)	0.2	0.2	0.17	0.54	0.57	0.19
Number of instruments	20	20	20	20	20	20
Observations	374	377	401	401	401	377
Number of id	90	90	94	94	94	90

Note: standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Source: author's construction.

Table 14: Interactive effect with type of institutions using GMM (II): beyond the short run

Dependent variable: non-resource tax revenue as a percentage of GDP				
	(1)	**(2)**	**(3)**	**(4)**
Variables				
L.tot_nrestax	0.951***	1.020***	-0.0717	0.534
	(0.300)	(0.287)	(0.501)	(0.410)
t_rent2gdp	0.434	0.308***	-0.499*	0.0859
	(0.280)	(0.104)	(0.272)	(0.104)
laworder	1.122			
	(1.359)			
c.t_rent2gdp#c.laworder	-0.108			
	(0.0813)			
grants	0.0149	0.0507	0.0745	0.0391
	(0.157)	(0.0882)	(0.163)	(0.141)
corrupt	0.795	-0.00918	0.511	0.669
	(0.925)	(0.843)	(0.622)	(1.099)
agricval2GDP	-0.0844**	-0.0799***	0.0201	-0.0525
	(0.0339)	(0.0257)	(0.0642)	(0.0418)
Log GDP per capita	-0.776	-0.633	2.025	0.228
	(0.963)	(0.758)	(1.447)	(0.926)
trade2GDP	-0.00925	-0.00562	0.00157	-0.00604
	(0.00877)	(0.00407)	(0.0102)	(0.00983)
bureacr		1.095		
		(0.858)		
c.t_rent2gdp#c.bureacr		-0.142**		
		(0.0616)		
investprof			-0.608	
			(0.384)	
c.t_rent2gdp#c.investprof			0.0283	
			(0.0255)	
socioecon				0.361
				(0.582)
c.t_rent2gdp#c.socioecon				-0.0279
				(0.0244)
Country effects	Yes	Yes	Yes	Yes
Time effects	Yes	Yes	Yes	Yes
AR(1) P-values	0.12	0.04	0.85	0.31
AR(2) P-values	0.11	0.18	0.26	0.6
Hansen J (P-values)	0.17	0.27	0.29	0.16
Number of instruments	20	20	20	20
Observations	406	406	406	406
Number of id	96	96	96	96

Note: standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Source: author's construction.

5 Conclusion

In this paper, I explore the role of institutions in mediating the relationship between natural resource rents and non-resource tax effort. I propose a simple theoretical model to frame this objective. A key prediction of the model is that redistributive institutions moderate the adverse effect of resource rents on non-resource tax effort when commodity prices are low. I test a variant of this hypothesis by exploring the effect of different types of institutions and find that constraints on executive power and democracy may be important in building non-resource tax effort, albeit not sufficient to do so. Other complementary factors, such as the level of GDP per capita, level of informality in the economy, control of corruption, openness to trade, and level of grants as a percentage of GDP, are associated with improved fiscal capacity.

References

Acemoglu, D., S. Naidu, P. Restrepo, and J.A. Robinson (2018). 'Democracy Does Cause Growth'. MIT Department of Economics Working Paper 14-09. Cambridge, MA: Massachusetts Institute of Technology. https://doi.org/10.2139/ssrn.2411791

Aoki, M. (2001). *Toward a Comparative Institutional Analysis*. Cambridge, MA: MIT Press. Available at: https://mitpress.mit.edu/books/toward-comparative-institutional-analysis (accesssed August 2019).

Bates, R.H., S.A. Block, G. Fayad, and A. Hoeffler (2012). 'The New Institutionalism and Africa'. *Journal of African Economies*, 22(4): 499–522. https://doi.org/10.1093/jae/ejs031

Baum, A., S. Gupta, E. Kimani, and S.J. Tapsoba (2017). 'Corruption, Taxes and Compliance'. IMF Working Paper 2017/255. Washington, DC: International Monetary Fund. https://doi.org/10.5089/9781484326039.001

Besley, T., and T. Persson (2011). 'The Logic of Political Violence'. *Quarterly Journal of Economics*, 126(3): 1411–45. https://doi.org/10.1093/qje/qjr025

Billor, N., A.S. Hadi, and P.F. Velleman (2000). 'BACON: Blocked Adaptive Computationally Efficient Outlier Nominators'. *Computational Statistics and Data Analysis*, 34(3): 279–98. https://doi.org/10.1016/S0167-9473(99)00101-2

Bisin, A., and T. Verdier (2017). 'On the Joint Evolution of Culture and Institutions'. NBER Working Paper 23375. Cambridge, MA: National Bureau of Economic Research. https://doi.org/10.3386/w23375

Bornhorst, F., S. Gupta, and J. Thornton (2009). 'Natural Resource Endowments and the Domestic Revenue Effort'. *European Journal of Political Economy*, 25(4): 439–46. https://doi.org/10.1016/j.ejpoleco.2009.01.003

Botlhole, T., J. Asafu-Adjaye, and F. Carmignani (2012). 'Natural Resource Abundance, Institutions and Tax Revenue Mobilisation in Sub-Saharan Africa'. *South African Journal of Economics*, 80(2): 135–56. https://doi.org/10.1111/j.1813-6982.2011.01305.x

Caselli, F., and A. Tesei (2016). 'Resource Windfalls, Political Regimes, and Political Stability'. *Review of Economics and Statistics*, 98(3): 573–90. https://doi.org/10.1162/REST_a_00538

Chachu, D.O. (2020). 'Domestic Revenue Displacement in Resource-Rich Countries: What's Oil Money Got To Do with It?'. *Resources Policy*, 66: 101656. https://doi.org/10.1016/j.resourpol.2020.101656

Chachu, D., and E. Nketiah-Amponsah (2020). 'Investigating the Fiscal Resource Curse. What's China Got To Do with It?'. WIDER Working Paper 2020/85. Helsinki: UNU-WIDER. https://doi.org/10.35188/UNU-WIDER/2020/842-9

Collier, P., and A. Hoeffler (2009). 'Testing the Neocon Agenda: Democracy in Resource-Rich Societies'. *European Economic Review*, 53(3): 293–308. https://doi.org/10.1016/j.euroecorev.2008.05.006

Cruz, C., P. Keefer, and C. Scartascini (2016). 'Database of Political Institutions 2015: Codebook' (176: January). Washington, DC: Inter-American Development Bank.

Eregha, P.B., and E.P. Mesagan (2016). 'Oil Resource Abundance, Institutions, and Growth: Evidence from Oil-Producing African Countries'. *Journal of Policy Modeling*, 38(3): 603–19. https://doi.org/10.1016/j.jpolmod.2016.03.013

Forstater, M. (2018). 'Tax and Development: New Frontiers of Research and Action'. CGD Policy Paper 118: 1–49. Washington, DC: Center for Global Development.

Glaeser, E.L., R. La Porta, F. Lopez-De-Silanes, and A. Shleifer (2004). 'Do Institutions Cause Growth?'. *Journal of Economic Growth*, 9(3): 271–303. Available at: https://www.jstor.org/stable/40215873 (accessed 21 April 2021).

Greif, A. (2006). *Institutions and the Path to the Modern Economy: Lessons from Medieval Trade*. Cambridge: Cambridge University Press. https://doi.org/10.3917/rpec.102.0121

Gupta, A.S. (2007). 'Determinants of Tax Revenue Efforts in Developing Countries'. IMF Working Paper 07(184). Washington, DC: International Monetary Fund. https://doi.org/10.5089/9781451867480.001

Kaldor, N. (1963). 'Taxation for Economic Development'. *The Journal of Modern African Studies*, 1(1): 7–23. https://doi.org/10.1017/S0001972000064846

Klomp, J., and J. de Haan (2016). 'Election Cycles in Natural Resource Rents: Empirical Evidence'. *Journal of Development Economics*, 121: 79–93. https://doi.org/10.1016/j.jdeveco.2016.03.002

Knutsen, C.H., A. Kotsadam, E.H. Olsen, and T. Wig (2017). 'Mining and Local Corruption in Africa'. *American Journal of Political Science*, 61(2): 320–34. https://doi.org/10.1111/ajps.12268

Marshall, M.G., T.R. Gurr, and K. Jaggers (2016). 'Polity IV Project Dataset Users' Manual, v.2015'. Polity IV Project, 1–86. https://doi.org/10.1177/0738894213499673

Masi, T., A. Savoia, and K. Sen (2018). 'Is There a Fiscal Resource Curse? Resource Rents, Fiscal Capacity and Political Institutions'. ESID Working Paper 96. Manchester, UK: Effective States and Inclusive Development. Available at: https://www.effective-states.org/wp-content/uploads/working_papers/final-pdfs/esid_wp_96_masi_savoia_sen.pdf (accessed 21 April 2021).

Mawejje, J. (2019). 'Natural Resources Governance and Tax Revenue Mobilization in Sub-Saharan Africa: The Role of EITI'. *Resources Policy*, 62(April): 176–83. https://doi.org/10.1016/j.resourpol.2019.04.001

McGuirk, E.F. (2013). 'The Illusory Leader: Natural Resources, Taxation and Accountability'. *Public Choice*, 154(3–4): 285–313. https://doi.org/10.1007/s11127-011-9820-0

Ndikumana, L., and K. Abderrahim (2010). 'Revenue Mobilization in African Countries: Does Natural Resource Endowment Matter?' *African Development Review*, 22(3): 351–65. https://doi.org/10.1111/j.1467-8268.2010.00250.x

North, D.C. (1981). *Structure and Change in Economic History*. New York: Norton.

North, D.C. (1990). *Institutions, Institutional Change and Economic Performance*. Cambridge: Cambridge University Press. Available at: https://doi.org/10.1017/CBO9780511808678 (accessed 21 April 2021).

Political Risk Services (2015). *International Country Risk Guide Methodology. In Country Reports*. Liverpool, NY: The PRS Group. https://doi.org/hdl/1902.1/21446

Ricciuti, R., A. Savoia, and K. Sen (2018). 'How Do Political Institutions Affect Fiscal Capacity? Explaining Taxation in Developing Economies'. *Journal of Institutional Economics*, 15(2): 351–30. https://doi.org/10.1017/S1744137418000097

Roodman, D. (2006). 'How To Do Xtabond2: An Introduction to "Difference" and "System" GMM in Stata'. CGD Working Paper 103. Washington, DC: Center for Global Development. https://doi.org/10.2139/ssrn.982943

Savoia, A., and K. Sen (2015). 'Measurement, Evolution, Determinants, and Consequences of State Capacity: a Review of Recent Research'. *Journal of Economic Surveys*, 29(3): 441–58. https://doi.org/10.1111/joes.12065

Von Haldenwang, C., and M. Ivanyna (2018). 'Does the Political Resource Curse Affect Public Finance? the Vulnerability of Tax Revenue on Resource-Dependent Countries'. *Journal of International Economics*, 30: 323–44. https://doi.org/10.1002/jid.3346

Weber, S. (2010). 'BACON: an Effective Way To Detect Outliers in Multivariate Data Using Stata (and Mata)'. *The Stata Journal*, 10(3): 331–38. https://doi.org/10.1177/1536867X1001000302

Williams, A. (2011). 'Shining a Light on the Resource Curse: an Empirical Analysis of the Relationship Between Natural Resources, Transparency, and Economic Growth'. *World Development*, 39(4): 490–505. https://doi.org/10.1016/j.worlddev.2010.08.015

Appendix A: Theoretical model

From the constraints in equation (1) of Section 2, $g_2 = pE - pe_{nr} + e_{nr} - g_1$.

Put $g_2 = pE - pe_{nr} + e_{nr} - g_1$ and $e_r = E - e_{nr}$into equation (1).

$$W = \alpha V_1(g_1) + (1-\alpha)V_2(pE - pe_{nr} + e_{nr} - g_1) - c(E - e_{nr}) - d(e_{nr})$$

The first-order conditions (FOCs) are:

$$\frac{\partial W}{\partial g_1} = \alpha V_1'(g_1) - (1-\alpha)V_2'(.) = 0 \qquad \text{(A1)}$$

where the Vs are partial derivatives and (.) is $pE - pe_{nr} + e_{nr} - g_1 = g_2$

The FOC in equation (A1) suggests that at the optimum, the weighted marginal utilities (benefits) of both elites and non-elites must be equal.

$$\frac{\partial W}{\partial e_{nr}} = (1-p)(1-\alpha)V_2'(.) + c'(E - e_{nr}) - d'(e_{nr}) = 0 \qquad \text{(A2)}$$

The FOC in equation (A2) suggests that at the optimum, the weighted marginal benefit (utility) of the elite group must be equal to the weighted marginal cost (i.e. the ratio of the cost differential between non-resource tax collection effort and resource revenue collection effort to their respective price differential). As the cost of tax collection effort in the resource sector goes up, export prices must go up by the same margin to maintain the same marginal utility for the elite group.

Second-order conditions (SOCs) for a maximum require that:

$$W_{11} \equiv \frac{\partial^2 W}{\partial g_1^2} < 0;\ W_{22} \equiv \frac{\partial^2 W}{\partial e_{nr}^2} < 0 \text{ and } W_{11}W_{22} - (W_{12})^2 > 0$$

Given our assumptions about the strict concavity of the utility functions, the SOCs hold. Thus, the Jacobian for the system of equations (A1) and (A2) is non-zero. By implicit function theorem, (A1) and (A2) give:

$$g_1^* = g_1^*(p, \alpha) \text{ and } e_{nr}^* = e_{nr}^*(p, \alpha) \qquad \text{(A3)}$$

Put (A3) into equations (A1) and (A2) and differentiate with respect to p.

From (A1)

$$\alpha V_1^{'}(g_1^*(p,\alpha)) - (1-\alpha)V_2^{'}(pE - p(e_{nr}^*(p,\alpha)) + e_{nr}^*(p,\alpha) - g_1^*(p,\alpha)) = 0$$

where $g_2^* = pE - p(e_{nr}^*(p,\alpha)) + e_{nr}^*(p,\alpha) - g_1^*(p,\alpha)$

Partially differentiating equation (A1) with respect to p yields:

$$\alpha V_1''(g_1^*)\frac{\partial g_1^*}{\partial p} - (1-\alpha)V_2''(g_2^*)\left(E + (1-p)\frac{\partial e_{nr}^*}{\partial p} - e_{nr}^* - \frac{\partial g_1^*}{\partial p}\right) = 0 \qquad \text{(A4)}$$

From (A2)

$$(1-p)(1-\alpha)V_2^{'}(pE - pe_{nr}^{*}(p,\alpha) + e_{nr}^{*}(p,\alpha) - g_1(p,\alpha)) + c^{'}(E - e_{nr}^{*}(p,\alpha)) - d^{'}(e_{nr}^{*}(p,\alpha)) = 0$$

Partially differentiating equation (A2) with respect to p yields:

$$-(1-\alpha)V_2'(g_2^*) + (1-p)(1-\alpha)V_2''(g_2^*)\left(E + (1-p)\frac{\partial e_{nr}^*}{\partial p} - e_{nr}^* - \frac{\partial g_1^*}{\partial p}\right) - c''(E - e_{nr}^*)\frac{\partial e_{nr}^*}{\partial p} - d''(e_{nr}^*)\frac{\partial e_{nr}^*}{\partial p} = 0 \quad \text{(A5)}$$

From equations (A4) and (A5), we group like terms, rearrange, put in matrix form, and apply Cramer's rule to get:

$\frac{\partial e_{nr}}{\partial p} = \frac{\begin{vmatrix} A & B \\ C & D \end{vmatrix}}{J}$; where J is the Jacobian. It is positive from the second-order condition. So the sign of $\frac{\partial e_{nr}}{\partial p}$ depends on the sign of the numerator. If p increases, then there is an exogenous increase in export prices and therefore in resource rents. If resource rents have a negative effect on non-resource tax effort, then we expect $\frac{\partial e_{nr}}{\partial p}$<0 and vice versa. To verify, we rearrange equations (A4) and (A5), group the like terms, put in matrix form, and apply Cramer's rule.

From (A4)

$$(\alpha V_1''(g_1^*) + (1-\alpha)V_2''(g_2^*))\frac{\partial g_1^*}{\partial p} - ((1-\alpha)(1-p)V_2''(g_2^*))\frac{\partial e_{nr}^*}{\partial p} = (1-\alpha)(E - e_{nr}^*)V_2''(g_2^*) \quad \text{(A6)}$$

From (A6)

$$-(1-p)(1-\alpha)V_2''(g_2^*)\frac{\partial g_1^*}{\partial p} + ((1-p)^2(1-\alpha)V_2''(g_2^*) - c''(E - e_{nr}^*) - d''(e_{nr}^*))\frac{\partial e_{nr}^*}{\partial p} =$$
$$(1-\alpha)V_2'(g_2^*) - (1-p)(1-\alpha)(E - e_{nr}^*)V_2''(g_2^*) \quad \text{(A7)}$$

Let $a = (1-\alpha)$ **and** $b = (1-p)$

The matrix form of the system of equations (A6) and (A7) becomes:

$$\begin{pmatrix} (1-a)V_1^{''}(g_1^*) + aV_2^{''}(g_2^*) & -abV_2^{''}(g_2^*) \\ -abV_2^{''}(g_2^*) & ab^2V_2^{''}(g_2^*) - c^{''}(E - e_{nr}^*) - d^{''}(e_{nr}^*) \end{pmatrix}\begin{pmatrix} \frac{\partial g_1^*}{\partial p} \\ \frac{\partial e_{nr}^*}{\partial p} \end{pmatrix} =$$
$$\begin{pmatrix} a(E - e_{nr}^*)V_2^{''}(g_2^*) \\ aV_2^{'}(g_2^*) + ab(E - e_{nr}^*)V_2^{''}(g_2^*) \end{pmatrix} \quad \text{(A8)}$$

Then

$$\frac{\partial e_{nr}^*}{\partial p} = \frac{\begin{vmatrix} (1-a)V_1''(g_1^*) + aV_2''(g_2^*) & a(E - e_{nr}^*)V_2''(g_2^*) \\ -abV_2''(g_2^*) & aV_2'(g_2^*) + ab(E - e_{nr}^*)V_2''(g_2^*) \end{vmatrix}}{J} \quad \text{(A9)}$$

Since the sign of equation (A9) depends on the sign of the numerator, we compute its determinant.

This gives:

$$\left((1-a)V_1^{''}(g_1^*) + aV_2^{''}(g_2^*)\right)\left((aV_2^{'}(g_2^*) + ab(E - e_{nr}^*)V_2^{''}(g_2^*)\right) + a^2b(E - e_{nr}^*)\left(V_2^{''}(g_2^*)\right)^2$$

When we expand the terms in the bracket and restore our definitions of a and b, we have:

$$\alpha(1-\alpha)V_2^{'}(g_2^*)V_1^{''}(g_1^*) + \alpha(1-\alpha)(1-p)(E-e_{nr}^*)V_2^{''}(g_2^*)V_1^{''}(g_1^*) + (1-\alpha)^2V_2^{''}(g_2^*)V_2^{'}(g_2^*) + 2(1-\alpha)^2(1-p)(E-e_{nr}^*)\left(V_2^{''}(g_2^*)\right)^2 \quad (10)$$

The sign of $\frac{\partial e_{nr}^*}{\partial p}$, which is our measure of the effect of resource rents on non-resource tax effort, now depends on the values of α (the weight of non-elites in social welfare) and p (export prices), which are non-zero. Note that the marginal utility terms denoted by the first partial derivatives are positive, while the second partial derivatives are negative, denoting diminishing marginal utility. In general, a higher value for α suggests that both non-elites and elites benefit from the redistribution of total revenue. This is indicative of active institutions working for the good of all groups in the society. Stronger institutions imply that the ability of the elites to appropriate resources to themselves is weaker (see for example Besley and Persson 2011 and Bisin and Verdier 2017). While an increasing α is desirable, we do not expect its value to be close to 1 as this would imply that society is happy when the incumbent surrenders a greater share or all of the revenue benefits to non-elites. This is not only a case of extreme inequality but also one that is unrealistic and counterintuitive. In the same vein, a value of α close to zero is suggestive of a society that does not care about the welfare of non-elites or those outside the incumbency. It connotes weak institutions. Thus, our best benchmark value for α is close to or equal to 0.5.

Having shown that the effect of resource rents on non-resource tax effort is dependent on the values of α and p, I proceed to perform a simulation exercise to detect the sign of the numerator of $\frac{\partial e_{nr}^*}{\partial p}$ for different possible levels of α and p. Equation (A10) has four terms as follows:

$$\overbrace{\alpha(1-\alpha)V_2^{'}(g_2^*)V_1^{''}(g_1^*)}^{\text{1st term}} + \overbrace{\alpha(1-\alpha)(1-p)(E-e_{nr}^*)V_2^{''}(g_2^*)V_1^{''}(g_1^*)}^{\text{2nd term}} + \overbrace{(1-\alpha)^2V_2^{''}(g_2^*)V_2^{'}(g_2^*)}^{\text{3rd term}} + \underbrace{2(1-\alpha)^2(1-p)(E-e_{nr}^*)\left(V_2^{''}(g_2^*)\right)^2}_{\text{4th term}}$$

I insert different values for α and p into equation (A10) to ascertain the ultimate sign for $\frac{\partial e_{nr}^*}{\partial p}$. Table A1 evaluates the different values and signs and provides possible interpretations of the results.

Table A1: Simulation exercise for values of α and p

Values of α	**Values of p**	**Sign of $\frac{\partial e_{nr}^*}{\partial p}$**	**Possible interpretation**
0.5	Less than 1	$\frac{\partial e_{nr}^*}{\partial p} > 0$	First scenario: A constraint on the incumbent incentivizes non-resource tax effort in the face of a marginal increase in export prices. In other words, when export prices are insufficiently high (*p*<1), a marginal increase in export prices sustains revenue effort in the non-resource sector. The social planner will seek to diversify the total revenue base in order to increase benefits.
0.5	Equal to 1	$\frac{\partial e_{nr}^*}{\partial p} < 0$	Second scenario: A marginally higher export price than the initial scenario reduces non-resource tax effort as it diverts attention towards maximizing resource rents, despite the constraint on the social planner.
0.5	Greater than 1	$\frac{\partial e_{nr}^*}{\partial p} < 0$	Third scenario: This scenario depicts a more pronounced version of the second scenario as sufficiently high export prices (*p*>1) further undermine effort towards non-resource tax mobilization. A marginal increase in export prices in such a situation will lead to a further shift in the incentive to mobilize revenues away from the non-resource sector.

Source: author's construction.