WPS8048

Policy Research Working Paper 8048

Does Oil Revenue Crowd Out Other Tax Revenues?

Policy Lessons for Uganda

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WORLD BANK GROUP
Macroeconomics and Fiscal Management Global Practice Group
May 2017

Policy Research Working Paper 8048

Abstract

This paper examines the relationship between hydrocarbon and non-hydrocarbon revenues using a probabilistic panel model with data covering 30 resource-rich countries over 1992–2012. It also discusses policy implications for Uganda, a country with recently discovered oil reserves. The findings show that although an increase in hydrocarbon revenues is likely to crowd out non-resource revenues, improved institutional quality could dampen or reverse this effect. In general, regulatory quality, rule of law, government effectiveness, and political stability are critically important governance indicators. In light of Uganda's forthcoming exploitation of its oil, the odds of avoiding the crowding out of non-resource revenues are high with a substantial improvement of institutional quality in terms of political stability, regulatory quality, and government effectiveness. Currently, these indicators stand very low for Uganda as compared with Botswana

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Does Oil Revenue Crowd Out Other Tax Revenues? Policy Lessons for Uganda*

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Keywords: Oil revenue, domestic revenue performance, quality of institutions.
JEL Classification: H20, O13.

*The authors are indebted to Travis Wiggans for his excellent research assistance and contributions to the literature review of this paper. The authors also thank Albert Zeufack, Abebe Adugna, Kevin Carey, Thorvaldur Gylfason, Amos Golan, and Desire Omgba for their comments and guidance.

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1 Introduction

Improving fiscal management remains critical to address development challenges in low-income countries. Increasing domestic revenue may not only help countries build their fiscal space to finance infrastructure projects and improve their stock of physical capital, but also support government policies to improve human capital development and social safety nets, including for vulnerable households.

However, tax collection remains a daunting challenge for developing countries. For instance, over the past two decades, tax performance (measured by the tax-to-GDP ratio) was about only 12 percent in low-income countries, compared with 32 percent for advanced economies (see International Monetary Fund (2011), Figure 2: Panel 3). Based on International Monetary Fund (2011), the main challenges associated with the weak domestic revenue performance in developing countries are the following. First, the presence of many sectors that are hard to tax (e.g., an extensive informal sector representing on average 40 to 60 percent of GDP or international services). Second, the lack of sufficient tax planning skills to match the adroitness of multinationals to reduce their tax liabilities continues to pose challenges to these countries to improve their domestic revenue collection performance . Third, difficulties in dealing with state-owned enterprises that abuse or ignore the tax system. Finally, the weak revenue administration and the quality of governance remain critical concerns in low-income countries.

Recent studies suggest that revenues from natural resources, particularly in Sub-Saharan Africa, play a significant role in improving countries' tax performance. Keen and Mansour (2010) find that during 1980-2005, resource-rich countries within Sub-Saharan Africa exhibited better revenue collection performance than their peers without significant reserves of natural resources. The stronger tax performance in resource-rich countries may therefore support the strand of the development literature suggesting a comparative advantage of resource-rich countries. However, given the finite nature of natural resources and the risk of the Dutch disease, this advantage may not be sustainable in the long run.

Another recent strand of the literature argues that abundance in natural resources is a curse rather than a blessing. This strand of literature predicts the potential crowding-out of non-resource revenues as one consequence of resource abundance. There are various transmission channels of the above-mentioned crowding out effect[1]. First, the Dutch disease could cause the non-resource sector to contract, leading to a decline in the overall non-resource revenues. Second, a government with significant revenue from extractives may decide to relieve the tax burden on its citizens, which, in turn, could result in the reduction of the demand for accountability and public service delivery. Third, resource abundance could be a disincentive for governments to implement tax reforms aimed at broadening the tax base and collecting more non-resource tax revenue. Several empirical studies have

[1] An assessment of the role of these transmission channels is left for future work.

examined the effect of resource revenues on countries' non-resource revenues and have generally found a crowding-out effect. In a sample of 30 hydrocarbon-producing countries for the period 1992-2005, Bornhorst, Gupta, and Thornton (2009) find that a unit increase of hydrocarbon revenues is associated with a decline in total non-hydrocarbon revenues of about 0.2 percentage points of GDP. Crivelli and Gupta (2014) extend the Bornhorst, Gupta, and Thornton (2009) study to 35 countries for 1992-2009, and analyze the impact of expanding resource revenues on different types of domestic (non-resource) tax revenues. They find that an increase in resource revenues of 1 percentage point of GDP lowers aggregate domestic revenue by 0.3 percentage point of GDP, which is mainly explained by a decline in revenue from taxes on goods and services. Ossowski and Gonzáles (2012), with a sample of 15 Latin American and Caribbean countries, also find that revenues from non-renewable resources tend to reduce non-resource revenue performance. Botlhole (2011) and Thomas and Trevino (2013) find similar results for Sub-Saharan African countries.

Unlike in developed countries where there is enough revenue to deliver adequate public services, a critical issue for developing countries, in need of more revenue, is therefore about how to avoid or reduce the crowding out of non-resource revenue by resource revenue. The critical role that institutional quality plays in tax revenue performance is explored in recent studies. For instance, El Anshasy and Katsaiti (2013) find that natural resources tend to hinder economic growth when a country has low-quality institutions. Bhattacharyya and Hodler (2014) find that resource revenues tend to hinder financial development in countries with weak political institutions; this negative effect decreases and vanishes as the quality of political institutions improves. Bird, Martinez-Vazquez, and Torgler (2008) and Bird, Martinez-Vazquez, and Torgler (2014) show that beyond traditional supply factors, the quality of institutions is a significant determinant of revenue mobilization in developing countries as well as in the developed world.

However, only a few existing studies have focused on the role that a better quality of institutions could play in avoiding (or at least lessening) the likelihood that tax revenue from resources (in resource-rich countries) will crowd out existing tax revenues. For instance, Botlhole (2011) shows that institutions are essential for ensuring natural resource taxes increase overall tax revenue. Their results suggest that more resource revenues impede tax revenue collection only in the absence of good governing institutions. Bornhorst, Gupta, and Thornton (2009) and Thomas and Trevino (2013) also find similar results. Ross (2013) argues that income from non-resource sources (agriculture, manufacturing and services) is more beneficial than income derived from the sale of assets such as oil reserves, which has significant political consequences. Rabah and Gylfason (2013) have argued that the quality of democratic institutions in resource-rich countries could explain the observed crowding out effect of resource tax revenues. They maintain that authoritarian regimes often deliberately reduce non-resource tax rates to quell the masses when they protest about not receiving their fair share of the resource rents. Clearly, from the point

of view of an authoritarian regime, there is strong economic logic behind the crowding-out effect mentioned above. This further reinforces the importance of institutional quality in improving tax revenue performance.

The above results are problematic for Uganda for three main reasons: (i) the discovery in 2006 of a significant quantity of oil in the Albertine basin, (ii) the country's challenges in improving its institutional quality, and (iii) the country?s low tax revenue performance for over the past decade. While only 40 percent of the country's potential are explored so far, Uganda's total oil reserves are currently estimated at 6.5 billion barrels (of which about 1.2-1.7 billion barrels are recoverable). It is estimated that recoverable reserves in Uganda could support production of 100,000 to 200,000 barrels per day for 20 to 40 years, depending on the speed of extraction. Based on the production sharing agreements already concluded, and assuming a long-term international price of US$90 per barrel, about 70 percent of the net present value of oil production would go to the government. The amount of additional public revenue would average US$2.5 billion/year (more than 35 percent of government revenue in 2016)[2]. This additional resource revenue could therefore lead to a crowding-out of non-resource tax revenue in Uganda. Botlhole (2011) suggests that the likelihood for this offset to occur in a country like Uganda is non-negligible, given the country?s challenges to close its institutional gap. The laws adopted and the oversight institutions created to promote good governance and minimize corruption are very strong on paper, but actual implementation remains limited (World Bank Group (2015)). According to Global Integrity (2011), Uganda's implementation of laws scores only 51 out of 100 on the Global Integrity Scale.

Uganda's tax to GDP ratio, which averaged 12.5 percent over 2000-2010, is well below the East African Community average of 16 percent. This is mainly due to the scope of the current tax exemptions and the nature of business in Uganda, which is largely dominated by the informal sector, making it easy for traders to evade taxes. Indeed, although all sectors except education and health are subject to tax, statistics for 2012/13 suggest that, agriculture contributed 24 percent to GDP but only comprised 0.3 percent of tax revenue, construction accounted for 13 percent of GDP but only 2 percent of tax revenue, and real estate represented 6 percent of GDP but 2 percent of tax revenue. Education and tourism activities, while accounting for a combined 10 percent of GDP, only provided about 2 percent of total tax revenue. A crowding out effect of other tax revenues by resource revenues in Uganda could worsen the country's already low tax performance level. As pointed out in Bornhorst, Gupta, and Thornton (2009), while the impact of the hydrocarbon revenue offset on long-term development prospects is not clear, there is a risk of a significant adjustment costs in moving to a higher level of domestic taxation once natural resources are depleted.

Our paper departs from the existing literature in several ways. First, to assess the

[2]With the current low oil price of below $50, one should expect lower resource revenue.

role of institutional quality, previous studies focused either on one indicator (corruption for Bornhorst, Gupta, and Thornton (2009) and Thomas and Trevino (2013)), or on an aggregate index of the quality of institutions (for Botlhole (2011), the Economic Freedom of the World index, which is a composite of 10 broad factors of economic freedom). In this paper, we assess individually the role of the six Worldwide Governance Indicators since using a composite governance indicator (e.g., Economic Freedom) may be misleading for our purpose, in the sense that the exact institutional weaknesses may not be identified adequately. Our goal is therefore two-fold: (i) to identify institutional variables that could play an important role in reducing the likelihood of occurrence of a non resource tax revenue crowding out, and (ii) to determine the threshold for these institutional variables, above which the likelihood of non resource tax revenue crowding out vanishes. This could help Ugandan authorities understand the level of effort needed to improve the country?s institutional quality in order to avoid a critical symptom of the natural resource curse. Second, our econometric methodology also differs from existing studies, which rely mostly on a linear model. In this paper, we consider a nonlinear probabilistic model to estimate the likelihood of an improvement of non-resource tax performance. This approach is convenient for out-of-sample predictions. With a linear model, the marginal effect on the dependent variable is not country-specific. Instead, a nonlinear model allows the analysis of marginal effects using country-specific characteristics, which is consistent with our goal of determining the threshold level for governance variables that Uganda needs to meet to avoid tax revenue crowding out.

As in previous studies, we find that an increase in hydrocarbon revenue induces a decline in non-resource revenue. Moreover, strengthening the quality of institutions is critical to reducing the risk of this crowding out effect. These results are robust to alternative specifications of both the linear and nonlinear models. In general, regulatory quality, rule of law, government effectiveness and political stability are the most important of the six Worldwide Governance Indicators (WGI)[3]. Our results also suggest that for Uganda, oil exploitation would be less likely to reduce domestic tax performance only if the levels of its governance indicators are at least around 0.5 for political stability, 1 for regulatory quality and 1.25 for government effectiveness. In 2012, those indicators were at -0.89, -0.24 and -0.56 respectively, implying that Uganda's government would need to take strong actions to improve its quality of institutions to a level that would avoid the resource curse.

The remainder of the paper is organized as follows. Section II describes some stylized facts about hydrocarbon and non-hydrocarbon revenues. Section III presents our empiri-

[3]The WGI are a research data set summarizing the views on the quality of governance provided by a large number of enterprise, citizen and expert survey respondents in industrial and developing countries. These data are gathered from a number of survey institutes, think tanks, non-governmental organizations, international organizations, and private sector firms. The six aggregate indicators are reported in two ways: (1) in their standard normal units, ranging from approximately -2.5 to 2.5 with higher values corresponding to better outcomes, and (2) in percentile rank terms from 0 to 100.

cal strategy and describes the variables used for the analysis. Section IV presents results for the linear model and robustness checks. Section V discusses the results under a probabilistic model specification. Section VI explores some policy implications for Uganda while Section VII concludes.

2 Descriptive analysis

For each country in our sample, Table 1 displays the average GDP share of non-hydrocarbon revenue and total revenue (including grants). The table also presents the average share of non-hydrocarbon revenue as a percentage of total revenue.

Some facts can be drawn from this table: over the period of the study, the median level of tax revenue is about 30 percent of GDP. Kuwait exhibits the highest level of taxes (61 percent of GDP), while Chad has the lowest taxes (15 percent of GDP). The table also shows that non-hydrocarbon sources are a relatively small component of tax revenue among the sampled nations. The maximum non-hydrocarbon tax revenue is 42 percent of GDP for Norway, while the median is only around 12 percent. Since the minimum level of non-hydrocarbon tax revenue is 5.5 percent, non-hydrocarbon tax revenue tends to be more concentrated on the left tail of the distribution. When we consider non-hydrocarbon revenue as a share of total revenue, it appears that most countries rely on hydrocarbon revenue. Indeed, among all countries, only 43 percent have a share of non-hydrocarbon revenue greater than 50 percent of total revenues.

Figure 1 displays the pattern of non-hydrocarbon, hydrocarbon and total revenues expressed as a share of GDP over time. As expected, it appears that total tax revenue fluctuations are essentially driven by hydrocarbon revenue. The hydrocarbon and total revenue variables seem to co-move over time with an underlying upward trend. Total tax revenue increased from about 31 percent in 1992 to about 32 percent in 2012. At the same time, hydrocarbon revenues have increased from about 14 percent to about 18 percent of GDP over the same period. Non-hydrocarbon revenues remained relatively stable, at around 13 percent.

Preliminary analysis indicates that hydrocarbon and non-hydrocarbon revenues are strongly negatively correlated, as shown in Figure 2.[4]

3 Empirical strategy

3.1 Model specification

To estimate the model in the linear case, we follow the literature on tax performance/tax effort. In this literature, non-hydrocarbon domestic revenue, R^{NH}, is modeled

[4]This strong negative relationship is also shown in Figure A1 in the appendix.

Table 1: Non-Hydrocarbon Government Revenue, 1992-2012

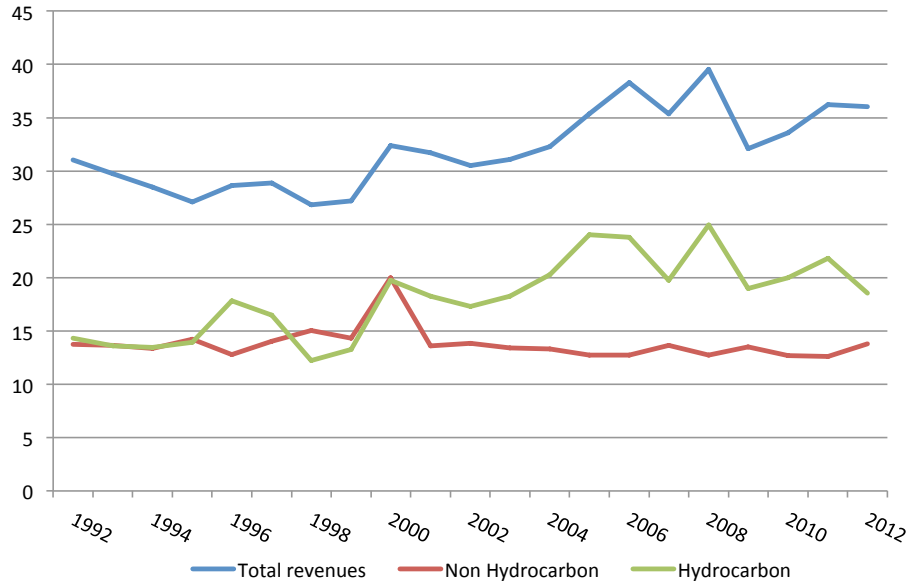
	Tax revenue as a percentage of GDP		Percentage of total revenue
	Non-hydrocarbon	Total revenue	Non-hydrocarbon
Norway	41.87	54.78	76.83
Russian Federation	28.57	36.97	77.63
Vietnam	21.50	23.89	88.79
Ecuador	18.90	24.55	80.46
Uganda	17.34	17.34	100.00
Trinidad and Tobago	17.25	27.22	64.27
Kazakhstan	16.41	25.07	66.58
Kuwait	16.17	61.05	27.26
Mexico	15.13	19.79	77.54
Azerbaijan	15.03	30.84	53.66
Syrian Arab Republic	14.62	26.36	55.67
Qatar	14.17	37.64	37.52
Venezuela, RB	13.43	30.10	45.19
Cameroon	12.91	20.49	68.43
Gabon	12.53	27.09	46.71
Indonesia	11.79	17.61	67.02
Libya	11.74	44.03	31.98
Algeria	11.22	34.90	33.12
United Arab Emirates	11.21	29.14	39.56
Yemen, Rep.	10.59	30.52	36.00
Chad	10.28	15.07	78.85
Iran, Islamic Rep.	10.28	23.44	45.36
Oman	9.27	42.52	22.18
Angola	8.94	43.81	21.05
Bahrain	8.46	29.20	29.40
Republic of Congo	8.20	34.42	25.39
Equatorial Guinea	7.89	35.39	23.96
Sudan	7.83	15.35	59.63
Nigeria	7.44	32.00	24.56
Brunei	6.60	43.04	16.70
Saudi Arabia	5.53	42.54	13.73
Min	***5.53***	***15.07***	***13.73***
Max	***41.87***	***61.05***	***88.79***
Median	***11.77***	***30.31***	***45.28***

Source: International Monetary Fund, authors' calculations. Uganda is excluded for the min, max and median calculations. Countries are sorted based on their non-hydrocarbon tax revenue as a percentage of GDP.

as a function of revenue from hydrocarbon products, R^H, normalized by GDP, Y, and a series of control variables as follows:

$$\left(\frac{R^{NH}}{Y}\right)_{it} = \alpha_i + \gamma_t + \beta_1 \left(\frac{R^H}{Y}\right)_{it} + X_{it}^{'}\beta_2 + u_{it},\ i = 1, \ldots, n,\ t = 1, \ldots, T., \qquad (1)$$

Figure 1: Government revenue from hydrocarbon and non-hydrocarbon sources (as a percentage of GDP), 1992-2012



Source: International Monetary Fund, authors' calculations.

β_1 is the coefficient of interest, $X_{it}^{'}$ is the vector of control variables, β_2 the vector of associated parameters, and α_i and γ_t are country and year fixed effects, respectively.

Since the main objective of the paper is to inform policy makers on the likelihood of a crowding out of domestic tax revenue by oil revenue in Uganda, we will later modify this specification and consider a nonlinear probability model that allows the use of information from the Ugandan economy for the marginal analysis. Clearly, the idea consists of estimating a probability model on countries exploiting natural resources and then using the estimated model to make inference about Uganda through a marginal effects analysis based on Uganda-specific data. This model is specified as follows:

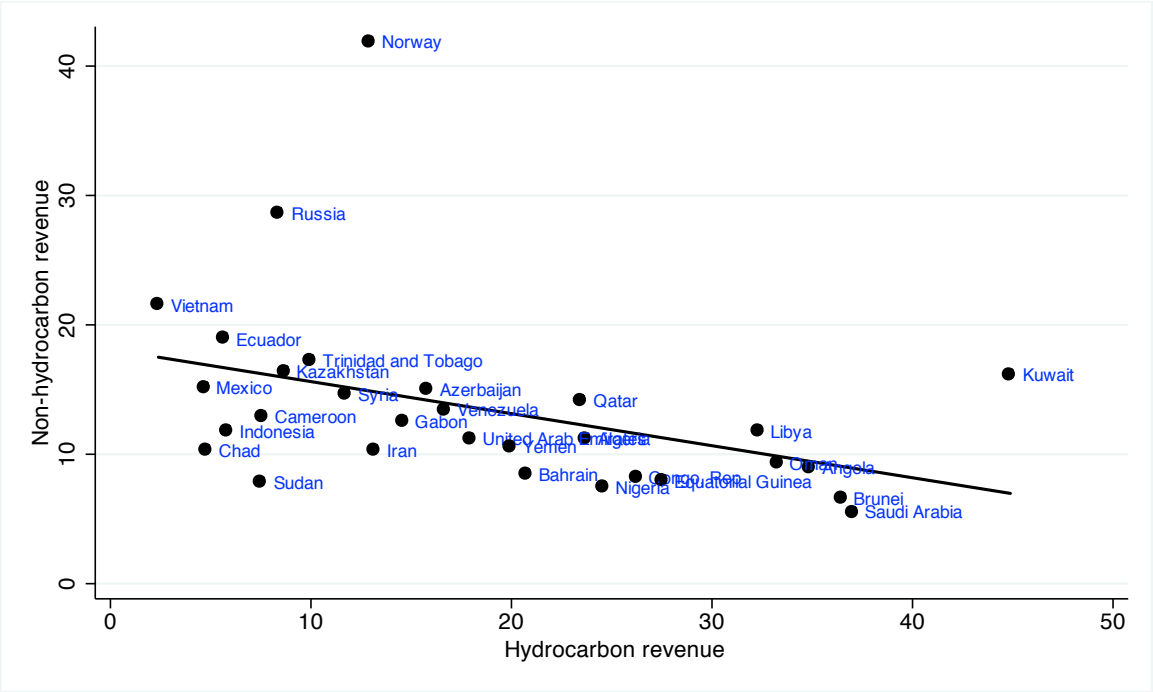
$$y_{it} = \begin{cases} 1 & \text{if } \left(\frac{R^{NH}}{Y}\right)_{it} - \left(\frac{R^{NH}}{Y}\right)_{it-1} > 0 \\ 0 & \text{in all other cases} \end{cases}$$

If $y_{it} = 1$, the country increases its non-hydrocarbon tax revenue relative to the previous year, whereas if $y_{it} = 0$, the country's non-hydrocarbon tax revenues decrease relative to the previous year. Therefore, we consider the following binary-choice model:

$$y_{it} = 1_{\left\{\alpha_i+\gamma_t+\beta_1\left(\frac{R^H}{Y}\right)_{it}+X_{it}^{'}\beta_2>\eta_{it}\right\}} \quad i = 1,\ldots,n,\ t = 1,\ldots,T, \tag{2}$$

where $\eta_{it} \sim$ i.i.d has a normal or a logistic distribution. Then, we estimate the following

Figure 2: Hydrocarbon and non-hydrocarbon revenues (as a percentage of GDP), 1992-2012



Source: International Monetary Fund, authors' calculations.

probability model:

$$P\left(y_{it}=1\left|\frac{R^H}{Y},X\right.\right)=F\left(\alpha_i+\gamma_t+\beta_1\left(\frac{R^H}{Y}\right)_{it}+X_{it}^{'}\beta_2\right)\ \ i=1,\ldots,n,\ \ t=1,\ldots,T,\ \ (3)$$

where F is the cumulative density function of the logistic distribution or the standard normal distribution. In this last specification, only the coefficients' signs and significance are of interest. For example, if β_1 is negative, it simply means that an additional percentage point of government revenue from hydrocarbons increases the likelihood of observing a decline in non-hydrocarbon domestic revenue effort, or equivalently, decreases the likelihood of observing an improvement in non-hydrocarbon domestic revenue effort. In this case, resource revenues have a crowding-out effect on non-resource tax revenue. To examine how the likelihood of observing crowding out varies with changes in hydrocarbon revenues, we compute the following marginal effect:

$$\frac{\partial P\left(y_{it}=1\left|\frac{R^H}{Y},X\right.\right)}{\partial\left(\frac{R^H}{Y}\right)_{it}}=\beta_1 F^{'}\left(\alpha_i+\gamma_t+\beta_1\left(\frac{R^H}{Y}\right)_{it}+X_{it}^{'}\beta_2\right)$$

The above formula can then be used to compute marginal effects of changes in $\frac{R^H}{Y}$ at

different points conditional on the vector X.

3.2 Choice of control variables

The choice of control variables is also made according to the literature on tax revenue effort/performance. However, we include additional controls that may help to better predict tax revenue performance. We include the following traditional variables in the analysis: grants as a share of GDP, the log of real GDP per capita expressed in real U.S. dollars, agriculture as share of GDP and a measure of a country's degree of openness.

Grants are expected to cause a decline in non-resource tax revenues. Indeed, an increase in grants creates a disincentive for governments to collect taxes. Real GDP per capita is included as measure of a representative household's income or a country's level of development. This variable is expected to cause an increase in non-resource revenues. The agricultural sector in many developing countries that are resource producers is difficult to tax. An expansion of the agricultural sector is frequently associated with a decline in a country's tax effort. The trade sector still remains an important source of revenues (from tariffs), as trade is not yet fully liberalized in most of these countries. An expansion of this sector is thus expected to cause an increase in non-resource tax revenues. Due to a lack of accurate data regarding exports,[5] we use imports as a share of GDP as a measure of openness. We also include manufacturing and value-added services as a share of GDP in some specifications. We expect that an expansion in the manufacturing and service sectors will increase non-hydrocarbon revenues, as these sectors are relatively less difficult to tax. In addition to these variables, we use the six worldwide governance indicators (control of corruption, voice and accountability, rule of law, political stability, government effectiveness and regulatory quality) to examine the importance of the quality of a country's institutions on the relationship between non-oil and oil revenues. We also include government spending as a share of GDP, to account for the size of government. An increase in government expenditures might be associated with an improvement of a country's non-hydrocarbon tax effort. Indeed, when countries embark on an intensive public spending program, they should increase revenues by collecting more taxes in order to fund the program.

4 Results: Linear specification

4.1 Results of the baseline specifications

Table 2 presents some empirical results for specifications without institutional quality. As in Bornhorst, Gupta, and Thornton (2009), the effect of hydrocarbon revenues on

[5] Usually, a measure of openness is total exports net of resources exports plus imports, expressed as share of GDP.

domestic revenue effort is statistically significant and negative in all model specifications. Moreover, in baseline specifications (1) and (2), the coefficient for $\frac{R^H}{Y}$ indicates that an additional percentage point of revenue from hydrocarbons reduces revenues from other domestic sources by 0.18 percentage point of GDP. Recall that Bornhorst, Gupta, and Thornton (2009) also found this coefficient to be 0.19 percentage point of GDP. As the tax-to-GDP ratio tends to be persistent over time, in specification (7) we include the lag of the dependent variable to take into account this dynamic. We used a generalized method of moments system proposed by Arellano and Bover (1995) and Blundell and Bond (1998) to estimate specification (7). Lagged values of hydrocarbon revenues and the dependent variable (non-resource tax to GDP ratio) are included as instruments.

Results remain consistent with other specifications: an increase in resource revenues causes a decline in non-resource revenues. With regard to control variables, in almost all the model specifications, the signs of the coefficients are consistent with our expectations, except for the logarithm of real GDP per capita. Grants as a share of GDP tend to significantly reduce domestic non-resource tax efforts. Although not significant, our findings also suggest that an expansion of the agriculture sector causes a decline in non-resources revenues. The manufacturing and service sectors tend to co-move with non-hydrocarbon revenues, capturing the fact that these sectors are easier to tax than agriculture. Also, as expected, non-hydrocarbon tax revenues increase with imports and government expenditures.

Table 2: Panel OLS results with country and time fixed effects

	Dependent variable: R^{NH}/Y									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
R^H/Y	-0.189***	-0.179***	-0.182***	-0.146***	-0.075***	-0.066***	-0.081**	-0.074***	-0.058**	-0.120***
	(0.021)	(0.022)	(0.028)	(0.026)	(0.021)	(0.022)	(0.032)	(0.024)	(0.023)	(0.025)
$\left(R^{NH}/Y\right)_{t-1}$							0.639***			
							-0.21			
Grants (% of GDP)		-1.003***	-1.238***	-1.037***	-0.957**	-1.130***	-0.501	-1.173***	-1.171***	-1.159***
		(0.299)	(0.329)	(0.320)	(0.374)	(0.369)	(0.772)	(0.355)	(0.366)	(0.329)
Log (GDP per capita)			-0.006	-0.024***	-0.009	-0.014*	0.047	-0.015*	-0.016*	-0.026***
			(0.007)	(0.008)	(0.009)	(0.009)	(0.032)	(0.008)	(0.008)	(0.008)
Agriculture (% of GDP)				-0.036	-0.017	0.007	0.229	-0.025	-0.003	-0.045
				(0.034)	(0.034)	(0.034)	(0.177)	(0.030)	(0.033)	(0.034)
Manufacturing (% of GDP)					0.071	0.177***		0.245***	0.268***	
					(0.055)	(0.059)		(0.067)	(0.071)	
Services (% of GDP)					0.236***	0.223***		0.149***	0.158***	
					(0.038)	(0.037)		(0.041)	(0.042)	
Openness (Imports, % of GDP)						0.047***	-0.008		0.041**	0.021
						(0.016)	(0.047)		(0.017)	(0.013)
Government size (Expenditures, % of GDP)								0.115***	0.097***	0.122***
								(0.024)	(0.024)	(0.022)
Constant	0.168***	0.169***	0.235***	0.436***	0.141	0.167*	-0.469	0.189*	0.179*	0.411***
	(0.006)	(0.006)	(0.079)	(0.094)	(0.102)	(0.099)	(0.367)	(0.099)	(0.102)	(0.095)
Observations	507	507	485	431	406	397	397	350	348	371
Number of Countries	28	28	28	27	27	27	27	27	27	27
AR(1)							0.012			
AR(2)							0.266			
Hansen (p-value)							0.998			

Notes: *** p<0.01, ** p<0.05, * p<0.1 R^{NH}/Y: Non-hydrocarbon revenue; R^H/Y: Hydrocarbon revenue

4.2 Role of institutional quality

Do good institutions help to dampen the crowding out of non-resource revenues by hydrocarbon tax revenues? We depart from specification (9) of Table 3 and include an interaction term between hydrocarbon revenues and the World Bank's six indicators of the quality of institutions.[6]

Results presented in Table 3 show that once different types of governance indicators are included, the coefficient on real GDP per capita becomes positive, as expected, whereas the coefficient on agriculture value-added as a share of GDP remains negative and significant. In specifications (2), (4), (6), (8), (10) and (12), where we control for the level of each indicator without including an interaction term, four of the six governance indicators tend to improve the collection of non-resource taxes. In specifications (3), (5), (7), (9), (11) and (13), we include the interaction term between each indicator and hydrocarbon revenues.

[6]To recap, the six governance indicators developed by the World Bank are voice and accountability, political stability and absence of violence, government effectiveness, regulatory quality, rule of law and control of corruption. For a definition of each indicator, visit http://info.worldbank.org/governance/wgi/index.aspx#faq.

Table 3: Panel OLS results with country and time fixed effects: Effect of institutions

	Dependent variable: R^{NH}/Y												
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**	**(13)**
R^H/Y	-0.120***	-0.071***	-0.062**	-0.067***	-0.064*	-0.074***	-0.055**	-0.071***	-0.064***	-0.066***	-0.059***	-0.073***	-0.060**
	(0.025)	(0.025)	(0.025)	(0.023)	(0.033)	(0.026)	(0.024)	(0.023)	(0.023)	(0.023)	(0.023)	(0.026)	(0.025)
Corruption		0.007	0.002										
		(0.007)	(0.009)										
$\left(R^H/Y\right)\times$Corruption			0.027										
			(0.022)										
Voice and accountability				0.024***	0.023***								
				(0.008)	(0.009)								
$\left(R^H/Y\right)\times$Voice and accountability					0.003								
					(0.024)								
Rule of law						-0.012	-0.022**						
						(0.008)	(0.010)						
$\left(R^H/Y\right)\times$Rule of law							0.045**						
							(0.021)						
Political stability								0.014***	0.006				
								(0.004)	(0.005)				
$\left(R^H/Y\right)\times$Political stability									0.039**				
									(0.016)				
Gov. effectiveness										0.024**	0.018		
										(0.010)	(0.011)		
$\left(R^H/Y\right)\times$Gov. effectiveness											0.027		
											(0.020)		
Regulatory quality												-0.013*	-0.026***
												(0.008)	(0.008)
$\left(R^H/Y\right)\times$Regulatory quality													0.053***
													(0.020)
Grants (% GDP)	-1.159***	-1.526***	-1.556***	-1.478***	-1.481***	-1.499***	-1.536***	-1.520***	-1.461***	-1.622***	-1.652***	-1.368***	-1.451***
	(0.329)	(0.466)	(0.462)	(0.440)	(0.448)	(0.456)	(0.436)	(0.406)	(0.379)	(0.453)	(0.453)	(0.475)	(0.475)
Log (GDP per capita)	-0.026***	0.013	0.016	0.012	0.013	0.014	0.018	0.008	0.009	0.012	0.014	0.02	0.027**
	(0.008)	(0.012)	(0.013)	(0.012)	(0.013)	(0.013)	(0.013)	(0.012)	(0.012)	(0.012)	(0.012)	(0.014)	(0.014)
Agriculture (% of GDP)	-0.045	-0.113**	-0.110**	-0.114**	-0.114**	-0.125**	-0.119**	-0.130***	-0.116**	-0.095**	-0.093**	-0.117**	-0.113**
	(0.034)	(0.049)	(0.048)	(0.048)	(0.048)	(0.051)	(0.050)	(0.048)	(0.047)	(0.047)	(0.046)	(0.050)	(0.048)
Openness (Imports, % of GDP)	0.021	0.079***	0.076***	0.080***	0.080***	0.084***	0.080***	0.083***	0.077***	0.076***	0.073***	0.086***	0.084***
	(0.013)	(0.023)	(0.022)	(0.022)	(0.023)	(0.023)	(0.022)	(0.022)	(0.023)	(0.021)	(0.021)	(0.023)	(0.023)
Government size (Expenditures, % of GDP)	0.122***	0.063*	0.079**	0.058*	0.058*	0.052	0.073**	0.058*	0.093**	0.062*	0.075**	0.046	0.067**
	(0.022)	(0.034)	(0.035)	(0.034)	(0.034)	(0.035)	(0.036)	(0.034)	(0.038)	(0.034)	(0.036)	(0.034)	(0.034)
Constant	0.411***	-0.029	-0.069	-0.006	-0.008	-0.046	-0.103	0.032	0.011	-0.008	-0.039	-0.116	-0.208
	(0.095)	(0.145)	(0.150)	(0.146)	(0.148)	(0.156)	(0.155)	(0.146)	(0.142)	(0.140)	(0.139)	(0.165)	(0.162)
Observations	371	268	268	268	268	268	268	268	268	268	268	268	268
Number of countries	27	26	26	26	26	26	26	26	26	26	26	26	26

Notes: *** p<0.01, ** p<0.05, * p<0.1 R^{NH}/Y: Non-hydrocarbon revenue; R^H/Y: Hydrocarbon revenue

The positive and significant coefficients for the interaction terms between $\frac{R^H}{Y}$ and rule of law, political stability and regulatory quality indicate that the negative response of domestic revenue effort to hydrocarbon revenues varies with the quality of institutions. Clearly, the better the quality of institutions, the less crowding out. Note that although not statistically significant, the coefficients for the interaction terms between $\frac{R^H}{Y}$ and control of corruption, government effectiveness, voice and accountability and political stability are also positive, suggesting that good institutions are important in leveraging the benefits of resource revenues. This relationship has been discussed extensively in the resource economics literature.

4.3 Results with the exclusion of outliers

In Table 4, we report the results of the same experiments but exclude outliers observed in Figure A1: the Russian Federation, Norway and Kuwait. We reach to the same conclusions about the role of institutional quality. In addition, the coefficient on the interaction term between resource revenues and control of corruption is now significant.

Table 4: Panel OLS results with country and time fixed effects: Effect of institutions (excluding Russia, Norway and Kuwait)

	Dependent variable: R^{NH}/Y												
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**	**(13)**
Corruption	-0.127***	-0.078***	-0.058**	-0.074***	-0.01	-0.080***	-0.055**	-0.077***	-0.070***	-0.071***	-0.061***	-0.081***	-0.065***
	(0.026)	(0.025)	(0.025)	(0.023)	(0.046)	(0.025)	(0.024)	(0.024)	(0.023)	(0.023)	(0.022)	(0.026)	(0.025)
		0.004	-0.008										
		(0.008)	(0.011)										
$\left(R^H/Y\right)$ ×Corruption			0.049*										
			(0.026)										
Voice and accountability				0.019***	0.01								
				(0.007)	(0.011)								
$\left(R^H/Y\right)$ ×Voice and accountability					0.059								
					(0.036)								
Rule of law						-0.008	-0.019*						
						(0.009)	(0.010)						
$\left(R^H/Y\right)$ ×Rule of law							0.053**						
							(0.024)						
Political stability								0.012***	0.006				
								(0.004)	(0.005)				
$\left(R^H/Y\right)$ ×Political stability									0.031**				
									(0.016)				
Gov. effectiveness										0.031***	0.023**		
										(0.010)	(0.012)		
$\left(R^H/Y\right)$ ×Gov. effectiveness											0.032		
											(0.022)		
Regulatory quality												-0.013*	-0.028***
												(0.008)	(0.009)
$\left(R^H/Y\right)$ ×Regulatory quality													0.062***
													(0.020)
Grants (%of GDP)	-0.109	-0.456	-0.448	-0.429	-0.463	-0.449	-0.485	-0.596	-0.577	-0.645	-0.643	-0.274	-0.318
	(0.269)	(0.402)	(0.399)	(0.360)	(0.369)	(0.403)	(0.390)	(0.386)	(0.372)	(0.409)	(0.402)	(0.384)	(0.364)
Log (GDP per capita)	-0.026***	0.013	0.017	0.012	0.014	0.013	0.018	0.009	0.009	0.013	0.015	0.02	0.029*
	(0.008)	(0.013)	(0.013)	(0.013)	(0.013)	(0.014)	(0.014)	(0.013)	(0.013)	(0.012)	(0.012)	(0.015)	(0.015)
Agriculture (% of GDP)	-0.044	-0.109**	-0.103**	-0.109**	-0.112**	-0.117**	-0.110**	-0.123**	-0.112**	-0.082*	-0.080*	-0.112**	-0.107**
	(0.035)	(0.050)	(0.050)	(0.049)	(0.050)	(0.052)	(0.051)	(0.050)	(0.048)	(0.046)	(0.047)	(0.051)	(0.049)
Openness (Imports, % of GDP)	0.021	0.083***	0.078***	0.083***	0.083***	0.086***	0.082***	0.087***	0.082***	0.079***	0.076***	0.090***	0.088***
	(0.013)	(0.024)	(0.023)	(0.023)	(0.023)	(0.024)	(0.023)	(0.023)	(0.023)	(0.022)	(0.022)	(0.024)	(0.024)
Government size (Expenditures, % of GDP)	0.120***	0.042	0.066*	0.038	0.032	0.035	0.055	0.038	0.067*	0.039	0.054	0.027	0.048
	(0.020)	(0.034)	(0.034)	(0.033)	(0.033)	(0.035)	(0.035)	(0.034)	(0.037)	(0.033)	(0.034)	(0.035)	(0.035)
Constant	0.386***	-0.034	-0.091	-0.01	-0.042	-0.048	-0.103	0.011	-0.002	-0.026	-0.054	-0.122	-0.223
	(0.098)	(0.152)	(0.155)	(0.152)	(0.157)	(0.162)	(0.159)	(0.152)	(0.149)	(0.140)	(0.140)	(0.173)	(0.171)
Observations	328	238	238	238	238	238	238	238	238	238	238	238	238
Number of countries	24	23	23	23	23	23	23	23	23	23	23	23	23

Notes: *** p<0.01, ** p<0.05, * p<0.1 R^{NH}/Y: Non-hydrocarbon revenue; R^H/Y: Hydrocarbon revenue

5 Results for the probabilistic model

Table 5 displays the results for the logit panel model with country fixed effects. We include traditional control variables (grants, real GDP per capita, share of agriculture, openness) and the size of government. To assess the role of institutions, we include each of the governance indicators and its interaction with hydrocarbon revenues. What is important for the probabilistic model is not the coefficients per se, but the signs and the significance of the parameters.

Overall, our results are very similar to the linear model. In all specifications, the probability of an improvement of domestic tax effort declines with an increase in hydrocarbon revenues. Along the same line, although not statistically significant, the agriculture sector and grants tend to cause a decline of the targeted probability. In contrast, the probability of an improvement in domestic tax effort tends to increase with real GDP per capita, openness and the size of government. With respect to governance indicators, the coefficient associated with the interaction term between each institutional indicator and hydrocarbon revenues is positive. As in the linear case, these positive coefficients reflect the fact that a high quality of institutions tends to dampen the negative impact of resource revenues on the probability of non-resource tax effort improvement. Among all indicators, those with significant effects are political stability, government effectiveness and regulatory quality. Meanwhile, in the linear case (Table 3), governance indicators with significant effects are political stability, regulatory quality and rule of law.

For robustness checks, we also estimate a logit model with country random effects, a probit model with country fixed effects (although these are known to deliver biased estimates) and a probit model with country random effects. The results displayed in the appendix are not very different from those obtained with a logit model with country fixed effects. However, although all coefficients associated with the interaction terms between governance indicators and resource revenues are positive, only one (the variable associated with political stability) remains significant.

Table 5: Binary logit panel with country fixed effects

	Dependent variable: $P(y_{it}=1)$												
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**	**(13)**
	-4.247**	-4.148**	-3.393*	-4.416**	-2.659	-4.256**	-3.449*	-4.131**	-3.62	-4.178**	-3.545*	-4.458**	-3.900**
	(1.832)	(2.024)	(1.866)	(1.982)	(3.146)	(1.940)	(1.888)	(1.960)	(2.271)	(2.101)	(1.819)	(1.990)	(1.953)
Corruption		-0.572	-1.086										
		(0.696)	(0.769)										
$\left(R^H/Y\right)$ ×Corruption			2.447										
			(1.649)										
Voice and accountability				-0.952*	-1.248*								
				(0.574)	(0.709)								
$\left(R^H/Y\right)$ ×Voice and accountability					1.821								
					(2.495)								
Rule of law						-0.374	-0.83						
						(0.701)	(0.866)						
$\left(R^H/Y\right)$ ×Rule of law							2.234						
							(1.505)						
Political stability								0.087	-0.825*				
								(0.383)	(0.422)				
$\left(R^H/Y\right)$ ×Political stability									5.046***				
									(1.824)				
Gov. effectiveness										-0.138	-0.721		
										(0.664)	(0.648)		
$\left(R^H/Y\right)$ ×Gov. effectiveness											2.869*		
											(1.611)		
Regulatory quality												-0.688	-1.433**
												(0.615)	(0.694)
$\left(R^H/Y\right)$ ×Regulatory quality													3.633**
													(1.576)
Grants (% of GDP)	-26.744	-14.704	-17.492	-19.137	-20.717	-18.474	-20.122	-17.679	-11.079	-17.02	-20.492	-12.31	-19.555
	(16.653)	(13.984)	(15.182)	(13.591)	(15.303)	(14.678)	(15.907)	(14.351)	(19.293)	(14.490)	(14.709)	(14.841)	(15.858)
Log (GDP per capita)	0.919	0.984	1.100*	0.932	0.968	1.076*	1.168*	1.002*	1.069*	1.031*	1.160*	1.290*	1.498**
	(0.565)	(0.629)	(0.643)	(0.644)	(0.632)	(0.652)	(0.658)	(0.602)	(0.628)	(0.624)	(0.630)	(0.722)	(0.742)
Agriculture (% of GDP)	0.737	-0.578	-0.296	-0.458	-0.531	-0.607	-0.34	-0.551	0.909	-0.526	-0.338	-0.202	0.063
	(2.175)	(2.842)	(2.835)	(3.090)	(3.029)	(2.839)	(2.734)	(2.765)	(2.344)	(2.855)	(2.757)	(2.998)	(2.811)
Openness (Imports, % of GDP)	0.85	1.003	0.624	0.837	0.757	0.976	0.729	0.917	0.286	0.923	0.545	1.066	0.732
	(0.625)	(1.172)	(1.249)	(1.187)	(1.214)	(1.170)	(1.220)	(1.145)	(1.184)	(1.142)	(1.218)	(1.135)	(1.179)
Government size (Expenditure, % of GDP)	3.859*	3.9	5.046	4.209	4.326	3.946	4.761	4.096	7.462*	4.123	5.251	3.471	4.635
	(2.141)	(3.778)	(3.560)	(3.828)	(3.781)	(3.756)	(3.681)	(3.870)	(4.443)	(3.891)	(3.774)	(3.709)	(3.664)
Observations	371	268	268	268	268	268	268	268	268	268	268	268	268
Number of countries	27	26	26	26	26	26	26	26	26	26	26	26	26

Notes: *** p<0.01, ** p<0.05, * p<0.1 R^{NH}/Y: Non-hydrocarbon revenue; R^H/Y: Hydrocarbon revenue

6 Marginal effects and policy lessons for Uganda

6.1 The linear model

Results for the linear specification show that governance indicators play a central role in dampening the decline in domestic revenues caused by hydrocarbon revenues. Using a specification that introduces the interaction term between hydrocarbon revenues and a governance indicator, we find that the marginal effect of an increase in resource revenue on non resource tax revenue changes with the level of the governance indicator, $INST$, as indicated in the following equation:

$$\frac{\partial \left(\frac{R^{NH}}{Y}\right)_{it}}{\partial \left(\frac{R^{H}}{Y}\right)_{it}} = \beta_1 + \beta_2^{Inst} \times INST \tag{4}$$

To have a positive marginal effect, there must be a minimum level of institutional quality:

$$INST \geq -\frac{\beta_1}{\beta^{Inst}}.$$

Using results presented in Tables 3 and 4, Table 6 displays the minimum level of governance indicators necessary to have a positive marginal effect. We only show indicators for which the associated coefficients are statistically significant.

Table 6: Thresholds of Governance Indicators

	Whole sample	Excluding outliers
Regulatory quality	1.13	1.05
Rule of law	1.22	1.04
Political stability	1.64	2.26
Control of corruption	-	1.18

Results from the linear model suggest that to avoid a decline in domestic tax performance caused by increasing resource revenues, any resource-rich country (including Uganda, which has yet to exploit its discovered resources) should improve its governance such that the above four indicators exceed a value of one. Countries should also prioritize the improvement of political stability.

Since marginal effects in the linear model are not country-specific, the probabilistic model is preferable in the sense that it allows the computation of marginal effects using Uganda's characteristics.

6.2 The probabilistic model

The marginal effect of an increase to resource revenues equivalent to one percentage point of GDP on the probability of seeing tax performance increase, when interaction

terms are included, is given by the following equation:

$$\frac{\partial P\left(y_{it}=1\right)}{\partial\left(\frac{R^H}{Y}\right)_{it}}=\left(\beta_1+\beta_2^{Inst}\times INST\right)F'\left(\alpha_i+\beta_1\left(\frac{R^H}{Y}\right)_{it}+\beta_2^{Inst}\times INST\times\left(\frac{R^H}{Y}\right)_{it}+X_{it}^{'}\beta_2\right)$$

The above formula can be interpreted as follows. Given a level of hydrocarbon resources, the left side of the equation expresses the change in the probability of an improvement in non-resource tax efforts associated with a marginal change in resource revenues. For Uganda, we calculate this probability change at different values using the three statistically significant governance indicators (political stability, regulatory quality and rule of law) to determine, for each of the indicators, the thresholds above which the change in the probability is positive. We set other controls at their average value over time. Because Uganda is not yet exploiting its oil resources, we set the initial values of resource revenues at very low levels.[7]

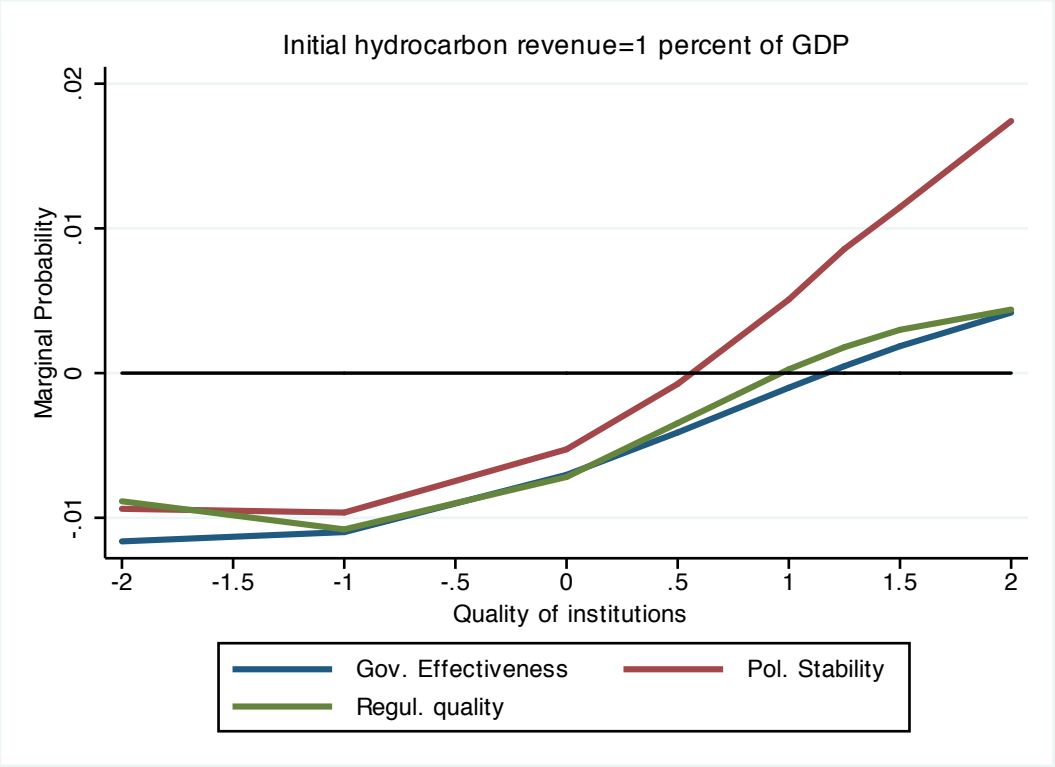
Figure 3 below displays, for Uganda, the marginal change in the probability associated with a slight increase in resource revenues for different values of the selected governance indicators. We have fixed the level of hydrocarbon revenue, from which the derivative is made, at 1 percent of GDP.

We observe that the marginal probability is an increasing function of the level of each governance indicator. This result suggests that an improvement to the quality of institutions could decrease the likelihood that resource exploitation causes a decline in non-resource tax performance.

With regard to the thresholds above which the marginal probability is positive, contrary to the linear model, political stability with a threshold around 0.5 seems to be the least demanding threshold among governance indicators related to the quality of institutions. The required threshold for regulatory quality is just below one, whereas the threshold for government effectiveness is 1.25, indicating that the Ugandan authorities should undertake stronger efforts to improve the latter governance indicators. On this front, Uganda could learn from the experience of other countries, such as Botswana. In fact, although the selected governance indicators for Botswana do not currently stand at the required levels indicated earlier and above which the marginal probability is positive, Botswana remains a good benchmark for a country such as Uganda, which has a weak institutional quality. We note that Botswana's scores on the governance indicators of political stability, regulatory quality and government effectiveness are 1.11, 0.69 and 0.44 respectively in 2012, compared with -0.89, -0.24 and -0.57 for Uganda. Meanwhile, despite receiving significant revenues from minerals (equal to about 10.6 percent of GDP), Botswana's non-mineral government revenues amounted to 20.2 percent of GDP in 2012.

[7] We present the case where initial hydrocarbon revenues are set at 1 percent of GDP. However, results for the level of initial hydrocarbon revenue equal to 5 percent and 10 percent are available upon request. Also for each indicator, the threshold is not dependent on the point from which the derivative is made.

Figure 3: Marginal probability of an improvement of domestic tax revenue alongside institutional quality



Notes: The figure displays, for Uganda, the marginal probability of an improvement of non-hydrocarbon tax effort induced by a slight increase in hydrocarbon revenues alongside three governance indicators: government effectiveness, political stability and regulatory quality.

7 Conclusion

This paper examines the relationship between hydrocarbon and non-hydrocarbon revenues for a sample of 30 countries from 1992-2012. We use two approaches and analyze the role of institutional quality to provide policy implications for Uganda, a country planning to exploit its natural resources.

In the first approach, we estimate a linear model of the relationship between non-hydrocarbon revenue and hydrocarbon revenue, including a set of control variables as is done in many studies in the literature. Consistent with the empirical literature, we find that an increase in hydrocarbon revenues induces a decline in non-resource revenues. This result remains robust in all alternative model specifications. However, this decline in non-resource revenues is dampened when interaction terms of selected governance indicators and hydrocarbon revenues are included. In particular, regulatory quality, rule of law and political stability play a significant role. A marginal analysis leads to the conclusion that, for any country exploiting resources, revenues from these resources will be associated with an increased domestic tax effort only if the level of the aforementioned governance

indicators are at least equal to one.

In the second approach, we examine the relationship between resource and non-resource revenues by modeling the probability of an improvement in domestic tax revenue with respect to a change in resource revenues. This approach allows us to draw country-specific policy lessons using unique characteristics of countries in the sample. As in the linear model, we find a robust result indicating that an increase in hydrocarbon revenues leads to a decline in the above probability. Similarly, better institutions tend to dampen this decline. Oil exploitation in Uganda would be less likely to induce a decline in domestic tax effort only if the levels of governance indicators reach a minimum of 0.5 for political stability, around 1 for regulatory quality and 1.25 for government effectiveness. Therefore, stronger actions are needed by Ugandan authorities to improve the country's institutional quality to levels that will allow the country to fully reap the benefits of its oil resources like in Botswana. However, while this paper emphasizes the importance of selected governance indicators, efforts to improve other Worldwide Governance indicators are also warranted.

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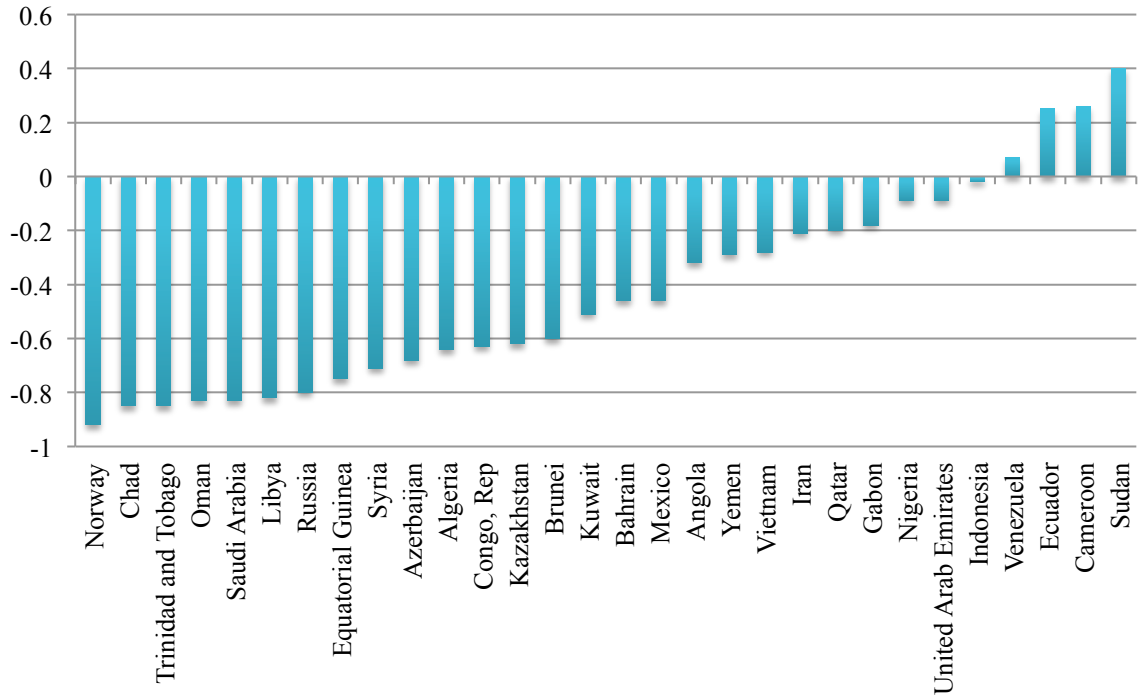
Appendix

Figures

Figure A1: Correlation between hydrocarbon and non-hydrocarbon revenues, 1992-2012



Source: International Monetary Fund, authors' calculations.

Tables

Table A1: Binary logit panel with country random effects

	Dependent variable: $P(y_{it}=1)$												
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**	**(13)**
	-2.282**	-2.853**	-2.295	-4.147**	-3.999	-2.881**	-2.305	-2.558**	-2.288*	-3.117	-2.608	-3.200**	-2.609
	(1.130)	(1.234)	(1.928)	(1.762)	(2.887)	(1.245)	(2.045)	(1.188)	(1.253)	(1.932)	(1.947)	(1.463)	(1.779)
Corruption		-0.214	-0.503										
		(0.259)	(0.502)										
$\left(R^H/Y\right)$ ×Corruption			1.353										
			(1.662)										
Voice and accountability				-0.458**	-0.479								
				(0.195)	(0.315)								
$\left(R^H/Y\right)$ ×Voice and accountability					0.137								
					(2.060)								
Rule of law						-0.293*	-0.589						
						(0.171)	(0.502)						
$\left(R^H/Y\right)$ ×Rule of law							1.33						
							(1.692)						
Political stability								-0.192	-0.766**				
								(0.197)	(0.298)				
$\left(R^H/Y\right)$ ×Political stability									2.613**				
									(1.179)				
Gov. effectiveness										-0.282	-0.671*		
										(0.334)	(0.401)		
$\left(R^H/Y\right)$ ×Gov. effectiveness											1.704		
											(1.949)		
Regulatory quality												-0.386	-0.916**
												(0.238)	(0.356)
$\left(R^H/Y\right)$ ×Regulatory quality													2.133
													(1.470)
Grants (% of GDP)	-9.698	-1.212	-6.041	-0.008	-0.546	-1.197	-4.714	-4.853	-6.19	-2.828	-5.791	-5.149	-10.21
	(11.455)	(13.726)	(12.009)	(9.155)	(14.809)	(10.594)	(12.890)	(12.046)	(14.480)	(10.476)	(12.945)	(11.565)	(12.660)
Log (GDP per capita)	-0.005	-0.025	-0.015	-0.026	-0.025	-0.017	-0.006	-0.015	0.013	-0.017	-0.001	-0.024	-0.013
	(0.050)	(0.061)	(0.046)	(0.046)	(0.044)	(0.058)	(0.055)	(0.046)	(0.052)	(0.051)	(0.043)	(0.036)	(0.045)
Agriculture (% of GDP)	0.205	-0.855	-0.851	-1.188	-1.206	-1.107	-1.165	-1.14	-1.271	-1.135	-1.32	-1.512	-2.014
	(1.143)	(1.185)	(1.464)	(1.417)	(1.618)	(1.300)	(1.692)	(1.503)	(1.753)	(1.391)	(1.594)	(1.217)	(1.643)
Openness (Imports, % of GDP)	-0.13	0.592	0.483	0.201	0.192	0.571	0.517	0.797	0.959	0.538	0.42	0.497	0.361
	(0.499)	(0.857)	(0.688)	(0.915)	(0.782)	(0.978)	(0.902)	(0.759)	(0.820)	(1.044)	(0.727)	(0.819)	(0.931)
Government size (Expenditures, % of GDP)	1.385	1.802	2.406	2.516	2.515	2.013	2.57	1.455	2.716	1.992	2.687	1.982	2.71
	(2.094)	(2.579)	(3.748)	(2.052)	(2.458)	(2.181)	(2.742)	(2.315)	(2.866)	(3.942)	(2.512)	(2.106)	(2.178)
Constant	0.121	-0.062	-0.441	-0.1	-0.116	-0.229	-0.635	-0.143	-1.049	-0.1	-0.537	0.021	-0.358
	(0.860)	(1.236)	(1.268)	(0.641)	(0.923)	(1.179)	(1.164)	(1.075)	(1.222)	(1.469)	(0.849)	(0.711)	(1.063)
Observations	371	268	268	268	268	268	268	268	268	268	268	268	268
Number of countries	27	26	26	26	26	26	26	26	26	26	26	26	26

Notes: *** p<0.01, ** p<0.05, * p<0.1 R^{NH}/Y: Non-hydrocarbon revenue; R^H/Y: Hydrocarbon revenue

Table A2: Binary probit panel with country fixed effects

	Dependent variable: $P(y_{it}=1)$												
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**	**(13)**
	-2.786**	-2.779*	-2.25	-2.944**	-1.7	-2.842**	-2.278	-2.749*	-2.323	-2.791*	-2.347	-2.994**	-2.576*
	(1.271)	(1.442)	(1.505)	(1.442)	(2.367)	(1.446)	(1.542)	(1.437)	(1.703)	(1.445)	(1.535)	(1.452)	(1.559)
Corruption		-0.403	-0.742										
		(0.530)	(0.612)										
$\left(R^H/Y\right)$ ×Corruption			1.605										
			(1.433)										
Voice and accountability				-0.624	-0.834								
				(0.554)	(0.651)								
$\left(R^H/Y\right)$ ×Voice and accountability					1.284								
					(1.988)								
Rule of law						-0.262	-0.567						
						(0.546)	(0.636)						
$\left(R^H/Y\right)$ ×Rule of law							1.457						
							(1.528)						
Political stability								0.053	-0.52				
								(0.283)	(0.369)				
$\left(R^H/Y\right)$ ×Political stability									2.975**				
									(1.425)				
Gov. effectiveness										-0.106	-0.51		
										(0.554)	(0.625)		
$\left(R^H/Y\right)$ ×Gov. effectiveness											1.875		
											(1.542)		
Regulatory quality												-0.484	-0.971*
												(0.425)	(0.516)
$\left(R^H/Y\right)$ ×Regulatory quality													2.36
													(1.438)
Grants (% of GDP)	-18.164	-10.363	-12.592	-13.143	-14.669	-13.082	-14.551	-12.565	-9.165	-11.939	-14.414	-8.598	-13.562
	(15.715)	(18.987)	(19.348)	(18.792)	(19.142)	(19.062)	(19.305)	(19.013)	(19.959)	(19.084)	(19.131)	(19.108)	(19.288)
Log (GDP per capita)	0.617	0.667	0.745	0.631	0.658	0.734	0.799	0.688	0.762	0.704	0.797	0.877*	1.015*
	(0.379)	(0.490)	(0.496)	(0.489)	(0.490)	(0.492)	(0.496)	(0.490)	(0.501)	(0.485)	(0.489)	(0.521)	(0.532)
Agriculture (% of GDP)	0.577	-0.27	-0.005	-0.187	-0.213	-0.278	-0.016	-0.201	0.999	-0.213	0.029	-0.016	0.288
	(1.752)	(2.262)	(2.287)	(2.270)	(2.286)	(2.269)	(2.284)	(2.295)	(2.364)	(2.281)	(2.308)	(2.263)	(2.316)
Openness (Imports, % of GDP)	0.565	0.671	0.419	0.563	0.5	0.662	0.499	0.624	0.231	0.63	0.384	0.716	0.497
	(0.614)	(0.924)	(0.966)	(0.922)	(0.929)	(0.920)	(0.945)	(0.908)	(0.914)	(0.911)	(0.948)	(0.918)	(0.939)
Government size (Expenditures, % of GDP)	2.515**	2.592	3.396	2.793	2.901	2.617	3.205	2.708	4.801**	2.726	3.561*	2.291	3.163
	(1.249)	(2.046)	(2.122)	(2.043)	(2.036)	(2.056)	(2.093)	(2.032)	(2.254)	(2.039)	(2.101)	(2.082)	(2.090)
Constant	-5.852*	-7.042	-8.079*	-7.124	-7.580*	-7.591*	-8.455*	-6.94	-8.194*	-7.22	-8.370*	-8.934*	-10.468**
	(3.516)	(4.470)	(4.534)	(4.446)	(4.485)	(4.559)	(4.599)	(4.587)	(4.629)	(4.448)	(4.470)	(4.827)	(4.912)
Observations	371	268	268	268	268	268	268	268	268	268	268	268	268
Number of countries	27	26	26	26	26	26	26	26	26	26	26	26	26

Notes: *** p<0.01, ** p<0.05, * p<0.1 R^{NH}/Y: Non-hydrocarbon revenue; R^H/Y: Hydrocarbon revenue

Table A3: Binary probit panel with country random effects

	Dependent variable: $P(y_{it}=1)$												
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**	**(13)**
	-1.423*	-1.755**	-1.409	-2.544***	-2.445	-1.771***	-1.415	-1.574**	-1.415	-1.903**	-1.592*	-1.945*	-1.583
	(0.787)	(0.744)	(1.052)	(0.841)	(1.638)	(0.657)	(1.327)	(0.660)	(0.932)	(0.926)	(0.953)	(1.132)	(1.204)
Corruption		-0.13	-0.308										
		(0.120)	(0.236)										
$\left(R^H/Y\right)$ ×Corruption			0.828										
			(0.767)										
Voice and accountability				-0.282***	-0.296								
				(0.095)	(0.230)								
$\left(R^H/Y\right)$ ×Voice and accountability					0.091								
					(1.249)								
Rule of law						-0.18	-0.362						
						(0.148)	(0.325)						
$\left(R^H/Y\right)$ ×Rule of law							0.814						
							(1.158)						
Political stability								-0.117	-0.472**				
								(0.138)	(0.216)				
$\left(R^H/Y\right)$ ×Political stability									1.611*				
									(0.881)				
Gov. effectiveness										-0.169	-0.405**		
										(0.175)	(0.183)		
$\left(R^H/Y\right)$ ×Gov. effectiveness											1.017		
											(0.837)		
Regulatory quality												-0.233	-0.560***
												(0.148)	(0.174)
$\left(R^H/Y\right)$ ×Regulatory quality													1.297
													(0.980)
Grants (% of GDP)	-6.085	-1.123	-3.972	-0.287	-0.65	-1.064	-3.161	-3.362	-3.971	-2.153	-3.873	-3.603	-6.62
	(8.556)	(7.383)	(6.516)	(5.875)	(9.202)	(4.995)	(8.606)	(6.415)	(7.179)	(7.055)	(7.780)	(5.050)	(8.348)
Log (GDP per capita)	-0.004	-0.016	-0.01	-0.016	-0.016	-0.011	-0.004	-0.01	0.008	-0.011	-0.001	-0.015	-0.008
	(0.035)	(0.026)	(0.032)	(0.028)	(0.032)	(0.032)	(0.032)	(0.031)	(0.028)	(0.034)	(0.031)	(0.025)	(0.024)
Agriculture (% of GDP)	0.122	-0.539	-0.53	-0.737	-0.749	-0.695	-0.723	-0.71	-0.754	-0.705	-0.809	-0.936	-1.228**
	(0.985)	(0.729)	(1.138)	(0.651)	(0.573)	(0.711)	(1.365)	(0.835)	(1.232)	(0.609)	(0.990)	(0.913)	(0.487)
Openness (Imports, % of GDP)	-0.078	0.374	0.306	0.132	0.125	0.361	0.328	0.495	0.598	0.344	0.269	0.313	0.222
	(0.354)	(0.456)	(0.472)	(0.484)	(0.464)	(0.535)	(0.497)	(0.554)	(0.491)	(0.412)	(0.504)	(0.333)	(0.541)
Government size (Expenditure, % of GDP)	0.853	1.09	1.459	1.529	1.528	1.229	1.564	0.898	1.664	1.191	1.617	1.191	1.637
	(1.124)	(1.409)	(1.705)	(1.168)	(1.241)	(1.683)	(1.923)	(1.049)	(1.481)	(1.632)	(1.213)	(1.799)	(1.497)
Constant	0.079	-0.03	-0.266	-0.059	-0.07	-0.138	-0.387	-0.084	-0.647	-0.049	-0.319	0.02	-0.215
	(0.526)	(0.563)	(0.701)	(0.489)	(0.491)	(0.737)	(0.793)	(0.518)	(0.610)	(0.730)	(0.539)	(0.603)	(0.519)
Observations	371	268	268	268	268	268	268	268	268	268	268	268	268
Number of countries	27	26	26	26	26	26	26	26	26	26	26	26	26

Notes: *** p<0.01, ** p<0.05, * p<0.1 R^{NH}/Y: Non-hydrocarbon revenue; R^H/Y: Hydrocarbon revenue